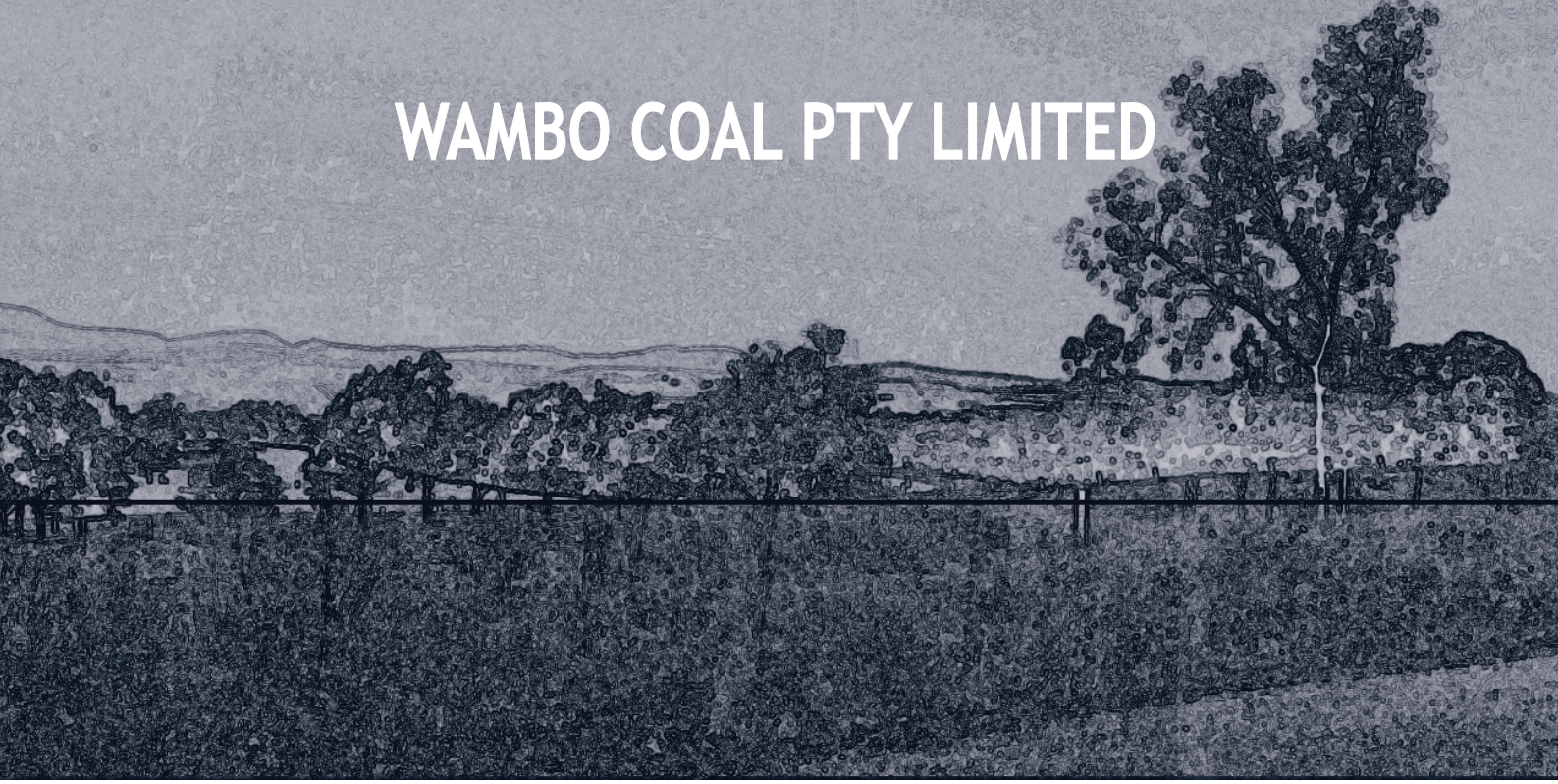


WAMBO COAL PTY LIMITED

SOUTH WAMBO UNDERGROUND MINE MODIFICATION

ENVIRONMENTAL ASSESSMENT

APPENDIX D

Flora Assessment

Peabody ENERGY

FLORASEARCH

South Wambo Underground Mine Modification - Flora Assessment



Prepared for Wambo Coal Pty Limited
by FloraSearch

March 2016

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EXECUTIVE SUMMARY

Flora Survey Findings

Flora Communities and Species

- This report collates data from 51 flora quadrats and 139 spot samples conducted on the Modification area in 2002, 2010, 2011, 2012, 2014 and 2015. Specific field surveys for this report were undertaken over 7 days in April and 6 days in December 2012, and 3 days in December 2015.
- The Study area was found to support remnants of thirteen vegetation communities comprising vegetation typical of the central Hunter Valley.
- A total of 462 flora species has been identified on the Modification area, of which 362 (78.4%) are native and 100 (21.6%) are introduced.
- The plant families with the highest numbers of species (Appendix A) were the Grasses, Poaceae (76 taxa); Daisies, Asteraceae (58 taxa); Pea Flowers, subfamily Faboideae (24 species); the Eucalypts and related genera in the family Myrtaceae (19 species), the Wattles, subfamily Mimosoideae (17 species), the Sidas and Lantern Bushes, Malvaceae (16 species) and the sedges, Cyperaceae (16 species). In all, some 87 plant families and sub-families were represented.
- The highest proportions of introduced species and weeds were in River Oak Riparian Woodland (53.6%) and Derived Grassland (49.6%). Weed levels were very low in areas of less disturbed natural communities.

Condition of the Vegetation

- The vegetation over the less disturbed parts of the Study area with continuous natural woodlands is assessed as being in excellent condition. The cleared derived grasslands are considered to be in poor condition.

Threatened Species

- No threatened flora species listed in the Schedules of the New South Wales (NSW) *Threatened Species Conservation Act, 1995* (TSC Act), or the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) were identified by the surveys.
- However, there are records of the Slaty Red Gum (*Eucalyptus glaucina*), listed as Vulnerable under the TSC and EPBC Acts, on the Modification area in the NSW Atlas of Wildlife. It is considered these records may represent misidentifications or misplaced georeferences.

Endangered Populations

- The surveys identified members of three endangered populations (EPs) on the Study area, *viz*.:
  - *Acacia pendula* population in the Hunter Catchment;
  - *Eucalyptus camaldulensis* population in the Hunter Catchment; and
  - *Cymbidium canaliculatum* population in the Hunter Catchment.

Threatened Ecological Communities

- Two Critically Endangered Ecological Communities (CEECs) listed in the Schedules of the EPBC Act occurs on the Study area (Table 4), *viz.:*
  - *Central Hunter Valley Eucalypt Forest and Woodland*.
  - *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley*.
- Six Endangered Ecological Communities (EECs) listed in the Schedules of the TSC Act occur within the Study area (Table 4), *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; and*
  - *Warkworth Sands Woodland in the Sydney Basin Bioregion.*
- One Vulnerable Ecological Community (VEC) listed in the schedules of the TSC Act occurs within the Study area (Table 4), *viz.:*
  - *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion.*

Conclusions of the Assessment

Potential Impacts of the Modification on Flora

- Potential impacts of the Modification on flora fall broadly into two categories:
  - impacts due to subsidence of the land surface, which include soil cracking, ponding of water, and bedrock cracking in streambeds leading to potential diversion of surface water flows to sub-surface fracture networks, and
  - impacts due to vegetation clearance and/or disturbance for surface infrastructure.
- Predictions of subsidence heights and tilts using modelling by the Incremental Profile Method have shown that the Modification would result in a decrease in the height of vertical subsidence and tilt compared with the mine layout approved in 2004 (Mine Subsidence Engineering Consultants [MSEC], 2016). The decreases in subsidence and tilt indicate the Modification has less potential for adverse impacts at the surface than the approved layout.
- Mine subsidence effects on the surface associated with the Modification, are expected to vary slightly according to the depth of cover above the coal seam and surface features such as steep narrow ridge lines. Surface cracking of soils may potentially occur over most of the lower flat areas within the Modification, however would likely be less prevalent as depth of cover increases towards the southern escarpment.

- Cracking of soils following past extraction of the Whybrow and Wambo seams within the Modification area at shallower depths of cover has produced no observable changes to vegetation condition or the health of individual plants.
- The Subsidence Assessment prepared for the Modification indicates an increase in the area of 'topographic depressions' would occur, potentially leading to increased ponding of water on the surface which may result in vegetation death in ponded areas. Increased ponding is also expected to occur on Wambo Creek, North Wambo Creek and Stony Creek which may adversely impact riparian vegetation. However, the amount of ponding is expected to be lower for the Modification than the approved arrangement.
- Subsidence modelling also indicates there is potential for cracking of shallow soils or bedrock to occur in the beds of the major creeks. This cracking has the potential to divert water flows to lower strata in the sedimentary rocks, reducing surface flows, which may have adverse effects on riparian vegetation along sections of the creeks.
- Overall, it is considered unlikely that vegetation on the Study area would be adversely affected by soil cracking due to mine subsidence. However, some woodland areas may be affected by ponding and minor effects to riparian vegetation may occur along the major creeks. Importantly these impacts are likely to be less for the Modification than for the existing approved arrangement.
- The Modification would result in small additional losses of native vegetation for surface infrastructure above those allowed in the existing approval. These additional losses total 7.9 hectares (ha), of which 4.5 ha is Derived Grassland and 3.4 ha is woody vegetation. The woody vegetation losses include 0.4 ha of the *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions Endangered Ecological Community*, 0.2 ha of *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* and 0.9 ha of the *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion Vulnerable Ecological Community*. The latter community forms part of the EPBC Act listed *Central Hunter Valley Eucalypt Forest and Woodland* CEEC.

Assessment of Significance

- Assessments of Significance were conducted to determine the impacts of the Modification on four potentially occurring threatened flora species, the White-flowered Wax Plant, *Cynanchum elegans*; the Slaty Red Gum, *Eucalyptus glaucina*; the Brown Pomaderris, *Pomaderris brunnea*, and the Illawarra Greenhood, *Pterostylis gibbosa*. The assessment indicated a significant adverse impact on the four species, if they were present, is unlikely.
- Assessments of Significance were also conducted to determine the impacts of the Modification on three EPs occurring on the Modification area; the *Eucalyptus camaldulensis population in the Hunter Catchment*, the *Acacia pendula population in the Hunter Catchment* and the *Cymbidium canaliculatum population in the Hunter Catchment*. The assessment found the Modification is unlikely to have a significant impact on the last two EPs, but that the *Eucalyptus camaldulensis population in the Hunter Catchment* would be reduced by up to 50 individuals comprising three mature trees and 47 young trees and saplings.
- Assessments of Significance were conducted to determine the impacts of the Modification on six NSW listed EECs and one NSW listed VEC that are present on the Study area. It is concluded that the Modification is unlikely to have a significant impact on the remnants of these threatened communities.

- An EPBC Act assessment of Matters of National Environmental Significance found that the Modification is unlikely to have a significant impact on four threatened flora species, the White-flowered Wax Plant (*Cynanchum elegans*), the Slaty Red Gum (*Eucalyptus glaucina*), the Brown Pomaderris (*Pomaderris brunnea*) and the Illawarra Greenhood (*Pterostylis gibbosa*) that may potentially occur on the Modification area, or on two CEECs, *Central Hunter Valley Eucalypt Forest and Woodland* and *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley*, that occur on the Modification area.

1 INTRODUCTION

FloraSearch was commissioned by Wambo Coal Pty Limited (WCPL) to conduct a flora assessment for the South Wambo Underground Mine Modification (the Modification). The existing Wambo Coal Mine is located approximately 15 kilometres (km) west of Singleton, near the village of Warkworth in the Hunter Valley, New South Wales (NSW) (Figures 1 and 2).

The Modification is a proposed realignment and extension to underground coal mining operations at the Wambo Coal Mine and related additional surface infrastructure and activities that are necessary to support the extension of underground mining. The general arrangement of the Modification is shown on Figure 3, including the extents of additional underground mining areas (Areas 1 to Area 3) and the extent of the infrastructure area extension, new access road and mine ventilation infrastructure.

The Modification would involve a realignment and extension/relocation of the approved South Wambo (Arrowfield Seam) Underground Mine longwall panels and mining of the Woodlands Hill Seam, rather than the Bowfield Seam. The rearrangement of the South Wambo Underground Mine would require a minor extension of the approved surface development area (Figure 3) and result in an extension of the approved mine life by 7 years (i.e. to 2032).

The underground mine Run of Mine (ROM) coal production rate would increase from 7.5 to 9.75 million tonnes per annum (Mtpa). The approved total ROM coal production rate (i.e. 14.7 Mtpa) would remain unchanged.

The Modification would not involve changes to any aspects of the approved North Wambo Underground Mine or South Bates Underground Mine.

The Modification would also include an extension of approved open cut mining operations by 3 years (i.e. up to and including 2020). The Modification would not include any change to the approved total open cut ROM coal production limit.

The Modification would use existing infrastructure associated with previously approved mining activities at the Wambo Coal Mine including the existing Coal Handling and Processing Plant, Wambo Coal Terminal, access roads, administration block, bathhouse, workshops, water storages and associated infrastructure. Five mine ventilation shafts and associated infrastructure (including four shafts additional to the one currently approved shaft) would be developed to support underground mining activities within the additional underground mining areas.

Further detail in regard to the Modification is provided in the South Wambo Underground Mine Modification Environmental Assessment main text.

1.1 SURVEY AND ASSESSMENT OBJECTIVES

The objectives of the survey and assessment were to:

- review existing flora information and mapping relevant to the Study area;
- sample the natural vegetation on the Study area (Section 1.2) using standard flora survey techniques (NSW Department of Environment and Conservation [DEC], 2004);
- determine and map the vegetation communities present within the Study area;
- compile a plant species list for each vegetation community, including collation of records from previous flora surveys within the same area;
- 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 Commonwealth *Environment Protection and Biodiversity Conservation Act*, *1999* (EPBC Act) that could potentially occur in the Study area;
- conduct targeted searches for potentially occurring threatened plant species, populations, communities and critical habitat, and map any occurrences;
- analyse the potential impacts of the proposed Modification on flora and their habitats; and
- assess the impact of the Modification on threatened flora according to the former Part 3A of the NSW *Environmental Planning and Assessment Act, 1979* and by consideration of the factors of assessment in the *Guidelines for Threatened Species Assessment* (DEC and NSW Department of Primary Industries [DPI], 2005) and against the federal assessment guidelines under the EPBC Act.

1.2 STUDY AREA

The Modification would involve a realignment and extension/relocation of the approved South Wambo (Arrowfield Seam) Underground Mine longwall panels and mining of the Woodlands Hill Seam rather than the Bowfield Seam. Longwall mining areas associated with the Modification are detailed below:

- **Area 1 (Woodlands Hill Seam)** – The modified mine layout includes additional longwall panels in the Woodlands Hill Seam beneath the approved Surface Development Area.
- **Area 2 (Arrowfield Seam and Woodlands Hill Seam)** – The modified mine layout includes a reorientation and minor extension of the approved Arrowfield Seam mine layout in Area 2. The Woodlands Hill Seam is proposed to replace the Bowfield Seam in this location with a reorientation and minor extension to the approved mine layout.
- **Area 3 (Arrowfield Seam and Woodlands Hill Seam)** – The modified mine layout includes an extension of mining in the Arrowfield Seam and Woodlands Hill Seam into Area 3, comprising three longwall panels in the Arrowfield Seam and four longwall panels in the Woodlands Hill Seam.

- **Area 4 (Approved Arrowfield Seam)** – The Modification does not propose any changes to the approved Arrowfield Seam mine layout to the east of Wollombi Brook. The approved Bowfield Seam mine layout is no longer proposed to be mined in Area 4 and therefore there would be a reduction in subsidence impacts in Area 4.

The modified layout of the Wambo Coal Mine is shown on Figure 3.

The Modification area encompasses the extent of conventional subsidence resulting from the modified longwall layout and the surface development areas (Figure 3).

Subsidence effects resulting from longwall mining the Arrowfield and Bowfield Seams in Area 4 were approved as part of the *Wambo Development Project Environmental Impact Statement* (WCPL, 2003). The modified subsidence impacts in Area 4 are predicted to reduce as only the Arrowfield Seam is proposed to be mined as part of the Modification (Mine Subsidence Engineering Consultants [MSEC], 2016). The potential impacts on agricultural resources in Area 4 are therefore also expected to reduce as a result of the Modification and therefore this assessment has not considered Area 4 any further.

Based on the above, the Study area has been adopted as the focus of this assessment and includes the surface development areas, the extent of subsidence from Areas 1, 2 and 3 and surrounds.

The surface area that is located above the proposed longwalls (would be subject to subsidence impacts as a result of the Modification) that has not been previously affected by mining (underground or open cut) and has not been previously approved is around 185 hectares (ha) (MSEC, 2016). Approximately 21 ha within the Modification area would be subject to surface disturbance, of which 7.9 ha is additional surface disturbance being assessed under this Modification (i.e. in addition to approved surface disturbance).

1.3 REGIONAL SETTING

The Wambo Coal Mine 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).

Rugged and densely forested lands of the Narrabeen sandstone–dominated Yengo and Wollemi National Parks occur to the south and west of the Study area, reaching altitudes of some 600 to 700 m. The Liverpool and Mount Royal Ranges, which rise to altitudes in excess of 1,100 m, occur to the north. The valley floor is broad, relatively flat and low, being only 40 m altitude at Singleton. Adjacent to major watercourses, such as the Hunter and Goulburn Rivers and Wollombi Brook, are extensive flat floodplains. These adjoin more extensive gently undulating lands that rise gradually 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 STUDY AREA AND SURROUNDS

1.4.1 Topography and Drainage

The Study area lies immediately to the north of Wollemi National Park and adjoins Wollombi Brook to the east (Figure 3). Wollombi Brook traverses a low flood plain, descending 11 m (67 m Australian Height Datum [AHD] in the south to 56 m in the north) over a distance of approximately 10 km. Wambo Creek and North Wambo Creek drain the Study area to Wollombi Brook (Figure 2). The highest altitudes (approximately 300 m) are in the west of the Study area below the escarpment adjacent to Wollemi National Park. Stony Creek (approximately 200 m AHD in the valley floor where it enters the Study area) drains the escarpment to Wambo Creek via an initially deep steep-sided valley between the escarpment and a south-easterly trending sandstone ridge (approximately 236 m AHD at its highest point).

North east of the sandstone ridge flanking the north side of Stony Creek, the naturally vegetated lands slope towards North Wambo Creek. The northern footslopes of the ridge form a parallel series of gently descending secondary ridges separated by drainage lines with the land becoming relatively flat where it borders the North Wambo Creek, with elevations between approximately 75 and 100 m AHD along the creek. The naturally vegetated lands in the south of the Study area also slope in a north easterly direction from the footslopes of the escarpment (approximately 160 m AHD) to flatter terrain along Wollombi Brook (approximately 55 m AHD).

1.4.2 Geology, Geomorphology and Soils

The Study 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 Study area includes remnants of Triassic Narrabeen series sandstone overlying the Permian sediments.

Kovac and Lawrie (1991) define five Soil Landscapes in the Study area and surrounds; the Bulga, Benjang, Lees Pinch, Warkworth and Wollombi Soil Landscapes:

- **Bulga.** The Bulga 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 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 valley floors and lower slopes adjacent to Wambo Creek, North Wambo Creek and Wollombi Brook. 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 steeper side ridges and mid slopes below the escarpments in the south and west of the Study area. It is developed in the Singleton 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 sandstone ridge tops in the south and west of the Study 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 the Narrabeen Group 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 soloths in breaks of slope; grey soloths in midslope areas and yellow podzolic soils and earthy sands on some upper slopes.
- **Wollombi.** The Wollombi Soil Landscape comprises small areas of alluvial soils along Wollombi Brook in the north east of the Study area. The soil landscape comprises active flood plains and levee banks up to 20 m above the river channel. The soils are loose black to brown loamy sands or sandy loams over deeper sandy clays and sands or sandy loams. The sands are derived from Narrabeen group sandstones.
- **Warkworth.** The Warkworth Soil Landscape is limited to the north east of the Study area where it occurs as low dune deposits, one to three metres high, on old river terraces beside Wollombi Brook. The dune deposits comprise wind-blown sand (aeolian) from sand bars within Wollombi Brook. The soils are loose bright brown loamy sand becoming orange at depth.

1.4.3 Climate

The Study area experiences a temperate climate with warm summers and no dry season (Sahukar *et al*., 2003). Significant rainfall may occur at any time of the year, although it is higher in summer on average. Relative humidities are comparatively high and do not vary greatly through the year, reflecting the near coastal location of the Study area. Frosts are common in winter.

1.4.4 Land Use

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 most of the Study area for farming would date from this time. A great variety of crops was grown in the Hunter Valley in the 1800s, including wine grapes, which date from 1823 and continue to be a major industry. Currently, the main agricultural industries in the region include beef cattle, dairying and horse studs. 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 the 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.

Much of the land within the western parts of the Study area comprises forest and woodland that has been set aside by WCPL as part of the Remnant Woodland Enhancement Program area for the Wambo Development Project. This land is now managed for biodiversity conservation, including exclusion of livestock grazing and surface disturbance, the closure and rehabilitation of unnecessary tracks and weed control.

1.5 BOTANICAL/BIOGEOGRAPHIC REGIONS

The Study 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, 1990-2002). 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, 1990-2002).

The intrusion of the Hunter Valley through the Great Dividing Range forms, in combination with the vast sandstone areas to the south, a critical biogeographical barrier for 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 Valley 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, 1990-2002) extends into the Hunter Valley almost as far as Singleton where it abuts the southern end of the North Coast Botanical Division.

The Study area lies just within the North Coast Botanical Division close to the junction of the North and Central Coast Botanical Divisions. Botanically therefore, the Study area can be expected to comprise a mix of Central Western Slopes and both 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 documented the flora of the central parts of the valley, including the Study area. 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 (2010, 2012, 2014, 2015) which included parts of the current Study area. An updated vegetation classification for the Hunter Valley has been produced by Stage 2 of the Hunter and Central Coast Regional Environmental Management Strategy (Somerville 2009). The BioMetric Vegetation Types (BVT) database (NSW Office of Environment and Heritage [OEH] 2012, 2016a) lists vegetation communities recognised for each Catchment Management Authority (CMA) (now Local Land Services [LLS]) region in NSW. The NSW Vegetation Information System includes a database of accepted Plant Community Types (PCT) used in the BioBanking credit calculator (OEH, 2016a).

For various reasons, the circumscription and naming of vegetation communities varies between studies and databases, which can create confusion in community identification. Understandably, regional studies specific to the area of interest tend to provide community descriptions that best match those on the Study area. For this reason, the Central Hunter vegetation classification of Peake (2006) best fits the Study area.

Hunter Remnant Vegetation Project **(Peake, 2006)**

The flora of the central parts of the Hunter Valley, including the Study area, has been documented and mapped by Peake (2006). Peake's report presents the findings of the Hunter Remnant Vegetation Project coordinated by the former Hunter-Central Rivers CMA (now Hunter LLS). In addition to conducting new survey work, the report incorporated data from previous surveys of the region.

Hunter, Central and Lower North Coast Vegetation Classification and Mapping Project **(Somerville, 2009)**

The *Hunter, Central and Lower North Coast Vegetation Classification and Mapping Project* (Somerville, 2009) incorporated data from many previous smaller scale surveys and new data into a regional vegetation classification analysis for the whole Hunter Valley, as well as the Central and Lower North Coasts. This study renamed, reclassified or merged many of Peake's (2006) central Hunter Valley communities with others across the wider region.

BioMetric Vegetation Types Database **(OEH, 2012)**

The BioMetric Vegetation Types Database lists the BVTs considered to occur in each CMA (LLS) region in NSW. This classification was developed for Property Vegetation Planning under the NSW *Native Vegetation Act 2003*, but has also been used more widely as a vegetation classification for environmental assessment. This report uses the 2012 version of the BVT database which is no longer available on the OEH website. BVTs have now been incorporated in the OEH Vegetation Information System (OEH, 2016a) and many new BVTs have been added. However, the documentation of the new BVTs is often very incomplete making the revised database ambiguous and difficult to use.

Plant Community Types Database **(OEH, 2016a)**

The Plant Community Types Database lists PCTs recognised by the OEH for BioBanking assessments (OEH, 2016a).

The vegetation communities occurring on the Study area are summarised in Table 1, along with the equivalent BVTs (OEH, 2012).

Table 1.
Vegetation Communities on the Study Area and Equivalent BioMetric Vegetation Types (OEH, 2012)

Landscape Position	Formation (Keith, 2004)	Class (Keith, 2004)	This Report			Nearest BVT (OEH, 2012)	
			Community	Community Name	Scientific Name	No.	Community Name
Riparian / Floodplain	Forested Wetlands	Eastern Riverine Forests	1	River Oak riparian woodland	*Casuarina cunninghamiana* subsp. *cunninghamiana*	HU598	River Oak riparian woodland of the North Coast and northern Sydney Basin
		Coastal Floodplain Wetlands	2	Forest Red Gum lowland forest	*Eucalyptus tereticornis –Eucalyptus crebra – Angophora floribunda*	HU544	Forest Red Gum - Grey Gum dry open forest on hills of the lower Hunter Valley, Sydney Basin
	Grassy Woodlands	Coastal Valley Grassy Woodlands	3	River Red Gum woodland	*Eucalyptus camaldulensis*	HU599	River Red Gum - Yellow Box riparian woodland in the Hunter Valley
Steep sheltered slopes	Rainforests	Dry Rainforests	4	Rusty Fig – Native Quince – Native Olive dry rainforest	*Ficus rubiginosa –Alectryon subcinereus– Notelaea microcarpa* var. *microcarpa*	HU578	Native Olive - Rusty Fig semi-evergreen vine thicket of the upper Hunter Valley, Sydney Basin
Steeper slopes	Grassy Woodlands	Coastal Valley Grassy Woodlands	5	Spotted Gum – Narrow-leaved Ironbark – Grey Box woodland	*Corymbia maculata – E. crebra – Eucalyptus moluccana*	HU556	Grey Ironbark - Spotted Gum - Grey Box open forest on hills of the Hunter Valley, Sydney Basin
Lower slopes and flats			6	Narrow-leaved Ironbark – Grey Box woodland	*Eucalyptus crebra – Eucalyptus moluccana — Allocasuarina luehmannii*	HU551	Grey Box - Narrow-leaved Ironbark shrubby woodland on hills of the Hunter Valley, North Coast and Sydney Basin
			7	Bull Oak grassy woodland	*A. luehmannii*	HU668	Bull Oak Forests of the Central Hunter Valley
			8	Weeping Myall Woodland	*Acacia pendula*	HU652	Weeping Myall - Coobah - Scrub Wilga shrubland of the Hunter Valley
Sandstone valleys	Dry Sclerophyll Forests (shrub/grass subformation)	Hunter-Macleay Dry Sclerophyll Forests	9	Sandstone riparian shrub forest	*E. punctata – A. floribunda – Eucalyptus acmenoides*	-	N/A
Flats with impeded drainage			10	Melaleuca decora low forest	*Melaleuca decora*	HU564	Melaleuca decora low forest of the central Hunter Valley, Sydney Basin
Steeper slopes (stony soils)	Dry Sclerophyll Forests (shrubby subformation)	Western Slopes Dry Sclerophyll Forests	11	Grey Box - Slaty Box woodland	*E. moluccana — Eucalyptus dawsonii*	HU618	Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin
Sandy dunes and flats		Sydney Sand Flats Dry Sclerophyll Forests	12	Rough-barked Apple - Coast Banksia woodland	*A. floribunda – Banksia integrifolia* subsp. *integrifolia*	HU600	Rough-barked Apple - Coast Banksia shrubby woodland on Warkworth Sands of the central Hunter Valley, Sydney Basin
Lower slopes and flats	Grasslands	Coastal Valley Grassy Woodlands	13	Derived Grassland	*Bothriochloa decipiens – Cynodon dactylon – Aristida personata*	HU670	Derived grasslands in Coastal Valleys

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 Study area were derived by consulting the following sources:

- BioNet website incorporating searches of the databases of the Atlas of NSW Wildlife, Royal Botanic Gardens and Domain Trust, Forests NSW and the Australian Museum (BioNet 2016).
- Protected Matters Search Tool (Commonwealth Department of the Environment 2016a).
- Schedules of the TSC Act and the EPBC Act.
- Preliminary and Final Determinations of the NSW Scientific Committee.
- Hunter Remnant Vegetation Project (Peake, 2006).
- Reports of previous flora surveys conducted on the Study area and surrounds (Orchid Research 2003, FloraSearch 2010, 2011, 2012, 2014, 2015).

Database searches were conducted within a 40 × 40 km square centred on the Study area. The databases were accessed in January 2016.

2.1 THREATENED FLORA SPECIES

Table 2 shows 19 threatened plant species listed in the Schedules of the TSC Act and the EPBC Act that were returned by the database searches and are considered possible occurrences within the Study area or surrounds. Table 2 assesses the likelihood of each threatened species occurring on the Study area by comparing their known habitats with those present within the Study area. Based on these considerations, four of these species were specifically targeted during the surveys conducted for this study, namely:

- White-flowered Wax Plant, *Cynanchum elegans*, listed as Endangered under both the TSC Act and EPBC Act;
- Slaty Red Gum, *Eucalyptus glaucina*, listed as Vulnerable under both the TSC Act and EPBC Act;
- Brown Pomaderris, *Pomaderris brunnea*, listed as Endangered under the TSC Act and Vulnerable under the EPBC Act; and
- Illawarra Greenhood, *Pterostylis gibbosa*, listed as Endangered under both the TSC Act and EPBC Act.

Of the threatened species selected for targeted searches, one is a vine, one is a tree, one is a shrub and one is an herb. The presence of the tree, shrub and vine 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 herb depends on flowering time and seasonal conditions. Plants of the herb would not grow at all, much less flower, in very dry conditions and may not be detectable.

2.2 THREATENED POPULATIONS

Twenty-nine endangered populations are currently (January 2016) listed in Schedule 1 of the TSC Act. Three of the populations may potentially occur on the Study area (Table 3), viz.:

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

Table 3 discusses the likelihood of these three populations being represented in the Study 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				
Allocasuarina glareicola	-	E	E	The known distribution is restricted to the Cumberland Plain west of Sydney, principally in the Richmond area, but with an outlying population found at Voyager Point, Liverpool (OEH, 2016b). This species was returned by the DotE (2016a) Protected Matters Search Tool. No records close to the Study 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, 2016b).	Nil	No
Asperula asthenes	Trailing Woodruff	V	V	Occurs only in NSW in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens/Wallis Lakes area (OEH, 2016b). Not known from the central or upper Hunter Valley.	Occurs in damp sites in coastal wet sclerophyll forests, often along river banks (OEH, 2016b). Similar habitats are absent from the Study area.	Nil	No
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	The Leafless Tongue Orchid was indicated as potentially occurring in the search area by the Department of the Environment (DotE) (2016a) Protected Matters Search Tool. However, no records were returned for the search area by BioNet (2016).	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. The Leafless Tongue Orchid is not considered further here.	Nil	No
Cynanchum elegans	White-flowered Wax Plant	E	E	From the coast to the escarpment of the Great Dividing Range. Wollongong to Queensland border (OEH 2016b).	Mainly in rainforest, but also occasionally in woodland (OEH, 2016b). The nearest records are deep within Wollemi National Park to the south-west of the Study area, where it is likely to occur in sandstone gully rainforest. Dry rainforest occurs along Stony Creek within the Study area.	Medium	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				
Darwinia biflora	-	V	V	Recorded in Ku-ring-gai, Hornsby, Baulkham Hills and Ryde local government areas. The northern, southern, eastern and western limits of the range are at Maroota, North Ryde, Cowan and Kellyville, respectively (OEH, 2016b). The known distribution is well to the south of the Study area.	Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include *Eucalyptus haemastoma, Corymbia gummifera* and/or *E. squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath (OEH, 2016b). These habitats do not occur on the Study area.	Nil	No
Dillwynia tenuifolia	-	V	-	The core distribution is the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee (OEH, 2016b). 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 (2016) search returned a record south of Bulga.	In western Sydney, may be locally abundant in scrubby/dry heath in Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays and in transitional areas with Castlereagh Scribbly Gum Woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone (OEH, 2016b). These habitats are absent from the Study area.	Nil	No
Diuris tricolor	Pine Donkey Orchid	V	-	Sporadically distributed from northern Victoria, the western slopes of NSW, where it extends from south of Narrandera to southern Queensland, and into the Hunter Valley as far east as Muswellbrook (OEH, 2016b).	The Pine Donkey Orchid grows in sclerophyll forest among grass, often with White Cypress Pine, *Callitris glaucophylla*. It is found in non-alluvial sandy soils, either on flats or small rises (OEH, 2016b). Suitable sandy soils and White Cypress Pine are absent from 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				
Eucalyptus fracta	Broken Back Ironbark	V	-	Confined largely to State Forest. Locally common but restricted to the northern Broken Back Range near Cessnock, NSW (OEH, 2016b).	The dominant tree in a narrow band along the upper edge of a sandstone escarpment. Occurs in dry eucalypt woodland in shallow soils. Associated species in slightly deeper soils include *Eucalyptus sparsifolia, E. maculata, Corymbia maculata* and *Angophora euryphylla* (OEH, 2016b). These habitats do not occur on the Study area.	Nil	No
Eucalyptus glaucina	Slaty Red Gum	V	V	From Broke to Taree and the Casino district (OEH, 2016b). There are several records within the BioNet (2016) search area, including within the Study area (Figure 6).	On deep, fertile soils in river valleys (OEH, 2016b).	High	Yes
Euphrasia arguta	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, Barrington Tops and the Hastings River after being thought extinct (OEH, 2016b).	Habitats include grassy areas beside rivers (Barker, 1992) and grassy forests (DotE, 2016b). This species prefers higher altitude areas of the Tablelands and upper slopes on relatively fertile soils. It is highly unlikely to occur on the Study area.	Nil	No
Olearia cordata	-	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, 2016b). There are several records within the BioNet (2016) search area to the south and south west of the Study area.	Dry sclerophyll forest and woodland on sandstone. Wiseman's Ferry to Wollombi. Grows in dry open sclerophyll forest and open shrubland, on sandstone plateaux (OEH, 2016b). Suitable habitat is absent from 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				
Pelargonium sp. *striatellum* (G.W. Carr 10345)	Omeo Storks-bill	E	E	The Omeo Storks-bill is a newly recognised species, so far only known in NSW from the Southern Tablelands (OEH, 2016b).	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, 2016b). Such habitat is absent from the Study area.	Nil	No
Pomaderris brunnea	Brown Pomaderris	E	V	Distributed in limited areas around the Colo, Nepean and Hawkesbury Rivers, and in the Capertee – Iford area. It also occurs near Walcha on the New England tablelands and in far eastern Gippsland in Victoria (OEH, 2016b).	Occurs on active alluvium. Active alluvium is present in the watercourse of Stony Creek.	Low	Yes
Prasophyllum petilum	Tarengo Leek Orchid	E	E	Known from five sites in NSW; Boorowa, Captains Flat, Ilford, Delegate and a newly recognised population approximately10 km south east of Muswellbrook. It also occurs at Hall in the Australian Capital Territory (OEH, 2016b).	Grows in open sites in Natural Temperate Grassland (Boorowa, Delegate), in grassy woodland in association with River Tussock *Poa labillardieri*, Black Gum *Eucalyptus aggregata* and Teatrees *Leptospermum* spp. (Captains Flat), in Kangaroo Grass under Box-Gum Woodland (Ilford, Hall). Highly susceptible to grazing, being retained only at little-grazed travelling stock reserves (Boorowa, Delegate) and in cemeteries (Captains Flat, Ilford, Hall) (OEH, 2016b). Suitable lightly grazed grassy areas are absent from the Study area.	Nil	No
Prasophyllum sp. Wybong (C. Phelps ORG 5269)	A Leek Orchid	-	CE	This taxon is now regarded as synonymous with *Prasophyllum petilum* (see above) (DotE, 2016b).	-	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				
Prostanthera cryptandroides subsp. *cryptandroides*	Wollemi Mint-bush	V	V	Occurs in the Cullen Bullen to Glen Davis area north of Lithgow; in the north of Wollemi National Park and to the west of Denman (BioNet, 2016).	The habitat is open forest on soils derived from Narrabeen Group sediments on talus slopes, amongst sandstone pagodas or on rocky ridgelines in the Cullen Bullen – Glen Davis area, and in open forest and heath associations on sandstone ridges and plateaux west of Denman and in the north of Wollemi National Park (OEH, 2016b). The Study area does not have Narrabeen Sandstone soils, plateaux or pagodas.	Nil	No
Pterostylis gibbosa	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 (OEH, 2016b).	Grows in woodland dominated by Forest Red Gum, *Eucalyptus tereticornis;* Woollybutt, *Eragrostis laniflora*; Honeymyrtle, *Melaleuca decora,* or open forest of Spotted Gum, *Corymbia maculata;* Forest Red Gum and Grey Ironbark, *Eucalyptus paniculata*. In the Hunter region, it grows in open woodland dominated by Narrow-leaved Ironbark, *Eucalyptus crebra*; Forest Red Gum and Black Cypress Pine, *Callitris endlicheri* (OEH, 2016b). Several of these tree species occur on the Study area.	Low	Yes
Thesium australe	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, 2016).	It is largely confined to grasslands, grassy woodlands or sub-alpine grassy heathlands (OEH, 2016b). Austral Toad-flax is usually hemiparasitic on Kangaroo Grass, but may associate less frequently with *Poa* spp. It is highly unlikely to occur on the Study area.	Nil	No
Wollemia nobilis	Wollemi Pine	CE	E	Restricted to a few small occurrences in the west of Wollemi National Park. This species was not returned in the BioNet (2016) search, but was returned as potentially occurring by the DotE (2016a) Protected Matters Search Tool.	Found only in deep sandstone gorges (OEH, 2016b) in the west of Wollemi National Park.	Nil	No

[1] Threatened flora species conservation status under the TSC Act and/or EPBC Act (current at January 2016).

