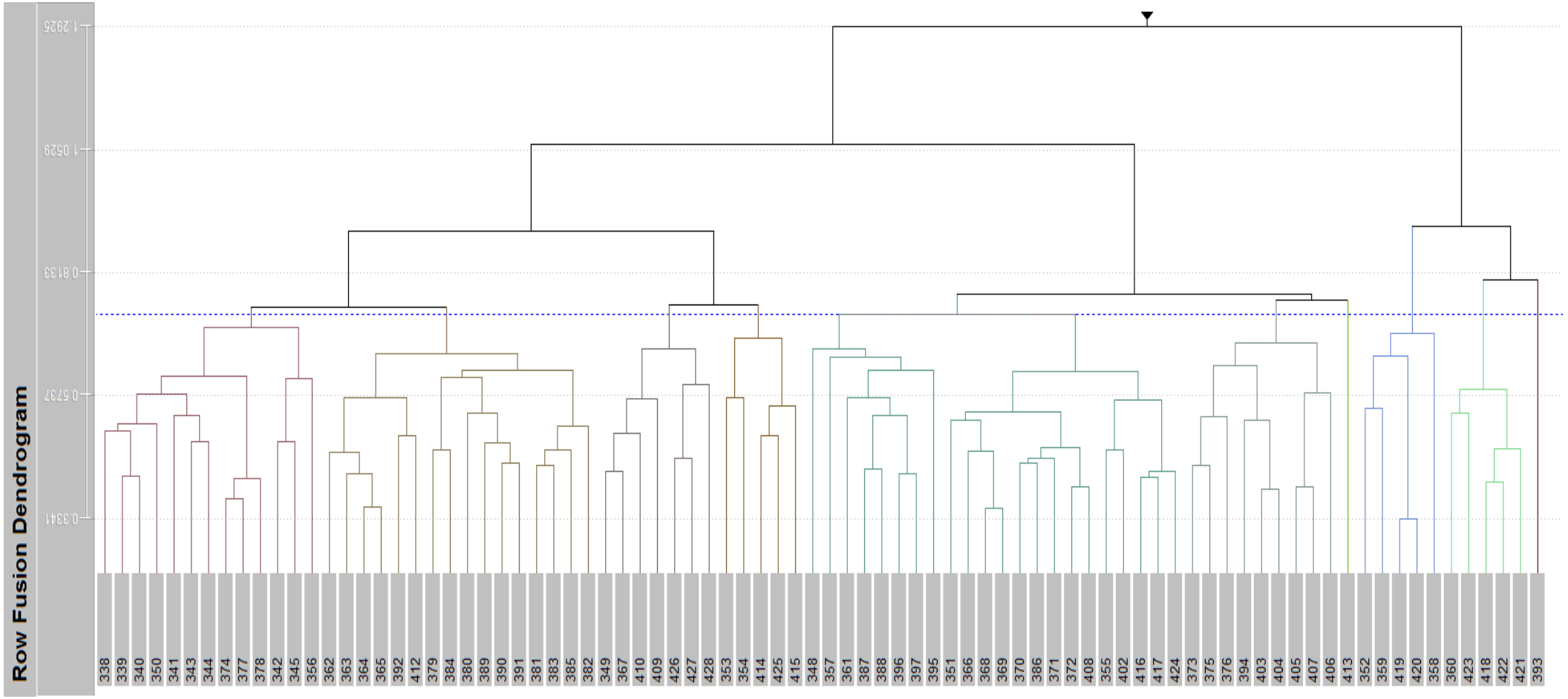
APPENDICES

Appendix A: Floristic Multi-variate Analysis (PATN Analysis) – Row Fusion Dendrogram



Appendix B: Vegetation Community Alignment

Niche Code	Niche Type	RBVT Code	RBVT	TSC EEC (NSW)	Keith Formation (sub-formation)	Keith Class
2a	White Box - White Cypress Pine - Cypress Regeneration	NA225	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Not an EEC	Dry Sclerophyll Forest (shrub/grass)	North-west Slopes Dry Sclerophyll Woodlands
2b	White Box - White Cypress Pine - Semi-cleared					
2c	White Box - White Cypress Pine - Derived Native Pasture					
2f	White Box - White Cypress Pine - Mature Cypress Forest					
3	White Box Grassy Woodland	NA226	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	White Box Yellow Box Blakely's Red Gum Woodland	Grassy Woodlands	Western Slopes Grassy Woodlands
7b	Silver-leaved Ironbark - White Box - White Cypress Pine – Semi-cleared	NA232	White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion	Not an EEC	Dry Sclerophyll Forests (shrubby)	Western Slopes Dry Sclerophyll Forests
7c	Silver-leaved Ironbark - White Box - White Cypress Pine - Derived Native Pasture					
7e	Silver-leaved Ironbark - White Box - White Cypress Pine - Mature Cypress Woodland					
8	Yellow Box - Blakely's Red Gum Grassy Woodland	NA237	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion	White Box – Yellow Box – Blakely's Red Gum Woodland	Grassy Woodlands	Western Slopes Grassy Woodlands
19c	Plains Grass – Blue Grass Derived Native Pasture	NA181	Plains Grass grassland on basaltic black earth soils mainly on the Liverpool Plains in the Brigalow Belt South Bioregion (Benson 102)	Not an EEC	Grasslands	Western Slopes Grasslands
20a	Poplar Box Grassy Woodland - Derived Woodland	NA185	Poplar Box grassy woodland on alluvial heavy clay soils in the Brigalow Belt South Bioregion (Benson 101)	Not an EEC	Dry Sclerophyll Forest (shrub/grass)	Pilliga Outwash Dry Sclerophyll Forest
20c	Poplar Box Grassy Woodland - Derived Native Pasture					

Niche Code	Niche Type	RBVT Code	RBVT	TSC EEC (NSW)	Keith Formation (sub-formation)	Keith Class
21	Weeping Myall Low Shrubland	NA219	Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions (Benson 27)	Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregion	Semi-arid Woodlands (Grassy subformation)	Riverine Plain Woodlands
22	Mixed Marsh Sedgeland	NA201	Shallow freshwater mixed marsh sedgeland of northern-western NSW floodplains (Benson 53)	Not an EEC	Freshwater Wetlands [N]	Inland Floodplain Swamps
23	River Red Gum Riverine Woodland	NA193	River Red Gum riverine woodlands and forests in the Nandewar and Brigalow Belt South Bioregions (Benson 78)	Not an EEC	Forested Wetlands	Inland Riverine Forest

Appendix C: Threatened Flora Likelihood of Occurrence

All unreferenced habitat information was obtained from the OEH threatened species profiles (OEH, 2012b).