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

Table 3.
Threatened Flora Populations Listed under the TSC Act with Potential to Occur on the Study Area

Scientific Name	Common Name	Status[1]	Likelihood of Occurrence	Comment
Acacia pendula population in the Hunter catchment	Weeping Myall	E	High	Weeping Myall, *Acacia pendula* 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; Bell and Driscoll 2014). Hunter Valley populations also rarely flower, have not been observed to produce seed and multiply vegetatively forming clonal colonies. Several known sites of Hunter Valley Weeping Myall occur quite close to the Study area (BioNet, 2016; FloraSearch 2014) on WCPL-owned land. 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 Study area, respectively (BioNet, 2016). Potential habitat occurs in the Study area.
Cymbidium canaliculatum population in the Hunter catchment	Tiger Orchid	E	High	Tiger Orchid, *Cymbidium canalicultatum* is a large epiphytic orchid that grows in the forks of tree branches, mainly eucalypts, but also Rough-barked Apple, *Angophora floribunda* and Cooba, *Acacia salicina*. A small population (as few as 90 colonies) in the Hunter Valley is at the south eastern extremity of the species' range (OEH, 2016b). It has been identified to the east of the Study area on WCPL-owned land in the Wallaby Scrub (BioNet, 2016) and is known at two other locations on WCPL mining leases. Suitable hosts and habitat occur within the Study area.
Diuris tricolor population in the Muswellbrook local government area	Pine Donkey Orchid	E	Nil	The Study area is not in the Muswellbrook Local Government Area (LGA), even though the database search area may have intruded into it. Therefore this population is not relevant to the Modification.
Eucalyptus camaldulensis population in the Hunter catchment	River Red Gum	E	High	River Red Gum, *E. camaldulensis* occurs as a disjunct population on the major floodplains of the Hunter River and its large tributaries, including Wollombi Brook and the Goulburn River (OEH, 2016b). A significant population occurs on alluvial flood terraces beside Wollombi Brook immediately to the east of the Study area (BioNet, 2016) on WCPL-owned land (Figure 6), and along the Hunter River to the north. Small areas of suitable floodplain occur in the north east of the Study area.

[1] Threatened flora population conservation status under the TSC Act (current at January 2016).

E – Endangered. CE – Critically Endangered

2.3 THREATENED ECOLOGICAL COMMUNITIES

Twenty eight threatened ecological communities (TEC) listed under the TSC Act were returned by the BioNet Atlas of NSW Wildlife database search and five TECs listed under the EPBC Act were returned by the Commonwealth Protected Matters Search Tool. Most of these communities have not been recorded in the central Hunter Valley (Peake, 2006) or in the vicinity of the Study area (Orchid Research, 2003; FloraSearch, 2010, 2011, 2012, 2014, 2015). Many of them are known only in near coastal habitats, close to Sydney or in sandstone plateaux environments. The TECs considered most likely to occur on or near the Study area are listed below and described briefly in Table 4.

Two Critically Endangered Ecological Communities (CEEC) listed in the Schedules of the EPBC Act are known or considered likely to occur on the Study area (Table 4), *viz.:*

- *Central Hunter Valley Eucalypt Forest and Woodland*.
- *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley*.

Six Endangered Ecological Communities (EECs) listed in the Schedules of the TSC Act are considered likely occurrences within the Study area (Table 4), *viz.:*

- *Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions;*[1]
- *Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions*[1]*;*
- *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.*[2]
- *Warkworth Sands Woodland in the Sydney Basin Bioregion.*

One Vulnerable Ecological Community (VEC) listed in the Schedules of the TSC Act is considered likely to occur within the Study area (Table 4), *viz*.:

- *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion.*[1]

2.4 CRITICAL HABITAT

No Critical Habitat for flora has been declared on or near the Study area under the TSC Act (OEH, 2016c) or the EPBC Act (DotE, 2016c).

[1] This community is equivalent to the *Central Hunter Valley Eucalypt Forest* and *Woodland* CEEC listed under the EPBC Act.
[2] This community is equivalent to the *Hunter Valley Weeping Myall* (*Acacia pendula*) *Woodland* CEEC under the EPBC Act.

Table 4.
Threatened Ecological Communities with Potential to Occur on the Study Area

Community Name	Conservation Status[1]		Dominant Species	Known Distribution	Potential Habitats	Likelihood of Occurrence
	TSC Act	EPBC Act				
Central Hunter Grey Box - Ironbark Woodland	E	-	*Eucalyptus crebra – Brachychiton populneus – Eucalyptus moluccana*	Singleton to Muswellbrook area of the Central Hunter Valley (OEH, 2016b).	Gently undulating hills, slopes and valleys, occasionally on rocky knolls, Permian lithology (OEH, 2016b).	High
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	E	-	*E. crebra – Corymbia maculata – E. moluccana*	Mainly Maitland to Muswellbrook in the central Hunter Valley (OEH, 2016b).	Undulating terrain on low rises and slopes. Permian clays and colluvium and alluvium in valleys (OEH, 2016b).	High
Central Hunter Valley Eucalypt Forest and Woodland	-	CE	*E. crebra – C. maculata - Eucalyptus dawsonii - E. moluccana*	Mainly in the Hunter Valley Interim Biogeographic Regionalisation for Australia (IBRA) subregion. Also in adjacent subregions for example, the Kerrabee IBRA subregion and the Upper Hunter IBRA subregion (OEH, 2016b).	Soils derived from Permian sedimentary rocks found on the valley floors, lower hillslopes and low ridges (OEH, 2016b).	High
Hunter Floodplain Red Gum Woodland	E	-	*Eucalyptus camaldulensis – Eucalyptus tereticornis – Eucalyptus melliodora – Angophora floribunda*	Hunter Valley including LGAs of Maitland, Mid-Western, Muswellbrook, Singleton, and Upper Hunter (OEH, 2016b).	Major floodplains and floodplain rises (OEH, 2016b). Major floodplains occur in the north east of the Study area.	High
Hunter Lowland Redgum Forest	E	-	*E. tereticornis – Eucalyptus punctata ± E. moluccana, Angophora costata, C. maculata* or *E. crebra*	Hunter Valley LGAs of Maitland, Cessnock, Port Stephens, Muswellbrook and Singleton (OEH, 2016b).	Gently sloping depressions and drainage flats of the Hunter Valley floor (OEH, 2016b).	High
Hunter Valley Weeping Myall Woodland	E	CE	*Acacia pendula – E. crebra – Acacia salicina*	Singleton and Muswellbrook LGAs in the central Hunter Valley (OEH, 2016b).	Occurs on heavy Permian clay soils (OEH, 2016b). There are two known occurrences close to the Study area; Jerrys Plains cemetery and within the Study area on WCPL owned land.	High

Table 4. (Continued)
Threatened Ecological Communities with Potential to Occur on the Study Area

Community Name	Conservation Status[1]		Dominant Species	Known Distribution	Potential Habitats	Likelihood of Occurrence
	TSC Act	EPBC Act				
Warkworth Sands Woodland	E	-	*A. floribunda – Banksia integrifolia*	Limited to the Warkworth area in the Singleton LGA of the central Hunter Valley (OEH, 2016b).	Restricted to aeolian sand deposits along Wollombi Brook, north and south of Warkworth (OEH, 2016b). An area of suitable soils occurs in the north east of the Study area.	High
White Box - Yellow Box - Blakely's Red Gum Woodland	E	CE	*Eucalyptus albens – E. melliodora – Eucalyptus blakelyi*	Tablelands and western slopes of NSW and the upper Hunter Valley (OEH, 2016b).	Deep fertile soils on undulating terrain (OEH, 2016b). Occurs on the footslopes of the Narrabeen Sandstone escarpments of the upper Hunter Valley. Occurrences of Yellow Box and Blakely's Red Gum within or close to the Study area are generally considered to be components of other communities (Peake, 2006), e.g. Hunter Floodplain Red Gum Woodland, Warkworth Sands Woodland.	Nil
Hunter Valley Footslopes Slaty Gum Woodland	V	-	*E. dawsonii – E. moluccana ± A. salicina, Allocasuarina luehmannii*	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, 2016b).	Occurs mainly on colluvium derived from Triassic sandstones and conglomerates over Permian lithology (OEH, 2016b). Suitable environments occur in the Study area.	High

[1] Threatened flora species conservation status under the TSC Act and/or EPBC Act (current at January 2016).

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

3 METHODS

The flora of most of the current Study area has been surveyed as part of previous applications for underground mining approvals (Orchid Research, 2003; FloraSearch, 2010, 2011, 2012, 2014, 2015) (Table 5). Data from the previous surveys is collated herein with additional survey work to fill any gaps in coverage. Specific field surveys for this report were undertaken over 7 days in April (3 to 5 and 16 to 19) and 6 days in December (4 to 9) 2012, and 3 days in December (4 to 9) 2015.

Table 5.
Previous Flora Sampling by Year, Project and Numbers of Samples

Year	Project	No. quadrats	No. spot samples	Reference
2002	Wambo Development Project	7	116	Orchid Research (2003)
2010	Curtilage Open Cut	3	7	FloraSearch (2010)
2011	North Wambo Underground	6	11	FloraSearch (2012)
2012	South Wambo Modification	18	0	This report
2014	Longwall 10a Modification	4	0	FloraSearch (2014)
2015a	South Bates Modification	2	0	FloraSearch (2015)
2015b	South Wambo Modification	11	0	This report
Total		**51**	**134**	

3.1 VEGETATION SAMPLING

Two methods of documenting the vegetation were employed; quadrat sampling and rapid assessment spot sampling. These methods are detailed in Sections 3.1.1 and 3.1.2, respectively. Figure 4 shows the locations of quadrat sample sites and spot sample sites.

3.1.1 Quadrat Sampling

A total of fifty one 20 × 20 m (0.04 hectare [ha]) flora quadrat sites were sampled over the Study area between 2002 and 2015 (as per DEC, 2004) (Figure 4). Twenty nine of the sites were specifically sampled for this Modification. 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 Braun-Blanquet scale (Table 6). 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 7).

Table 6.
Modified Braun-Blanquet Cover Abundance Rating Scale (as used since 2012)

Rating	Percent Ground Cover	Rating	Percent Ground Cover
1	<5, rare (< 3 individuals)	5	6 to 25
2	<5, uncommon	6	26 to 50
3	<5, common	7	51 to 75
4	<5, abundant	8	76 to 100

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, 139 rapid assessment spot samples were conducted (Figure 4), all prior to 2012 (Table 7). 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.

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 (OEH, 2016b) and the Commonwealth DotE (DotE, 2016b), as well as on the website of the Royal Botanic Gardens and Domain Trust Sydney (RBGDT, 2016).

The species and populations targeted are those considered to have some likelihood of occurring on the Study area as assessed in Tables 2 and 3. Random meanders of approximately 30 minutes duration were conducted by a team of two people walking approximately 10 m apart from each bushland quadrat site, during the post 2010 surveys.

3.2 VEGETATION MAPPING

The approximate distribution of each vegetation community was mapped onto colour aerial photos of the Study area during the field work. The field mapping was later refined by air photo interpretation using high resolution aerial photography in the office and cross-referenced to the large number of rapid assessment spot sample and quadrat sites.

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 opportunistically during random meanders or 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 Royal Botanic Gardens and Domain Trust, Sydney.

Table 7.
Sampling Effort Stratified by Vegetation Communities

Community Number (this study)	Community Name (this study)	Quadrat Numbers							Spot Sample Numbers		
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]	2002[1]	2010[2]	2011[3]
1	River Oak riparian woodland								C16		2, 3, 4
2	Forest Red Gum lowland forest	34, 41	1, 2, 3	2		2			S (7, 8, 23, 32, 42, 44, 47, 48, 58); C (48, 73)	4	1, 6, 7
3	River Red Gum woodland										
4	Rusty Fig – Native Quince – Native Olive dry rainforest							9			
5	Spotted Gum – Narrow-leaved Ironbark – Grey Box – woodland	35, 36, 37			4, 6, 9, 18		14	4	S (5, 6, 9, 10-18, 24, 27, 31, 33, 36, 45, 49, 52-54); C53		
6	Narrow-leaved Ironbark – Grey Box woodland	38		1, 6	1, 2, 3, 5, 7, 8, 10, 11, 12, 15			1, 2, 7, 8	S (2-4, 6a, 19-22, 25, 26, 28-30, 34, 35, 37-42, 46, 56; C (1-3, 6-8, 14, 20-26, 30, 31, 34-37, 40, 41, 49, 50, 56, 57, 61, 62, 64, 65, 74-78)	5, 7	8
7	Bull Oak grassy woodland			3		1			S1; C (15, 17, 18, 28, 29)		
8	Weeping Myall Woodland							3	C27		
9	Sandstone riparian shrub forest							5, 6	C (38, 39, 51, 52, 55)		
10	Melaleuca decora low forest			4					C13		
11	Grey Box - Slaty Box woodland	42		5	16, 17		13		C (4, 5, 9, 10-12, 42, 58-60, 63, 70, 79)		10
12	Rough-barked Apple - Coast Banksia woodland										
13	Derived Grassland				13, 14	3, 4		10, 11		1, 2, 3, 8	5, 9, 11

[1] Orchid Research (2003).
[2] FloraSearch (2010).
[3] FloraSearch (2011).
[4] This report
[5] FloraSearch (2014).
[6] FloraSearch (2015).

3.4 VEGETATION CONDITION ASSESSMENT

Native vegetation condition varies 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 across the Study area similar to those generated by methodologies such as BioMetric (Gibbons *et al.,* 2005) or BioBanking (OEH, 2016d). 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 OVERVIEW

The Study area supports a high diversity of central Hunter Valley vegetation from the floodplain of Wollombi Brook to the steep colluvial slopes below the Narrabeen Sandstone escarpment flanking the south side of the valley. Thirteen vegetation communities occur on the Study area (Table 1); their distributions shown on Figure 4. The distributions of their equivalent TECs are shown on Figure 5. The vegetation varies considerably in condition from extensive cleared grasslands through fragmented woodlands to extensive continuous woodland areas still supporting most of the original flora diversity.

A small part of the Study area in the north east impinges on the Wollombi Brook floodplain, which has been cleared historically of most of its tree cover in this area. Here the flood channels have remnant stands of River Red Gum (*Eucalyptus camaldulensis*) and Forest Red Gum (*Eucalyptus tereticornis*) (Community 3). The lowlands of the Wambo Creek and North Wambo Creek valleys formerly supported tall forests dominated by Forest Red Gum (Community 2) with a mid storey of Honeymyrtle (*Melaleuca decora*) in areas of poor drainage. Rough-barked Apple (*Angophora floribunda*) and Grey Box (*Eucalyptus moluccana*) were also common in these areas, as was Swamp Oak (*Casuarina glauca*). The watercourses, frequently flooded sandbanks and cobble beds of Wambo Creek and North Wambo Creek host the River Oak (*Casuarina cunninghamiana*) (Community 1).

On slightly higher and drier ground, Forest Red Gum forest graded into ironbark woodlands dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) and Grey Box (Community 6), but only isolated remnants of the Forest Red Gum remain today. Lower lying areas within the Ironbark – Grey Box woodlands and broad moist lower gullies support a more or less dense mid-storey dominated by the honeymyrtle, *Melaleuca decora* (Community 10). Extensive areas of ironbark woodlands remain on the Study area, albeit mostly regeneration from past clearing. South of North Wambo Creek in the centre of the Study area, extensive patches of former ironbark woodland have dense regeneration of Bull Oak, *Allocasuarina luehmannii* (Community 7). Within the Bull Oak regeneration is possibly the largest remaining natural stand of the erect Hunter Valley form of Weeping Myall (Community 8).

Above the ironbark woodlands, the steeper stony ridges and footslopes running north-east from the Narrabeen Sandstone escarpments carry a tall open woodland dominated by Slaty Box (*Eucalyptus dawsonii*) (Community 11) in the west of the Study area. Fingers of Slaty Box woodland extend into the ironbark dominated areas on low ridges. In the west of the Study area, Slaty Box woodland extends over the ridgeline into the Stony Creek gorge. In the south of the Study area, the drier low ridges support Spotted Gum, *Corymbia maculata* (Community 5) woodland instead.

Parallel ridges running north east from the escarpment generally have an open shrubby understorey with a variety of course tussock grasses, sometimes in dense patches. The gullies between the ridges tend to support denser thickets of tall shrubs and low trees, particularly Native Olive, *Notelaea microcarpa* var. *microcarpa* with lesser amounts of Scrub Wilga, *Geijera salicifolia*; Cooba, *Acacia salicina* and Kurrajong, *Brachychiton populneus*. Native Olive is also prominent in the Slaty Box woodland south of the ridgeline on the north side of Stony Creek.

The deep gorge of Stony Creek provides habitat for plant communities requiring more sheltered conditions, including dry rainforest (Community 4) and Spotted Gum, *Corymbia maculata* sheltered forest (Community 5). A riparian community dominated by Grey Gum, *Eucalyptus punctata*; Rough-barked Apple, *Angophora floribunda*; Spotted Gum and White Mahogany, *Eucalyptus acmenoides* (Community 9) occurs along the lower reaches of Stony Creek within the Study area.

4.2 VEGETATION COMMUNITY DESCRIPTIONS

The following Tables (8 – 18) provide descriptions of eleven of the thirteen vegetation mapping units on the Study area using sample data collected in this and previous surveys on site (Appendices A and B). Two vegetation communities, River Red Gum woodland and Rough-barked Apple - Coast Banksia woodland, are not described because they occupy very small areas and were not formally sampled.

Forested Wetlands

Table 8.
Vegetation Community 1. River Oak Riparian Woodland

No. of Samples:	4 spot samples
Landscape Position:	River Oak Riparian Woodland is confined to the riparian zone and adjacent alluvial soils on the lower reaches of North Wambo Creek and parts of Wambo Creek, where it forms discontinuous strips owing to past clearing (Figure 4).
General comments:	Four rapid assessment samples were conducted in this community due to its small representation on the study area (Plate 1) and highly fragmented nature. Community 1 is highly variable across its distribution in the Hunter Valley (Peake, 2006). While River Oak, *Casuarina cunninghamiana* subsp. *cunninghamiana*, is always the dominant mid storey species it may associate with a variety of other trees.
Dominant and Characteristic Species:	
Trees:	River Oak and Forest Red Gum, *Eucalyptus tereticornis*, with Rough-barked Apple, *Angophora floribunda* as a less common associate.
Low Trees:	Common mid storey species include Cooba, *Acacia salicina*; Scrub Wilga, *Geijera salicifolia*, and Bull Oak, *Allocasuarina luehmannii*.
Shrubs:	The low native shrub Small-leaf Bluebush, *Maireana microphylla*, is present.
Vines / Creepers:	No vines or creepers were recorded.
Ground Covers:	The most common native ground cover species include 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*.
Introduced Species:	The understorey of Community 1 tends to be dominated by introduced species. These include 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*.
Equivalent BioMetric Vegetation Type:	River Oak riparian woodland of the North Coast and northern Sydney Basin (HU598) (OEH, 2012).
Equivalent NSW TEC:	Nil
Equivalent Commonwealth TEC:	Nil



Plate 1. Vegetation Community 1. River Oak Riparian Woodland

Forested Wetlands

Table 9.
Vegetation Community 2. Forest Red Gum Lowland Forest

No. of Samples:	8 quadrats, 15 spot samples
Landscape Position:	Remnants of Forest Red Gum Lowland Forest occur on a swampy area of the floodplain south of the existing WCPL administrative buildings, along the course of Stony Creek in the centre of the study area, near the confluence of North Wambo Creek and Wollombi Brook and in the south of the Study area along drainage lines (Figure 4).
General comments:	Community 2 would formerly have covered much of the cleared parts of the Study area on the floodplains of Wollombi Brook and its major tributaries (Plate 2). Most remnants are highly fragmented and heavily weed infested. The patch south of the WCPL administrative buildings is on a low area of swampy ground and is the best example of the community on the Study area.
Dominant and Characteristic Species:	
Trees:	The community is characterised by an overstorey dominated by Forest Red Gum, *Eucalyptus tereticornis*. The most common associate of Forest Red Gum along the creeks is Rough-barked Apple, *Angophora floribunda*, while Coast Grey Box, *Eucalyptus moluccana* and Narrow-leaved Ironbark, *Eucalyptus crebra*, are less common associates.
Low Trees:	The dominant low tree in the swampy area is Honeymyrtle, *Melaleuca decora*, which may form a dense low canopy below the Forest Red Gums. Other low trees or tall shrubs include Cooba, *Acacia salicina*; White Cedar, *Melia azedarach*; Native Olive, *Notelaea microcarpa* var. *microcarpa* and Scrub Wilga, *Geijera salicifolia* var. *salicifolia*.
Shrubs:	Low shrubs along the watercourses include Small leaf Bluebush, *Maireana microphylla*, which was a common, while *Bertya oleifolia* and Native Rosella, *Hibuscus heterophyllus* subsp. *heterophyllus*, were occasional.
Vines / Creepers:	No vines were recorded. The main creepers were Love Creeper, *Glycine clandestina* and Variable Glycine, *Glycine tabacina*.
Ground Covers:	Common native ground cover species include Poison Rock Fern, *Cheilanthes sieberi*; Bristly Cloak Fern, *Cheilanthes distans*; Indian Pennywort, *Centella asiatica*; Common Everlasting, *Chrysocephalum apiculatum*; Carrot Weed, *Cotula australis*; Spreading Sneezeweed, *Centipeda minima*; Red Berry Saltbush, *Einadia hastata*; Climbing Saltbush, *Einadia nutans subsp. linifolia*; Kidney Weed, *Dichondra repens*; Slender Tick-trefoil, *Desmodium varians*; Trailing Speedwell, *Veronica plebeia*; Water Pepper, *Persicaria hydropiper*, and Amulla, *Eremophila debilis*. Rushes and grasses are common and include Slender Flat-sedge, *Cyperus gracilis*; Knob Sedge, *Carex inversa*; Couch, *Cynodon dactylon*; Speargrass, *Austrostipa scabra*; Slender Bamboo Grass, *Austrostipa verticillata*; Plump Windmill Grass, *Chloris ventricosa*; Barbwire Grass, *Cymbopogon refractus;* Windmill Grass, *Enteropogon acicularis*; Brown's Lovegrass, *Eragrostis brownii*; Paddock Lovegrass, *Eragrostis leptostachya* and Weeping Grass, *Microlaena stipoides*, among many others.
Introduced Species:	Introduced species are common and include African Olive, *Olea europaea subsp. cuspidata*; Galenia, *Galenia pubescens*; Pavonia, *Pavonia hastata*; 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*; Creeping Pear, *Opuntia humifusa*; 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 bonariensis* and Pale Pigeon Grass, *Setaria pumila*, among many others.
Equivalent BioMetric Vegetation Type:	Forest Red Gum – Grey Gum dry open forest on hills of the lower Hunter Valley, Sydney Basin.(HU544) (OEH, 2012)
Equivalent NSW TEC:	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC.
Equivalent Commonwealth TEC:	Nil



Plate 2. Vegetation Community 2. Forest Red Gum Lowland Forest

Rainforests

Table 10.
Vegetation Community 4. Rusty Fig – Native Quince – Native Olive Dry Rainforest

No. of Samples:	1 quadrat
Landscape Position:	A small area of Community 4 occupies the valley floor of a steep tributary of Stony Creek and an adjoining steep south facing lower slope in the extreme west of the Study area (Figure 4).
General comments:	Dry rainforest in sandstone gullies occurs extensively in Wollemi National Park to the south and west of the Study area, but is largely absent from the Study area itself (Plate 3).
Dominant and Characteristic Species:	
Trees:	The dominant tree is Brush Bloodwood, *Baloghia inophylla*, with some Lilly Pilly, *Acmena smithii*.
Low Trees:	A diversity of low trees is scattered throughout including Red Olive-berry, *Elaeodendron australe*; Black Plum, *Diospyros australis*; Grey Myrtle, *Backhousia myrtifolia*; Native Olive, *Notelaea microcarpa*; Native Frangipani, *Hymenosporum flavum* and Native Quince, *Alectryon subcinereus*.
Shrubs:	Low shrubs include Native Holly, *Alchornea ilicifolia*; Native Rosella, *Hibiscus heterophyllus*; Cockspur Thorn, *Maclura cochinchinensis*; Coffee Bush, *Breynia oblongifolia* and Orange Thorn, *Pittosporum multiflorum*.
Vines / Creepers:	Vines are common and include Gum Vine, *Aphanopetalum resinosum*; Downy Milk Vine, *Marsdenia pleiadenia*; Wonga Wonga Vine, *Pandorea pandorana*; Headache Vine, *Clematis glycinoides*; Water Vine, *Cissus Antarctica* and Three-leaved Water Vine, *Tetrastigma nitens*.
Ground Covers:	The ground cover is very sparse, comprising mainly scattered clumps of ferns; Common Maidenhair, *Adiantum aethiopicum*; Giant Maidenhair, *Adiantum formosum*; Rough Maidenhair Fern, *Adiantum hispidulum* and a Sickle Fern, *Pellaea paradoxa*.
Introduced Species:	No introduced species were recorded.
Equivalent BioMetric Vegetation Type:	Native Olive – Rusty Fig semi-evergreen vine thicket of the upper Hunter Valley, Sydney Basin (HU578) (OEH, 2012).
Equivalent NSW TEC:	Nil
Equivalent Commonwealth TEC:	Nil



Plate 3. Vegetation Community 4. Rusty Fig – Native Quince – Native Olive Dry Rainforest



Plate 4. Vegetation Community 5. Spotted Gum – Narrow-leaved Ironbark – Grey Box Woodland



Plate 5. Vegetation Community 6. Narrow-leaved Ironbark – Grey Box Woodland

Grassy Woodlands

Table 11.
Vegetation Community 5. Spotted Gum – Narrow-leaved Ironbark – Grey Box Woodland

No. of Samples:	7 quadrats, 22 spot samples
Landscape Position:	Community 5 has two distinct areas of occurrence within the Study area; one on the lower slopes within the Stony Creek gorge and the second on footslopes and ridges below the escarpment in the south of the Study area (Figure 4, Plate 4).
General comments:	The two occurrences of Community 5 occupy different geomorphological settings which influence community structure and composition. The Stony Creek occurrence is sheltered within the creek gorge and experiences greater shading and moister conditions than the southern occurrence which is on more open terrain having greater exposure to the sun and drier conditions. These two variants correspond to two different vegetation communities recognised by Peake (2006); viz. MU21 '*Southern Hunter Footslopes Sheltered Forest*' for the Stony Creek occurrence and MU12 '*Southern Hunter Escarpment Spotted Gum Woodland*' for the southern occurrence.
Dominant and Characteristic Species:	
Trees:	Community 5 is defined by the dominant presence of Spotted Gum, *Corymbia maculata*. Associated trees may include Narrow-leaved Ironbark, *Eucalyptus crebra*; Grey Gum, *Eucalyptus punctata* and Grey Box, *Eucalyptus moluccana*.
Low Trees:	Low trees include Bulga Wattle, *Acacia bulgaensis*; Coast Myall, *Acacia binervia*; Hickory Wattle, *Acacia implexa*; Cooba, *Acacia salicina*; Bull Oak, *Allocasuarina luehmannii*; Native Olive, *Notelaea microcarpa*; Shiny-leaved Canthium, *Psydrax odorata*; Brush Wilga, *Geijera salicifolia*; Kurrajong, *Brachychiton populneus*; Black Cypress Pine, *Callitris endlicheri* and White Cedar, *Melia azedarach*.
Shrubs:	The main shrubs include Sticky Daisy-bush, *Olearia elliptica*; Rice Flower, *Ozothamnus diosmifolius*; Urn-heath, *Melichrus urceolatus*; Narrow-leaved Orangebark, *Denhamia sylvestris*; Blunt Beard-heath, *Leucopogon muticus*; Spiny Bush-pea, *Pultenaea spinosa*; Fan Wattle, *Acacia amblygona*; Coffee Bush, *Breynia oblongifolia*; Blackthorn, *Bursaria spinosa*; *Grevillea montana*; Narrow-leaved Geebung, *Persoonia linearis*; White Sour-bush, *Choretrum candollei*; Wedge-leaf Hopbush, *Dodonaea viscosa* subsp. *cuneata* and *Macrozamia reducta*.
Vines / Creepers:	Vines are uncommon and include Wonga Wonga Vine, *Pandorea pandorana*; Headache Vine, *Clematis glycinoides*; Native Grape, *Cayratia clematidea* and Pepper Vine, *Clematocissus opaca*. Creepers are more frequent including Red-berry Saltbush, *Einadia hastata*; Purple Coral Pea, *Hardenbergia violacea*; Love Creeper, *Glycine clandestina* and Variable Glycine, *Glycine tabacina*.
Ground Covers:	The ground cover is relatively sparse, commonly including Bristly Cloak Fern, *Cheilanthes distans*; Poison Rock Fern, *Cheilanthes sieberi*; Blue Trumpet, *Brunoniella australis*; Slender Plantain, *Plantago debilis*; Kidney Weed, *Dichondra repens*; Slender Tick-trefoil, *Desmodium gunnii*; Corrugated Sida, *Sida corrugata*; Common Saw-sedge, *Gahnia aspera*; Wattle Mat-rush, *Lomandra filiformis* subsp. *filiformis*; Blue Flax-lily, *Dianella caerulea* var. *caerulea*; Spreading Flax-lily, *Dianella revoluta*; Purple Wire-grass, *Aristida personata*; Threeawn Speargrass, *Aristida vagans*; Speargrass, *Austrostipa scabra*; Barbwire Grass, *Cymbopogon refractus*; Wiry Panic, *Entolasia stricta*; Basket Grass, *Oplismenus imbecillis*; Hairy Panic, *Panicum effusum*; *Paspalidium distans* and Slender Rat's Tail Grass, *Sporobolus creber.*
Introduced Species:	Introduced species are relatively uncommon owing to the undisturbed condition of most remnants on the Study area. The most commonly encountered introduced species were Narrow-leaved Cotton Bush, *Gomphocarpus fruticosus* and Common Prickly Pear, *Opuntia stricta*.
Nearest BioMetric Vegetation Type:	Grey Ironbark - Spotted Gum - Grey Box open forest on hills of the Hunter Valley, Sydney Basin (HU556) (OEH, 2012). This BVT equates to MU27 of Peake (2006) and is closest to Peake's MU12 discussed above in the general comments. There are no BVTs directly equivalent to Peake's MU12 or MU21. [Note also that Grey Ironbark (*Eucalyptus paniculata*) does not occur in MU27 and is not mentioned in the profile of HU556 in OEH (2012)].
Equivalent NSW TEC:	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions EEC.
Equivalent Commonwealth TEC:	Central Hunter Valley Eucalypt Forest and Woodland CEEC.