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Acacia ausfeldii	Ausfeld's Wattle	V	-	Found to the east of Dubbo in the Mudgee, Ulan - Gulgong area of the New South Wales (NSW) South Western Slopes bioregion, with some records in the adjoining Brigalow Belt South, South Eastern Highlands and the Sydney Basin bioregions. Associated species include White Box (*Eucalyptus albens*), Blakely's Red Gum (*E. blakelyi*) and *Callitris* spp., with an understorey dominated by *Cassinia* spp. and grasses.	Low
Acacia flocktoniae	Flockton Wattle	V	V	Grows in dry sclerophyll forest on sandstone. The Flockton Wattle is found only in the Southern Blue Mountains (at Mt Victoria, Megalong Valley and Yerranderie).	None
Acacia jucunda		E	-	*Acacia jucunda* abundance in populations has been recorded as locally occasional, locally common and frequent, with one population noted as being about one acre in extent. Mainly restricted to dry eucalypt woodland communities on sandy to sandy-loam soils. In Queensland, the species is found in dry ranges on loams or clay-loams in eucalypt communities. Associated species at the NSW sites include Western Silver Wattle (*Acacia polybotrya*) and Black Cypress Pine (*Callitris endlicheri*).	None
Acacia pubifolia	Velvet Wattle	E	V	Velvet Wattle generally grows in dry shrubby woodland on granite and metasediment soils. Velvet Wattle occurs in NSW and Queensland. In NSW it is known from two main populations, one north of Emmaville and the other near Warrabah National Park.	None
Acacia pycnostachya	Bolivia Wattle	V	V	Restricted to NSW where it is known from only three localities on the New England Tablelands, Bolivia Hill and Bluff Rock south of Tenterfield, and a site on private land west of Tenterfield. The locations span a distance of approximately 50 kilometres (km). Grows in dry sclerophyll forest amongst granite outcrops, on hillsides at altitudes of 700 to 900 metres (m). Soil types range from sandy and skeletal on exposed outcrops, to shallow sandy loams in less exposed sites. It often grows in stands in areas sheltered from fire. Generally plants appear to dominate the understorey or tall shrub stratum below an open canopy of taller shrubs or trees. Associated species include Orange Gum (*Eucalyptus prava*), New England Blackbutt (*Eucalyptus andrewsii*), Black Cypress Pine (*Callitris endlicheri*), Wallangarra Wattle (*Acacia aduncа*), New England Blackbutt (*Eucalyptus campanulata*), Slender Tea-tree (*Leptospermum brevipes*), Silver Wattle (*Acacia neriifolia*), Nodding Blue Lily (*Stypandra glauca*), Native Olive (*Notelaea microcarpa*) and *Callitris* spp.	None
Asterolasia sp. "Dungowan Creek"	Dungowan Starbush	E	-	Dungowan Starbush is only known from a single population at Dungowan Dam near Tamworth. This location is not currently within a conservation reserve but is within a restricted-access area. Dungowan Starbush grows in rocky alluvial soil along a creekbank dominated by River Oak (*Casuarina cunninghamiana*).	None

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Bertya opponens	Coolibah Bertya	V	V	This plant is currently known from only four scattered sites in NSW: one from private property near Coolabah in western NSW and two to the south of Narrabri on the North West Slopes, including the largest population in Jacks Creek State Forest. The fourth population was known from private property near Cobar but this population has not been seen since 1982 and is possibly now extinct. Coolabah Bertya occurs in a range of habitats ranging from stony mallee ridges and cypress pine forest on red soils in the west, to coastal cliff edges in open eucalypt forest in the east. The wide variation in habitat type between the populations makes the identification of critical habitat very difficult. Consideration of disturbance regimes and grazing management are probably more important to the survival of populations in the long-term.	Low
Boronia granitica	Granite Boronia	V	E	Granite Boronia occurs in scattered localities on the New England Tablelands and North West Slopes north from the Armidale area to the Stanthorpe district in southern Queensland. Grows on granitic soils amongst rock outcrops, often in rock crevices, and in forests and woodlands on granite scree and shallow soils. Important site characteristics include low precipitation and high levels of solar radiation. This semi-arid soil environment would have selected the more xerophytic species from the available regional assemblage of rainforest species. Bright pink flowers 6 - 10 millimetres (mm) long appear from July to October.	None
Boronia ruppii	Rupp's Boronia	E	-	Restricted to Woods Reef, east of Barraba. Rupp's Boronia grows in dry eucalypt woodland on soils derived from serpentinite rock. The pale to bright pink flowers are 6 - 10 mm long and occur during July to November.	None
Cadellia pentastylis	Ooline	V	V	Occurs along the western edge of the North West Slopes from north of Gunnedah to west of Tenterfield. Also occurs in Queensland. The natural range of Ooline is from 24 degrees (º) south to 30º south in the 500 to 750 mm per annum rainfall belt. Forms a closed or open canopy mixing with eucalypt and cypress pine species. There appears to be a strong correlation between the presence of Ooline and low to medium-nutrient soils of sandy clay or clayey consistencies, with a typical soil profile having a sandy loam surface layer, grading from a light clay to a medium clay with depth. Has the capacity to resprout from rootstock and coppice vigorously from stumps, a feature which may be critical for the species survival in a fire-prone environment.	Low
Callistemon pungens	Bottlebrush	-	V	Callistemon pungens occurs in south-east Queensland and the northern tablelands of north-east NSW. In NSW, it occurs from near Inverell to the eastern escarpment in New England, along rocky watercourses usually with sandy granite (or occasionally basalt) creek beds, and generally among naturalised species. Flowers over spring and summer, mostly in November.	None

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Calotis glandulosa	Mauve Burr-daisy	V	V	Mauve Burr-daisy's main distribution is in the Monaro and Kosciuszko regions. There are three known sites in the upper Shoalhaven catchment There are old and possibly dubious records from near Oberon, the Dubbo area and Mt Imlay. Found in subalpine grassland (dominated by *Poa* spp.), and montane or natural temperate grassland (dominated by *Themeda australis*) and Snow Gum (*Eucalyptus pauciflora*) Woodlands on the Monaro and Shoalhaven area. Appears to be a coloniser of bare patches, which explains why it often occurs on roadsides. Flowers in spring and summer.	Low
Chiloglottis platyptera	Barrington Tops Ant Orchid	V	-	Flowers from July to October. Found along the eastern edge of the New England Tablelands, from Ben Halls Gap to east of Tenterfield, and also in the Barrington Tops area. Grows in moist areas in tall open eucalypt forest with a grassy understorey, and also around rainforest edges. It generally occurs in rich brown loam soils.	None
Cynanchum elegans	White-flowered Wax Plant	E	E	Recorded from rainforest gullies scrub and scree slopes from the Gloucester district to the Wollongong area and inland to Mt Dangar. Listed as a Rare of Threatened Australian Plant (ROTAP): 3ECi.	Low
Cyperus conicus		E	-	Occurs rarely in the Pilliga area of NSW and is also found in Victoria, Queensland, the Northern Territory and Western Australia. Often associated with other sedge species including *Cyperus victoriensis, C. difformis, C. iria, C. compressus, C. nervulosus, C. dactylotes, Fimbristylis* spp. and *Eleocharis* spp. Grows in open woodland on sandy soil. In central Australia, the species grows near waterholes and on the banks of streams in sandy soils. In Queensland the species usually found on heavy soils.	Low
Desmodium campylocaulon	Creeping Tick-trefoil	E	-	Occurs chiefly in the Collarenebri and Moree districts in the north-western plains of NSW. Also occurs in the Northern Territory and Darling Downs district of south-eastern Queensland. Creeping Tick-Trefoil is confined to clay soils, usually with *Astrebla* and *Iseilema* species. In NSW, *Desmodium campylocaulon* grows on cracking black soils in the Narrabri, Moree and Walgett local government areas. Associated species include Brigalow (*Acacia harpophylla*), Barley Mitchell Grass (*Astrebla pectinata*) and *Sorghum* spp., *Dichanthium* spp. and *Panicum* spp. Flowers summer and autumn.	**Moderate** Habitat exists within the study area, however *D. campylocaulon* has not previously been recorded in the locality
Dichanthium setosum	Bluegrass	V	V	Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas. Associated with heavy basaltic black soils. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. Often collected from disturbed open grassy woodlands on the northern tablelands, where the habitat has been variously grazed, nutrient-enriched and water-enriched. It is open to question whether the species tolerates or is promoted by a certain amount of disturbance, or whether this is indicative of the threatening processes behind its depleted habitat.	**Moderate** Habitat exists within the study area, however *D. setosum* has not previously been recorded in the locality and the preferred soil is absent