Grassy Woodlands

Table 12.
Vegetation Community 6. Narrow-leaved Ironbark – Grey Box Woodland

No. of Samples:	17 quadrats, 56 spot samples
Landscape Position:	Community 6 dominates the flat non-floodplain areas of the valley floor and the adjoining gently undulating lower slopes and ridges (Figure 4, Plate 5).
General comments:	Community 6 is the most extensive vegetation type on the Study area. On low flat areas it forms an open forest with sparse low shrubs and groundcover. Shrub size and density tend to increase on sloping sites and in upper gullies. Broad low drainage lines within the community support more or less dense stands of Honeymyrtle, *Melaleuca decora*, (Community 10) where drainage is impeded.
Dominant and Characteristic Species:	
Trees:	Community 5 is dominated by Narrow-leaved Ironbark, *Eucalyptus crebra* and Grey Box, *Eucalyptus moluccana*.
Low Trees:	The most common low tree is Bull Oak, *Allocasuarina luehmannii*. Other frequent low trees include Cooba, *Acacia salicina*; Native Olive, *Notelaea microcarpa* and Brush Wilga, *Geijera salicifolia*.
Shrubs:	The main shrubs include Sticky Daisy-bush, *Olearia elliptica*; Small-leaf Bluebush, *Maireana microphylla*; Fan Wattle, *Acacia amblygona*; Bead Bush, *Spartothamnella juncea*; Blackthorn, *Bursaria spinosa*; Wedge-leaf Hopbush, *Dodonaea viscosa subsp. cuneata*; Western Boobialla, *Myoporum montanum* and Violet Nightshade, *Solanum brownii*.
Vines / Creepers:	Vines are absent from Community 6. Creepers include Climbing Saltbush, *Einadia nutans subsp. linifolia*; Love Creeper, *Glycine clandestina* and Variable Glycine, *Glycine tabacina*.
Ground Covers:	The ground cover is relatively sparse but very diverse, commonly including Bristly Cloak Fern, *Cheilanthes distans*; Poison Rock Fern, *Cheilanthes sieberi*; Blue Trumpet, *Brunoniella australis*; Pink Tongues, *Rostellularia adscendens*; Lemon Beauty-heads, *Calocephalus citreus*; Purple Burr-daisy, *Calotis cuneifolia*; Yellow Burr-daisy, *Calotis lappulacea*; Common Everlasting, *Chrysocephalum apiculatum*; Cobbler's Tack, *Glossocardia bidens*; Australian Bluebell, *Wahlenbergia gracilis*; Red Berry Saltbush, *Einadia hastata*; Wingless Bluebush, *Maireana enchylaenoides*; Slender Plantain, *Plantago debilis*; Kidney Weed, *Dichondra repens*; Large Tick-trefoil, *Desmodium brachypodum*; Slender Tick-trefoil, *Desmodium gunnii*; Trailing Speedwell, *Veronica plebeia*; Common Woodruff, *Asperula conferta*; Amulla, *Eremophila debilis*; Slender Flat-sedge, *Cyperus gracilis*; Common Fringe-sedge, *Fimbristylis dichotoma*; Wattle Mat-rush, *Lomandra filiformis* subsp. *filiformis*; Many-flowered Mat-rush, *Lomandra multiflora*; Blue Flax-lily, *Dianella caerulea* var. *caerulea*; Spreading Flax-lily, *Dianella revoluta*; Purple Wire-grass, *Aristida personata*; Threeawn Speargrass, *Aristida vagans*; Speargrass, *Austrostipa scabra*; Red Grass, *Bothriochloa decipiens*; Plump Windmill Grass, *Chloris ventricosa*; Barbwire Grass, *Cymbopogon refractus*; Paddock Lovegrass, *Eragrostis leptostachya*; Weeping Grass, *Microlaena stipoides*; Hairy Panic, *Panicum effusum*; *Paspalidium distans*; A Wallaby Grass, *Rytidosperma racemosum var. obtusatum* and Slender Rat's Tail Grass, *Sporobolus creber.*
Introduced Species:	Introduced species are relatively common in the more disturbed parts of this community on the flat valley floor. The most commonly encountered introduced species were Spear Thistle, *Cirsium vulgare*; various Fleabanes, *Conyza* spp.; Catsear, *Hypochaeris radicata*; Fireweed, *Senecio madagascariensis*; Common Sowthistle, *Sonchus oleraceus* and Common Prickly Pear, *Opuntia stricta*.
Nearest BioMetric Vegetation Type:	Grey Box - Narrow-leaved Ironbark shrubby woodland on hills of the Hunter Valley, North Coast and Sydney Basin (HU551) (OEH, 2012).
Equivalent NSW TEC:	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC.
Equivalent Commonwealth TEC:	Central Hunter Valley Eucalypt Forest and Woodland CEEC.

Grassy Woodlands

Table 13.
Vegetation Community 7. Bull Oak Grassy Woodland

No. of Samples:	2 quadrats, 6 spot samples
Landscape Position:	This vegetation community occurs mainly on flat terrain to the south of North Wambo Creek, in semi-cleared country to the south of Wambo Creek with some smaller patches in the north east of the Study area (Figure 4, Plate 6).
General comments:	Community 7 is considered to be a derived community following clearing of Community 6 (Peake, 2006). Bull Oak is a colonising species that readily increases in cleared paddocks, if grazing is withdrawn. It forms pure stands, often with little or no shrub layer and minimal ground cover, except in open areas.
Dominant and Characteristic Species:	
Trees:	The dominant tree species is Bull Oak, *Allocasuarina luehmannii*. Narrow-leaved Ironbark, *Eucalyptus crebra* and Grey Box, *Eucalyptus moluccana*, may occur as regeneration or occasional remnant mature trees.
Low Trees:	Apart from Bull Oak, the only other low tree recorded was Native Olive, *Notelaea microcarpa*.
Shrubs:	Broom Bitter Pea, *Daviesia genistifolia* may be prominent in openings. Other shrubs may include Fan Wattle, *Acacia amblygona*; Sticky Daisy-bush, *Olearia elliptica* and Rice Flower, *Ozothamnus diosmifolius*.
Vines / Creepers:	Vines are absent from this community. Creepers include Climbing Saltbush, *Einadia nutans subsp. nutans*; Love Creeper, *Glycine clandestina* and Variable Glycine, *Glycine tabacina*.
Ground Covers:	Native ground cover is often relatively sparse and comprises mainly coarse native grasses and scattered soft herbs. Poison Rock Fern, *Cheilanthes sieberi,* may be common. Herbs include Blue Trumpet, *Brunoniella australis*; Lemon Beauty Heads, *Calocephalus citreus*; Common Everlasting, *Chrysocephalum apiculatum*; Cobblers Tack, *Glossocardia bidens*; Slender Tick-trefoil, *Desmodium varians*; Creeping Mint, *Mentha satureoides*; Corrugated Sida, *Sida corrugata*; Trailing Speedwell, *Veronica plebeia* and Amulla, *Eremophila debilis*. Sedges, rushes and grasses mainly include Common Fringe-sedge, *Fimbristylis dichotoma*; Many-flowered Mat-rush, *Lomandra multiflora*; Purple Wiregrass, *Aristida personata*; Threeawn Speargrass, *Aristida vagans*; Red Grass, *Bothriochloa decipiens*; Plump Windmill Grass, *Chloris ventricosa*; Umbrella Grass, *Digitaria divaricatissima*; Curly Windmill Grass, *Enteropogon acicularis*; Clustered Lovegrass, *Eragrostis elongata*; Wallaby Grass, *Rytidosperma fulvum* and Slender Rat's Tail Grass, *Sporobolus creber*.
Introduced Species:	Introduced species are uncommon in this community; the more frequently encountered species include Catsear, *Hypochaeris radicata*; Fireweed, *Senecio madagascariensis*; Scarlet Pimpernel, *Anagallis arvensis*; Lamb's Tongue, *Plantago lanceolata* and Pale Pigeon Grass, *Setaria pumila*.
Equivalent BioMetric Vegetation Type:	Bull Oak Forests of the Central Hunter Valley (HU668) (OEH, 2012).
Equivalent NSW TEC:	Nil
Equivalent Commonwealth TEC:	Nil



Plate 6. Vegetation Community 7. Bull Oak Grassy Woodland

Grassy Woodlands

Table 14.
Vegetation Community 8. Weeping Myall Woodland

No. of Samples:	1 quadrat, 1 spot sample
Landscape Position:	This vegetation community occurs on gently sloping terrain close to North Wambo Creek, Wambo Creek and Wollombi Brook, with a fourth cluster of remnants on a hillside north of Wambo Creek (Figure 4).
General comments:	Remnants of Community 8 occur in six broad areas in cleared parts of the Study area. In most cases the remnants are either associated with, or close to, patches of Communities 6 and 7. The largest patch adjoins the eastern end of the North Wambo Creek diversion and is regarded as one of the best remaining examples of Hunter Valley Weeping Myall Woodland (OEH, 2013). It is the only patch that is considered large enough to represent the threatened community (Plate 7). The remaining patches comprise small groups of stems that likely represent clusters of genetically identical root suckers from the same parent. The smaller patches are discussed as part of the '*Acacia pendula population in the Hunter Catchment*' Endangered Population below (Section 4.6.1, Figure 6).
Dominant and Characteristic Species:	
Trees:	Narrow-leaved Ironbarks, *Eucalyptus crebra*, occur as emergent overstorey trees.
Low Trees:	The defining tree of Community 8 is the erect Hunter Valley form of Weeping Myall, *Acacia pendula*. Other low trees are Cooba, *Acacia salicina*; Native Olive, *Notelaea microcarpa* and Bull Oak, *Allocasuarina luehmannii*.
Shrubs:	Shrubs include Creeping Saltbush, *Atriplex semibaccata*; Ruby Saltbush, *Enchylaena tomentosa*; Small-leaf Bluebush, *Maireana microphylla*; Straggly lantern Bush, *Abutilon oxycarpum* and Violet Nightshade, *Solanum brownii*.
Vines / Creepers:	Vines are absent from this community. Creepers include only Climbing Saltbush, *Einadia nutans* subsp*. linifolia*.
Ground Covers:	Native ground cover is relatively sparse and comprises mainly Bristly Cloak Fern, *Cheilanthes distans*; Blue Trumpet, *Brunoniella australis*; two species of Fuzzweed, *Vittadinia muelleri* and *V. pustulata*; Red Berry Saltbush, *Einadia hastata*; Kidney Weed, *Dichondra repens*; Spiked Sida, *Sida hackettiana*; Slender Plantain, *Plantain debilis* and Amulla, *Eremophila debilis*. Sedges, rushes and grasses mainly include Slender Flat-sedge, *Cyperus gracilis*; Threeawn Speargrass, *Aristida vagans*; Speargrass, *Austrostipa scabra*; Plump Windmill Grass, *Chloris ventricosa*; Barbwire Grass, *Cymbopogon refractus*; Curly Windmill Grass, *Enteropogon acicularis*; Slender Panic, *Paspalidium gracile*; Wallaby Grass, *Rytidosperma bipartitum* and Slender Rat's Tail Grass, *Sporobolus creber*.
Introduced Species:	Introduced species are relatively common in this community owing to the highly disturbed nature of its habitat. The most common species are Galenia, *Galenia pubescens*; Narrow-leaved Cotton Bush, *Gomphocarpus fruticosus*; Spear Thistle, *Cirsium vulgare*; Fireweed, *Senecio madagascariensis* and Paddy's Lucerne, *Sida rhombifolia*.
Equivalent BioMetric Vegetation Type:	Weeping Myall – Coobah – Scrub Wilga shrubland of the Hunter Valley (HU652) (OEH; 2012).
Equivalent Threatened Ecological Community:	Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC*.*
Equivalent Commonwealth TEC:	Hunter Valley Weeping Myall (*Acacia pendula*) Woodland CEEC.



Plate 7. Vegetation Community 8. Weeping Myall Woodland



Plate 8. Vegetation Community 9. Sandstone Riparian Shrub Forest



Plate 9. Vegetation Community 10. *Melaleuca decora* Low Forest

Dry Sclerophyll Forests

Table 15.
Vegetation Community 9. Sandstone Riparian Shrub Forest

No. of Samples:	2 quadrats, 5 spot samples
Landscape Position:	This vegetation community occurs on the banks of Stony Creek in the western part of the Study area (Figure 4).
General comments:	Community 9 forms a narrow strip along Stony Creek (Plate 8). It includes a variety of trees and shrubs found only on the deep moist soils of the creek bank mixed with those of the surrounding communities. In places the shrubs may form dense thickets. The habitat supports species with rainforest affinities with some small rainforest-like patches present.
Dominant and Characteristic Species:	
Trees:	Trees tend to be diverse owing to the varied conditions along different sections of the creek. The presence of Rough-barked Apple, *Angophora floribunda*; White Mahogany, *Eucalyptus acmenoides* and Grey Gum, *Eucalyptus punctata*, where suitable, define this community. Also prominent are Narrow-leaved Ironbark, *Eucalyptus crebra*; Spotted Gum, *Corymbia maculata* and Grey Box, *Eucalyptus moluccana*.
Low Trees:	Community 9 includes a variety of low trees with wet forest and rainforest affinities, including Bulga Wattle, *Acacia bulgaensis*; Green Wattle, *Acacia irrorata* subsp. *irrorata*; Gosford Wattle, *Acacia prominens*; Brush Kurrajong, *Commersonia fraseri*; White Cedar, *Melia azedarach*; Sandpaper Fig, *Ficus coronata*; Port Jackson Fig, *Ficus rubiginosa*; Cheese Tree, *Glochidion ferdinandii*; Native Frangipani, *Hymenoporum flavum*; Native Olive, *Notelaea microcarpa* and Native Quince, *Alectryon subcinereus*. Other prominent species are Kurrajong, *Brachychiton populneus*; Hickory Wattle, *Acacia implexa* and Coast Wattle, *Acacia binervia*.
Shrubs:	Shrubs are varied and include most commonly a Macrozamia, *Macrozamia reducta*; Sticky Daisy-bush, *Olearia stricta*; Native Holly, *Alchornea ilicifolia*; a Bertya, *Bertya oleifolia*; Sickle Wattle, *Acacia falcata*; Kerrawang, *Commersonia dasyphylla*; Rusty Velvet-bush, *Lasiopetalum ferrugineum* var. *cordatum*; Native Rosella, *Hibiscus heterophyllus*; *Sannantha pluriflora*; Large Mock-olive, *Notelaea longifolia* f. *longifolia*; Coffee Bush, *Breynia oblongifolia*; Scrubby Spurge, *Phyllanthus gunnii*; Blackthorn, *Bursaria spinosa*; *Grevillea montana*; Narrow-leaved Geebung, *Persoonia linearis* and Curved Rice-flower, *Pimelea curviflora* var. *divergens*.
Vines / Creepers:	This community supports a variety of vines and creepers. The most prominent vines are Gum Vine, *Aphanopetalum resinosum*; Round-leaf Vine, *Legnephora moorei*; Snake Vine, *Stephania japonica*; Molucca Bramble, *Rubus moluccanus* var. *trilobus*; Native Raspberry, *Rubus parvifolius*; Headache Vine, *Clematis glycinoides* and Native Grape, *Cayratia clematidea*. Common creepers include Purple Coral Pea, *Hardenbergia violacea*; Common Devil's Twine, *Cassytha pubescens*; Wombat Berry, *Eustrephus latifolius* and Scrambling Lily, *Geitonoplesium cymosum*.
Ground Covers:	Ground covers are a mix of species from moist and dry habitats depending on the microhabitats along the creek. Common ground covers include Common Maidenhair, *Adiantum aethiopicum*; Rough Maidenhair, *Adiantum hispidulum*; Bristly Cloak Fern, *Cheilanthes distans*; Poison Rock Fern, *Cheilanthes sieberi*; Indian Weed, *Sigesbeckia orientalis* subsp. *orientalis*; Kidney Weed, *Dichondra repens*; Slender Tick-trefoil, *Desmodium gunnii*; Whiteroot, *Pratia purpurascens*; Slender Plantain, *Plantago debilis* and Trailing Speedwell, *Veronica plebeia*. Sedges, rushes and grasses mainly include Common Saw-sedge, *Gahnia aspera*; Variable Sword-sedge, *Lepidosperma laterale*; Spiny-headed Mar-rush, *Lomandra longifolia*; Stout Bamboo Grass, *Austrostipa ramosissima*; Barbwire Grass, *Cymbopogon refractus*; Couch, *Cynodon dactylon*; Bordered Panic, *Entolasia marginata*; Blady Grass, *Imperata cylindrica* and Basket Grass, *Oplismenus imbecillis*.
Introduced Species:	Introduced species are rare in this community owing to the lack of disturbance. Only two species were recorded; Narrow-leaved Cotton Bush, *Gomphocarpus fruticosus* and Common Prickly Pear, *Opuntia stricta*.
Equivalent Biometric Vegetation Type:	There is no equivalent BVT (OEH, 2012).
Equivalent NSW TEC:	Nil
Equivalent Commonwealth TEC:	Nil

Dry Sclerophyll Forests (shrub/grass subformation)

Table 16.
Vegetation Community 10. *Melaleuca decora* Low Forest

No. of Samples:	1 quadrat, 1 spot sample
Landscape Position:	This vegetation community occurs mainly near the North Wambo Creek diversion in the north west of the Study area and on the eastern and southern margins of the central water storage dam (Figure 4). The community occurs on flat terrain and broad low gullies with impeded drainage (Plate 9).
General comments:	Community 10 is characterised by the prominent presence of Honeymyrtle, *Melaleuca decora*, within areas otherwise dominated by Narrow-leaved Ironbark (Community 6) or Forest Red Gum (Community 2). Communities 6 and 10 intergrade with no sharp boundaries. Accordingly, they have many flora species in common. *M. decora* is also common within areas of Community 6 in the south of the Study area and in the patch of Community 2 south of the administration complex, although difficult to separate as a distinct community in both cases.
Dominant and Characteristic Species:	
Trees:	The dominant tree species is Narrow-leaved Ironbark, *Eucalyptus crebra*, and/or Forest Red Gum, *Eucalyptus tereticornis*, with occasional Grey Box, *Eucalyptus moluccana*.
Low Trees:	The dominant low tree is Honeymyrtle, *Melaleuca decora*. Data from adjoining areas to the west of the Study area indicates Bull Oak, *Allocasuarina luehmannii* is also prominent, while Cooba, *Acacia salicina*; Coast Myall, *Acacia binervia* and Hickory Wattle, *Acacia implexa* may be occasional (FloraSearch 2011).
Shrubs:	A prominent shrub layer is usually present, including Sticky Daisy-bush, *Olearia elliptica*; Showy Guinea Flower, *Hibbertia linearis*; Large Tick-trefoil, *Desmodium brachypodum*; occasional Sickle Wattle, *Acacia falcata*; Native Olive, *Notelaea microcarpa*; Coffee Bush, *Breynia oblongifolia*; Blackthorn, *Bursaria spinosa*; a Grevillea, *Grevillea montana*; White Sour Bush, *Choretrum candollei* and Wedge-leaf Hop-bush, *Dodonaea viscosa* subsp. *cuneata* (FloraSearch 2011).
Vines / Creepers:	Vines are not prominent in this community. The only creeper recorded was Variable Glycine, *Glycine tabacina*.
Ground Covers:	Owing to the moist conditions a high proportion of the ground surface is usually covered with forbs and grasses (FloraSearch 2011). The resurrection ferns Bristly Cloak Fern, *Cheilanthes distans*, and Poison Rock Fern, *Cheilanthes sieberi*, may be abundant. Herbs include Pink Tongues, *Rostellularia adscendens*; Cut-leaved Daisy, *Brachyscome multifidi*; Purple Burr-daisy, *Calotis cuneifolia*; Common Everlasting, *Chrysocephalum apiculatum*; Carrot Weed, *Cotula australis*; Star Cudweed, *Euchiton involucratus*; Vernonia, *Vernonia cinerea*; Fuzzweed, *Vittadinia cuneata* var. *hirsuta*; Red Berry Saltbush, *Einadia hastata*; Native Wandering Jew, *Commelina cyanea*; Kidney Weed, *Dichondra repens*; Round-leaf Goodenia, *Goodenia rotundifolia*; Spiked Sida, *Sida hackettiana*; Amulla, *Eremophila debilis* and Slender Wire Lily, *Laxmannia gracilis*. Sedges, rushes and grasses mainly include Slender Flat-sedge, *Cyperus gracilis*; Common Fringe-sedge, *Fimbristylis dichotoma*; Wattle Mat-rush, *Lomandra filiformis* subsp. *filiformis*; Blue Flax-lily, *Dianella caerulea* var. *cinerascens*; Blueberry Lily, *Dianella revoluta*; Threeawn Speargrass, *Aristida vagans*; Speargrass, *Austrostipa scabra*; Slender Bamboo Grass, *Austrostipa verticillata*; Plump Windmill Grass, *Chloris ventricosa*; Barbwire Grass, *Cymbopogon refractus*; Open Summer Grass, *Digitaria diffusa*; a Finger Grass, *Digitaria ramularis*; Wiry Panic, *Entolasia stricta*; Brown's Lovegrass, *Eragrostis brownii*; Weeping Grass, *Microlaena stipoides*; a Paspalidium, *Paspalidium distans* and Slender Rat's Tail Grass, *Sporobolus creber*.
Introduced Species:	Introduced species are more frequently encountered in this community owing to its higher moisture status and include mainly Greater Beggar's Ticks, *Bidens subalternans*; Flaxleaf Fleabane, *Conyza bonariensis*; Smooth Catsear, *Hypochaeris glabra*; Fireweed, *Senecio madagascariensis*; Common Sowthistle, *Sonchus oleraceus*; a Peppercress, *Lepidium bonariense*; Red-flowered Mallow, *Modiola caroliniana*; Paddy's Lucerne, *Sida rhombifolia*; Lamb's Tongue, *Plantago lanceolata* and Common Prickly Pear, *Opuntia stricta*.
Equivalent BioMetric Vegetation Type:	Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion (HU564) (OEH, 2012)
Equivalent NSW TEC:	Nil
Equivalent Commonwealth TEC:	Nil

Dry Sclerophyll Forests (shrubby subformation)

Table 17.
Vegetation Community 11. Grey Box – Slaty Box Woodland

No. of Samples:	6 quadrats, 14 spot samples
Landscape Position:	Community 11 occurs on steep north-facing slopes of the ridges flanking Stony Creek and on undulating hills west of the South Wambo Dam (Figure 4). Patches also occur in semi-cleared land south east of Wambo Creek (Figure 4) where it occurs on flatter terrain. It is distributed mainly on undulating to steep terrain on colluvium derived from Narrabeen Sandstone. Soils are usually dry, stony and relatively infertile and surface rock may be present (Plate 10).
General comments:	Community 11 may be dominated by large well-spaced Slaty Box trees with a sparse to dense mid storey and a generally sparse ground cover (Plate 10). Community 11 has many flora species in common with Community 6, but also has a distinctive suite of additional species adapted to dry stony soils.
Dominant and Characteristic Species:	
Trees:	The dominant tree species is Slaty Box, *Eucalyptus dawsonii*, which is often co-dominant with Narrow-leaved Ironbark, *Eucalyptus crebra* with smaller representations of Grey Box, *Eucalyptus moluccana* and occasional White Box, *Eucalyptus albens*.
Low Trees:	The main associated low trees are Bull Oak, *Allocasuarina luehmannii*; Native Olive, *Notelaea microcarpa* and Coast Myall (*Acacia binervia*). Scattered Kurrajong, *Brachychiton populneus*, may also be present.
Shrubs:	A prominent shrub layer is usually present, including mainly a Macrozamia, *Macrozamia reducta*; Cough Bush, *Cassinia quinquefaria*; Sticky Daisy-bush, *Olearia elliptica*; Small-leaf Bluebush, *Maireana microphylla*; a Bertya, *Bertya oleifolia*; Large Tick-trefoil, *Desmodium brachypodum*; Australian Indigo, *Indigofera australis*; Spiny Bush-pea, *Pultenaea spinosa*; Fan Wattle, *Acacia amblygona*; Knife-leaf Wattle, *Acacia cultriformis*; Western Silver Wattle, *Acacia decora*; Varnish Wattle, *Acacia verniciflua*; Bead Bush, *Spartothamnella juncea*; Straggly Lantern Bush, *Abutilon oxycarpum*; Hill Hibiscus, *Hibiscus sturtii* var. *sturtii*; Spiked Sida, *Sida hackettiana*; Coffee Bush, *Breynia oblongifolia*; Blackthorn, *Bursaria spinosa*; White Sour Bush, *Choretrum candollei*; Sticky Hop-bush, *Dodonaea viscosa* subsp. *mucronata* and a Nightshade, *Solanum amblymerum*.
Vines / Creepers:	Vines are not prominent in this community, although Caustic Vine, *Cynanchum viminale* subsp. *brunonianum*, is occasional. Creepers include Climbing Slatbush, *Einadia nutans* subsp. *linifolia*; Love Creeper, *Glycine clandestina* and Variable Glycine, *Glycine tabacina*.
Ground Covers:	Owing to dry soil conditions ground cover is usually sparse. The resurrection ferns Bristly Cloak Fern, *Cheilanthes distans* and Poison Rock Fern, *Cheilanthes sieberi*, may be common. Herbs include Blue Trumpet, *Brunoniella australis*; Pink Tongues, *Rostellularia adscendens*; Yellow Burr-daisy, *Calotis lappulacea*; Fuzzweed, *Vittadinia cuneata* var. *hirsuta*; Red Berry Saltbush, *Einadia hastata*; Kidney Weed, *Dichondra repens*; Native Wandering Jew, *Commelina cyanea*; Corrugated Sida, *Sida corrugata*; Slender Plantain, *Plantago debilis*; Amulla, *Eremophila debilis* and a Pimelea, *Pimelea curviflora* subsp. *divergens*. Sedges, rushes and grasses mainly include Slender Flat-sedge, *Cyperus gracilis*; Common Saw-sedge, *Gahnia aspera*; Wattle Mat-rush, *Lomandra filiformis* subsp. *filiformis*; Many-flowered Mat-rush, *Lomandra multiflora*; Blue Flax-lily, *Dianella caerulea* var. *cinerascens*; Spreading Flax-lily, *Dianella revoluta*; Hooky Grass, *Ancistrachne uncinulata*; Purple Wiregrass, *Aristida personata*; Threeawn Speargrass, *Aristida vagans*; Speargrass, *Austrostipa scabra*; Slender Bamboo Grass, *Austrostipa verticillata*; Barbwire Grass, *Cymbopogon refractus*; Hairy Panic, *Panicum effusum*; Slender Panic, *Paspalidium gracile* and Long-leaved Wallaby Grass, *Rytidosperma longifolium*.
Introduced Species:	Introduced species are rare in this community and include mainly Common Prickly Pear, *Opuntia stricta*, Fireweed, *Senecio madagascariensis* and Spiked Malvastrum, *Malvastrum americanum*.
Equivalent BioMetric Vegetation Type:	Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin (HU618) (OEH, 2016a)
Equivalent NSW TEC:	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion VEC.
Equivalent Commonwealth TEC:	Central Hunter Valley Eucalypt Forest and Woodland CEEC.



Plate 10. Vegetation Community 11. Grey Box - Slaty Box Woodland



Plate 11. Vegetation Community 13. Derived Grassland

Grasslands

Table 18.
Vegetation Community 13. Derived Grassland

No. of Samples:	6 quadrats, 7 spot samples.
Landscape Position:	This anthropogenic vegetation community occurs through much of the Study area on flatter terrain associated with the valley floors (Figure 4).
General comments:	Community 13 is dominated by native grasses with a mix of native and introduced herbs (Plate 11).
Dominant and Characteristic Species	
Trees:	The grassland includes isolated regenerating Narrow-leaved Ironbarks, *Eucalyptus crebra*.
Low Trees:	Occasional Bull Oaks, *Allocasuarina luehmannii*, occur.
Shrubs:	The only native shrubs recorded were low numbers of Small-leaf Bluebush, *Maireana microphylla* and Spiked Sida, *Sida hackettiana*.
Vines / Creepers:	No vines or creepers were recorded.
Ground Covers:	The ground cover was dominated by the native grasses including Red Grass, *Bothriochloa decipiens*; Purple Wiregrass, *Aristida personata*; Weeping Grass, *Microlaena stipoides*; Barbwire Grass, *Cymbopogon refractus* and Couch, *Cynodon dactylon*. Other common native grasses were Slender Bamboo Grass, *Austrostipa verticillata*; Umbrella Grass, *Digitaria divaricatissima*; Hairy Panic, *Panicum effusum* and Slender Rat's Tail Grass, *Sporobolus creber*. The main native forbs were Poison Rock Fern, *Cheilanthes sieberi*; Common Everlasting, *Chrysocephalum apiculatum*; Carrot Weed, *Cotula australis*; Blue Storksbill, *Erodium crinitum* and an Oxalis, *Oxalis radicosa*.
Introduced Species:	Introduced species were common in this community, although not dominant, and included Narrow-leaved Cotton Bush, *Gomphocarpus fruticosus*; Greater Beggar's Ticks, *Bidens pilosa*; Spear Thistle, *Cirsium vulgare*; Flaxleaf Fleabane, *Conyza bonariensis*; Tall Fleabane; *Conyza sumatrensis*; Annual Trampweed, *Facelis retusa*; Catsear, *Hypochaeris radicata*; Dwarf Marigold, *Schkuhria pinnata* var. *abrotanoides;* Fireweed, *Senecio madagascariensis*; Stinking Roger, *Tagetes minuta*; Mouse-ear Chickweed, *Cerastium glomeratum*; Lesser Chickweed, *Stellaria pallida*; Hop Clover, *Trifolium campestre*; Yellow Suckling Clover, *Trifolium dubium*; Subterranean Clover, *Trifolium subterraneum*; Red-flowered Mallow, *Modiola caroliniana*; Scarlet Pimpernel, *Anagallis arvensis*; Lamb's Tongue, *Plantago lanceolata*; Veined Verbena, *Verbena rigida*; Onion Grass, *Romulea rosea*; Paspalum, *Paspalum dilatatum* and Pale Pigeon Grass, *Setaria pumila*.
Equivalent Plant Community Type:	Derived grasslands in coastal valleys (HU670) (OEH, 2012).
Equivalent NSW TEC:	Nil
Equivalent Commonwealth TEC:	Nil

4.3 FLORA SPECIES

A total of 462 flora species was identified by the quadrat plots, spot samples, random meanders and in general movement around the Study area in all surveys conducted between 2002 and 2015 (Appendix A, Table 19). Of these, 362 (78.4%) are native to the natural communities of the Study area and 100 (21.6%) are introduced. The numbers of species found in each community generally varied according to the sampling intensity (Table 19). The largest number of native species was found in Communities 2, 5, 6 and 11, with 139, 166, 215 and 125 species, respectively. These were also the most widespread and hence most heavily sampled communities.

The plant families with the highest numbers of species (Appendix A) were the Grasses, Poaceae (76 taxa); Daisies, Asteraceae (58 taxa); Pea Flowers, subfamily Faboideae (24 species); the Eucalypts and related genera in the family Myrtaceae (19 species), the Wattles, subfamily Mimosoideae (16 species), the Sidas and Lantern Bushes, Malvaceae (16 species) and the sedges, Cyperaceae (16 species). In all, some 87 plant families and sub-families were represented.

Table 19.
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	69	32	46.4	37	53.6
2	23	186	139	74.7	47	25.3
3[1]	0	-	-	-	-	-
4	1	23	23	100.0	0	0.0
5	29	182	166	91.2	16	8.8
6	73	255	215	84.3	40	15.7
7	8	75	62	82.7	13	17.3
8	2	45	36	80.0	9	20.0
9	7	112	109	97.3	3	2.7
10	2	109	87	79.8	22	20.2
11	20	136	125	91.9	11	8.1
12[1]	0	-	-	-	-	-
13	13	115	58	50.4	57	49.6
Total	182	462	362	78.4	100	21.6

[1] Communities 3 and 12 were not sampled owing to the very small size of their occurrences on the Study area.

4.4 INTRODUCED SPECIES AND WEEDS

The number of introduced species is high (100) (21.6%) (Table 19). The highest proportions of introduced species, 49.6 and 53.6 percent were found in the derived grassland (Community 13) and River Oak Riparian Woodland (Community 1), respectively, both of which are highly disturbed, fertile environments favourable to many introduced species. Semi-cleared, regenerating communities on valley floors, such as communities 2, 6, 7, 8 and 10, tended to have between 15 and 25 percent introduced species. The proportions of introduced species were below ten percent in less disturbed communities on steep sites with poor soils, e.g. Communities 4, 5, 9 and 11.

Seven introduced species recorded in this survey (Appendix A, Table 20) are listed as class 3 or 4[3] noxious weeds in the Singleton Shire (DPI 2016). The most common and widespread noxious weeds on the Study area are Fireweed, *Senecio madagascariensis*, and the Common Prickly Pear, *Opuntia stricta* var. *stricta*. However, neither was abundant anywhere within the Study area, although widespread and scattered (Appendix A). The remaining noxious weeds were encountered infrequently; African Boxthorn, *Lyceum ferocissimum*; Green Cestrum, *Cestrum parqui* and Tiger Pear, *Opuntia aurantiaca*; or once only; Paterson's Curse, *Echium plantagineum* and Silver-leaf Nightshade, *Solanum elaeagnifolium.*

[3] For class 3 noxious weeds, *'The plant must be fully and continuously suppressed and destroyed and/or the plant must not be sold, propagated or knowingly distributed.'*

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

Table 20.
Noxious Weeds Recorded on the Study Area

Scientific Name	Common Name	Noxious Weed Class
Echium plantagineum	Paterson's Curse	4
Cestrum parqui	Green Cestrum	3
Lyceum ferocissimum	African Boxthorn	3
Opuntia aurantiaca	Tiger Pear	4
Opuntia stricta	Common Prickly Pear	4
Senecio madagascariensis	Fireweed	4
Solanum elaeagnifolium	Silver-leaf Nightshade	4

4.5 THREATENED FLORA SPECIES

No threatened flora species were detected on the Study area by the surveys reported here. However, Slaty Red Gum, *Eucalyptus glaucina*, was recorded on the Study area to the west of the South Wambo Dam in 2006 (BioNet, 2016) (Figure 6).

4.6 THREATENED POPULATIONS

The surveys identified members of three threatened populations on the Study area, *viz*.:

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

4.6.1 *Acacia pendula* population

The erect Hunter Valley form of *Acacia pendula* is widespread around the lower reaches of Wambo Creek and North Wambo Creek on the Study area (Figure 6). The largest patch is also part of the *Hunter Valley Weeping Myall Woodland* EEC and was described in Table 14. In this section additional information is provided on the other occurrences of *A. pendula* on the Study area (Table 21).