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Digitaria porrecta	Finger Panic Grass	E	E	Finger Panic Grass occurs in NSW and Queensland. In NSW it is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran. It largely occurs on private land. Native grassland, woodlands or open forest with a grassy understorey, on richer soils. Often found along roadsides and travelling stock routes where there is light grazing and occasional fire. *Digitaria porrecta* is a perennial tussock-forming grass that can vegetatively reproduce.	**Moderate** Potential habitat exists within the study area, however *D. porrecta* has not previously been recorded in the locality
Diuris pedunculata	Small Snake Orchid	E	E	Confined to NSW. It was originally found scattered from Tenterfield south to the Hawkesbury River, but is now mainly found on the New England Tablelands, around Armidale, Uralla, Guyra and Ebor. Grows on grassy slopes or flats, often on peaty soils in moist areas. Also known from shale and trap soils, on fine granite, and among boulders.	None
Diuris tricolor	Pine Donkey Orchid	V	-	Sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the far north of NSW. Localities include the Condobolin-Nymagee road, Wattamondara towards Cowra, Cooyal, Adelong, Red Hill north of Narrandera, Coolamon, near Darlington Point, Eugowra, Girilambone, Dubbo, Muswellbrook, and several sites west of Wagga Wagga. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats. Associated species include White Cypress Pine (*Callitris glaucophylla*), Bimble Box *(Eucalyptus populnea*), Gum Coolibah (*Eucalyptus intertexta*), Ironbark and Acacia shrubland. The understorey is often grassy with herbaceous plants such as *Bulbine* spp.	Low
Eucalyptus mckieana	McKie's Stringybark	V	V	Confined to the drier western side of the New England Tablelands of NSW, from Torrington to Bendemeer. Most populations occur on private property, but it does occur in Kings Plain National Park, Torrington State Conservation Area and Severn River Nature Reserve. *Eucalyptus mckieana* is found in grassy open forest or woodland on poor sandy loams, most commonly on gently sloping or flat sites.	None
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield, largely on private property. Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite.	None
Eucalyptus oresbia	Small-fruited Mountain Gum	V	-	Restricted to a small area between Nundle and Hanging Rock in the southern section of the New England Tablelands and also north of Murrurundi in the upper Hunter Valley. Steep slopes in wet forest at higher altitudes.	None
Eucalyptus rubida subsp. *barbigerorum*	Blackbutt Candlebark	V	V	Known from scattered populations on the New England Tablelands from Guyra to the Tenterfield area. Most populations occur on private property. Woodland on medium or high fertility soils. Often on cold flats.	None

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Euphrasia arguta	-	CE	CE	*Euphrasia arguta* had not been found since 1904 until its rediscovery in 2008. The species is now known from six sites up to 25 km apart in the area of Nundle State Forest, south-east of Tamworth, NSW. All sites are in the Nandewar Bioregion (subregion 4) of northern NSW, in the south-east section of Namoi Natural Resource Management region. Prior to its rediscovery, the only information on the habitat of *Euphrasia arguta* came from the type specimen. The species previous habitat consisted of grassy areas near rivers at elevations up to 700 m above sea level, with an annual rainfall of 600 mm. The recently discovered populations are in grassy forests or regrowth vegetation.	None
Geijera paniculata	Axe-Breaker	E	-	Moderately common in restricted habitat in Queensland between the Brisbane River and the central Queensland coast, but very rare in north-east NSW, where it is known from the Tweed, Lismore and Wardell areas. Axebreaker is found in dry subtropical rainforest and vine scrub, often along rivers.	None
Hakea pulvinifera	Lake Keepit Hakea	E	E	Lake Keepit Hakea is confined to the North West Slopes of NSW, where it is known from a single population near Lake Keepit, north-east of Gunnedah. Recorded from a single population on a hard rocky hillside below a dam. The site is also recorded as being hot and dry and well drained.	None
Haloragis exalata subsp. *velutina*	Tall Velvet Sea-berry	V	V	This subspecies of Tall Sea-berry occurs on the north coast of NSW and south-eastern Queensland. It is plentiful in inaccessible areas of the upper Macleay River. Grows in damp places near watercourses. This subspecies also occurs in woodland on the steep rocky slopes of gorges.	None
Homoranthus binghiensis	Binghi Homoranthus	E	-	Known only from Ironbark Nature Reserve and neighbouring properties, north-east of Barraba. Occurs in open and exposed sites in shrubland and low woodland on granite outcrops between 650 - 970 m altitude. Often grows in rock crevices on bare rocky slopes and in the surrounding shallow soils.	None
Homoranthus darwinioides	-	V	V	Rare in the central tablelands and western slopes of NSW, occurring from Putty to the Dubbo district. It is found west of Muswellbrook between Merriwa and Bylong, and north of Muswellbrook to Goonoo State Forest. The species has been collected from Lee's Pinch, but not relocated at its original locality north of Mt Coricudgy above the headwaters of Widden Brook. Goonoo State Forest is established as a definite locality. Grows in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Landforms the species has been recorded growing on include flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes, and a slight depression on a roadside with loamy sand.	None