Hunter Valley Weeping Myall usually occurs as more or less dense clusters of small (<1m high) and medium (1 to 3m high) stems around one or more tall stems (3 to 10m or more) (Plates 12 to 13). This growth pattern is thought to be the result of the sometimes copious production of new stems as root suckers from the older (taller) plants (Bell, 2006, 2007; Bell and Driscoll 2014). At Wambo old plants have trunks up to 25 cm in diameter at breast height and may grow to 16 metres or more high. Table 21 gives counts of the numbers of small, medium and large plants in discrete clusters. Given the root suckering mode of reproduction in this taxon, it is likely that each cluster comprises a single genetic individual (genet).

A total of 32 clusters of *A. pendula* have been identified (Table 21), aside from the main patch that has been known since the original Wambo Development Project Environmental Assessment where it was erroneously identified as *Acacia aneura* (Orchid Research, 2003). The population outside the main occurrence comprises over 540 stems, of which over 100 are tall plants and the remainder are smaller more recent root suckers.



Plate 12. Hunter Valley Weeping Myall Paddock Cluster 30
[Typical cluster of stems isolated in cleared paddocks.
Another group is behind on the right.]



Plate 13. Hunter Valley Weeping Myall Paddock Cluster 29

Table 21.
Stem counts of *Acacia pendula* in discrete clusters.

Patch[1]	Easting	Northing	No. of stems			
			Small	Medium	Tall	Total
1	0311856	6390362	39	17	0	56
2	0311879	6390338	14	0	1	15
3	0311878	6390326	22	0	18	40
4	0311867	6390315	30	0	0	30
5	0311870	6390307	48	0	0	48
6	0311863	6390306	21	0	0	21
7	0311713	6390141	0	0	1	1
8	0311707	6390155	5	0	4	9
9	0311708	6390177	8	0	2	10
10	0311905	6390233	0	18	11	29
11	0311887	6390251	0	7	10	17
12	0311865	6390133	4	4	0	8
13	0311876	6390133	0	0	1	1
14	0311846	6390159	2	1	3	6
15	0311857	6390145	2	2	0	4
16	0311588	6390572	9	4	4	17
17	0311595	6390584	0	0	3	3
18	0311590	6390537	20	2	47	69
19	0311594	6390520	4	5	0	9
20	0311652	6390511	0	0	1	1
21	0310926	6390349	18	0	0	18
22	0310952	6390357	11	0	0	11
23	0310140	6390975	33	14	0	47
24	0309973	6390882	28	2	0	30
25	0310008	6390830	7	0	0	7
26	0309997	6390876	18	1	0	19
27	0309884	6390960	0	2	2	4
28[2]	0311513	6391794	many	-	2	2
29[2]	0311422	6391674	4	7	0	11
30[2]	0311684	6391926	-	-	-	-
31[2]	0311748	6391922	-	-	-	-
32[2]	0311730	6391879	-	-	-	-
Total			347	86	110	543

[1] Patches 1 to 27 were documented in September 2015.

[2] Patches 28 to 32 were identified in June 2014 (FloraSearch, 2014) and were not fully documented.

4.6.2 *Eucalyptus camaldulensis* population

River Red Gum, *Eucalyptus camaldulensis*, is confined to flood terraces along Wollombi Brook. The Study area avoids flood terraces, except for a small area in the north east where the proposed overpass for access to the proposed new administration complex crosses the edge of the floodplain (Figure 6). The overpass crosses a flood channel supporting a small patch of River Red Gums. The patch comprises three old growth trees and 47 smaller trees and saplings that have regenerated from them.

4.6.3 *Cymbidium canaliculatum* population

Random meander searching identified a large colony of the Tiger Orchid, *Cymbidium canaliculatum*, on a Grey Box, *Eucalyptus moluccana*, tree on a steep ridge below the sandstone escarpment in the west of the Study area (Figure 6) (Plates 14 to 16).



Plate 14. Tiger Orchid Colony in Grey Box Tree



Plate 15. Tiger Orchid Colony in Grey Box Tree



Plate 16. Tiger Orchid Colony in Grey Box Tree

4.7 THREATENED ECOLOGICAL COMMUNITIES

The equivalence between the thirteen vegetation communities recognised on the Study area in this study and the potential TECs identified in Table 4 is given in the community descriptions (Tables 8 to 18). Two EECs listed under the TSC Act, *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* and *Warkworth Sands Woodland in the Sydney Basin Bioregion* are represented by very small occurrences on the Study area have not been included in the community descriptions (Tables 8 to 18). The distributions of the TECs are shown on Figure 5.

Two CEECs listed in the Schedules of the EPBC Act occur on the Study area (Table 22), *viz.:*

- *Central Hunter Valley Eucalypt Forest and Woodland.*
- *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley*.

Six EECs listed in the schedules of the TSC Act occur within the Study area (Table 22), *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; and*
- *Warkworth Sands Woodland in the Sydney Basin Bioregion.*

One VEC listed in the Schedules of the TSC Act occurs within the Study area (Table 22), *viz.:*

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

Table 22.
Threatened Ecological Communities in the Study Area

Community		Status[1]			
No.	Name	TSC Act		EPBC Act	
1	River Oak Riparian Woodland	-	-	-	-
2	Forest Red Gum Floodplain Forest	E	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	-	-
3	River Red Gum Woodland	E	Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions	-	-
4	Rusty Fig – Native Quince – Native Olive Dry Rainforest	-	-	-	-
5	Spotted Gum – Narrow-leaved Ironbark – Grey Box Woodland	E	Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	CE	Central Hunter Valley Eucalypt Forest and Woodland
6	Narrow – leaved Ironbark – Grey Box Woodland	E	Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	CE	Central Hunter Valley Eucalypt Forest and Woodland
7	Bull Oak Grassy Woodland	-	-	-	-
8	Weeping Myall Woodland	E	Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	CE	Hunter Valley Weeping Myall (*Acacia pendula*) Woodland
9	Sandstone Riparian Scrub	-	-	-	-
10	*Melaleuca decora* Low Forest	-	-	-	-
11	Grey Box – Slaty Box Woodland	V	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	CE	Central Hunter Valley Eucalypt Forest and Woodland
12	Rough-barked Apple – Coast Banksia Woodland	E	Warkworth Sands Woodland in the Sydney Basin Bioregion	-	-
13	Derived Grassland	-	-	-	-

[1] E – Endangered; CE – Critically Endangered; V – Vulnerable.

5 CONDITION OF THE VEGETATION

Vegetation condition varies considerably across the Study area from poor to excellent condition depending on land use history and the degree of disturbance. Much of the vegetation is in remarkably good condition, despite a long history of agriculture prior to the current mining phase. Historic disturbance factors on the Study area have included clearing of native vegetation, generally on areas of gentler topography and better soil types; logging; grazing by livestock and introduced feral herbivores such as rabbits; the construction of tracks and fire trails; and wildfires, the most recent being in 1994. Despite these disturbances the native vegetation on most of the Study area has retained its resilience and has resisted colonisation by most introduced species. There are few old growth trees reflecting the effects of past clearing, logging and wildfires. All unhealthy or dead trees on the site had been severely impacted by the 1994 wildfire. There was no tree death observed that could be attributable to other causes. Nevertheless, active regeneration of trees, shrubs and ground cover has occurred and is continuing. The vegetation over the bulk of the continuously wooded areas is assessed as being in excellent condition.

The most alienated parts of the Study area are the derived grasslands on the flat valley floors of Wambo Creek, North Wambo Creek and to a lesser extent, 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 some may have been cropped historically. Long-term unassisted recovery would depend on slow recolonisation of this area from adjacent bushland, which has started to occur to some extent in areas where grazing has been withdrawn or is light. The derived grassland has the highest levels of introduced species on the Study area, along with the riparian zones of Wambo and North Wambo Creeks, but still retains a significant part of its original ground cover diversity. However, the derived grasslands lack many sensitive native ground cover species and native shrubs. The biodiversity value and resilience of the derived grassland is considered to be low.

6 FLORA IMPACT ASSESSMENT

Potential impacts of the Modification on flora fall broadly into two categories;

- impacts due to subsidence of the land surface, which include soil cracking, ponding of water, and bedrock cracking in streambeds leading to potential diversion of surface water flows to sub-surface fracture networks (Section 6.1), and
- impacts due to vegetation clearance and/or disturbance for surface infrastructure (section 6.3).

6.1 POTENTIAL IMPACTS OF SUBSIDENCE ON FLORA

The surface area located above the proposed longwalls that has not previously been affected by underground mining and has not been previously approved is around 185 ha (MSEC, 2016). Predictions of subsidence heights and tilts using modelling by the Incremental Profile Method have shown that the Modification would result in a decrease in the height of vertical subsidence and tilt compared with the mine layout approved in 2004 for most areas (MSEC, 2016). This stems from slightly decreased extraction heights and the adoption of panel layouts that are offset or re-oriented from those that have been extracted above, rather than being stacked identically. Decreases in subsidence and tilt compared with the approved layout indicate the Modification has less potential for adverse impacts at the surface.

Mine subsidence effects on the surface associated with the Modification, are expected to vary according to the depth of cover above the coal seam and the presence of surface features such as steep narrow ridge lines and valleys. Surface cracking of soils may potentially occur over most of the lower flat areas within the Modification, however would likely be less prevalent as depth of cover increases towards the southern escarpment.

Inspection of previously undermined areas above the Whybrow and Wambo Seams has shown that surface cracking of the soil may be relatively frequent on low flat areas supporting Narrow-leaved Ironbark – Grey Box Woodland (Plates 17 to 20). The condition of the vegetation on undermined areas was not noticeably different from that on adjacent similar areas that had not been subject to undermining. Tree health in the undermined Narrow-leaved Ironbark – Grey Box Woodland was good with no signs of dieback. The naturally sparse shrub and ground layers were likewise in good health (Plates 21 to 23). Similarly, areas of *Melaleuca decora* Low Forest also showed no signs of decline (Plate 24). The latter community might be expected to be susceptible to water loss through soil cracking, since it occurs on sites that may remain wet for long periods after heavy rain. In addition, no scientific evidence of adverse surface effects on vegetation from minor soil cracking induced by subsidence is known from underground mining anywhere in Australia. Soil surface cracking would be less severe under the Modification than for the approved arrangement.



Plate 17. Typical soil cracking



Plate 18. Typical soil cracking



Plate 19. Typical soil cracking



Plate 20. Typical soil cracking



Plate 21. Undermined Narrow-leaved Ironbark – Grey Box Woodland



Plate 22. Undermined Narrow-leaved Ironbark – Grey Box Woodland



Plate 23. Undermined Narrow-leaved Ironbark – Grey Box Woodland



Plate 24. Undermined *Melaleuca decora* Low Forest

Relatively wide cracks may occur in surface soils associated with steep slopes (MSEC, 2016). Steep slopes and narrow ridges occur on either side of the deeply incised Stony Creek gorge. These areas are likely to be slightly more affected by the Modification than the approved layout. MSEC (2016) states; '*The maximum predicted tilt and curvatures, based on the Modified Layout, are similar to but slightly greater than the maxima predicted based on the Approved Layout*'. However, observations of vegetation associated with soil cracking following previous mining at Wambo on steep slopes have shown no obvious affects on tree health.

Uneven subsidence at the surface from underground coal mining may result in topographical depressions (MSEC, 2016). The resultant ponding of water in such depressions is known to kill terrestrial vegetation. The Subsidence Assessment prepared for the Modification shows that most potential for increased ponding is restricted to cleared areas of the valley floor (MSEC, 2016). However, some small depressions are likely to develop in wooded areas, including EECs (Figure 5.27 in MSEC [2016]). A small loss of woodland owing to waterlogging may occur.

Modelling by MSEC (2016) indicates that new ponds would develop in North Wambo Creek, Wambo Creek and Stony Creek as a result of the formation of topographical depressions due to subsidence and tilting. The effects are expected to be reduced for the Modification compared with that in the approved arrangement in North Wambo Creek, to be greater in Wambo Creek and similar in Stony Creek. It is possible such ponding may impact on riparian vegetation.

In the west of the Study area, modelling by MSEC (2016) indicates there is minimal potential for valley related movements, i.e. valley closure and upsidence, within the parts of Stony Creek affected by the Modification. WCPL would repair any resultant bedrock cracking that may potentially direct surface flows to cracks in lower strata. It is also considered likely that fracture networks may 'self-repair' by filling with sediments over time. However, detection of damage may not be possible where bedrock occurs below sediments and the capacity for self repair is unknown (PAC, 2010).

In conclusion, it is considered unlikely that vegetation on the Study area would be adversely affected by soil cracking. However, there may be a small loss of woodland due to surface ponding and possible effects to riparian vegetation where ponding occurs along creeks, or fracture networks develop below Stony Creek. However, these impacts would be lower for the Modification than for the approved arrangement. In addition, Advisian (2016) concludes that remediation of ponding by regrading creek beds are likely to result in a greater disturbance (e.g. erosion and surface disturbance) than the ponding itself.

6.2 DESCRIPTION OF SURFACE ACTIVITIES

The existing surface infrastructure and supporting services at Wambo would be supplemented for the Modification with the South Wambo Underground Mine infrastructure area, access road, ventilation infrastructure, gas management infrastructure and other ancillary activities, including monitoring, subsidence remediation works and general site maintenance activities, among others. Surface infrastructure for the Modification would total 21 ha (Table 23), of which 7.9 ha is additional surface disturbance being assessed under the Modification (i.e. in addition to existing approved surface disturbance).

Table 23.
Modification Disturbance Areas

Area	Disturbance (ha)
South Wambo Underground Mine Infrastructure Area	2.6
Wambo Access Road	1.7
Ventilation Infrastructure	3.2
Gas Management Infrastructure	13.5
Total:	**21.0**

South Wambo Underground Mine Infrastructure Area

The Modification would require an extension of 2.6 ha to the existing/approved surface infrastructure area to allow for the additional South Wambo Underground Mine infrastructure area.

Wambo Access Road

An access road to the South Wambo Underground Mine infrastructure area would be constructed, including upgrades to existing access roads and the construction of a grade separated crossing of the existing Wambo access road. The extent of additional surface disturbance for the access road is approximately 1.7 ha.

Ventilation Infrastructure

The Modification would require the construction of an additional four ventilation shafts compared to the approved South Wambo Underground Mine. One of these ventilation shafts would be located within the existing/approved surface development area. These ventilation shafts would be staged with the progression of mining and may be used as upcast shafts (including installation of fans) or downcast shafts, depending on the location of mining. Each ventilation shaft would require an approximate 75 m by 75 m construction footprint with ancillary disturbance for associated infrastructure. The ventilation shafts would also require access roads, fencing, electrical infrastructure, water management and flood control infrastructure and other associated ancillary infrastructure. The total surface disturbance area for mine ventilation infrastructure would be approximately 3.2 ha.

Gas Management Infrastructure

Surface disturbance for gas management infrastructure would include gas drainage boreholes, centralised gas plants and associated infrastructure such as access tracks, power supply and pipelines. Surface disturbance associated with gas management infrastructure would be temporary and isolated in nature. The surface disturbance would occur progressively and would be rehabilitated progressively as the gas management infrastructure is no longer required.

Surveys of potential gas management infrastructure locations would be conducted to identify any threatened flora species, communities or populations. If any threatened flora is identified consideration would be given to relocating the works so as to avoid direct impacts. It is expected that threatened flora species and threatened populations would be able to be avoided. Impacts to threatened communities would be minimised by the minor nature of the disturbance (small, isolated and temporary) and by locating the surface components to reduce clearance requirements (e.g. using existing cleared areas or areas with a sparse mid or over story cover).

Gas management infrastructure associated with the Modification would require a disturbance of approximately 13.5 ha. This disturbance would be progressively rehabilitated, with less than approximately 1 ha disturbed at any time.

6.3 IMPACTS OF MODIFICATION SURFACE ACTIVITIES ON FLORA

The main impact of Modification surface activities on flora is vegetation clearance, which is listed as a Key Threatening Process under the TSC Act (OEH, 2016e) and EPBC Act (DotE, 2016a). Of the 21 ha of vegetation clearance required for the Modification (Table 23), 12.9 ha are available under the existing approval. Accordingly, the Modification requires approval for an additional 7.9 ha of vegetation clearance. The breakdown of the additional clearance by vegetation community is given in Table 24.

Table 24.
Additional Vegetation Clearance for the Modification by Vegetation Community

Community		TEC (TSC Act)	Area (ha)
No.	Name		
1	River Oak riparian woodland	N/A	0
2	Forest Red Gum lowland forest	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	0.4
3	River Red Gum woodland	Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC	0.2
4	Rusty Fig – Native Quince – Native Olive dry rainforest	N/A	0
5	Spotted Gum – Narrow-leaved Ironbark – Grey Box woodland	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions EEC	0
6	Narrow-leaved Ironbark – Grey Box woodland	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC	0
7	Bull Oak grassy woodland	N/A	1.8
8	Weeping Myall Woodland	Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC	0
9	Sandstone riparian shrub forest	N/A	0
10	Melaleuca decora low forest	N/A	0.1
11	Grey Box - Slaty Box woodland	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion VEC	0.9
12	Rough-barked Apple - Coast Banksia woodland	Warkworth Sands Woodland in the Sydney Basin Bioregion EEC	0
13	Derived Grassland	N/A	4.5
		Total	7.9

6.4 CUMULATIVE IMPACTS ON FLORA

By contrast with open cut mining methods, which potentially have significant impacts on native vegetation because of the need to remove the overburden above the ore body, underground mining is relatively benign. The minimal amount of vegetation clearance for this Modification means that it will make only a very small contribution to the cumulative vegetation losses resulting from extensive open cut coal mining in the south-western parts of the Hunter Valley.

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 EPBC Act and/or the TSC Act is assessed here in accordance with the former 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?

The assessment in this section is confined to the limit of potential subsidence impacts and direct surface disturbance associated with the Modification.

7.1 THREATENED FLORA SPECIES

A total of four threatened flora species have potential to occur on the Study area (Tables 2 and 25).

Records of Slaty Red Gum, *Eucalyptus glaucina*, on the Study area were returned by a search of the NSW Atlas of Wildlife (BioNet, 2016). This species was not detected by the extensive surveys reported here. Slaty Red Gum is a large conspicuous species that would have been detected by the survey if it was present. In addition, the location of the records places the sightings in an area mapped as Grey Box – Slaty Box Woodland (Community 10), a community in which it is unlikely to occur. It is considered likely that the records are misidentifications of juvenile Slaty Box, *Eucalyptus dawsonii*, trees, which have similar bark colour and foliage shape and colouration to Slaty Red Gum. However, in view of the records, Slaty Red Gum is included in the assessment below.

Table 25.
Threatened Flora Species for Impact Assessment

Common Name	Scientific Name
White-flowered Wax Plant	*Cynanchum elegans*
Slaty Red Gum	*Eucalyptus glaucina*
Brown Pomaderris	*Pomaderris brunnea*
Illawarra Greenhood	*Pterostylis gibbosa*

The different habitat preferences and characteristics of the four species indicate that they would, if present, occur in different parts of the Study area.

The Illawarra Greenhood is the only species most likely to occur in the flatter terrain occupied by Communities 3, 6, 7 and 8, and may potentially be impacted by subsidence associated with the Modification. White-flowered Wax Plant, if it was present, would most likely be associated with the dry rainforest in the steep valley of a tributary of Stony Creek that may potentially be impacted by subsidence associated with the Modification. The Brown Pomaderris, if present, would occur in alluvial sand deposits along Stony Creek. Flora surveys within the suitable lower reaches of Stony Creek have not identified this species.

The four species are subjected to an impact assessment below.

Assessment of Impact

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

The Modification would result in 7.9 ha of additional vegetation clearance (apart from subsidence remediation works if required), most of which (4.5 ha) is in cleared derived grasslands, with 1.5 ha to be undertaken in vegetation mapped as TECs (Table 24). None of the clearance would be in habitats likely to support White-flowered Wax Plant or the Brown Pomaderris. Similarly, Slaty Red Gum would be avoided at its recorded location. The species most likely to be inadvertently affected by clearance and/or disturbance is the Illawarra Greenhood, if it were present, owing to its small size and inconspicuousness. However, the very limited area of surface disturbance relative to the much larger areas of potential habitat available indicates the likelihood of a significant impact on the Illawarra Greenhood due to surface disturbance would be small, if populations are present. Notwithstanding this, the extensive surveys over many years indicate it is unlikely the Illawarra Greenhood is present.

Soil cracking as a result of subsidence is most likely to occur in the potential habitat of the Illawarra Greenhood in the lower lying terrain of the north and east of the Study area (Section 6.1). 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 any potential surface cracks would be widely spaced (Plates 17 to 20) and unlikely to impact on more than a very small part of the population, if it were present. There is no plausible scenario in which subsidence could exert a significant adverse effect on Illawarra Greenhood pollinator populations.

Valley closure, upsidence and potential shallow soil or bedrock cracking in the tributary of Stony Creek is considered unlikely to have a significant impact on White-flowered Wax Plant, if it were to occur. Stony Creek is an intermittent watercourse that only flows for relatively short periods after rain. Although these flows may be important for wetting the riparian zone, the riparian zone is very limited in the parts of the gorge where dry rainforest occurs. In general, the rainforest is on the footslopes beside the creek rather than in the riparian zone, so that impacts of reduced water flows in Stony Creek on the White-flowered Wax Plant would be minimal.

Reduction in surface flows in Stony Creek due to substrate cracking has potential to affect the viability of the Brown Pomaderris, if it were present. Brown Pomaderris depends on sandy soils in the riparian zone that are periodically watered by surface runoff. However, no Brown Pomaderris have been recorded in surveys of the Study area or in the surrounding region, despite the Hunter Valley being well surveyed botanically. The nearest records are near Wiseman's Ferry and Capertee (BioNet, 2016).

It is concluded that the Modification is unlikely to initiate or exacerbate any threatening processes that would significantly reduce the long term viability of populations of the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood, if they were present.

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 Modification avoid the need for large scale surface disturbance. Additional surface disturbance for the Modification totals 7.9 ha (Table 24). This would not result in any potential habitat loss for the White-flowered Wax Plant or Brown Pomaderris in the Study area since no infrastructure is planned in potential habitat for these species. The Modification may affect very small amounts of potential habitat for the Slaty Red Gum and Illawarra Greenhood, although no known actual habitat would be affected. Other minor surface disturbance that may be required, for subsidence monitoring for example, would be undertaken in already disturbed areas, such as beside existing access tracks or in derived grassland.

In addition, subsidence impacts are unlikely to adversely affect surface habitats as demonstrated by the continued health of native vegetation on previously undermined areas on WCPL land at similar depths of cover (Section 6.1).

It is concluded that significant adverse impacts on potential habitats of the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood are highly unlikely.

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

If the Illawarra Greenhood were to occur on the Study area, it would be at its known north western distributional limit; the nearest known population being at Milbrodale approximately 12 km south of the Study area (BioNet 2016). However, significant impacts to the Illawarra Greenhood are not expected to occur. The White-flowered Wax Plant, Slaty Red Gum and Brown Pomaderris would not be at the limits of their known distributions (BioNet 2016).

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

Clearing of Native Vegetation is listed as Key Threatening Process (OEH, 2016e). The Modification would result in an additional 3.4 ha of vegetation clearance (apart from subsidence remediation works if required) in naturally wooded areas.

The Modification may result in minor changes to current surface land uses, e.g. by fencing out ventilation shafts and gas management infrastructure. Part of the Study area is set aside as a Remnant Woodland Enhancement Program area and this would not be altered by the Modification. The proposal is not expected to influence the frequency or severity of wildfires, or the presence of noxious weeds or pests. The presence of WCPL employees increases the likelihood of early detection and suppression of fires, weeds and feral animals.

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

The proposal does not involve large scale native vegetation clearance with potential to result in habitat fragmentation. Most clearance would take place within existing cleared areas (4.5 ha). Clearance in wooded areas would occur at point locations within larger areas of continuous habitat and would be limited to 3.4 ha additional to approved surface activities (Table 24). Therefore, habitat connectivity would not be reduced for the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood.

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

No Critical Habitat for any of the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood has been declared under the TSC Act (OEH 2016c) on the Study area or surrounds.

Conclusion

It is concluded that the Modification is unlikely to significantly impact on the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood, if they were to occur on the Study area.

7.2 ENDANGERED POPULATIONS

Three Endangered Populations (EP) occur on the Study area (Section 4.6);

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

Assessment of Impact

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

The Modification would result in an additional 7.9 ha of surface disturbance or vegetation clearance (apart from subsidence remediation works if required). This clearance would be targeted to avoid any known occurrences of *A. pendula* or *C. canaliculatum*. However, part of the *E. camaldulensis* population in the Hunter Catchment occurs within the footprint of the proposed grade separated crossing of the existing Wambo access road. This would potentially result in the loss of 3 mature *E. camaldulensis* trees and 47 younger tree and saplings. The Hunter Valley population of the River Red Gum was thought to number between 600 and 1000 mature and semi-mature individuals at the time it was listed as an endangered population (OEH, 2016b). On this basis the loss of 3 mature trees represents 0.3 to 0.5 percent of the then known population. Subsequent survey work has increased the known population, including on WCPL-owned land, where over 300 mature and semi-mature individuals were identified in 2012 in RWEP Area A on the eastern side of Wollombi Brook (Figure 6).

Many of the *Acacia pendula in the Hunter Catchment EP* individuals on WCPL owned land have been undermined by previous mining in the Whybrow and Wambo seams within the Study area, in some areas by both. In addition, the large occurrence of *A. pendula* south of the North Wambo Creek diversion has been undermined by Longwall 4 at the approved North Wambo Underground Mine. Despite the undermining, it is clear that all extant occurrences of *A. pendula* have survived and/or fully recovered (RPS in WCPL, 2012). Therefore, although there is potential for minor root damage caused by soil cracking, subsidence impacts are not expected to significantly harm any *A. pendula* plants.

The Tiger Orchid, *C. canaliculatum* grows as an epiphyte in tree hollows of old growth eucalypts, angophoras and large acacias. It would only be impacted by subsidence if it caused trees to fall or tree trunks to split. There is no evidence that subsidence causes such effects on old growth trees. The largest impact is likely to be some damage to minor roots due to soil cracking, which is not known to result in tree fall, trunk splitting or tree death. The available evidence suggests that tree health is not significantly affected by minor soil cracking. The *C. canaliculatum* colony found in the west of the Study area by these surveys was on a steep narrow ridge where soil cracking had occurred as a result of undermining by the North Wambo Underground Mine. Both the orchid colony and the host tree were in good health at the time of the inspection (Plates 14 to 16).

It is concluded that the Modification is unlikely to initiate or exacerbate any threatening processes that would reduce the long term viability of the parts of the *Acacia pendula in the Hunter Catchment EP* or the *Cymbidium canaliculatum population in the Hunter Catchment EP* that occur on the Study area. However, the Modification is expected to result in a reduction of the *Eucalyptus camaldulensis* population in the Hunter Catchment EP by up to 50 mostly immature individuals.

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 for the Modification avoid the need for large scale surface disturbance. Additional vegetation clearance associated with the Modification area would be limited to 7.9 ha, of which 3.4 ha is in naturally wooded areas, and potential impacts associated with vehicle movements, subsidence monitoring and subsidence remediation works, if required.

Potential habitat for the *Eucalyptus camaldulensis* population in the Hunter Catchment includes flood terraces and channels along Wollombi Brook. The only potential disturbance to these habitats due to the Modification is the proposed overpass on the Wambo access road which passes over a small section of the floodplain. The floodplain and terraces within the Study area are not proposed to be undermined for the Modification.

Potential habitat for the *Acacia pendula* population in the Hunter Catchment is the gentle footslopes and rises above the lower floodplains of Wambo Creek and North Wambo Creek. These areas are largely cleared or support remnants of Communities 6 and 7 (Figure 4). Disturbance to potential habitat for *A. pendula* may occur, since most of the potential habitat is cleared derived grassland. However, while *A. pendula* could survive and grow in these areas, it is unlikely to colonise or recolonise them because it does not produce seed (Bell, 2006, 2007; Bell and Driscoll 2014) and appears incapable of even short distance dispersal beyond its root zone. Accordingly, conservation of *A. pendula* relies on protection of existing stands, which would not be affected by clearance or surface disturbance for the Modification.

Potential habitat for the *Cymbidium canaliculatum* population in the Hunter Catchment includes all old growth eucalypts, large acacias and angophoras with broken limbs exposing rotting corewood. Such trees may potentially occur anywhere within the Study area. It is also important to protect old growth trees that have not yet developed hollows as these will develop them much sooner than the young regenerating trees that make up the bulk of the trees on the Study area. Old growth trees are not likely to be adversely affected by subsidence-induced soil cracking (Section 6.1). Removal of old growth trees would be avoided where practicable. Surface infrastructure would be placed in treeless areas wherever possible and no trees with *C. canaliculatum* colonies would be removed.

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 (Section 6.1).

There are not expected to be any significant adverse impacts on the habitats of *A. pendula* or *C. canaliculatum*. The proposed Modification would result in a small reduction in actual habitat for the *E. camaldulensis* population in the Hunter Catchment EP, which is not considered significant in a regional sense for this population.

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

The *A. pendula* population on the Study area is not at the known limits of the species distribution in the Hunter Valley (BioNet, 2016), which are near Branxton in the east, near Broke in the south, near Bylong in the west and near Scone in the north.

The *C. canaliculatum* population on the Study area is not at the known limits of the species distribution in the Hunter Valley (BioNet, 2016), which are near Maitland in the east, near Cessnock in the south, near Bylong in the west and near Murrurundi in the north.

The *E. camaldulensis* population on the Study area is not at the known limits of the species distribution in the Hunter Valley (BioNet, 2016), which are near Maitland in the east, near Broke in the south, near Wollar in the west and near Scone in the north.

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

Clearing of Native Vegetation is listed as Key Threatening Process (OEH, 2016e). The Modification would result in 3.4 ha of additional wooded native vegetation clearance (Table 24) (apart from subsidence remediation works if required).

Much of the Study area is set aside as a Remnant Woodland Enhancement Program area and the Modification will not affect these areas. The proposal is not expected to influence the frequency or severity of wildfires, weed incursions or feral animal populations. The presence of WCPL employees increases the likelihood of early detection and suppression of fires, weeds and feral animals.

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

The proposal does not involve large scale native vegetation clearance with potential to result in habitat fragmentation. Most clearance would take place within existing cleared areas (4.5 ha). Clearance in wooded areas would occur at point locations within larger areas of continuous habitat and would be limited to 3.4 ha additional to approved surface activities (Table 24). Consequently habitat connectivity would not be reduced for the *E. camaldulensis*, *A. pendula* and *C. canaliculatum* EPs.

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

No Critical Habitat for *E. camaldulensis*, *A. pendula* or *C. canaliculatum* EPs has been declared under the TSC Act (OEH 2016c) on the Study area or surrounds.

Conclusion

It is concluded that the Modification is unlikely to significantly impact on the *Acacia pendula in the Hunter Catchment EP* or the *Cymbidium canaliculatum population in the Hunter Catchment EP* that occur on the Study area. The Modification is expected to result in a reduction of the *Eucalyptus camaldulensis* population in the Hunter Catchment EP by three mature and up to 50 immature individuals, which is not considered significant in the context of the Hunter Valley population as a whole.

7.3 ENDANGERED ECOLOGICAL COMMUNITIES

Six EECs listed in the Schedules of the TSC Act occur on the Study area (Table 22):

- *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; and*
- *Warkworth Sands Woodland in the Sydney Basin Bioregion.*

One VEC listed in the Schedules of the TSC Act occurs within the Study area (Table 22), *viz.:*

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

The potential impact of the Modification on these communities is assessed below.

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 Modification avoid the need for large surface disturbance. Additional clearance of natural woody vegetation associated with the Modification would be limited to 3.4 ha (Table 24) and potential impacts associated with vehicle movements, subsidence monitoring and subsidence remediation works, if required. Of the additional 3.4 ha, 1.5 ha involves actual habitat of two TSC Act listed TECs; 0.4 ha of *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC*, 0.2 ha of *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* and 0.9 ha of the *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion VEC* (Table 24). In addition, part of the additional 4.5 ha of cleared derived grassland may include potential habitat of TECs. These areas are very small when compared with the large areas of remnant vegetation, including TECs, on the Study area and in the Remnant Woodland Enhancement Program areas.

Subsidence impacts are unlikely to adversely affect surface trees, shrubs and ground cover as demonstrated by the continued health of native vegetation on parts of the Study area that have been undermined for the Whybrow and Wambo seams at shallower depths of cover (Section 6.1).

There are not expected to be any significant adverse impacts of the Modification on the TECs listed under the TSC Act.

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

Not applicable.

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

Clearing of Native Vegetation is listed as a Key Threatening Process (OEH, 2016e). The Modification would result in 3.4 ha of additional wooded native vegetation clearance (Table 24) (apart from subsidence remediation works if required).

Much of the Modification area is set aside as a Remnant Woodland Enhancement Program area and the Modification will not affect these areas, except for the possible clearing of point locations for ventilation or gas drainage works. The proposal is not expected to influence the frequency or severity of wildfires, weed incursions or feral animal populations. The presence of WCPL employees increases the likelihood of early detection and suppression of fires, weeds and feral animals.

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

The proposal does not involve large scale native vegetation clearance with potential to result in habitat fragmentation for any of the TECs listed under the TSC Act. Most clearance for the Modification would take place within existing cleared areas (4.5 ha). Clearance in wooded areas would occur at point locations within larger areas of continuous habitat and would be limited to 3.4 ha additional to approved surface activities (Table 24). This clearance would directly affect three of the TECs; 0.4 ha of *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC*, 0.2 ha of *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* and 0.9 ha of the *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion VEC* (Table 24), all of which are well represented on the Study area and already fragmented, both naturally and by historical clearing (Figure 5). The very small scale of the clearing at point locations means that habitat connectivity would not be significantly reduced for the TSC Act listed TECs.

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

No Critical Habitat for any of the seven TECs has been declared under the TSC Act (OEH 2016c) on the Study area or surrounds. The area of habitat occupied by the *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC* on the Study area is regarded as one of the two best extant occurrences of this community (OEH, 2013) and would be considered critical to its survival. This is recognised by WCPL which has fenced the area to exclude unwanted access by people or livestock. No disturbance of the *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC* habitat is proposed for the Modification.

Conclusion

It is concluded that the Modification is unlikely to significantly impact on any TSC Act listed TECs.

7.4 OVERALL CONCLUSION OF THE TSC ACT ASSESSMENT

It is concluded from the above assessments that the proposed Modification would have no significant impact on threatened flora species, ecological communities or critical habitat. It would result in a reduction in size of the *E. camaldulensis population in the Hunter Catchment Endangered Population*, but would not affect any other endangered populations.

7.5 EPBC ACT ASSESSMENT

This section conducts an assessment of Matters of National Significance under the EPBC Act in accordance with the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DotE, 2013).