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Homoranthus prolixus	Granite Homoranthus	V	V	Scattered locations between Inverell and Bendemeer. This species is only conserved in The Basin Nature Reserve near Bundarra. *Homoranthus prolixus* grows in heath patches, in skeletal soil among crevices of granite outcrops. Associated vegetation at the 'Longford station' site north-east of Bendemeer is comprised of Silver Wattle (*Acacia neriifolia*), *Acacia granitica,* Sticky Daisy-bush (*Olearia elliptica*), Bitter Cryptandra (*Cryptandra amara*) and Black Cypress Pine (*Callitris endlicheri*). Associated vegetation at other sites includes *Callitris endlicheri,* Thumbledown Red Gum (*Eucalyptus dealbata*) and Apple (*Angophora floribunda*) forest, and dry heath or open scrub with Spurwing Wattle (*Acacia triptera*), Violet Kunza (*Kunzea parvifolia*), *Leptospermum* spp. and *Callitris* spp. Likely to be highly fire-sensitive and intolerant to frequent fire disturbance.	None
Indigofera efoliata	Leafless Indigo	E	E	Very rare and possibly now extinct, known only from a few collections in the Dubbo area. Mr E.F. Biddiscombe is the only person alive to have seen *Indigofera efoliata* in the wild, in August 1955. Sites were located along the Dubbo to Minore railway line and road, on Wallaringa and Geurie properties and in Goonoo State Forest. It almost certainly dies back to a substantial underground rootstock in unfavourable seasons and it is possible that aerial parts do not appear at all unless there is significant rainfall. Recorded in Goonoo State Forest in Narrow-leaved Ironbark (*Eucalyptus crebra*) and White Cypress Pine (*Callitris glaucophylla*) dry sclerophyll forest, and in *E. microcarpa* and *C. glaucophylla* tall woodland. Herbarium records note the species as growing on slight rises amongst ironstone formation in stony red-brown sandy loam.	None
Ipomoea diamantinensis	Desert Cow-vine	E	-	Occurs north from near Goodooga, in the north-western slopes and plains of NSW. Localities include Narran River and Inverell. The species is also found in Queensland, the Northern Territory, South Australia and the Kimberley region of Western Australia. Grows on clay soils on floodplains, often in shallow water and mud on cracking grey clay. Flowers mainly summer to autumn.	**Moderate** Habitat exists within the study area, however *I. diamantinensis* has not previously been recorded in the locality
Lepidium aschersonii	Spiny Peppercress	V	V	Found on ridges of gilgai clays dominated by Brigalow (*Acacia harpophylla*), with *Austrodanthonia* spp. and/or *Austrostipa* spp. in the understorey. The species grows as a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense Brigalow, with sparse grassy understorey and occasional heavy litter.	Low
Lepidium hyssopifolium	Aromatic Peppercress	E	E	The species occurs in a variety of habitats including woodland with a grassy understorey and grassland. In NSW, there is a small population consisting near Bathurst, two populations near Bungendore, and one near Crookwell. Historical records also exist from near Armidale and possibly Cooma.	None