7.5.1 Threatened Flora Species

The potential impacts of the Modification on threatened species are assessed below using the relevant significant impact criteria (DotE, 2013), which differ slightly for Endangered and Vulnerable species (Table 26).

Table 26.
Significant Impact Criteria for Endangered and Vulnerable Species under the EPBC Act

Criterion	Endangered	Vulnerable
Population size	Will the Action lead to a long-term decrease in the size of a population?	Will the Action lead to a long-term decrease in the size of an important population of a species?
Area of occupancy	Will the Action reduce the area of occupancy of the species?	Will the Action reduce the area of occupancy of an important population?
Habitat fragmentation	Will the Action fragment an existing population into two or more populations?	Will the Action fragment an existing important population into two or more populations?
Critical habitat	Will the Action adversely affect habitat critical to the survival of a species?	Will the Action adversely affect habitat critical to the survival of a species?
Life cycle disruption	Will the Action disrupt the breeding cycle of a population?	Will the Action disrupt the breeding cycle of an important population?
Habitat quality	Will the Action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Will the Action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
Invasive species	Will the Action result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	Will the Action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?
Disease	Will the Action introduce disease that may cause the species to decline?	Will the Action introduce disease that may cause the species to decline?
Recovery	Will the Action interfere with the recovery of the species?	Will the Action interfere substantially with the recovery of the species?

Four threatened flora species listed under the EPBC Act were considered to have potential to occur on the Study area in Table 2 and are listed below (Table 27). The potential impacts of the Modification on the four species are considered together below.

Table 27.
EPBC Act Listed Threatened Flora Species with Potential to Occur on the Study Area

Common Name	Scientific Name	Status[1]
White-flowered Wax Plant	*Cynanchum elegans*	E
Slaty Red Gum	*Eucalyptus glaucina*	V
Brown Pomaderris	*Pomaderris brunnea*	V
Illawarra Greenhood	*Pterostylis gibbosa*	E

[1] Threatened flora species conservation status under the EPBC Act (current as at January 2016).

E – Endangered. V – Vulnerable.

Assessment of Impact

1. Population Size

The Modification would result in 7.9 ha of additional vegetation clearance (apart from subsidence remediation works if required), 4.5 ha of which is in cleared derived grasslands and 3.4 ha in areas mapped as forest or woodland (Table 24). The total area of native forest and woodland in the Study area is 1043 ha. Approval is sought to clear only 0.33 percent of this area. None of the clearance would be in habitats likely to support White-flowered Wax Plant or the Brown Pomaderris. Similarly, Slaty Red Gum would be avoided at its recorded location. The species most likely to be inadvertently affected by clearance and/or disturbance is the Illawarra Greenhood, if it were present, owing to its small size and inconspicuousness. However, the very limited area of surface disturbance relative to the much larger areas of potential habitat available indicates the likelihood of a significant impact on the Illawarra Greenhood due to surface disturbance would be small, if populations are present. Notwithstanding this, the extensive surveys over many years indicate it is unlikely the Illawarra Greenhood is present.

Valley closure, upsidence and potential shallow soil or bedrock cracking in the tributary of Stony Creek is considered unlikely to have a significant impact on White-flowered Wax Plant, if it were to occur. Stony Creek is an intermittent watercourse that only flows for relatively short periods after rain. Although these flows may be important for wetting the riparian zone, the riparian zone is very limited in the parts of the gorge where dry rainforest occurs. In general, the rainforest is on the footslopes beside the creek rather than in the riparian zone, so that impacts of reduced water flows in Stony Creek on the White-flowered Wax Plant would be minimal.

Reduction in surface flows in Stony Creek due to substrate cracking has potential to affect the viability of the Brown Pomaderris, if it were present. Brown Pomaderris depends on sandy soils in the riparian zone that are periodically watered by surface runoff. However, no Brown Pomaderris have been recorded in surveys of the Study area or in the surrounding region, despite the Hunter Valley being well surveyed botanically. The nearest records are near Wiseman's Ferry and Capertee (BioNet, 2016).

It is concluded that the Modification is unlikely to initiate or exacerbate any threatening processes that would significantly reduce the long term size of populations of the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood, if they were present.

2. Area of Occupancy

The underground mining methods to be employed by the Modification avoid the need for large scale surface disturbance. Additional surface disturbance for the Modification totals 7.9 ha (Table 24). This would not result in any potential reduction of habitat for the White-flowered Wax Plant or Brown Pomaderris in the Study area since no infrastructure is planned in potential habitat for these species. The Modification may affect very small amounts of potential habitat for the Slaty Red Gum and Illawarra Greenhood, although no known actual habitat would be affected. Other minor surface disturbance that may be required, for subsidence monitoring for example, it would be undertaken in already disturbed areas, such as beside existing access tracks or in derived grassland.

In addition, subsidence impacts are unlikely to adversely affect surface habitats as demonstrated by the continued health of native vegetation on previously undermined areas on WCPL land at similar depths of cover (Section 6.1).

It is concluded that significant reductions in actual or potential habitat areas of the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood are highly unlikely.

3. Habitat Fragmentation

The proposal does not involve large scale native vegetation clearance with potential to result in habitat fragmentation. Most clearance would take place within existing cleared areas (4.5 ha). Clearance in wooded areas would occur at point locations within larger areas of continuous habitat and would be limited to 3.4 ha additional to approved surface activities (Table 24). Therefore, habitat connectivity would not be reduced for the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood.

4. Critical Habitat

No Critical Habitat for any of the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood has been declared under the EPBC Act (DotE 2016c) on the Study area or surrounds. In addition, no populations of the any of these species are known on the Study area despite extensive surveys over many years. Accordingly, it is highly unlikely that habitat is present that may be critical to the survival of these species.

5. Life Cycle Disruption

None of the clearance would be in habitats likely to support White-flowered Wax Plant or the Brown Pomaderris. Similarly, Slaty Red Gum would be avoided at its recorded location. Surface disturbance would occur only at point locations with localised impacts unlikely to significantly affect ecosystem functioning. Accordingly, the ecosystem and landscape processes that support the life cycles of the four threatened species are unlikely to be significantly disrupted, if they are present.

Soil cracking as a result of subsidence is most likely to occur in the potential habitat of the Illawarra Greenhood in the lower lying terrain of the north and east of the Study area (Section 6.1). 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 any potential surface cracks would be widely spaced (Plates 17 to 20) and unlikely to impact on more than a very small part of the population, if it were present. There is no plausible scenario in which subsidence could exert a significant adverse effect on Illawarra Greenhood pollinator populations.

6. Habitat Quality

Except for a few highly localised areas, the Modification is not expected to result in a decline in habitat quality for the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood. Some 1043 ha of remnant woodland and forest remain on the Study area, of which only an additional 3.4 ha (0.33 percent) above that already approved would be disturbed for surface infrastructure.

The Wambo Coal Project and this Modification have removed considerable areas of native woodland and forest from agricultural pursuits, which has resulted in substantial natural habitat regeneration and the permanent setting aside of significant areas for the WCPL Remnant Woodland Enhancement Program. Overall, the Wambo Coal Project has resulted in a significant improvement in habitat quality for a significant area of Central Hunter Valley forest and woodland.

7. Invasive Species

Soil disturbance due to earthworks for surface infrastructure may provide temporary habitat for colonising weed species. However, extensive flora surveys of the Study area have shown that an extensive weed flora already exists in disturbed sites on the Study area as a legacy of the long history of agriculture on the site. Any weeds with potential to establish on the small Modification disturbance areas would already be established in the surrounds. Furthermore, much of the remnant forest and woodland with continuous canopy cover on the Study area has very low weed levels, especially where soils are relatively infertile. Gradual natural regeneration following the withdrawal of livestock grazing over much of the area has resulted in an overall improvement in habitat quality and a decline in exotic species.

There is no indication that subsidence soil cracking or water ponding have encouraged invasive species at Wambo or other underground mining areas.

8. Disease

Increases in plant disease incidence have not been associated anywhere with underground mining and are considered highly unlikely to occur as a result of the Modification.

9. Recovery

No Recovery Plans or recovery actions exist for the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood on the Study area. Accordingly, the Modification would not affect any current recovery actions for these species. In any event, there are no records of White-flowered Wax Plant, Brown Pomaderris or the Illawarra Greenhood on the Study area, so that general recovery actions for these species do not cover the Study area. Records of Slaty Red Gum on the Study area (BioNet, 2016) may be in error (Section 7.1). Conservation of the Slaty Red Gum is via a site-managed species strategy (OEH, 2016b). There are two proposed management sites, one near Cessnock and the other near Braemer in the Richmond Valley. No site management is proposed for the Study area.

Conclusion

From the above assessment it is concluded that the Modification would not have a significant impact on the White-flowered Wax Plant, Slaty Red Gum, Brown Pomaderris or the Illawarra Greenhood, if they were present on the Study area.

7.5.2 Threatened Ecological Communities

The potential impacts of the Modification on threatened ecological communities are assessed below using the relevant significant impact criteria (DotE, 2013) (Table 28).

Table 28.
Significant Impact Criteria for Critically Endangered Ecological Communities under the EPBC Act

Factor	Criterion
Community extent	Will the Action reduce the extent of an ecological community?
Community fragmentation	Will the Action fragment or increase fragmentation of an ecological community?
Critical habitat	Will the Action adversely affect habitat critical to the survival of an ecological community?
Abiotic factors	Will the Action modify or destroy abiotic factors necessary for an ecological community's survival?
Species composition	Will the Action cause a substantial change in the species composition of an occurrence of an ecological community?
Quality or integrity	Will the Action cause a substantial reduction in the quality or integrity of an occurrence of an ecological community?
Recovery	Will the Action interfere with the recovery of an ecological community?

Two CEECs listed in the Schedules of the EPBC Act are known to occur on the Study area (Section 4.7, Table 22), *viz.:*

- *Central Hunter Valley Eucalypt Forest and Woodland*.
- *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley*.

Assessment of Impact

1. Community Extent

The underground mining methods to be employed by the Modification avoid the need for large scale surface disturbance. The Modification would result in 7.9 ha of additional vegetation clearance (apart from subsidence remediation works if required), 4.5 ha of which is in cleared derived grasslands and 3.4 ha in areas mapped as forest or woodland (Table 24). The total area of native forest and woodland in the Study area is 1043 ha. Approval is sought to clear only 0.33 percent of this area. Of the additional 3.4 ha, only 0.9 ha involves potential clearance of an EPBC Act listed TEC, the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (Table 24). No clearing would take place within the area occupied by the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC.* Other minor surface disturbance that may be required, for subsidence monitoring for example, would be undertaken in already disturbed areas, such as beside existing access tracks, in derived grassland or in minor clearings within areas mapped as forest and woodland.

Subsidence impacts are unlikely to adversely affect surface trees, shrubs and ground cover as demonstrated by the continued health of native vegetation on parts of the Study area that have been undermined for the Whybrow and Wambo seams at shallower depths of cover (Section 6.1).

Overall, the areas affected by surface clearance are very small when compared with the large areas of remnant vegetation (1043 ha), including TECs, in the Remnant Woodland Enhancement Program areas and on the Study area as a whole. There are not expected to be any significant adverse impacts of the Modification on EPBC Act listed TECs.

2. Community Fragmentation

The proposal does not involve large scale native vegetation clearance with potential to result in habitat fragmentation for either of the CEECs listed under the EPBC Act. Most clearance for the Modification would take place within existing cleared areas (4.5 ha). Clearance in wooded areas would occur at point locations within larger areas of continuous habitat and would be limited to 3.4 ha additional to approved surface activities (Table 24). This clearance would directly affect only 0.9 ha of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (Table 24), which is well represented on the Study area and already fragmented, both naturally and by historical clearing (Figure 5). No clearing would take place within the area occupied by the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC.* The very small scale of the clearing at point locations means that habitat connectivity would not be significantly reduced for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

3. Critical Habitat

No Critical Habitat for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* or the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC* has been declared under the EPBC Act (DotE 2016c) on the Study area or surrounds. The area of habitat occupied by the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC* on the Study area is regarded as one of the three best extant occurrences of this community (OEH, 2013) and would be considered critical to its survival. This is recognised by WCPL which has fenced the area to exclude unwanted access by people or livestock. No disturbance of the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC* habitat is proposed for the Modification.

4. Abiotic Factors

Surface disturbance would occur only at point locations with localised impacts unlikely to significantly affect ecosystem functioning. Accordingly, the ecosystem and landscape processes that support the two CEECs are unlikely to be significantly disrupted by vegetation clearance.

Soil cracking as a result of subsidence has some potential to affect surface water flows by redirecting some of it to lower levels in the soil profile. However, this is unlikely to affect more than a small percentage of surface flows. It is also possible that soil cracking may damage the roots or tubers of individual plants resulting in desiccation and death. However, this is unlikely to affect more than a few individuals, since any potential surface cracks would be widely spaced (Plates 17 to 20) and unlikely to impact on more than a very small part of plant populations. The limited impact of subsidence cracking is demonstrated by the continued health of native vegetation on parts of the Study area that have been undermined for the Whybrow and Wambo seams at shallower depths of cover (Section 6.1).

The subsidence impact most likely to result to impact the two CEECs composition is topographic depression (MSEC, 2016) resulting in areas of surface water ponding. Ponding can cause tree death and conversion of dryland sites to ephemeral wetlands. However, this phenomenon is unlikely to affect more than a few small areas of woodland and forest on the Study area (MSEC, 2016). MSEC (2016) modelling indicates it would not impact the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC*, but has some potential to impact the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

5. Species Composition

The subsidence impact most likely to result in changes to plant community composition water ponding due to topographic depression (MSEC, 2016). Excessive water can cause tree death and conversion of dryland sites to ephemeral wetlands. However, ponding is unlikely to affect more than a few small areas of woodland and forest on the Study area (MSEC, 2016). MSEC (2016) modelling indicates it would not impact the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC*, but has some potential to impact the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

6. Quality or Integrity

The Wambo Coal Project and this Modification have removed considerable areas of native woodland and forest from agricultural pursuits, which has resulted in substantial natural habitat regeneration and vegetation community recovery. Significant areas of forest and woodland on WCPL-owned land have been set aside permanently for the Remnant Woodland Enhancement Program, including the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC* occurrence and large areas of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. Overall, the Wambo Coal Project has resulted in a significant improvement in habitat quality for a large area of Central Hunter Valley forest and woodland. The small amount of vegetation clearance, an additional 3.4 ha out of 1043 ha, associated with the Modification and the expected minor subsidence impacts are not considered to significantly detract from the large conservation benefits of the Remnant Woodland Enhancement Program and the habitat improvement that has taken place under WCPL management.

Soil disturbance due to earthworks for surface infrastructure may provide temporary habitat for colonising weed species. However, extensive flora surveys of the Study area have shown that an extensive weed flora already exists in disturbed sites on the Study area as a legacy of the long history of agriculture on the site. Any weeds with potential to establish on the small Modification disturbance areas would already be established in the surrounds. Furthermore, much of the remnant forest and woodland with continuous canopy cover on the Study area has very low weed levels, especially where soils are relatively infertile. Gradual natural regeneration following the withdrawal of livestock grazing over much of the area has resulted in an overall improvement in habitat quality and a decline in exotic species.

There is no indication that subsidence soil cracking or water ponding as a result of previous underground mining at Wambo or other underground mining areas have encouraged invasive species or plant diseases.

Overall, it is concluded that the Modification would not result in any significant decline in the quality or integrity of the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC* or the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

9. Recovery

No Recovery Plans or recovery actions exist specifically for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* on the Study area. Similarly, although the Study area occurrence of the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC* is recognised as one of the three best examples of the community in the National Recovery Plan (OEH, 2013), there are no recovery actions specific to the Study area site. Most recovery actions are directed to the occurrence at Jerry's Plains Cemetery. Nevertheless, WCPL has fenced the site and no disturbance associated with the Modification would occur there.

Accordingly, the Modification would not affect any current recovery actions for these CEECs.

Conclusion

From the above assessment it is concluded that the Modification would not have a significant impact on the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC* or the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

7.6 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*; River Red Gum, *Eucalyptus camaldulensis*; Large-fruited Grey Gum, *Eucalyptus punctata* and White Box, *Eucalyptus albens*, are listed as favoured Koala food trees in Schedule 2 of SEPP 44. Fragmented remnants of Forest Red Gums (Community 2, Figure 4) are scattered through the lower lying parts of the Study area, while remnant mature Large-fruited Grey Gum trees occur sparingly in the riparian zone along Stony Creek (Community 9, Figure 4) and on the steeper ridges in the west and south of the Modification area. One small patch of River Red Gum (Community 3, Figure 4) occurs in the north east of the Study area on the floodplain of Wollombi Brook and White Box is a rare tree, occupying small areas of the site. SEPP 44 requires consideration of parts 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 Gum and Large-fruited Grey Gum, 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, 2016; Niche Environment and Heritage, 2014). Accordingly, the Study area does not include ‘core’ Koala habitat and an SEPP 44 plan of management is not required.

8 IMPACT AVOIDANCE AND MITIGATION MEASURES

Key impact avoidance and mitigation measures relevant to flora are described in Section 3.2 of the Modification main text, including:

1. Minimising surface infrastructure extent. Surface components of the Modification have been designed to be as small as practicable within technical constraints.

2. Siting surface infrastructure to avoid and/or minimise impacts on threatened species, populations and communities. Surveys of potential gas management infrastructure locations should be conducted to identify any threatened flora (e.g. species, communities or populations). If any threatened flora is identified, consideration would be given to relocating the works so as to avoid direct impacts.

Impacts to threatened communities would be minimised by the minor nature of the disturbance (small, isolated and temporary) and by locating the surface components to reduce clearance requirements (e.g. using existing cleared areas or areas with a sparse mid/over story).

Due to their sparse nature across the Modification area, surface impacts should be avoided to the *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC (*also listed under the EPBC Act as *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley*) and the two threatened populations *Acacia pendula* and *Cymbidium canaliculatum.*

3. Temporary nature of surface components. Surface disturbance associated with gas management infrastructure would be temporary and isolated in nature. The surface disturbance would occur progressively over the life of the Modification and should be rehabilitated progressively as the gas management infrastructure is no longer required.

9 PROPOSED BIODIVERSITY OFFSET STRATEGY

Some 7.9 ha of native vegetation is proposed to be cleared for the Modification, of which 3.4 ha is in areas mapped as native forest or woodland and 4.5 ha is in cleared areas currently supporting derived native grassland (Figure 4, Table 29). To offset these native vegetation losses, the existing Remnant Woodland Enhancement Program (RWEP) area would be augmented with an additional offset area, RWEP Area E, as part of the Modification. The proposed offset strategy is described in Sections 9.1 (characteristics), 9.2 (proposed management), 9.3 (reconciliation against OEH offset principles), 9.4 (ecological gains) and 9.5 (reconciliation against EPBC Act requirements). It is proposed that the existing RWEP area located within the Modification Study area would be expanded by the addition of 41.6 ha of adjoining land, RWEP Area E (Table 29, Figures 4 and 7). The vegetation communities in the proposed offset area (Figure 7) are described as part of this report (Section 4.2).

9.1 OFFSET AREA CHARACTERISTICS

The proposed offset area includes remnants of three natural vegetation communities; Forest Red Gum Floodplain Forest, Narrow-leaved Ironbark – Grey Box Woodland and Grey Box – Slaty Box Woodland, as well as areas of derived grassland (Table 29, Figure 7). Most of the natural vegetation has been disturbed historically by semi-clearing, logging and grazing. Protection of these areas from grazing and further disturbance is intended to facilitate natural regeneration and an improvement in condition over time. All three natural communities in the proposed offset area comprise parts of Endangered or Critically Endangered ecological communities listed at the State or Federal levels (Table 29).

The proposed offset area was selected in consideration of a range of factors:

1. Relationship to existing offset areas.
2. Proximity to the Modification area.
3. Regional conservation priorities and vegetation most in need of conservation.
4. The available land tenure on which to locate an offset area.
5. The vegetation composition of the Modification area relative to the proposed offset area; meeting the ‘like for like or better’ criterion.
6. The size of the proposed offset area relative to the Modification area.
7. The ecosystem resilience and condition of the proposed offset area.
8. The presence of similar threatened species and ecological community records and/or potential habitat to those within the Modification area.

These factors are discussed collectively in Sections 9.1.1 to 9.1.5 below.

Table 29
Comparison of Vegetation Community Areas in the Proposed Disturbance and Offset Area

Comm. Number	Community Name	Status				Proposed Disturbance Area (ha)	Proposed Offset	
		TSC Act		EPBC Act				
1	River Oak Riparian Woodland	-	-	-	-	0	0	
2	Forest Red Gum Lowland Forest	E	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	-	-	0.4	9.1	9.1
2a	Forest Red Gum – *Melaleuca decora* Forest						0	
3	River Red Gum Woodland	E	Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC	-	-	0.2	0	
4	Rusty Fig – Native Quince – Native Olive Dry Rainforest	-	-	-	-	0	0	
5	Spotted Gum – Narrow-leaved Ironbark – Grey Box Woodland	E	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	CE	Central Hunter Valley Eucalypt Forest and Woodland	0	0	
6	Narrow-leaved Ironbark – Grey Box Woodland	E	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	CE	Central Hunter Valley Eucalypt Forest and Woodland	0	1.1	13
6a	Narrow-leaved Ironbark – Grey Box Woodland (Disturbed)						11.9	
7	Bull Oak Grassy Woodland	-	-	-	-	1.8	0	
8	Weeping Myall Woodland	E	Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	CE	Hunter Valley Weeping Myall [*Acacia pendula*] Woodland	0	0	
9	Sandstone Riparian Scrub	-	-	-	-	0	0	
10	*Melaleuca decora* Low Forest	-	-	-	-	0.1	0	
11	Grey Box – Slaty Box Woodland	V	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	CE	Central Hunter Valley Eucalypt Forest and Woodland	0.9	4.9	5
11a	Grey Box – Slaty Box Woodland (Disturbed)						0.1	
12	Rough-barked Apple – Coast Banksia Woodland	E	Warkworth Sands Woodland in the Sydney Basin Bioregion	-	-	0	0	
13	Derived Grassland	-	-	-	-	4.5	14.5	
					Total:	**7.9**	**41.6***	

* Excludes 1.1 ha of existing disturbed land (roads, access tracks, existing exploration sites etc.) and 0.6 ha (0.3 ha of Community 2, 0.2 ha of Community 6a and 0.1 ha of Community 11) that may be subject to disturbance due to surface infrastructure.

9.1.1 Vegetation Types

The proposed offset area is within the Modification area and includes similar vegetation to that which would be disturbed by the Modification (Table 29, Figures 4 and 7). Two disturbance area communities; Forest Red Gum Lowland Forest (0.4 ha) and Grey Box – Slaty Box Woodland (0.9 ha) are well represented in the offset area, 9.1 and 5 ha, respectively (Table 29). However, there are some differences; three communities in the disturbance areas that are not listed as threatened are absent from the offset area. Two of these are represented by very small areas; River Red Gum Woodland (0.2 ha) and *Melaleuca decora* Low Forest (0.1 ha) (Table 29). The third unrepresented community, Bull Oak Grassy Woodland, is proposed to have a larger area of disturbance (1.8 ha), however it is a derived community resulting from the clearing of Narrow-leaved Ironbark – Grey Box Woodland, which is well represented in the proposed offset area (13.2 ha).

It is considered that the vegetation of the proposed offset area, although not exactly 'like for like' in terms of each individual vegetation community, nevertheless represents similar good quality vegetation of high conservation value and satisfies the 'like-for-like or better conservation outcomes' because:

- Forest Red Gum Floodplain Forest is listed as Endangered in NSW and is very poorly represented in the central Hunter Valley. With 9.1 ha protected compared to the 0.4 ha disturbed, the offset area represents a significant environmental gain for this community.
- The offset area would protect 18 ha of the EPBC Act listed *Central Hunter Valley Eucalypt Forest and Woodland CEEC*, against the 0.9 ha proposed to be cleared.
- The proposed offset contains 13 ha of a vegetation community not present in the disturbance areas; Narrow-leaved Ironbark - Grey Box Woodland, which is part of the TSC Act listed *Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC* and the EPBC Act listed *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.
- The Little Lorikeet (*Glossopsitta pusilla*) was recorded in the proposed offset area.
- The proposed offset includes a significant length of Stony Creek and its riparian zone. This important landscape element provides a key habitat resource for wildlife and its restoration would be important for landscape functioning.
- The proposed offset also includes representations of all the fauna habitat types that would be impacted by the Modification.
- The proposed offset area does not include any *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* or *Eucalyptus camaldulensis population in the Hunter Catchment EP*, both of which are impacted by the same 0.2 ha of proposed clearance of a small patch of River Red Gums, *E. camaldulensis*. However, a significant area of this EEC and EP are protected in RWEP Area A, which was established to offset other vegetation communities in 2003. Subsequent surveys in 2012 have shown that RWEP Area A includes over 300 River Red Gums, many of which are mature old growth trees.

9.1.2 Relationship to Existing Offset

The proposed offset adjoins the existing Remnant Woodland Enhancement Program Area B which was set aside to offset disturbance resulting from the 2003 approval of the Wambo Development Project and subsequent Modifications. Expansion of the existing Remnant Woodland Enhancement Program Area B would increase its size and long term sustainability, and is preferable to establishing an entirely new, small offset area elsewhere.

9.1.3 Proximity to the Modification Area

The proposed offset area is located within the same Local Land Services (LLS) region and IBRA subregion as the Study area (i.e. the Hunter LLS Region and the Hunter subregion of the Sydney Basin Bioregion) and would therefore benefit biodiversity values in the same region as the Study area.

9.1.4 Size and Shape

The proposed offset is 41.6 ha while the Modification disturbance area is 7.9 ha. The addition of the proposed offset area to the Remnant Woodland Enhancement Program area creates a larger and more viable conservation area overall. The offset is approximately square, thereby maximising the perimeter to area ratio and minimising potential edge effects.

9.1.5 Ecosystem Resilience and Condition

The vegetation communities in the proposed offset area are similar to or better in condition than those in the disturbance areas (Figure 9, Table 25). In general the disturbance areas are small point locations, whereas the offset comprises a much larger area of contiguous bushland, albeit disturbed historically. The small size and highly fragmented nature of the disturbance areas associated with the infrastructure area and access road renders them intrinsically less valuable than the more continuous offset area vegetation. In addition, as far as practicable the ventilation and gas management infrastructure would be installed in existing clearings and openings within woodland areas of the Modification, minimising the actual vegetation losses. From this consideration it can be seen that the calculated vegetation losses on the basis of vegetation mapping overestimate the actual losses that are likely to occur. Accordingly, the offset ratios are conservative.

9.2 OFFSET AREA MANAGEMENT

9.2.1 Conservation in Perpetuity

The existing Remnant Woodland Enhancement Program areas are located on land held by WCPL and are in the process of being protected in perpetuity by a Voluntary Conservation Agreement. The same method of conservation security would be applied to the proposed RWEP Area E.

9.2.2 Proposed Management and Management Plan

The management of the proposed offset area would be described within an updated Flora and Fauna Management Plan (FFMP). Management measures should include:

- exclusion of livestock grazing;
- control of weeds;

- management of exotic animal pests;
- bushfire management;
- revegetation;
- control of vehicular access; and
- minimising disturbance.

Brief summaries of these management strategies are given below.

Management of Livestock Grazing

Uncontrolled livestock and feral animal grazing would be prevented by appropriate fencing of the proposed offset area.

Control of Weeds

Seven introduced species, listed as Noxious for Singleton Shire (DPI, 2015) have been recorded within the Modification area (Section 4.4). All are listed as Category 3 or 4 weeds and would be controlled by appropriately qualified personnel using standard environmentally safe mechanical or chemical control methods. Regular site inspections would identify the need for further control. However, none of the weeds are abundant and most are uncommon indicating a generally low risk and previous good control.

Animal Pest Management

Five introduced pest animal species listed as Key Threatening Processes have been observed within the vicinity of the proposed offset area, namely the Red Fox (*Vulpes vulpes*), Feral Dog (*Canis familiaris*), European Brown Hare (*Lepus europaeus*) and the European Rabbit (*Oryctolagus cuniculus*) (Ecological 2016). These, and other noxious and feral species that may be present, would be controlled and monitored by appropriately qualified personnel using standard and ethical methods.

Bushfire Management

Bushfire prevention is required under the *Rural Fires Act, 1997*. Appropriate access tracks throughout the proposed offset would be maintained for fire management. Fuel loads would be monitored annually and hazard reduction burns conducted in consultation with the Rural Fire Service, as necessary. The FFMP and/or voluntary conservation agreement would establish a bushfire management strategy to reduce the risk of bushfire outbreaks and to establish emergency responses (including fires lit by lightning).

Revegetation

It is intended that the offset vegetation would be allowed to regenerate naturally to preserve the genetic integrity of the existing flora. This is likely to be successful within those parts of the area that have substantial remnant native tree and shrub cover. It is expected that native tree and shrub cover would migrate gradually outwards from existing remnants into areas of derived grassland, as has been occurring on various other parts of WCPL land from which grazing has been withdrawn. In the more fertile parts of the offset area formerly occupied by Forest Red Gum Floodplain Forest, natural revegetation may be inhibited by dense growth of exotic grasses and other weeds. If there is no indication of natural regeneration of the lowland alluvial parts of the offset within five years, a program of replanting would be initiated. The details of any rehabilitation program would be outlined in the FFMP and/or voluntary conservation agreement.

Controlling Vehicular Access

Vehicular access would be controlled by fencing, signing the proposed offset, locking gates and restricting access to authorised personnel.

Minimising Disturbance

Disturbance from surface infrastructure within RWEP Area E would be minimised by implementing the strategies described in Section 8 and limiting disturbance to 0.6 ha (0.3 ha of Community 2, 0.2 ha of Community 6a and 0.1 ha of Community 11).

The areas used in the assessment of the proposed offset against the NSW and Federal offset principles, including applying the EPBC Offset Calculator are all exclusive of the areas quoted above that may be subject to disturbance from surface infrastructure.

As the proposed offset is partially located above the longwall mining area it would be subject to subsidence movements as part of the Modification. However as described in Section 6.1 it is very unlikely that subsidence would result in any material impacts to the vegetation within the offset area. Section 6.1 also describes ponding along Stony Creek (traverse the proposed offset area) as a potential impact of the Modification although clarifies that impacts due to ponding would be lower for the Modification than for the approved arrangement. In regard to potential ponding impacts, Advisian (2016) concludes that remediation of ponding by regrading creek beds are likely to result in a greater disturbance (e.g. erosion and surface disturbance) than the ponding itself.

Notwithstanding, monitoring of potential subsidence and ponding impacts would be undertaken (including within the offset area) as part of the Modification. WCPL would also undertake geomorphic surveys of Stony Creek before and after mining to measure change against. If any impact is observed within the proposed offset, remedial measures would be considered by WCPL in consultation with DP&E, DRE and OEH.

9.2.3 Monitoring

The existing offset monitoring program on WCPL offset areas would be expanded to the proposed offset to monitor and report on the effectiveness of offset management measures. The monitoring would be undertaken by a suitably qualified person(s).

9.3 RECONCILIATION OF THE PROPOSED OFFSET STRATEGY AGAINST OEH OFFSET PRINCIPLES

The OEH has developed principles for the use of offsets for projects other than those that are State significant (OEH, 2014). The proposed biodiversity offset strategy for the Modification provides for residual impacts to biodiversity resulting from approximately 7.9 ha of surface disturbance of native vegetation. The biodiversity offset strategy involves the establishment of a 41.6 ha Offset (RWEP Area E) and securing its long term protection and management. A reconciliation of the proposed biodiversity offset strategy against the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014) is provided in Table 30.

Table 30.
Reconciliation of the Proposed Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2014)	How the Proposed Offset Strategy Addresses the OEH Offset Principles
1. *Impacts must be avoided first by using prevention and mitigation measures.*	The offset strategy addresses residual impacts associated with the Modification. Prior to offset development impacts have first been avoided and minimised, as described in Section 8.
2. *All regulatory requirements must be met.*	WCPL is required to meet all statutory requirements and the offset strategy is not proposed to substitute other licence/approval requirements.
3. *Offsets must never reward ongoing poor performance.*	The offset strategy addresses residual impacts associated with the Modification.
4. *Offsets would complement other government programs.*	The proposed offset area would complement other lands already conserved by the State government (resulting in a greater area of vegetation conserved in NSW).
5. *Offsets must be underpinned by sound ecological principles.*	The proposed offset area expands the existing Remnant Woodland Enhancement Program area (Figures 4 and 7), thereby resulting in a larger conservation area. The structure, function and compositional elements of biodiversity (including threatened species and ecological communities) have been considered in the selection of the proposed offset area (Section 9.1). Biodiversity is likely to be enhanced at a range of scales due to the proposed management measures, particularly the exclusion of livestock grazing, weed and feral animal management and strategic rehabilitation. The proposed enhancement of the habitat would contribute towards protecting the long-term viability and functionality of local biodiversity.
6. *Offsets should aim to result in a net improvement in biodiversity over time.*	The offset strategy targets vegetation communities and high conservation priorities in the region. It is considered that the vegetation of the proposed offset, although not exactly 'like for like' in terms of vegetation communities, nevertheless represents good quality vegetation of high conservation value and satisfies the 'like-for-like or better conservation outcomes', for the following reasons: • Three of the vegetation communities are threatened and known to be inadequately protected in the region at present. • The proposed offset adjoins and enhances the existing Remnant Woodland Enhancement Program area, improving its long term viability. • The condition of the vegetation in the proposed offset area is at least equivalent to that in the disturbance areas. • Fauna habitat types impacted by the Modification are all represented in the proposed offset area. • The proposed offset includes land previously disturbed that would be managed to improve its biodiversity values over time.

OEH Offset Principles (OEH, 2014)	How the Proposed Offset Strategy Addresses the OEH Offset Principles
7. Offsets must be enduring. They must offset the impact of the development for the period that the impact occurs.	The proposed offset will be secured and managed by Voluntary Conservation Agreement in the same way as the existing Remnant Woodland Enhancement Program area to which it would be added.
8. Offsets should be agreed prior to the impact occurring.	The offset strategy addresses residual impacts associated with the Modification.
9. Offsets must be quantifiable. The impacts and benefits must be reliably estimated.	The impacts and benefits have been reliably assessed as follows: • The area of impact and proposed offset is quantified in Table 29 and shown on Figure 7. • The types of vegetation communities and habitat to be conserved are described and mapped. • The conservation status of vegetation communities and threatened species has been assessed, mapped and quantified, where relevant.
10. Offsets must be targeted.	The offset strategy addresses residual impacts associated with the Modification. The proposed offset area was selected in consideration of a range of factors, including: 1. Relationship to existing offset areas. 2. Proximity to the Modification area. 3. Regional conservation priorities and vegetation most in need of conservation. 4. The available land tenure on which to locate an offset area. 5. The vegetation composition of the Modification area relative to the proposed offset area; meeting the 'like for like or better' criterion. 6. The size of the proposed offset area relative to the Modification area. 7. The ecosystem resilience and condition of the proposed offset area. 8. The presence of similar threatened species and ecological community records and/or potential habitat to those within the Modification area.
11. Offsets must be located appropriately.	The proposed offset area is located within the Modification area in a similar topographic, climatic and geographic environment. It also adjoins the existing RWEP Areas.
12. Offsets must be supplementary.	The implementation of the offset strategy is beyond existing requirements, in that it is not part of any conservation reserve system or existing offset.
13. Offsets and their actions must be enforceable through Development Consent conditions, licence conditions, conservation agreements or a contract.	The offset requirement is likely to be a condition of Project approval and its management in perpetuity required by a conservation agreement that would be registered on the title of the land.

9.4 ECOLOGICAL GAINS OF THE PROPOSED OFFSET

It is considered that the Modification meets the standard in the requirements of the Director-General of the NSW DP&E that flora biodiversity values in the region would be maintained and improved in the long-term. The proposed offset contains a similar array of natural vegetation types (and vegetation communities) to those in the disturbance areas, which are also in similar condition.

Ecological gains from the proposed biodiversity offset area are listed below:

- Similar vegetation communities/fauna habitats to the disturbance areas would be conserved/ enhanced in the proposed biodiversity offset.
- The proposed offset is suitably located to benefit flora and fauna populations (biodiversity values) potentially impacted by the Modification.
- The proposed offset area removes a substantial area of native vegetation from the deleterious effects of livestock grazing thereby allowing it to recover and improve over time.
- The proposed offset area is located adjacent to an existing biodiversity offset area (Remnant Woodland Enhancement Program) and would complement the existing reserve system (Figures 4 and 7).
- There is capacity for the ecological function of the vegetation in the proposed biodiversity offset area to significantly improve with the removal of grazing by livestock, strategic rehabilitation where needed and the control of weeds and feral animals such as rabbits and foxes.

The proposed biodiversity offset strategy is therefore considered to be a suitable offset against the residual flora and fauna impacts associated with the Modification.

9.5 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The former Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has developed principles for the use of offsets for projects affecting Matters of National Environmental Significance (MNES) under the EPBC Act (SEWPaC, 2012). The proposed biodiversity offset strategy for the Modification compensates for residual significant impacts to MNES resulting from approximately 7.9 ha of surface disturbance of native vegetation, of which 0.9 ha involves clearance of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and approximately 3.4 ha of potential habitat for the Regent Honeyeater listed under the EPBC Act. The offset strategy involves the establishment of a 41.6 ha offset (RWEP Area E) and securing its long term protection and management.

The area of disturbance described and assessed in this report slightly differs from the area described and assessed in the EPBC Act Referral lodged with the Department of the Environment. This difference is due to the Referral describing an Action that excludes portions of the Project being assessed by the NSW government as they overlap with an existing EPBC Act approval for the Wambo Coal Mine. The difference in area as it relates to the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and the Regent Honeyeater is described in footnotes of Table 31.

Section 9.4.1 provides an assessment of the proposed offset strategy against the EPBC Act Offset Calculator (SEWPaC, 2012) (and supporting *EPBC Act Offsets Assessment Guide*) and Section 9.4.2 provides a reconciliation of the proposed offset strategy against the *Commonwealth Environmental Offsets Policy* (SEWPaC, 2012).

9.5.1 EPBC Offset Calculator

In applying the EPBC Offset Calculator the following values/assumptions were used:

- Average start quality of vegetation to be disturbed, 7.
- Average start quality of the offset, 6 (considering the large proportion of 'disturbed' woodland variant present within the offset area).
- A loss of 1 condition score if the offset (and its management/protection) is not in place and a gain of 2 condition score (over 10 years) if the offset is in place.
- All vegetation communities and fauna habitat types (excluding the derived grassland) were conservatively assumed to provide potential habitat for the Regent Honeyeater

As shown in Table 31, the proposed offset meets more than 100% of the EPBC Act offset liability and is therefore consistent with the requirements of the *Environment Protection and Biodiversity Conservation Act, 1999 Environmental Offsets Policy* (SEWPaC, 2012).

Table 31.
Assessment of Proposed Offset Area against EPBC Act Offset Policy

MNES	Area of Habitat Impacted (ha)	Area of Habitat in Offset Area (ha)	Offset Policy Met[1]
Central Hunter Valley Eucalypt Forest and Woodland	0.9[2]	18.3	Yes (402.38%)
Regent Honeyeater	3.4[3]	27.7	Yes (161.22%)

[1] In accordance with the *Environment Protection and Biodiversity Conservation Act, 1999 Environmental Offsets Policy* (SEWPaC, 2012).

[2] Described in the EPBC Referral as 4 ha. The 3.1 ha difference is already provided for in the existing Wambo biodiversity offsets and therefore this assessment focuses on offsetting the additional 0.9 ha.

[3] Described in the EPBC Referral as 4.7 ha. The 1.3 ha difference is already provided for in the existing Wambo biodiversity offsets and therefore this assessment focuses on offsetting the additional 4.7 ha.

9.5.2 EPBC Offset Principles

A reconciliation of the proposed Offset strategy against the EPBC offset principles from the *Commonwealth Environmental Offsets Policy* (SEWPaC, 2012) is provided in Table 32.

Table 32.
Reconciliation of the Proposed Offset Strategy against EPBC Act Offset Principles

EPBC Act Offset Principles (SEWPaC, 2012)	How the Proposed Offset Addresses the OEH Offset Principles
Offsets must: 1. *deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action*	A major focus of the offset strategy is the protection and enhancement of 18 ha of the EPBC Act listed *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. This compares with 0.9 ha of this vegetation that would be cleared for the Modification (an offset ratio of 20:1). Much of the vegetation in the offset area is in a disturbed condition, having been semi-cleared, logged and grazed historically. The offset would be fenced to exclude livestock and managed to control weeds and feral animals under a management plan to be approved by the Department of the Environment. It is expected that the condition of the offset area will improve over time through management including natural regeneration and, where necessary, strategic plantings.
2. *be built around direct offsets but may include other compensatory measures*	The whole offset strategy is the setting aside of a direct offset of 41.6 ha, almost half of which (18 ha) comprises the federally listed *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and 27.1 ha comprises potential habitat for the Regent Honeyeater. The offset would be secured in perpetuity through a Voluntary Conservation Agreement with the NSW National Parks and Wildlife Service.
3. *be in proportion to the level of statutory protection that applies to the protected matter*	The Modification is proposed to impact 0.9 ha of the EPBC Act listed *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and 3.4 ha of potential habitat for the Regent Honeyeater. The statutory protection level of Critically Endangered for both merits a strong offset response. The proposed offset meets this expectation with the reservation of 18 ha of the threatened community at an offset ratio of 20:1 and 27.1 ha of Regent Honeyeater habitat compared to 3.4 ha disturbed.
4. *be of a size and scale proportionate to the residual impacts on the protected matter*	

EPBC Act Offset Principles (SEWPaC, 2012)	How the Proposed Offset Addresses the OEH Offset Principles
5. *effectively account for and manage the risks of the offset not succeeding*	The proposed offset area expands the existing Remnant Woodland Enhancement Program area (Figures 4 and 7), thereby resulting in a much larger conservation area that is likely to be more viable in the long term. The offset would be managed under the existing FFMP. This management plan specifies how all identifiable threats to offsets would be managed, monitored and reported upon. It also includes strategies for ensuring that the expected levels of habitat improvement are achieved, e.g. if natural regeneration of endemic native trees and shrubs does not occur in derived grasslands, a strategic program of plantings would be initiated.
6. *be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6)*	The implementation of the proposed offset strategy is beyond existing requirements, in that it is not part of any existing conservation reserve system or offset.
7. *be efficient, effective, timely, transparent, scientifically robust and reasonable*	The proposed offset will be secured and managed by Voluntary Conservation Agreement through the NSW National Parks and Wildlife Service in the same way as the existing Remnant Woodland Enhancement Program area to which it would be added. This process ensures transparency, scientific robustness, efficiency and effectiveness. Timeliness is guaranteed by the fact that the offset land is already in WCPL ownership and the company is committed internally to its allocation as an offset. The reasonableness of the proposed offset is demonstrated by its practical square shape with low perimeter to area ratio and its landscape position adjoining and expanding an existing larger offset area.
8. *have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.*	Governance of the offset would be through a management plan with clear lines of responsibility in WCPL. The point of contact would be the WCPL Manager: Environment and Community. The management plan would specify offset monitoring methods, timing, reporting and auditing. Enforcement of approval conditions relating to offsets would be through reports on offset condition to the NSW government. The management, monitoring and reporting of the proposed offset area would also be formalised in a conservation agreement with the NSW Minister for the Environment. This agreement would be registered on the title of the land and therefore would apply in perpetuity.

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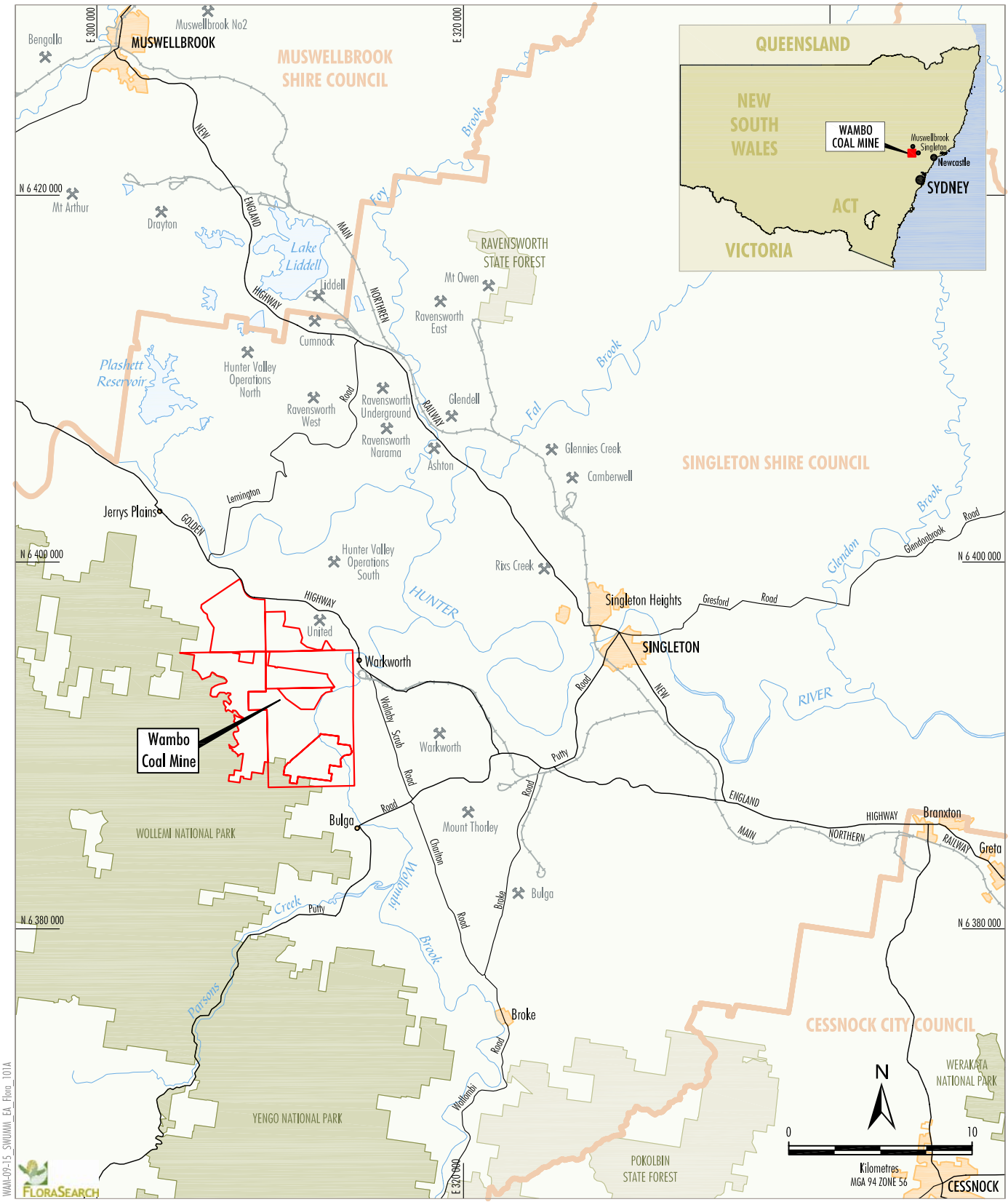
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FIGURES



LEGEND

- Mining and Coal Lease Boundary
- Local Government Boundary
- Mining Operation

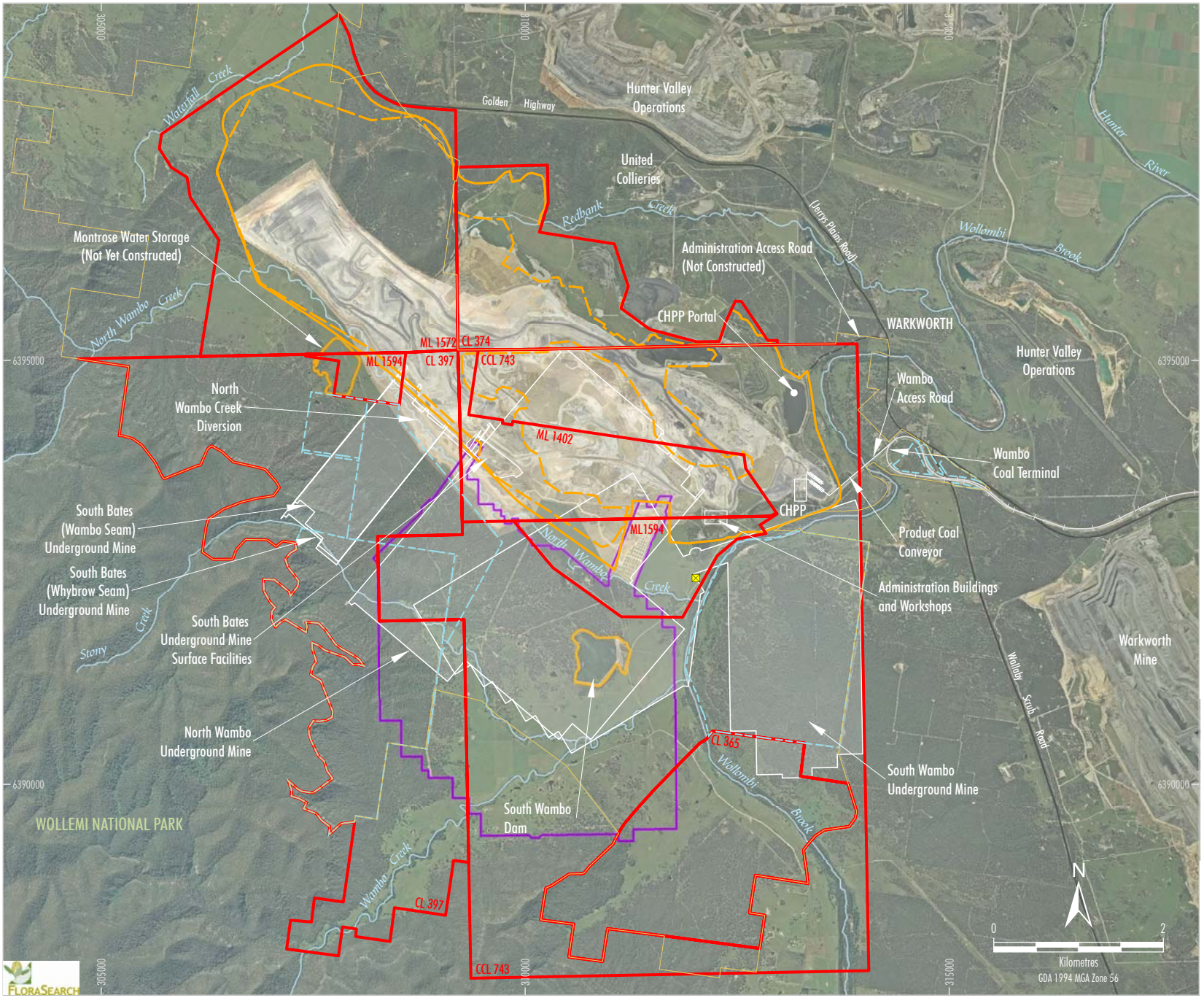
Source: Geoscience Australia (2009)

Peabody ENERGY

WAMBO COAL MINE

Regional Location

Figure 1



LEGEND

- Mining and Coal Lease Boundary
- WCPL Owned Land
- Existing/Approved Surface Development Area
- Approved Open Cut Limit
- Approved Underground Development
- Historic Underground Workings
- Approved Ventilation Shaft
- Remnant Woodland Enhancement Program (RWEP) Area

Source: Department of Lands (July 2009); WCPL (2015); WCPL Orthophoto (Apr-Oct 2013)

Peabody ENERGY

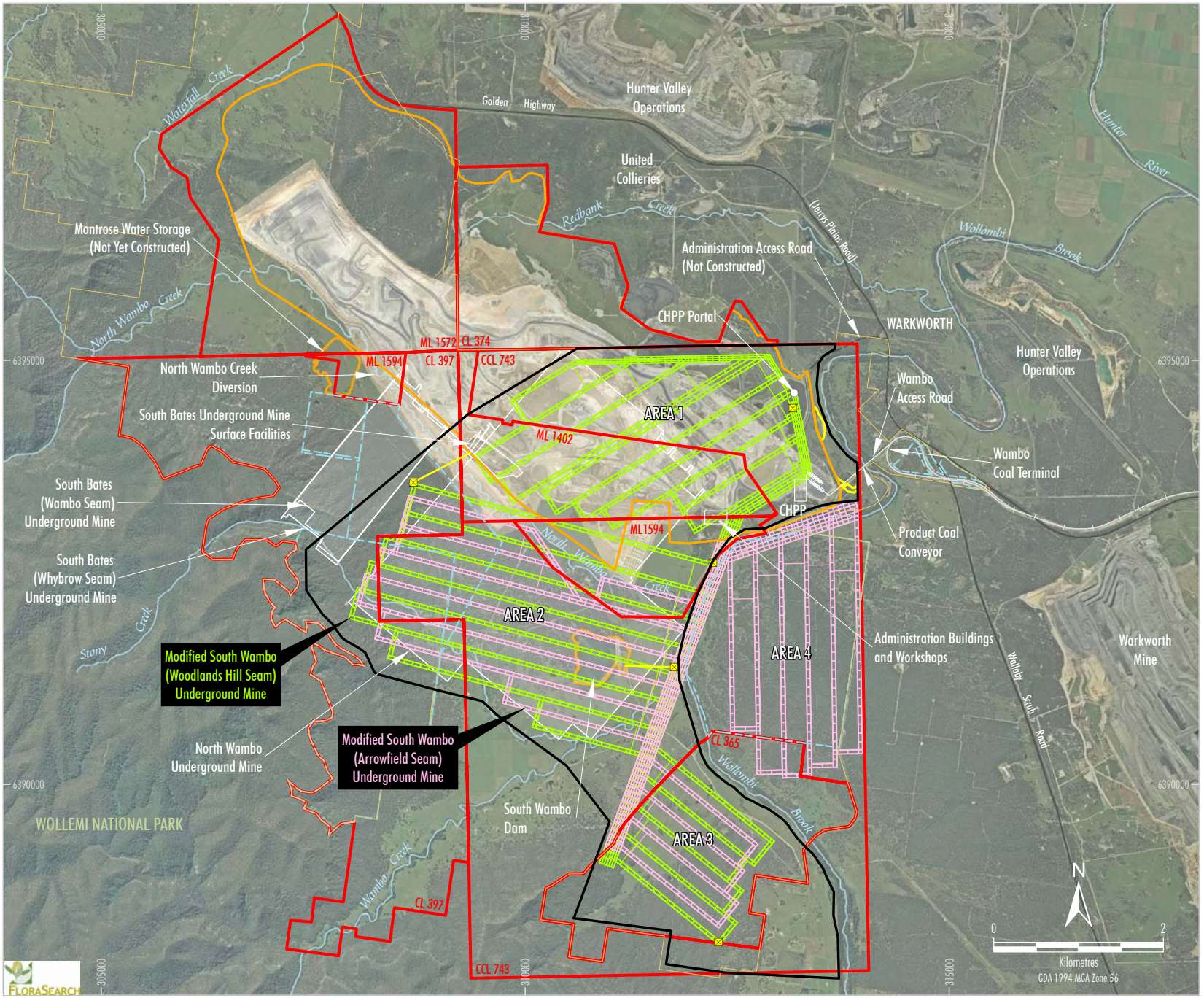
WAMBO COAL MINE

Approved Wambo Coal Mine General Arrangement

Figure 2

FLORASEARCH

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Peabody ENERGY

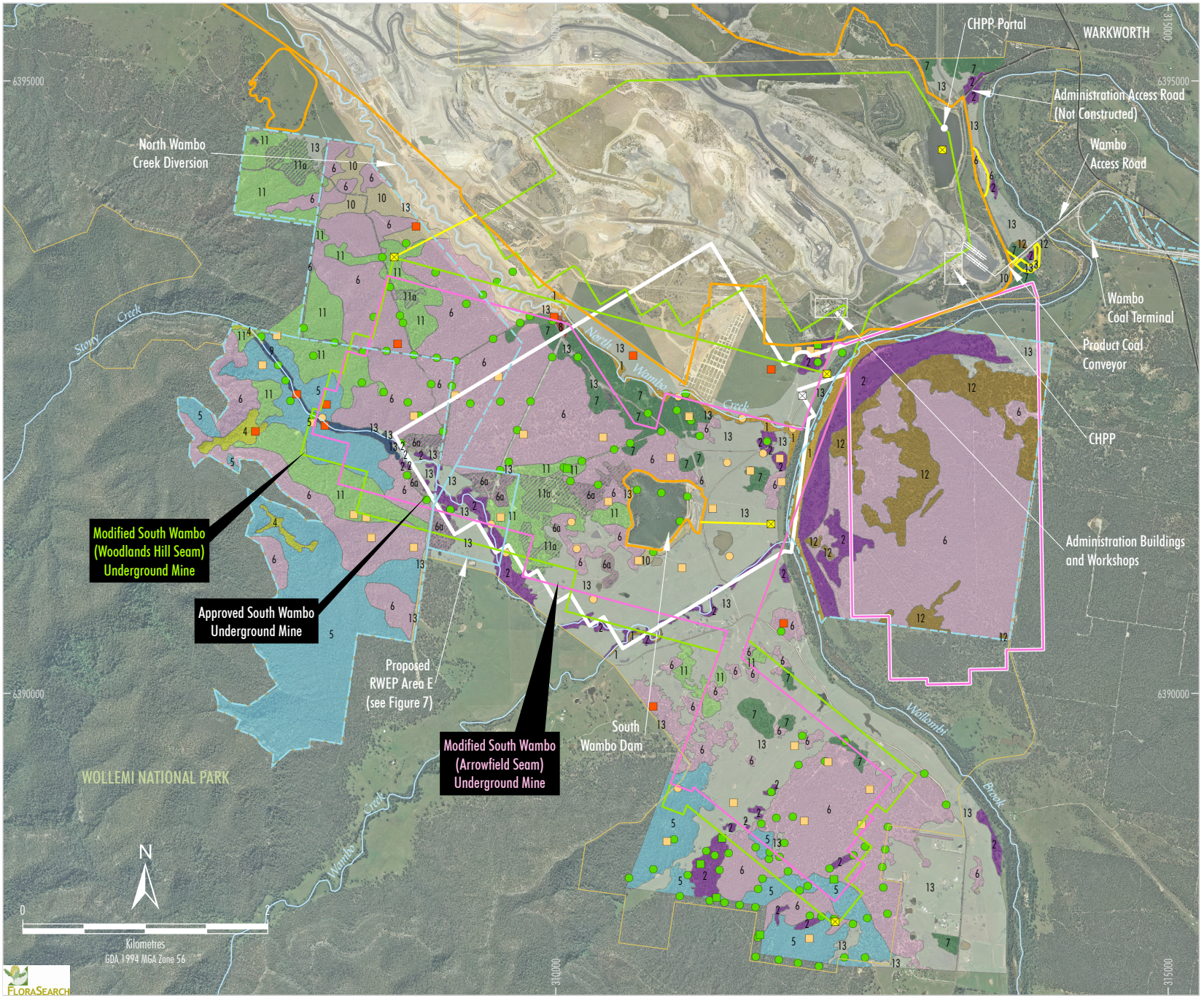
WAMBO COAL MINE

Modified Wambo Coal Mine
General Arrangement

Figure 3

FLORASEARCH

WAM-09-15_SWUMM_EA_Flora_202B



LEGEND

- Existing/Approved Surface Development Area
- Modified Surface Development Area
- Approved South Wambo Underground Mine Development
- Modified South Wambo (Woodlands Hill Seam) Underground Mine
- Modified South Wambo (Arrowfield Seam) Underground Mine
- Approved Ventilation Shaft
- Modified Ventilation Shaft
- Remnant Woodland Enhancement Program (RWEP) Area
- WCPL Owned Land

Sample Sites

- 2015 South Wambo Modification Quadrat locations
- 2010-2015 Quadrat locations
- 2010-2015 Spot Sample locations
- Pre-2010 Quadrat Locations
- Pre-2010 Spot Sample Locations

Vegetation Communities

- Community 1 - River Oak Riparian Woodland
- Community 2 - Forest Red Gum Floodplain Forest
- Community 3 - River Red Gum Woodland
- Community 4 - Rusty Fig - Native Quince - Native Olive Dry Rainforest
- Community 5 - Spotted Gum - Narrow-leaved Ironbark - Grey Box Woodland
- Community 6 - Narrow-leaved Ironbark - Grey Box Woodland
- Community 6a - Narrow-leaved Ironbark - Grey Box Woodland (Disturbed)
- Community 7 - Bull Oak Grassy Woodland
- Community 8 - Weeping Myall Woodland
- Community 9 - Sandstone riparian scrub
- Community 10 - *Melaleuca decora* Low Forest
- Community 11 - Grey Box - Slaty Box Woodland
- Community 11a - Grey Box - Slaty Box Woodland (Disturbed)
- Community 12 - Rough-barked Apple - Coast Banksia Woodland
- Community 13 - Derived Grassland

Proposed Offset Area

- RWEP Area E

Source: Department of Lands (July 2009); WCPL (2015); WCPL Orthophoto (Apr-Oct 2013)

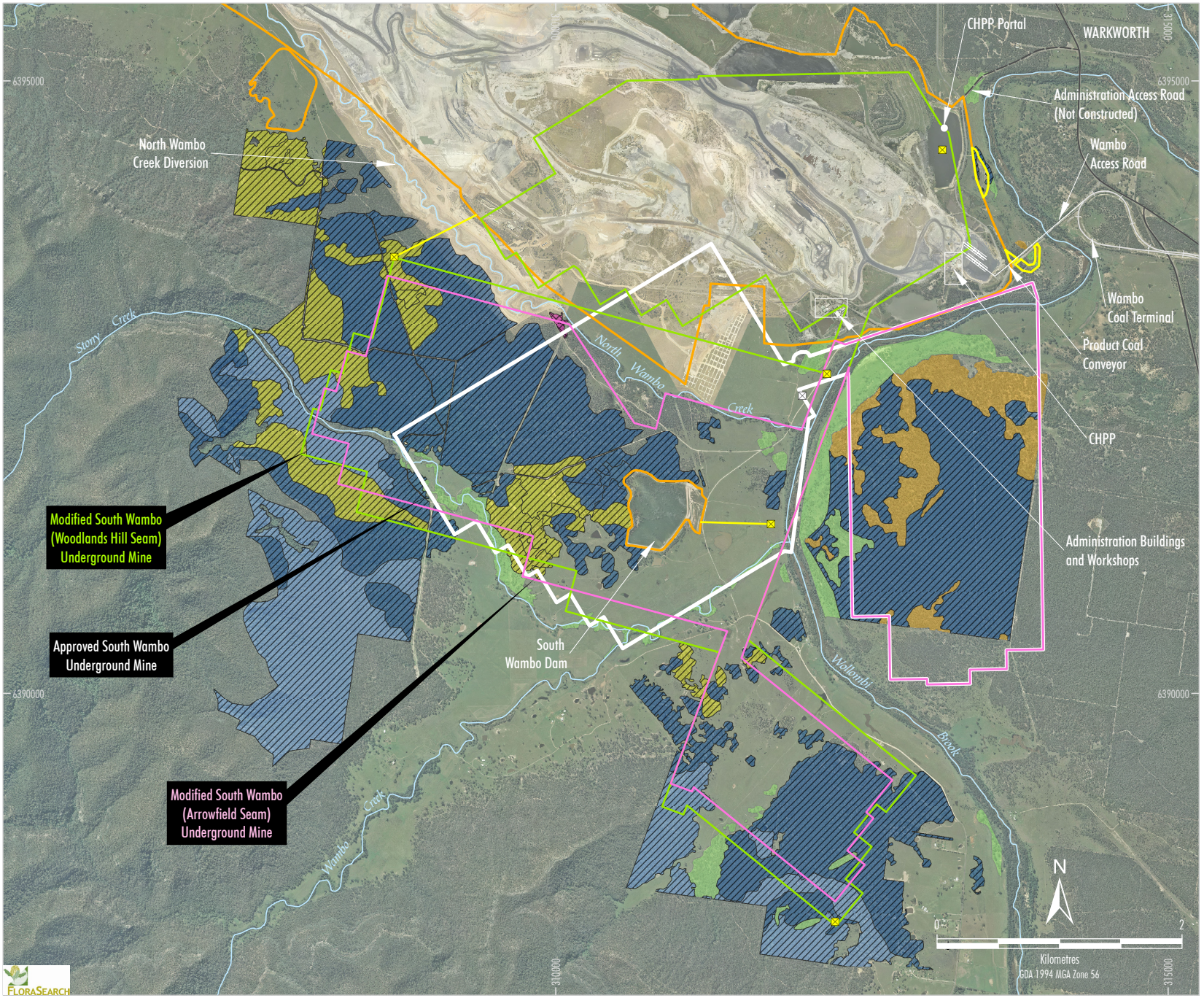
Peabody ENERGY

WAMBO COAL MINE

Vegetation Communities and Flora Sampling Locations

Figure 4

WAM-09-15_SWUMM_EA_Flora_203F



LEGEND

- Modified Surface Development Area
- Existing/Approved Surface Development Area
- Approved South Wambo Underground Mine Development
- Modified South Wambo (Woodlands Hill Seam) Underground Mine
- Modified South Wambo (Arrowfield Seam) Underground Mine
- Approved Ventilation Shaft
- Modified Ventilation Shaft

Threatened Ecological Communities - TSC Act

- Central Hunter Grey Box-Ironbark Woodland EEC
- Central Hunter Ironbark-Spotted Gum-Grey Box Forest EEC
- Hunter Lowland Redgum Forest EEC
- Hunter Valley Footslopes Slaty Gum Woodland VEC
- Hunter Valley Weeping Myall Woodland EEC
- Warkworth Sands Woodland EEC

Threatened Ecological Communities - EPBC

- Central Hunter Valley Eucalypt Forest and Woodland CEEC
- Hunter Valley Weeping Myall *(Acacia pendula)* Woodland CEEC

Source: Department of Lands (July 2009); WCPL (2015); WCPL Orthophoto (Apr-Oct 2013)

Peabody ENERGY

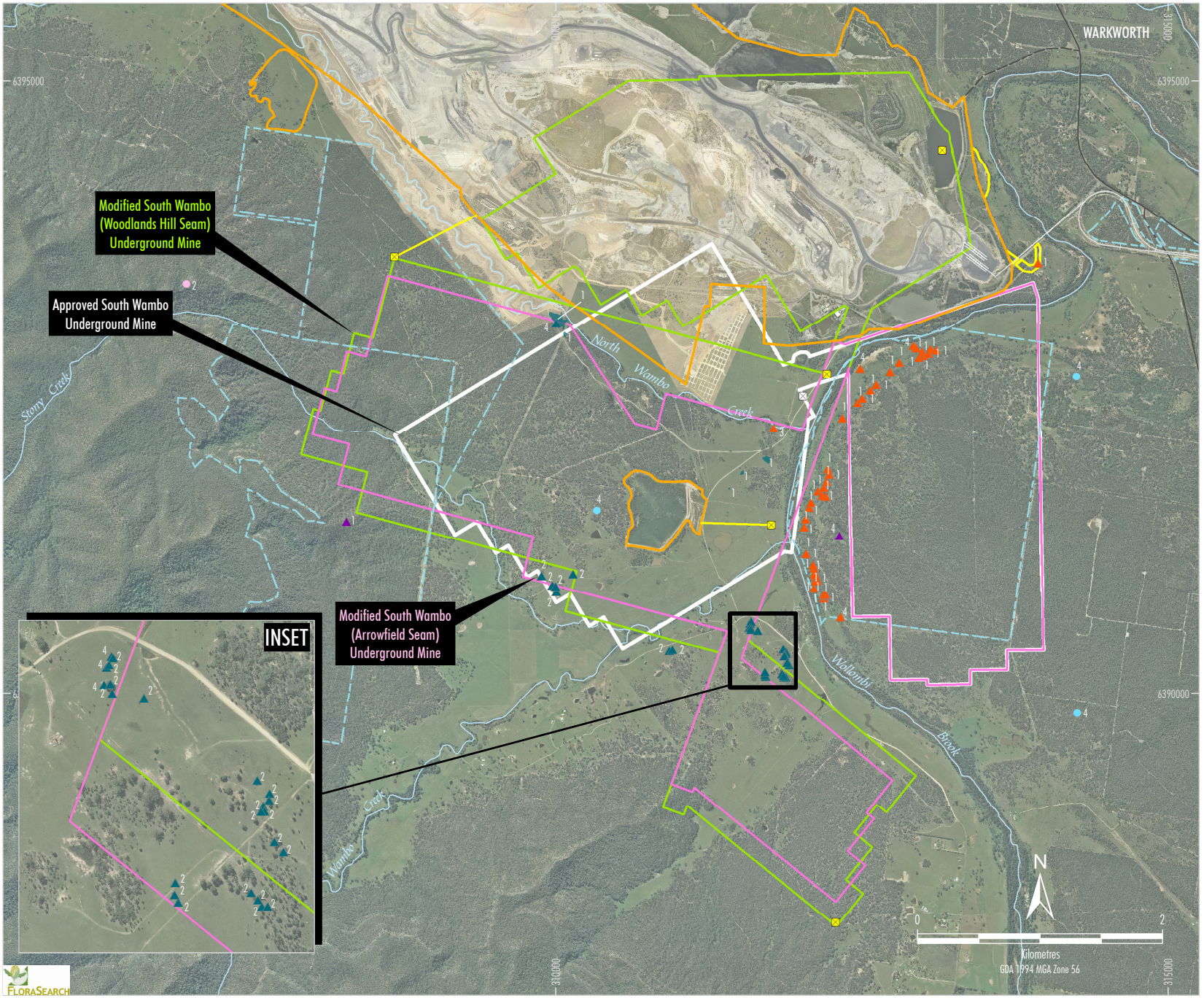
WAMBO COAL MINE

Threatened Ecological Communities

Figure 5

FLORASEARCH

WAM-09-15_SWUMM_EA_Flora_204F



LEGEND

- Modified Surface Development Area
- Existing/Approved Surface Development Area
- Approved South Wambo Underground Mine Development
- Modified South Wambo (Woodlands Hill Seam) Underground Mine
- Modified South Wambo (Arrowfield Seam) Underground Mine
- Approved Ventilation Shaft
- Modified Ventilation Shaft
- Remnant Woodland Enhancement Program (RWEP) Area

Threatened Populations

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

Threatened Species

- Small-flower Grevillea
- Slaty Red Gum

Source: Department of Lands (July 2009); WCPL (2015); WCPL Orthophoto (Apr-Oct 2013)

Reference:
1 - FloraSearch (2016)
2 - FloraSearch (2015)
3 - EcoLogical (2016)
4 - OEH (2015)

Peabody ENERGY

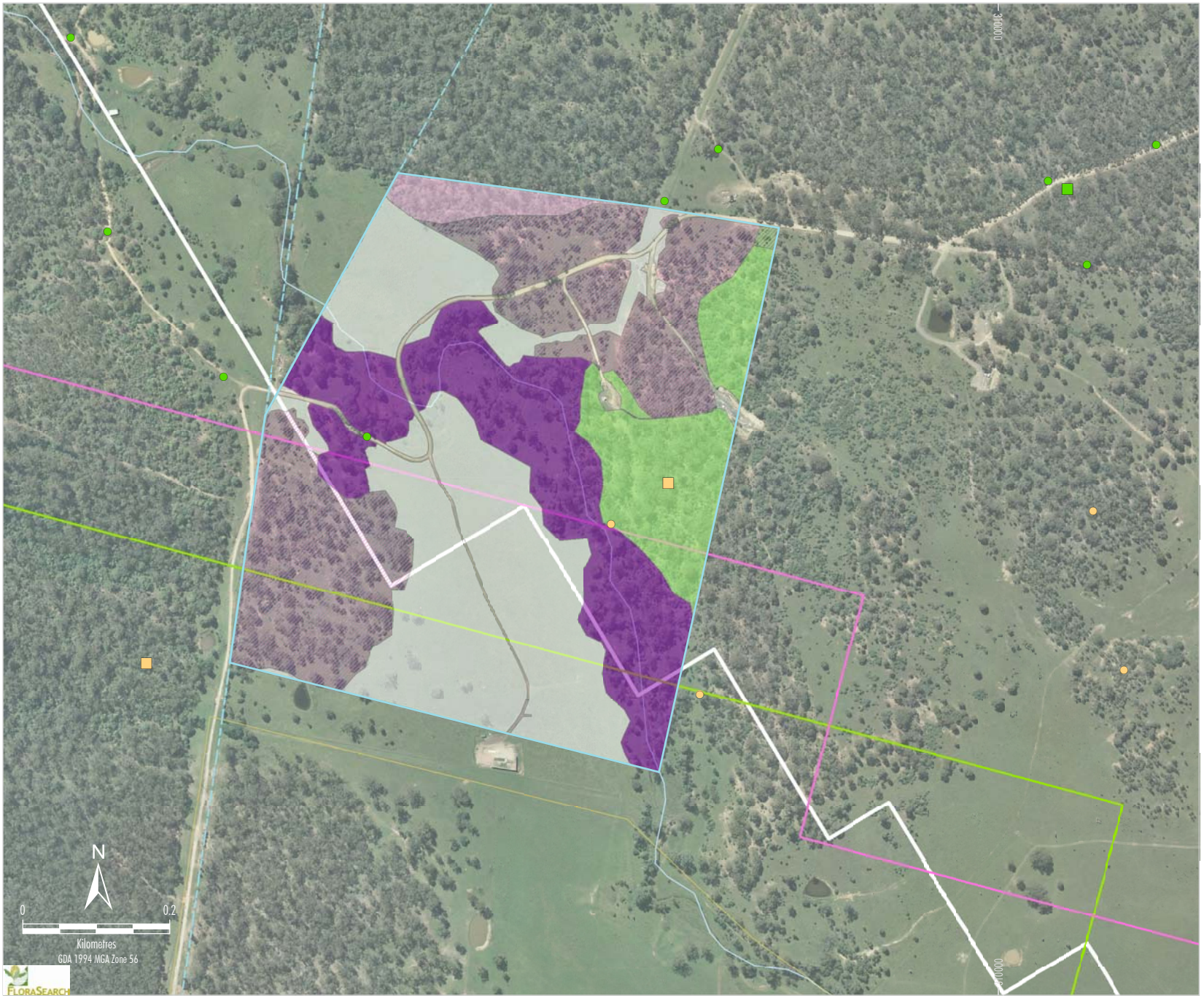
WAMBO COAL MINE

Threatened Flora Species and Populations

Figure 6

FLORASEARCH

WAM-09-15_SWUMM_EA_Flora_205G



LEGEND

- Approved South Wambo Underground Mine Development
- Modified South Wambo (Woodlands Hill Seam) Underground Mine
- Modified South Wambo (Arrowfield Seam) Underground Mine
- Remnant Woodland Enhancement Program (RWEP) Area
- WCPL Owned Land
- 2010-2015 Quadrat locations
- 2010-2015 Spot Sample locations
- Pre-2010 Quadrat Locations
- Pre-2010 Spot Sample Locations

Proposed Offset Area

- RWEP Area E
- Community 2 - Forest Red Gum Floodplain Forest
- Community 6 - Narrow-leaved Ironbark - Grey Box Woodland
- Community 6a - Narrow-leaved Ironbark - Grey Box Woodland (Disturbed)
- Community 11 - Grey Box - Slaty Box Woodland
- Community 11a - Grey Box - Slaty Box Woodland (Disturbed)
- Community 13 - Derived Grassland

Source: Department of Lands (July 2009); WCPL (2015); WCPL Orthophoto (Apr-Oct 2013)

Peabody ENERGY

WAMBO COAL MINE

Proposed Offset Area

Figure 7

WAM-09-15_SWUMM_EA_Flora_207A

APPENDIX A

FLORA SPECIES LIST ACCORDING TO VEGETATION COMMUNITIES ON THE STUDY AREA

APPENDIX A
FLORA SPECIES LIST ACCORDING TO VEGETATION COMMUNITIES ON THE STUDY AREA

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
CLASS FILICOPSIDA													
Blechnaceae													
Doodia aspera	Prickly Rasp Fern								●				
Marsileaceae													
Marsilea drummondii	Common Nardoo		●										
Pteridaceae													
Adiantum aethiopicum	Common Maidenhair			●					●				
Adiantum formosum	Giant Maidenhair			●									
Adiantum hispidulum	Rough Maidenhair Fern			●					●				
Cheilanthes distans	Bristly Cloak Fern	●	●		●	●		●	●	●	●		
Cheilanthes sieberi	Poison Rock Fern	●	●		●	●	●		●	●	●	●	
Pellaea falcata	Sickle Fern				●								●
Pellaea paradoxa	A Sickle Fern			●					●				
Pteris tremula	Tender Brake								●				
Salviniaceae													
Azolla sp.			●										
CLASS CYCADOPSIDA													
Zamiaceae													
Macrozamia concinna	A Macrozamia				●								
Macrozamia reducta	A Macrozamia				●	●			●		●		
CLASS CONIFEROPSIDA													
Cupressaceae													
Callitris endlicheri	Black Cypress Pine				●	●				●			
CLASS MAGNOLIOPSIDA													
SUBCLASS MAGNOLIIDAE													
Acanthaceae													
Brunoniella australis	Blue Trumpet		●		●	●	●	●	●	●	●		

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Rostellularia adscendens var. *adscendens*	Pink Tongues					●					●		
Aizoaceae													
**Galenia pubescens*	Galenia	●	●			●		●		●		●	
Alismataceae													
Damasonium minus	Starfruit		●										
Amaranthaceae													
Alternanthera denticulata	Lesser Joyweed		●									●	
Alternanthera sp. *A*			●			●				●			
**Gomphrena celosioides*	Gomphrena Weed					●	●			●		●	
Amygdalaceae													
**Prunus persica*	Peach								●				
Anacardiaceae													
**Schinus areira*	Pepper Tree	●				●							
Aphanopetalaceae													
Aphanopetalum resinosum	Gum Vine			●					●				
Apiaceae													
Centella asiatica	Indian Pennywort		●										
**Cyclospermum leptophyllum*	Slender Celery				●	●						●	
Daucus glochidiatus	Native Carrot											●	
Hydrocotyle tripartita	Pennywort	●											
Apocynaceae													
**Araujia sericifera*	Moth Vine		●										
Cynanchum viminale subsp. *brunonianum*	Caustic Vine				●						●		
**Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	●	●		●	●	●	●	●	●	●	●	
Marsdenia pleiadenia				●									
Parsonsia straminea	Common Silkpod												●
Araliaceae													
Astrotricha floccosa	Woolly Star-hair								●				
Asteraceae													
**Aster subulatus*	Wild Aster		●									●	
**Bidens pilosa*	Cobblers Pegs				●								

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
**Bidens subalternans*	Greater Beggar's Ticks		●		●	●				●		●	
Brachyscome ciliaris	Variable Daisy					●							
Brachyscome dentata						●							
Brachyscome leptocarpa	Small Hairy Daisy					●							
Brachyscome multifida	Cut-leaved Daisy				●	●							
Calocephalus citreus	Lemon Beauty-heads					●	●			●			
Calotis cuneifolia	Purple Burr-daisy					●							
Calotis lappulacea	Yellow Burr-daisy		●			●	●			●	●	●	
**Carduus pycnocephalus*	Slender Thistle	●											
Cassinia arcuata	Sifton Bush				●	●	●						
Cassinia cunninghamii	Cunninghams Everlasting		●		●	●				●	●		
Cassinia laevis	Cough Bush		●									●	
Cassinia quinquefaria	Cough Bush		●		●	●	●				●		
**Centaurea melitensis*	Maltese Cockspur		●										
Centipeda minima	Spreading Sneezeweed		●										
Chrysocephalum apiculatum	Common Everlasting		●			●	●			●	●	●	
**Cirsium vulgare*	Spear Thistle	●	●		●	●	●	●		●		●	
**Conyza bonariensis*	Flaxleaf Fleabane	●	●		●	●				●		●	
**Conyza parva*					●	●							
**Conyza sumatrensis*	Tall Fleabane		●			●						●	
Cotula australis	Carrot Weed		●			●				●	●	●	
**Cotula coronopifolia*	Water Buttons	●											
Cymbonotus sp.											●		
Eclipta platyglossa			●										
Epaltes australis	Spreading Nut-heads					●				●			
Euchiton involucratus	Star Cudweed		●							●			
Euchiton sphaericus	Cudweed		●		●	●					●	●	
**Facelis retusa*		●										●	
**Gamochaeta purpurea*	Purple Cudweed					●							
Glossocardia bidens	Cobbler's Tack		●		●	●	●			●	●		
**Hypochaeris glabra*	Smooth Catsear		●			●				●		●	

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
**Hypochaeris microcephala* var. *albiflora*	White Flatweed					●						●	
**Hypochaeris radicata*	Catsear		●		●	●	●			●		●	
Lagenophora gracilis	Slender Lagenophora					●				●			
Lagenophora stipitata	Blue Bottle-daisy					●							
Leptorhynchos squamatus			●			●					●		
Minuria leptophylla	Minuria					●							
Olearia elliptica	Sticky Daisy-bush		●		●	●	●		●		●		
Ozothamnus diosmifolius	Rice Flower				●	●	●						●
**Schkuhria pinnata* var. *abrotanoides*	Dwarf Marigold		●							●		●	
Senecio hispidulus	Hill Fireweed					●							
**Senecio madagascariensis*	Fireweed	●	●		●	●	●	●		●	●	●	
Senecio quadridentatus	Cotton Fireweed				●								
Sigesbeckia orientalis subsp. *orientalis*	Indian Weed		●		●	●			●				
**Silybum marianum*	Variegated Thistle	●											
**Soliva* sp	Burweed		●										
**Sonchus oleraceus*	Common Sowthistle	●	●		●	●		●		●	●	●	
**Tagetes minuta*	Stinking Roger		●										
**Taraxacum officinale*	Dandelion	●	●									●	
Vernonia cinerea	A Vernonia	●			●	●				●	●		
Vittadinia cuneata var. *cuneata*					●	●							
Vittadinia cuneata var. *hirsuta*	Fuzzweed					●					●		
Vittadinia muelleri	A Vittadinia					●		●					
Vittadinia pustulata	A Vittadinia		●			●	●	●					
**Xanthium italicum*	Hunter Burr	●	●									●	
**Xanthium spinosum*	Bathurst Burr		●										
Bignoniaceae													
Pandorea pandorana	Wonga Wonga Vine			●	●								
Boraginaceae													
**Echium plantagineum*	Paterson's Curse	●											
Cynoglossum suaveolens					●								
**Heliotropium amplexicaule*	Blue Heliotrope		●										

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Brassicaceae													
**Lepidium africanum*	A Peppercress	●				●							
**Lepidium bonariense*										●			
Lepidium pseudohyssopifolium	Peppercress					●							
**Lepidium virginicum*	Virginian Peppercress					●				●			
**Rorippa nasturtium-aquaticum*	Watercress	●											
Cactaceae													
**Opuntia aurantiaca*	Tiger Pear		●			●	●			●	●		
**Opuntia humifusa*	Creeeping Pear		●			●	●				●		
**Opuntia stricta* var. *stricta*	Common Prickly Pear		●		●	●			●	●	●	●	
Campanulaceae													
Wahlenbergia communis	Tufted Bluebell					●				●		●	
Wahlenbergia gracilis	Australian Bluebell		●		●	●				●		●	
Caryophyllaceae													
**Arenaria serpyllifolia*	Thyme-leaved Sandwort												●
**Cerastium glomeratum*	Mouse-ear Chickweed											●	
**Paronychia brasiliana*	Brasilian Whitlow		●			●				●		●	
**Petrorhagia dubia*												●	
**Petrorhagia nanteuilii*												●	
**Spergularia rubra*	Sandspurry									●			
**Stellaria media*	Common Chickweed	●											
**Stellaria pallida*	Lesser Chickweed											●	
Casuarinaceae													
Allocasuarina luehmannii	Bulloak	●	●		●	●	●	●	●	●	●	●	
Allocasuarina torulosa	Forest Oak								●				●
Casuarina cunninghamiana subsp. *cunninghamiana*	River Sheoak	●	●										
Casuarina glauca	Swamp Oak				●	●							
Celastraceae													
Denhamia silvestris	Narrow-leaved Orangebark				●	●			●		●		
Elaeodendron australe				●									

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Chenopodiaceae													
Atriplex semibaccata	Creeping Saltbush	●				●		●				●	
**Chenopodium ambrosioides*	Mexican Tea	●											
Einadia hastata	Red Berry Saltbush		●		●	●	●	●		●	●		
Einadia nutans subsp. *linifolia*	Climbing Saltbush	●	●			●	●	●		●	●	●	
Einadia nutans subsp. *nutans*	Climbing Saltbush						●	●				●	
Einadia polygonoides	Knotweed Goosefoot		●			●				●	●		
Einadia trigonos	Fishweed		●			●					●		
Enchylaena tomentosa	Ruby Saltbush		●			●	●	●					
Maireana enchylaenoides	Wingless Bluebush					●	●	●			●		
Maireana microphylla	Small-leaf Bluebush	●	●			●	●	●		●	●	●	
Clusiaceae													
Hypericum gramineum	Small St. John's Wort						●					●	
Commelinaceae													
Commelina cyanea	Native Wandering Jew		●		●	●				●	●		
Murdannia graminea	Grass Lily					●				●			
Convolvulaceae													
Convolvulus graminetinus								●					
Dichondra repens	Kidney Weed		●		●	●		●	●	●	●	●	
Evolvulus alsinoides						●				●			
Crassulaceae													
Crassula sieberiana	Australian Stonecrop					●	●						
Dilleniaceae													
Hibbertia cistiflora					●								
Hibbertia linearis	Showy Guinea Flower				●				●		●		
Hibbertia obtusifolia	Hoary Guinea Flower										●		
Ebenaceae													
Diospyros australis	Black Plum			●									
Ericaceae - Styphelioideae													
Leucopogon muticus	Blunt Beard-heath				●	●							
Melichrus urceolatus	Urn-heath				●				●		●		

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Euphorbiaceae													
Alchornea ilicifolia	Native Holly			●		●			●				
Baloghia inophylla	Brush Bloodwood			●									
Bertya oleifolia	A Bertya		●		●				●				
Chamaesyce dallachyana						●							
Chamaesyce drummondii	Caustic Weed		●			●	●						
Euphorbia planticola	Plains Spurge					●				●			
Fabaceae - Caesalpinioideae													
Senna artemisioides subsp. *zygophylla*						●							
Senna barronfieldii						●							
Senna coronilloides	A Cassia	●				●					●		
**Senna multiglandulosa*					●								
Fabaceae: Faboideae													
Bossiaea prostrata						●							
Chorizema parviflorum	Eastern Flame Pea									●			
Daviesia genistifolia	Broom Bitter Pea		●		●	●	●		●	●	●		
Daviesia ulicifolia	Gorse Bitter Pea				●	●							
Desmodium brachypodum	Large Tick-trefoil				●	●				●	●		
Desmodium gunnii	Slender Tick-trefoil				●	●			●		●		
Desmodium rhytidophyllum					●				●				
Desmodium varians	Slender Tick-trefoil		●			●	●			●			
Dillwynia retorta					●					●			
Glycine clandestina	Love Creeper		●		●	●	●			●	●		
Glycine microphylla	Small-leaf glycine					●							
Glycine tabacina	A Glycine		●		●	●	●		●	●	●	●	
Hardenbergia violacea	Purple Coral Pea		●		●	●					●		
Hovea lanceolata					●								
Indigofera australis	Australian Indigo				●	●							
Jacksonia scoparia	Winged Broom-pea					●							
**Medicago* sp.			●			●						●	
Pultenaea spinosa	Spiny Bush-pea				●						●		

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Swainsona galegifolia	Smooth Darling-pea				●	●			●		●		
**Trifolium campestre*	Hop Clover											●	
**Trifolium dubium*	Yellow Suckling Clover											●	
**Trifolium repens*	White Clover	●	●									●	
**Trifolium subterraneum*	Subterranean Clover											●	
Zornia dyctiocarpa var. *dyctiocarpa*	Zornia									●			
Fabaceae: Mimosoideae													
Acacia amblygona	Fan Wattle		●		●	●	●		●	●	●		
Acacia binervia	Coast Myall		●		●	●			●		●		
Acacia bulgaensis	Bulga Wattle (ROTAP: 2RC-)				●	●			●				
Acacia cultriformis	Knife-leaf Wattle					●			●				
Acacia decora	Western Silver Wattle				●	●					●		
Acacia elongata	Swamp Wattle				●						●		
Acacia falcata	Sickle Wattle		●		●	●			●	●	●		
Acacia implexa	Hickory Wattle		●		●	●			●		●		
Acacia irrorata subsp. *irrorata*	Green Wattle								●				
Acacia maidenii	Maiden's Wattle					●							
Acacia parramattensis	Parramatta Wattle					●							
Acacia parvipinnula	Silver Stemmed Wattle		●										
Acacia pendula	Weeping Myall					●		●					
Acacia prominens	Gosford Wattle					●			●				●
Acacia salicina	Cooba	●	●		●	●		●	●		●	●	
Acacia verniciflua	Varnish Wattle				●						●		
Neptunia gracilis forma gracilis	Sensitive Plant		●			●							
Gentianaceae													
**Centaurium erythraea*	Common Centaury		●			●						●	
Geraniaceae													
Erodium crinitum	Blue Storksbill											●	
**Erodium moschatum*	Musky Crowfoot											●	
Geranium solanderi	Native Geranium		●									●	
Goodeniaceae													

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Goodenia hederacea	Forest Goodenia				●	●				●			
Goodenia ovata	Hop Goodenia										●		
Goodenia rotundifolia	A Goodenia				●	●				●	●		
Velleia paradoxa	Spur Velleia					●							
Lamiaceae													
Ajuga australis	Austral Bugle		●		●	●							
**Marrubium vulgare*	White Horehound		●										
Mentha satureioides	Creeping Mint						●					●	
Scutellaria humilis	Dwarf Skullcap					●							
Spartothamnella juncea	Bead Bush	●	●		●	●			●		●		
**Stachys arvensis*	Stagger Weed											●	
Lauraceae													
Cassytha pubescens	Common Devil's Twine				●				●				
Linaceae													
Linum marginale	Native Flax		●			●	●						●
Lobeliaceae													
Pratia purpurascens	Whiteroot		●			●			●				
Loranthaceae													
Amyema cambagei		●			●								
Amyema gaudichaudii	Paper-bark Mistletoe					●				●			
Amyema miquelii	Stalked Mistletoe		●										
Amyema pendulum subsp. *pendulum*	Drooping Mistletoe				●	●							
Amyema quandang var. *quandang*	Grey Mistletoe							●					
Muellerina eucalyptoides						●							
Malvaceae													
Abutilon oxycarpum	Straggly Lantern-bush		●		●	●		●	●		●		
Brachychiton populneus	Kurrajong	●	●		●	●			●		●		
Commersonia dasyphylla	Kerrawang								●				
Commersonia fraseri	Brush Kurrajong								●				●
Commersonia rugosa													●
Hibiscus heterophyllus subsp. *heterophyllus*	Native Rosella		●	●					●				

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Hibiscus sturtii var. *sturtii*	Hill Hibiscus										●		
Lasiopetalum ferrugineum var. *cordatum*	Rusty Velvet-bush								●				●
Lasiopetalum macrophyllum	Shrubby Velvet-bush								●				
**Malvastrum americanum*	Spiked Malvastrum					●					●		
**Modiola caroliniana*	Red-flowered Mallow	●	●							●		●	
**Pavonia hastata*			●										
Sida corrugata	Corrugated Sida		●		●	●	●	●			●		
Sida hackettiana	Spiked Sida		●			●		●		●	●		
**Sida rhombifolia*	Paddy's Lucerne	●	●			●		●		●	●	●	
Sida trichopoda	Hairy Sida										●		
Meliaceae													
Melia azedarach	White Cedar		●		●	●			●				
Menispermaceae													
Legnephora moorei	Round-leaf Vine								●				
Stephania japonica	Snake Vine								●				
Monimiaceae													
Daphnandra sp. *A*	Socketwood								●				
Moraceae													
Ficus coronata	Sandpaper Fig								●				
Ficus rubiginosa	Port Jackson Fig				●				●				●
Maclura cochinchinensis	Cockspur Thorn			●									
Myrsinaceae													
**Anagallis arvensis*	Scarlet Pimpernel	●	●			●	●			●	●	●	
Myrsine variabilis	Muttonwood				●				●				
Myrtaceae													
Acmena smithii	Lilly Pilly			●									
Angophora floribunda	Rough-barked Apple	●	●		●				●				
Backhousia myrtifolia	Grey Myrtle			●					●				
Callistemon pinifolius	Pine-leaved Bottlebrush								●				
Corymbia maculata	Spotted Gum		●		●	●			●				
Eucalyptus acmenoides	White Mahogany								●				

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Eucalyptus albens	White Box									●	●		
Eucalyptus blakelyi	Blakely's Red Gum		●										
Eucalyptus crebra	Narrow-leaved Ironbark		●		●	●	●	●	●	●	●		
Eucalyptus dawsonii	Slaty Gum		●		●	●			●		●		
Eucalyptus melliodora	Yellow Box		●			●							
Eucalyptus moluccana	Grey Box		●		●	●	●		●	●	●		
Eucalyptus punctata	Grey Gum				●	●			●				
Eucalyptus tereticornis	Forest Red Gum	●	●		●					●			
Melaleuca decora	A Honeymyrtle		●		●	●	●			●	●		
Melaleuca ericifolia	Swamp Paperbark					●							
Melaleuca nodosa	Prickly-leaved Paperbark				●								
Melaleuca thymifolia	Thyme Honey-myrtle					●							
Sannantha pluriflora									●				
Nyctaginaceae													
Boerhavia dominii	Tarvine					●					●		
Oleaceae													
Jasminum volubile	Stiff Jasmine								●				
**Ligustrum sinense*	Small-leaved Privet					●							
Notelaea longifolia f. longifolia					●	●			●				
Notelaea microcarpa var. *microcarpa*	Native Olive	●	●	●	●	●	●	●	●		●		
Notelaea ovata									●				
**Olea europaea* subsp. *cuspidata*	African Olive	●	●			●						●	
Onagraceae													
Ludwigia peploides	Water Primrose		●										
**Oenothera mollissima*												●	
Oxalidaceae													
Oxalis chnoodes	An Oxalis					●			●				
Oxalis radicosa	An Oxalis		●		●					●		●	
Oxalis sp.	An Oxalis		●		●	●			●	●	●	●	
Oxalis thompsoniae	An Oxalis											●	
Phyllanthaceae													

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Breynia oblongifolia	Coffee Bush		●	●	●	●			●		●		
Glochidion ferdinandi	Cheese Tree								●				
Phyllanthus gunnii	Scrubby Spurge								●		●		
Phyllanthus virgatus	A Phyllanthus				●	●						●	
Pittosporaceae													
Bursaria spinosa	Blackthorn	●	●		●	●			●		●		
Hymenosporum flavum	Native Frangipani			●					●				
Pittosporum multiflorum	Orange Thorn			●									
Plantaginaceae													
Bacopa monnieri	Bacopa		●										
Plantago debilis	Slender Plantain		●		●	●		●	●				
Plantago gaudichaudii	Narrow Plantain					●							
**Plantago lanceolata*	Lamb's Tongue	●	●		●	●	●	●		●	●	●	
Veronica calycina	Hairy Speedwell				●								
Veronica plebeia	Trailing Speedwell		●		●	●	●		●	●		●	
Polygonaceae													
Persicaria hydropiper	Water Pepper		●										
Persicaria lapathifolia	Pale Knotweed		●										
Persicaria orientalis	Princes Feathers		●										
Rumex brownii	Swamp Dock		●										
**Rumex crispus*	Curled Dock	●											
Proteaceae													
Grevillea montana	ROTAP : 2VC				●	●			●		●		
Persoonia linearis	Narrow-leaved Geebung		●		●				●		●		
Ranunculaceae													
Clematis glycinoides	Headache vine			●	●	●			●				
Rhamnaceae													
Alphitonia excelsa	Red Ash					●							
Pomaderris betulina	Birch Pomaderris								●				
Rosaceae													
Rubus moluccanus var. *trilobus*	Molucca Bramble								●				

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Rubus parvifolius	Native Raspberry								●				
Rubiaceae													
Asperula conferta	Common Woodruff				●	●	●				●		●
Galium leiocarpum	A Bedstraw				●	●					●		
Galium leptogonium						●							
Opercularia hispida	Hairy Stinkweed										●		
Opercularia sp.	A Stinkweed		●										
Pomax umbellata	Pomax				●								
Psydrax odorata	Shiny-leaved Canthium		●		●	●				●	●		
**Richardia stellaris*			●			●						●	
Rutaceae													
Correa reflexa	Native Fuchsia				●								
Geijera salicifolia	Brush Wilga	●	●		●	●			●		●	●	●
Philotheca difformis subsp. *smithiana*	Small-leaf Wax-flower								●				
Santalaceae													
Alectryon subcinereus	Native Quince			●	●				●				●
Choretrum sp. *Coxs Gap*					●	●			●		●		
Exocarpos cupressiformis	Native Cherry		●		●	●					●		
Exocarpos strictus	Dwarf Cherry		●								●		
Santalum lanceolatum	Northern Sandalwood					●					●		
Sapindaceae													
Dodonaea sinuolata subsp. *sinuolata*						●							
Dodonaea triangularis	A Hop-bush					●			●				
Dodonaea triquetra	Large-leaf Hop-bush								●				
Dodonaea truncatiales	Angular Hop-bush				●								
Dodonaea viscosa subsp. *angustifolia*	Sticky Hop-bush					●							
Dodonaea viscosa subsp. *cuneata*	Wedge-leaf Hop-bush		●		●	●			●		●		
Scrophulariaceae													
Eremophila debilis	Amulla	●	●		●	●	●	●		●	●		
Myoporum montanum	Western Boobialla		●		●	●				●	●		
Solanaceae													

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
**Cestrum parqui*	Green Cestrum	●	●										
**Datura stramonium*	Common Thornapple				●								
**Lycium ferocissimum*	African Boxthorn	●	●			●		●				●	
**Nicotiana glauca*	Tree Tobacco	●											
Solanum brownii	Violet Nightshade		●		●	●		●	●		●		
Solanum cinereum	Narrawa Burr					●		●				●	
**Solanum elaeagnifolium*	Silver-leaved Nightshade											●	
**Solanum mauritianum*	Wild Tobacco Bush	●											
**Solanum nigrum*	Black-berry Nightshade	●	●			●		●			●	●	
Solanum stelligerum	Devil's Needles				●								
Stackhousiaceae													
Stackhousia viminea	Slender Stackhousia					●							
Thymelaeaceae													
Pimelea curviflora var. *divergens*	Curved Rice-flower				●				●		●		
Urticaceae													
Urtica incisa	Stinging Nettle	●	●										
Verbenaceae													
**Verbena bonariensis*	Purpletop		●			●						●	
**Verbena caracasana*		●	●		●	●						●	
**Verbena rigida*	Veined Verbena		●			●						●	
**Verbena x brasiliensis*	Gin Case											●	
Vitaceae													
Cayratia clematidea	Native Grape		●		●				●				
Cissus antarctica	Kangaroo Vine			●									
Clematicissus opaca	Pepper Vine				●	●							
Tetrastigma nitens				●									
SUBCLASS LILIIDAE													
Anthericaceae													
Arthropodium milleflorum	Pale Vanilla-lily					●							
Arthropodium minus	Small Vanilla Lily				●	●				●			
Dichopopogon fimbriatus	Nodding Chocolate Lily									●			

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Laxmannia gracilis	Slender Wire Lily				●	●	●			●			
Asparagaceae													
**Asparagus officinalis*	Asparagus	●	●										
Cyperaceae													
Carex brownii						●							
Carex inversa	Knob Sedge		●			●						●	
**Cyperus aggregatus*					●	●				●		●	
Cyperus difformis			●										
Cyperus fulvus	Sticky Sedge				●								
Cyperus gracilis	Slender Flat-sedge		●			●		●		●	●		
Cyperus haspan					●							●	
Cyperus laevis						●							
Cyperus sp.			●		●	●			●				
Eleocharis sp.			●										
Fimbristylis dichotoma	Common Fringe-sedge				●	●	●			●	●	●	●
Gahnia aspera	Common Saw-sedge		●		●	●			●		●		
Gahnia melanocarpa	Black-fruit Saw-sedge								●				
Lepidosperma gunnii					●						●		
Lepidosperma laterale	Variable Sword-sedge				●	●			●		●		
Scleria mackaviensis					●	●					●		
Iridaceae													
**Romulea rosea*	Onion Grass											●	
Juncaceae													
**Juncus acutus*	Sharp Rush	●											
Juncus subsecundus	Finger Rush					●				●			
Juncus usitatus			●			●						●	
Lemnaceae													
Lemna sp.			●										
Lomandraceae													
Lomandra confertifolia subsp. *pallida*	Mat-rush		●		●	●			●		●		
Lomandra filiformis subsp. *coriacea*	Wattle Mat-rush		●			●	●				●		

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush		●		●	●		●	●	●	●	●	
Lomandra glauca	Pale Mat-rush					●				●			
Lomandra longifolia	Spiny-headed Mat-rush				●				●				
Lomandra multiflora	Many-flowered Mat-rush		●		●	●	●		●	●	●		
Luzuriagaceae													
Eustrephus latifolius	Wombat Berry				●	●			●		●		
Geitonoplesium cymosum	Scrambling Lily								●				
Orchidaceae													
Pterostylis sp.					●						●		
Phormiaceae													
Dianella caerulea var. *caerulea*	Blue Flax Lily				●	●				●			
Dianella caerulea var. *cinerascens*	Blue Flax Lily		●		●	●			●		●		
Dianella longifolia var. *longifolia*	A Flax Lily		●		●	●				●			
Dianella longifolia var. *stenophylla*											●		
Dianella revoluta	Spreading Flax-lily				●	●				●	●		
Dianella sp.						●					●		
Poaceae													
Ancistrachne uncinulata	Hooky Grass				●						●		●
Aristida acuta					●	●							
Aristida echinata					●								
Aristida jerichoensis var. *jerichoensis*	Jericho Wiregrass										●		
Aristida personata	Purple Wire-grass	●	●		●	●	●		●	●	●	●	
Aristida ramosa var. *ramosa*	Purple Wiregrass		●			●						●	
Aristida vagans	Threeawn Speargrass		●		●	●	●	●		●	●	●	
Austrostipa ramosissima	Stout Bamboo Grass		●			●			●				
Austrostipa scabra	Speargrass		●		●	●	●	●		●	●		
Austrostipa verticillata	Slender Bamboo Grass	●	●		●	●				●	●	●	
**Axonopus fissifolius*	Narrow-leafed Carpet Grass											●	
Bothriochloa decipiens	Red Grass	●	●		●	●	●			●	●	●	
**Briza minor*	Shivery Grass											●	
**Bromus catharticus*	Prairie Grass	●											

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
**Chloris gayana*	Rhodes Grass	●				●						●	
Chloris truncata	Windmill Grass					●				●		●	
Chloris ventricosa	Plump Windmill Grass	●	●		●	●	●	●		●	●		
Cymbopogon refractus	Barbwire Grass	●	●		●	●	●	●	●	●	●	●	
Cynodon dactylon	Couch	●	●		●	●	●		●		●	●	
Dichanthium sericeum	Queensland Bluegrass											●	
Dichelachne micrantha	Shorthair Plumegrass				●	●						●	
Digitaria breviglumis					●								
Digitaria brownii	Cotton Panic Grass		●			●						●	
Digitaria diffusa	Open Summer Grass		●		●	●	●			●	●		
Digitaria divaricatissima	Umbrella Grass		●			●	●					●	
Digitaria parviflora	Small-flowered Finger Grass				●								
Digitaria ramularis					●	●					●		
Echinochloa colona	Awnless Barnyard Grass		●										
Echinopogon caespitosus	Bushy Hedgehog-grass					●							
**Ehrharta erecta*	Panic Veldtgrass	●	●										
**Eleusine tristachya*	Goose Grass		●									●	
Elymus scaber					●	●							
Enteropogon acicularis	Curly Windmill Grass		●			●	●	●		●		●	
Entolasia marginata	Bordered Panic				●				●				
Entolasia stricta	Wiry Panic				●	●				●			
Eragrostis alveiformis						●				●			
Eragrostis brownii	Brown's Lovegrass		●		●	●							
**Eragrostis curvula*	African Lovegrass					●							
Eragrostis elongata	Clustered Lovegrass		●		●	●	●			●		●	
Eragrostis lacunaria	Purple Love-grass					●				●			
Eragrostis leptostachya	Paddock Lovegrass		●			●	●			●	●	●	
Eragrostis parviflora	Weeping Lovegrass		●		●	●				●	●	●	
**Eragrostis pilosa*	Soft Lovegrass						●						
Eriochloa procera	Spring Grass		●			●						●	
Eriochloa pseudoacrotricha	Early Spring Grass				●	●	●			●	●		

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Eulalia aurea	Silky Browntop		●				●						
Imperata cylindrica	Blady Grass				●				●				
Lachnagrostis filiformis						●					●	●	
Leptochloa asthenes	A Canegrass				●	●							
**Lolium perenne*	Perennial Ryegrass											●	
**Melinis repens*	Red Natal Grass						●						
Microlaena stipoides	Weeping Grass	●	●		●	●	●				●	●	
Oplismenus imbecillis	Basket Grass	●			●				●				
Panicum effusum	Hairy Panic		●		●	●	●			●	●	●	
Panicum simile	Two Coloured Panic		●		●	●	●			●	●	●	
Paspalidium criniforme	Fine Panic					●	●			●	●		
Paspalidium distans			●		●	●	●			●			
Paspalidium gracile	Slender Panic		●		●	●		●					
Paspalum distichum	Water Couch		●										
**Paspalum dilatatum*	Paspalum		●				●					●	
**Pennisetum clandestinum*	Kikuyu Grass		●										
**Phalaris aquatica*	Phalaris											●	
Phragmites australis	Common Reed	●											
Poa sieberiana var. *sieberiana*	Snowgrass				●								
Rytidosperma bipartitum	Wallaby Grass				●	●		●					
Rytidosperma fulvum	Wallaby Grass		●		●	●	●			●	●		
Rytidosperma longifolium	Long-leaved Wallaby Grass				●	●	●				●		
Rytidosperma racemosum var. *obtusatum*			●			●					●		
Rytidosperma racemosum var. *racemosum*					●	●							
**Setaria pumila*	Pale Pigeon Grass	●	●			●	●					●	
Sorghum leiocladum	Wild Sorghum											●	
Sporobolus caroli	Fairy Grass					●							
Sporobolus creber	Slender Rat's Tail Grass	●	●		●	●	●	●		●	●	●	
Sporobolus elongatus	Slender Rat's Tail Grass											●	
Themeda australis	Kangaroo Grass					●					●		
**Vulpia* sp.												●	

Scientific Name	Common Name	Community											
		1	2	4	5	6	7	8	9	10	11	13	Opp.
Typhaceae													
Typha orientalis	Broadleaf Cumbungi	●											
TOTAL NATIVE SPECIES	362	32	139	23	166	215	62	36	109	87	125	58	
TOTAL INTRODUCED SPECIES	100	37	47	0	16	40	13	9	3	22	11	57	
GRAND TOTAL SPECIES	462	69	186	23	182	255	75	45	112	109	136	115	

* Introduced species

Opp. Opportunistic species

APPENDIX B

FLORA SPECIES LIST ACCORDING TO YEAR OF SURVEY

APPENDIX B
FLORA SPECIES LIST ACCORDING TO YEAR OF SURVEY

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
CLASS FILICOPSIDA								
Blechnaceae								
Doodia aspera	Prickly Rasp Fern	●						
Marsileaceae								
Marsilea drummondii	Common Nardoo		●					
Pteridaceae								
Adiantum aethiopicum	Common Maidenhair	●						●
Adiantum formosum	Giant Maidenhair							●
Adiantum hispidulum	Rough Maidenhair Fern	●						●
Cheilanthes distans	Bristly Cloak Fern			●	●	●	●	●
Cheilanthes sieberi	Poison Rock Fern	●	●	●	●	●	●	●
Pellaea falcata	Sickle Fern							●
Pellaea paradoxa	A Sickle Fern							●
Pteris tremula	Tender Brake	●						
Salviniaceae								
Azolla sp.			●					
CLASS CYCADOPSIDA								
Zamiaceae								
Macrozamia concinna	A Macrozamia	●						●
Macrozamia reducta	A Macrozamia	●			●		●	●
CLASS CONIFEROPSIDA								
Cupressaceae								
Callitris endlicheri	Black Cypress Pine	●			●			
CLASS MAGNOLIOPSIDA								
SUBCLASS MAGNOLIIDAE								
Acanthaceae								

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Brunoniella australis	Blue Trumpet			●	●	●	●	●
Rostellularia adscendens var. *adscendens*	Pink Tongues			●	●		●	●
Aizoaceae								
**Galenia pubescens*	Galenia	●	●	●		●		●
Alismataceae								
Damasonium minus	Starfruit		●					
Amaranthaceae								
Alternanthera denticulata	Lesser Joyweed		●					
Alternanthera sp. *A*			●	●	●			
**Gomphrena celosioides*	Gomphrena Weed				●	●		●
Amygdalaceae								
**Prunus persica*	Peach	●						
Anacardiaceae								
**Schinus areira*	Pepper Tree	●	●	●				
Aphanopetalaceae								
Aphanopetalum resinosum	Gum Vine	●						●
Apiaceae								
Centella asiatica	Indian Pennywort		●					
**Cyclospermum leptophyllum*	Slender Celery				●	●		
Daucus glochidiatus	Native Carrot							●
Hydrocotyle tripartita	Pennywort			●				
Apocynaceae								
**Araujia sericifera*	Moth Vine	●						
Cynanchum viminale subsp. *brunonianum*	Caustic Vine				●			
**Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	●	●	●	●	●	●	●
Marsdenia pleiadenia								●
Parsonsia straminea	Common Silkpod		●					
Araliaceae								
Astrotricha floccosa	Woolly Star-hair	●						
Asteraceae								
**Aster subulatus*	Wild Aster		●	●	●			
**Bidens pilosa*	Cobblers Pegs	●						

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
**Bidens subalternans*	Greater Beggar's Ticks		●	●	●	●		
Brachyscome ciliaris	Variable Daisy		●					
Brachyscome dentata					●			
Brachyscome leptocarpa	Small Hairy Daisy				●			
Brachyscome multifida	Cut-leaved Daisy			●	●		●	
Calocephalus citreus	Lemon Beauty-heads			●	●	●		
Calotis cuneifolia	Purple Burr-daisy	●		●	●			●
Calotis lappulacea	Yellow Burr-daisy		●	●	●			●
**Carduus pycnocephalus*	Slender Thistle	●						
Cassinia arcuata	Sifton Bush	●				●		
Cassinia cunninghamii	Cunninghams Everlasting	●		●	●			●
Cassinia laevis	Cough Bush			●				
Cassinia quinquefaria	Cough Bush	●	●		●		●	●
**Centaurea melitensis*	Maltese Cockspur	●						
Centipeda minima	Spreading Sneezeweed		●					
Chrysocephalum apiculatum	Common Everlasting	●	●	●	●	●		●
**Cirsium vulgare*	Spear Thistle	●	●	●	●	●		●
**Conyza bonariensis*	Flaxleaf Fleabane		●	●	●	●		
**Conyza parva*					●			
**Conyza sumatrensis*	Tall Fleabane		●	●	●			
Cotula australis	Carrot Weed			●		●		●
**Cotula coronopifolia*	Water Buttons	●						
Cymbonotus sp.				●				
Eclipta platyglossa			●					
Epaltes australis	Spreading Nut-heads				●			
Euchiton involucratus	Star Cudweed			●				
Euchiton sphaericus	Cudweed			●	●			●
**Facelis retusa*				●				●
**Gamochaeta purpurea*	Purple Cudweed				●			
Glossocardia bidens	Cobbler's Tack			●	●	●		●
**Hypochaeris glabra*	Smooth Catsear			●	●			●
**Hypochaeris microcephala* var. *albiflora*	White Flatweed				●	●		

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
**Hypochaeris radicata*	Catsear	●	●	●	●	●		●
Lagenophora gracilis	Slender Lagenophora				●			
Lagenophora stipitata	Blue Bottle-daisy				●			
Leptorhynchos squamatus				●				
Minuria leptophylla	Minuria	●			●			
Olearia elliptica	Sticky Daisy-bush	●		●	●	●	●	●
Ozothamnus diosmifolius	Rice Flower	●			●			●
**Schkuhria pinnata* var. *abrotanoides*	Dwarf Marigold		●	●	●	●		
Senecio hispidulus	Hill Fireweed				●			
**Senecio madagascariensis*	Fireweed	●	●	●	●	●		●
Senecio quadridentatus	Cotton Fireweed				●			
Sigesbeckia orientalis subsp. *orientalis*	Indian Weed			●	●			●
**Silybum marianum*	Variegated Thistle			●				
**Soliva* sp	Burweed		●					
**Sonchus oleraceus*	Common Sowthistle	●		●	●	●	●	●
**Tagetes minuta*	Stinking Roger		●	●		●		
**Taraxacum officinale*	Dandelion	●				●		
Vernonia cinerea	A Vernonia			●	●		●	
Vittadinia cuneata var. *cuneata*				●	●			
Vittadinia cuneata var. *hirsuta*	Fuzzweed		●	●	●			●
Vittadinia muelleri	A Vittadinia		●		●			●
Vittadinia pustulata	A Vittadinia		●		●	●		●
**Xanthium italicum*	Hunter Burr		●	●				
**Xanthium spinosum*	Bathurst Burr		●					
Bignoniaceae								
Pandorea pandorana	Wonga Wonga Vine							●
Boraginaceae								
**Echium plantagineum*	Paterson's Curse	●						
Cynoglossum suaveolens					●			
**Heliotropium amplexicaule*	Blue Heliotrope	●						
Brassicaceae								
**Lepidium africanum*	A Peppercress			●	●			

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
**Lepidium bonariense*				●				
Lepidium pseudohyssopifolium	Peppercress				●			
**Lepidium virginicum*	Virginian Peppercress				●			
**Rorippa nasturtium-aquaticum*	Watercress	●		●				
Cactaceae								
**Opuntia aurantiaca*	Tiger Pear	●	●	●	●	●		●
**Opuntia humifusa*	Creeeping Pear		●	●	●	●		
**Opuntia stricta* var. *stricta*	Common Prickly Pear	●	●		●		●	●
Campanulaceae								
Wahlenbergia communis	Tufted Bluebell		●		●			
Wahlenbergia gracilis	Australian Bluebell		●	●	●			●
Caryophyllaceae								
**Arenaria serpyllifolia*	Thyme-leaved Sandwort							●
**Cerastium glomeratum*	Mouse-ear Chickweed					●		●
**Paronychia brasiliana*	Brasilian Whitlow		●	●	●			●
**Petrorhagia dubia*								●
**Petrorhagia nanteuilii*				●				
**Spergularia rubra*	Sandspurry			●				
**Stellaria media*	Common Chickweed			●				
**Stellaria pallida*	Lesser Chickweed							●
Casuarinaceae								
Allocasuarina luehmannii	Bulloak	●	●	●	●	●	●	●
Allocasuarina torulosa	Forest Oak	●						●
Casuarina cunninghamiana subsp. *cunninghamiana*	River Sheoak	●		●				
Casuarina glauca	Swamp Oak	●						
Celastraceae								
Denhamia silvestris	Narrow-leaved Orangebark	●		●	●			●
Elaeodendron australe								●
Chenopodiaceae								
Atriplex semibaccata	Creeping Saltbush	●	●	●				●
**Chenopodium ambrosioides*	Mexican Tea			●				

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Einadia hastata	Red Berry Saltbush	●	●	●	●	●	●	●
Einadia nutans subsp. *linifolia*	Climbing Saltbush	●	●	●	●	●		●
Einadia nutans subsp. *nutans*	Climbing Saltbush			●	●			●
Einadia polygonoides	Knotweed Goosefoot	●		●				
Einadia trigonos	Fishweed		●	●				●
Enchylaena tomentosa	Ruby Saltbush	●	●			●		●
Maireana enchylaenoides	Wingless Bluebush	●			●			
Maireana microphylla	Small-leaf Bluebush	●	●	●	●	●		●
Clusiaceae								
Hypericum gramineum	Small St. John's Wort			●	●	●		
Commelinaceae								
Commelina cyanea	Native Wandering Jew		●		●			●
Murdannia graminea	Grass Lily				●			
Convolvulaceae								
Convolvulus graminetinus								●
Dichondra repens	Kidney Weed	●	●	●	●	●	●	●
Evolvulus alsinoides					●			
Crassulaceae								
Crassula sieberiana	Australian Stonecrop			●	●			
Dilleniaceae								
Hibbertia cistiflora		●						
Hibbertia linearis	Showy Guinea Flower	●			●			●
Hibbertia obtusifolia	Hoary Guinea Flower						●	
Ebenaceae								
Diospyros australis	Black Plum							●
Ericaceae - Styphelioideae								
Leucopogon muticus	Blunt Beard-heath	●			●			
Melichrus urceolatus	Urn-heath	●			●		●	
Euphorbiaceae								
Alchornea ilicifolia	Native Holly	●						●
Baloghia inophylla	Brush Bloodwood							●
Bertya oleifolia	A Bertya	●		●	●		●	●

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Chamaesyce dallachyana					●			
Chamaesyce drummondii	Caustic Weed		●	●		●		
Euphorbia planticola	Plains Spurge				●			
Fabaceae - Caesalpinioideae								
Senna artemisioides subsp. *zygophylla*		●						
Senna barronfieldii		●						
Senna coronilloides	A Cassia	●		●	●			
**Senna multiglandulosa*		●						
Fabaceae: Faboideae								
Bossiaea prostrata								●
Chorizema parviflorum	Eastern Flame Pea				●			
Daviesia genistifolia	Broom Bitter Pea	●		●	●	●		●
Daviesia ulicifolia	Gorse Bitter Pea	●			●			
Desmodium brachypodum	Large Tick-trefoil			●	●		●	●
Desmodium gunnii	Slender Tick-trefoil				●		●	●
Desmodium rhytidophyllum		●			●			
Desmodium varians	Slender Tick-trefoil		●	●	●	●		●
Dillwynia retorta		●			●			
Glycine clandestina	Love Creeper	●		●	●	●		●
Glycine microphylla	Small-leaf glycine				●			
Glycine tabacina	A Glycine		●	●	●	●		●
Hardenbergia violacea	Purple Coral Pea	●			●		●	●
Hovea lanceolata		●						
Indigofera australis	Australian Indigo	●					●	
Jacksonia scoparia	Winged Broom-pea				●			
**Medicago* sp.			●	●				
Pultenaea spinosa	Spiny Bush-pea	●			●		●	
Swainsona galegifolia	Smooth Darling-pea	●						
**Trifolium campestre*	Hop Clover					●		●
**Trifolium dubium*	Yellow Suckling Clover				●			●
**Trifolium repens*	White Clover	●		●		●		●
**Trifolium subterraneum*	Subterranean Clover							●

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Zornia dyctiocarpa var. *dyctiocarpa*	Zornia				●			
Fabaceae: Mimosoideae								
Acacia amblygona	Fan Wattle	●		●	●			●
Acacia binervia	Coast Myall	●			●			
Acacia bulgaensis	Bulga Wattle (ROTAP: 2RC-)	●					●	●
Acacia cultriformis	Knife-leaf Wattle	●						
Acacia decora	Western Silver Wattle	●		●	●			
Acacia elongata	Swamp Wattle	●						
Acacia falcata	Sickle Wattle	●			●			●
Acacia implexa	Hickory Wattle	●			●			●
Acacia irrorata subsp. *irrorata*	Green Wattle	●						
Acacia maidenii	Maiden's Wattle	●						
Acacia parramattensis	Parramatta Wattle		●					
Acacia parvipinnula	Silver Stemmed Wattle	●						
Acacia pendula	Weeping Myall	●						●
Acacia prominens	Gosford Wattle	●						●
Acacia salicina	Cooba	●	●	●	●			●
Acacia verniciflua	Varnish Wattle	●					●	
Neptunia gracilis forma gracilis	Sensitive Plant			●	●			
Gentianaceae								
**Centaurium erythraea*	Common Centaury	●		●				
Geraniaceae								
Erodium crinitum	Blue Storksbill					●		●
**Erodium moschatum*	Musky Crowfoot					●		
Geranium solanderi	Native Geranium		●		●			
Goodeniaceae								
Goodenia hederacea	Forest Goodenia				●			
Goodenia ovata	Hop Goodenia	●						
Goodenia rotundifolia	A Goodenia			●	●		●	●
Velleia paradoxa	Spur Velleia	●						
Lamiaceae								
Ajuga australis	Austral Bugle		●		●			

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
**Marrubium vulgare*	White Horehound	●						
Mentha satureioides	Creeping Mint					●		●
Scutellaria humilis	Dwarf Skullcap				●			
Spartothamnella juncea	Bead Bush	●	●	●	●		●	●
**Stachys arvensis*	Stagger Weed							●
Lauraceae								
Cassytha pubescens	Common Devil's Twine	●			●			●
Linaceae								
Linum marginale	Native Flax	●				●		●
Lobeliaceae								
Pratia purpurascens	Whiteroot				●	●		●
Loranthaceae								
Amyema cambagei		●		●				
Amyema gaudichaudii	Paper-bark Mistletoe				●			●
Amyema miquelii	Stalked Mistletoe			●				
Amyema pendulum subsp. *pendulum*	Drooping Mistletoe	●			●			
Amyema quandang var. *quandang*	Grey Mistletoe	●						
Muellerina eucalyptoides			●					
Malvaceae								
Abutilon oxycarpum	Straggly Lantern-bush	●		●	●	●		●
Brachychiton populneus	Kurrajong	●		●	●		●	●
Commersonia dasyphylla	Kerrawang	●						
Commersonia fraseri	Brush Kurrajong							●
Commersonia rugosa								●
Hibiscus heterophyllus subsp. *heterophyllus*	Native Rosella	●		●				●
Hibiscus sturtii var. *sturtii*	Hill Hibiscus				●			
Lasiopetalum ferrugineum var. *cordatum*	Rusty Velvet-bush	●						●
Lasiopetalum macrophyllum	Shrubby Velvet-bush	●						
**Malvastrum americanum*	Spiked Malvastrum				●			
**Modiola caroliniana*	Red-flowered Mallow		●	●				●
**Pavonia hastata*		●		●				
Sida corrugata	Corrugated Sida	●	●	●	●	●		●

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Sida hackettiana	Spiked Sida	●		●	●			●
**Sida rhombifolia*	Paddy's Lucerne	●	●	●	●	●		●
Sida trichopoda	Hairy Sida	●						
Meliaceae								
Melia azedarach	White Cedar	●		●	●		●	
Menispermaceae								
Legnephora moorei	Round-leaf Vine	●						
Stephania japonica	Snake Vine	●						●
Monimiaceae								
Daphnandra sp. *A*	Socketwood	●						
Moraceae								
Ficus coronata	Sandpaper Fig	●						●
Ficus rubiginosa	Port Jackson Fig	●						●
Maclura cochinchinensis	Cockspur Thorn							●
Myrsinaceae								
**Anagallis arvensis*	Scarlet Pimpernel	●		●	●	●		●
Myrsine variabilis	Muttonwood	●			●			●
Myrtaceae								
Acmena smithii	Lilly Pilly							●
Angophora floribunda	Rough-barked Apple	●		●				●
Backhousia myrtifolia	Grey Myrtle							●
Callistemon pinifolius	Pine-leaved Bottlebrush	●						
Corymbia maculata	Spotted Gum	●			●		●	●
Eucalyptus acmenoides	White Mahogany	●						
Eucalyptus albens	White Box				●			
Eucalyptus blakelyi	Blakely's Red Gum	●						
Eucalyptus crebra	Narrow-leaved Ironbark	●	●	●	●	●	●	●
Eucalyptus dawsonii	Slaty Gum	●		●	●		●	
Eucalyptus melliodora	Yellow Box	●		●				
Eucalyptus moluccana	Grey Box	●	●	●	●			●
Eucalyptus punctata	Grey Gum	●						●
Eucalyptus tereticornis	Forest Red Gum	●	●	●		●		

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Melaleuca decora	A Honeymyrtle	●	●	●	●			●
Melaleuca ericifolia	Swamp Paperbark		●					
Melaleuca nodosa	Prickly-leaved Paperbark	●						
Melaleuca thymifolia	Thyme Honey-myrtle	●						
Sannantha pluriflora		●						●
Nyctaginaceae								
Boerhavia dominii	Tarvine				●			
Oleaceae								
Jasminum volubile	Stiff Jasmine	●						
**Ligustrum sinense*	Small-leaved Privet				●			
Notelaea longifolia f. longifolia		●					●	●
Notelaea microcarpa var. *microcarpa*	Native Olive	●	●	●	●	●	●	
Notelaea ovata		●						●
**Olea europaea* subsp. *cuspidata*	African Olive	●	●	●				
Onagraceae								
Ludwigia peploides	Water Primrose		●					
**Oenothera mollissima*					●			
Oxalidaceae								
Oxalis chnoodes	An Oxalis				●			●
Oxalis radicosa	An Oxalis				●	●		
Oxalis sp.	An Oxalis		●	●	●		●	●
Oxalis thompsoniae	An Oxalis				●			
Phyllanthaceae								
Breynia oblongifolia	Coffee Bush	●		●	●		●	●
Glochidion ferdinandi	Cheese Tree	●						●
Phyllanthus gunnii	Scrubby Spurge	●						●
Phyllanthus virgatus	A Phyllanthus				●			
Pittosporaceae								
Bursaria spinosa	Blackthorn	●		●	●		●	●
Pittosporum multiflorum	Orange Thorn							●
Plantaginaceae								
Bacopa monnieri	Bacopa		●					

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		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Plantago debilis	Slender Plantain		●		●		●	●
Plantago gaudichaudii	Narrow Plantain							●
**Plantago lanceolata*	Lamb's Tongue	●	●	●	●	●		●
Veronica calycina	Hairy Speedwell	●						
Veronica plebeia	Trailing Speedwell		●	●	●	●		●
Polygonaceae								
Persicaria hydropiper	Water Pepper		●					
Persicaria lapathifolia	Pale Knotweed		●	●				
Persicaria orientalis	Princes Feathers		●					
Rumex brownii	Swamp Dock	●	●					
**Rumex crispus*	Curled Dock	●		●				
Proteaceae								
Grevillea montana	ROTAP : 2VC	●			●			●
Persoonia linearis	Narrow-leaved Geebung	●			●			
Ranunculaceae								
Clematis glycinoides	Headache vine				●		●	●
Rhamnaceae								
Alphitonia excelsa	Red Ash	●						
Pomaderris betulina	Birch Pomaderris	●						
Rosaceae								
Rubus moluccanus var. *trilobus*	Molucca Bramble	●						
Rubus parvifolius	Native Raspberry							●
Rubiaceae								
Asperula conferta	Common Woodruff		●	●	●	●		●
Galium leiocarpum	A Bedstraw				●		●	
Galium leptogonium								●
Opercularia hispida	Hairy Stinkweed						●	
Pomax umbellata	Pomax	●			●			
Psydrax odorata	Shiny-leaved Canthium	●		●	●			●
**Richardia stellaris*			●	●	●			
Rutaceae								
Correa reflexa	Native Fuchsia				●			

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Geijera salicifolia	Brush Wilga	●	●	●	●			●
Philotheca difformis subsp. *smithiana*	Small-leaf Wax-flower	●						
Santalaceae								
Alectryon subcinereus	Native Quince	●						●
Choretrum sp. *Coxs Gap*		●			●		●	●
Exocarpos cupressiformis	Native Cherry	●						
Exocarpos strictus	Dwarf Cherry		●	●		●	●	
Santalum lanceolatum	Northern Sandalwood	●	●					
Sapindaceae								
Dodonaea sinuolata subsp. *sinuolata*		●						
Dodonaea triangularis	A Hop-bush	●			●			
Dodonaea triquetra	Large-leaf Hop-bush	●						
Dodonaea truncatiales	Angular Hop-bush	●						
Dodonaea viscosa subsp. *angustifolia*	Sticky Hop-bush				●			
Dodonaea viscosa subsp. *cuneata*	Wedge-leaf Hop-bush	●		●	●			●
Scrophulariaceae								
Eremophila debilis	Amulla	●	●	●	●	●		●
Myoporum montanum	Western Boobialla	●		●	●			
Solanaceae								
**Cestrum parqui*	Green Cestrum			●				
**Datura stramonium*	Common Thornapple	●						
**Lycium ferocissimum*	African Boxthorn	●	●	●		●		●
**Nicotiana glauca*	Tree Tobacco			●				
Solanum brownii	Violet Nightshade	●		●	●		●	●
Solanum cinereum	Narrawa Burr	●				●		●
**Solanum elaeagnifolium*	Silver-leaved Nightshade					●		
**Solanum mauritianum*	Wild Tobacco Bush			●				
**Solanum nigrum*	Black-berry Nightshade	●	●	●	●			●
Solanum stelligerum	Devil's Needles						●	
Stackhousiaceae								
Stackhousia viminea	Slender Stackhousia	●			●			
Thymelaeaceae								

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Pimelea curviflora var. *divergens*	Curved Rice-flower				●		●	●
Urticaceae								
Urtica incisa	Stinging Nettle	●		●				
Verbenaceae								
**Verbena bonariensis*	Purpletop	●	●	●	●			
**Verbena caracasana*				●	●	●		
**Verbena rigida*	Veined Verbena		●		●	●		●
**Verbena x brasiliensis*	Gin Case							●
Vitaceae								
Cayratia clematidea	Native Grape	●		●			●	●
Cissus antarctica	Kangaroo Vine							●
Clematicissus opaca	Pepper Vine				●		●	
Tetrastigma nitens								●
SUBCLASS LILIIDAE								
Anthericaceae								
Arthropodium milleflorum	Pale Vanilla-lily				●			
Arthropodium minus	Small Vanilla Lily				●			●
Dichopopogon fimbriatus	Nodding Chocolate Lily			●				
Laxmannia gracilis	Slender Wire Lily	●		●	●			●
Asparagaceae								
**Asparagus officinalis*	Asparagus	●	●					
Cyperaceae								
Carex brownii					●			
Carex inversa	Knob Sedge		●		●			
**Cyperus aggregatus*				●	●			
Cyperus difformis			●					
Cyperus fulvus	Sticky Sedge	●						
Cyperus gracilis	Slender Flat-sedge		●	●	●	●		●
Cyperus haspan					●	●		
Cyperus laevis					●			
Eleocharis sp.			●					
Fimbristylis dichotoma	Common Fringe-sedge		●	●	●	●		

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Gahnia aspera	Common Saw-sedge	●		●	●		●	●
Gahnia melanocarpa	Black-fruit Saw-sedge	●						
Lepidosperma gunnii							●	
Lepidosperma laterale	Variable Sword-sedge	●			●			●
Scleria mackaviensis					●		●	
Iridaceae								
**Romulea rosea*	Onion Grass			●		●		●
Juncaceae								
**Juncus acutus*	Sharp Rush	●		●				
Juncus subsecundus	Finger Rush				●			
Juncus usitatus		●	●					
Lemnaceae								
Lemna sp.			●					
Lomandraceae								
Lomandra confertifolia subsp. *pallida*	Mat-rush	●			●		●	
Lomandra filiformis subsp. *coriacea*	Wattle Mat-rush	●						
Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush	●	●	●	●	●		●
Lomandra glauca	Pale Mat-rush				●			
Lomandra longifolia	Spiny-headed Mat-rush	●					●	●
Lomandra multiflora	Many-flowered Mat-rush	●	●	●	●	●		●
Luzuriagaceae								
Eustrephus latifolius	Wombat Berry				●		●	●
Geitonoplesium cymosum	Scrambling Lily	●						●
Orchidaceae								
Pterostylis sp.					●		●	
Phormiaceae								
Dianella caerulea var. *caerulea*	Blue Flax Lily				●			
Dianella caerulea var. *cinerascens*	Blue Flax Lily	●		●			●	●
Dianella longifolia var. *longifolia*	A Flax Lily	●	●	●	●			
Dianella longifolia var. *stenophylla*					●			
Dianella revoluta	Spreading Flax-lily	●		●	●		●	●
Dianella sp.				●	●			●

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		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Poaceae								
Ancistrachne uncinulata	Hooky Grass	●		●	●		●	●
Aristida acuta					●			
Aristida echinata					●			
Aristida jerichoensis var. *jerichoensis*	Jericho Wiregrass	●						
Aristida personata	Purple Wire-grass	●		●	●	●		●
Aristida ramosa var. *ramosa*	Purple Wiregrass		●					
Aristida vagans	Threeawn Speargrass	●	●	●	●	●	●	●
Austrostipa ramosissima	Stout Bamboo Grass	●						●
Austrostipa scabra	Speargrass	●	●	●	●		●	●
Austrostipa verticillata	Slender Bamboo Grass	●	●	●	●	●		●
**Axonopus fissifolius*	Narrow-leafed Carpet Grass				●			
Bothriochloa decipiens	Red Grass		●	●	●	●		●
**Briza minor*	Shivery Grass							●
**Bromus catharticus*	Prairie Grass	●						
**Chloris gayana*	Rhodes Grass	●	●	●				
Chloris truncata	Windmill Grass		●	●	●			
Chloris ventricosa	Plump Windmill Grass	●	●	●	●	●		●
Cymbopogon refractus	Barbwire Grass	●	●	●	●	●	●	●
Cynodon dactylon	Couch	●	●	●	●	●		●
Dichanthium sericeum	Queensland Bluegrass							
Dichelachne micrantha	Shorthair Plumegrass				●	●		
Digitaria breviglumis					●			
Digitaria brownii	Cotton Panic Grass		●	●		●		
Digitaria diffusa	Open Summer Grass		●	●	●	●		
Digitaria divaricatissima	Umbrella Grass			●	●	●		
Digitaria parviflora	Small-flowered Finger Grass						●	
Digitaria ramularis					●		●	
Echinochloa colona	Awnless Barnyard Grass		●					
Echinopogon caespitosus	Bushy Hedgehog-grass				●			
**Ehrharta erecta*	Panic Veldtgrass		●	●				
**Eleusine tristachya*	Goose Grass		●					

Scientific Name	Common Name	Year of Survey						
		2002[1]	2010[2]	2011[3]	2012[4]	2014[5]	2015a[6]	2015b[4]
Elymus scaber			●		●			
Enteropogon acicularis	Curly Windmill Grass		●	●	●	●		●
Entolasia marginata	Bordered Panic				●			●
Entolasia stricta	Wiry Panic				●		●	
Eragrostis alveiformis					●			
Eragrostis brownii	Brown's Lovegrass		●	●	●			●
**Eragrostis curvula*	African Lovegrass			●				
Eragrostis elongata	Clustered Lovegrass			●	●	●		
Eragrostis lacunaria	Purple Love-grass			●	●			
Eragrostis leptostachya	Paddock Lovegrass		●	●	●	●		
Eragrostis parviflora	Weeping Lovegrass		●	●	●			
**Eragrostis pilosa*	Soft Lovegrass	●						
Eriochloa procera	Spring Grass		●					
Eriochloa pseudoacrotricha	Early Spring Grass			●	●	●		
Eulalia aurea	Silky Browntop			●		●		
Imperata cylindrica	Blady Grass	●					●	●
Lachnagrostis filiformis		●				●		
Leptochloa asthenes	A Canegrass				●			●
**Lolium perenne*	Perennial Ryegrass							●
**Melinis repens*	Red Natal Grass	●						
Microlaena stipoides	Weeping Grass	●	●	●	●	●	●	
Oplismenus imbecillis	Basket Grass			●	●		●	●
Panicum effusum	Hairy Panic	●	●	●	●	●	●	●
Panicum simile	Two Coloured Panic		●	●	●	●		●
Paspalidium criniforme	Fine Panic			●	●			
Paspalidium distans			●		●	●		
Paspalidium gracile	Slender Panic				●	●		●
Paspalum distichum	Water Couch		●					
**Paspalum dilatatum*	Paspalum		●	●	●	●		
**Pennisetum clandestinum*	Kikuyu Grass		●					
**Phalaris aquatica*	Phalaris		●					
Phragmites australis	Common Reed			●				

Scientific Name	Common Name	Year of Survey						
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Poa sieberiana var. *sieberiana*	Snowgrass				●			
Rytidosperma bipartitum	Wallaby Grass		●		●			●
Rytidosperma fulvum	Wallaby Grass	●	●	●	●	●		
Rytidosperma longifolium	Long-leaved Wallaby Grass	●			●		●	●
Rytidosperma racemosum var. *obtusatum*			●	●	●			
Rytidosperma racemosum var. *racemosum*			●		●			
**Setaria pumila*	Pale Pigeon Grass		●	●	●	●		
Sorghum leiocladum	Wild Sorghum				●			
Sporobolus caroli	Fairy Grass				●			
Sporobolus creber	Slender Rat's Tail Grass		●	●	●	●		●
Sporobolus elongatus	Slender Rat's Tail Grass			●				
Themeda australis	Kangaroo Grass	●			●			
**Vulpia* sp.								●
Typhaceae								
Typha orientalis	Broadleaf Cumbungi	●						
TOTAL NATIVE SPECIES	359	172	96	125	203	66	66	158
TOTAL INTRODUCED SPECIES	100	39	37	53	38	30	3	33
GRAND TOTAL SPECIES	459	211	133	178	241	96	69	191

* Introduced species

Opp. Opportunistic species

[1] Orchid Research (2003).

[2] FloraSearch (2010).

[3] FloraSearch (2011).

[4] This report

[5] FloraSearch (2014).

[6] FloraSearch (2015).