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Lepidium monoplocoides	Winged Peppercress	E	E	Widespread in the semi-arid western plains regions of NSW. Collected from widely scattered localities, with large numbers of historical records but few recent collections. Occurs on seasonally moist to waterlogged sites, on heavy fertile soils, with a mean annual rainfall of around 300-500 mm. Predominant vegetation is usually an open woodland dominated by Bulloak (*Allocasuarina luehmannii*) and/or eucalypts, particularly Black Box *(Eucalyptus largiflorens*) or Poplar Box *(Eucalyptus populnea*). The field layer of the surrounding woodland is dominated by tussock grasses. Recorded in a wetland-grassland community comprising Cane Grass (*Eragrostis australasica*), *Lachnagrostis filiformis, Rytidosperma duttonianum, Walwhalleya proluta, Myriophyllum crispatum,* Fairy Aprons (*Utricularia dichotoma*) and Drumsticks (*Pycnosorus globosus*), on waterlogged grey-brown clay. Also recorded from a Black Bluebush (*Maireana pyramidata*) shrubland. Flowers from late winter to spring, or August to October. The species is highly dependent on seasonal conditions. Occurs in periodically flooded and waterlogged habitats and does not tolerate grazing disturbance. The number of plants at each site varies greatly with seasonal conditions, but sites tend to be small in area with local concentrations of the plant. Has been recorded as uncommon to locally common with hundreds of plants at sites.	**Known** Recorded in the study area during the current field survey (Figure 7)
Marsdenia longiloba	Slender Marsdenia	E	V	Scattered sites on the north coast of NSW north from Barrington Tops. Also occurs in south-east Queensland. Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops.	None
Monotaxis macrophylla	Large-leaf Monotaxis	E	-	Large-leaf Monotaxis is recorded from several highly disjunct populations in NSW: eastern edge of Deua NP (west of Moruya), Bemboka portion of South East Forests National Park, Cobar area (Hermitage Plains), the Tenterfield area, and Woodenbong (near the Queensland border). It is also in Queensland. A recent record from the eastern spur of the Nandewar Range is in the Namoi catchment. *Monotaxis macrophylla* displays the properties of a fire ephemeral species in many ways. Flowers in August. Plants have a short life span and do not seem to persist longer than six months. Many hundreds of plants have been observed growing with *Muehlenbeckia costata* on recently burnt rock outcrops. Grows on rocky ridges and hillsides.	None
Phyllanthus maderaspatanus	-	E	-	Recorded for the Brewarrina and Collarenebri districts in the north-western plains of NSW. Also occurs in Queensland, the Northern Territory, South Australia and Western Australia. Grows in floodplain areas on heavy soils and may rely on appropriate and intermittent rainfall and flooding events for its survival. The species is described as being a summer-growing annual and is thus dependent on seasonal conditions.Often associated with open grasslands and eucalypt woodlands in or near creek beds, and grassy flats and levees near watercourses. Flowering time is spring to summer, and the species is a summer-growing annual. Seeding is recorded in March. Occurs after summer rains and readily drops its leaves as it dries off.	Low

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Picris evae	Hawkweed	V	V	Known in NSW north from the Inverell area, in the north-western slopes and plains regions. It has been collected from Elsmore (16 km east of Inverell), Oxley Park (Tamworth) and also from Dangar Falls in the Oxley Wild Rivers National Park in the northern tablelands of NSW. The species also occurs in south-eastern Queensland. All recent collections appear to come from modified habitats such as weedy roadside vegetation. Its main habitat is open *Eucalyptus* spp. forest and *Dichanthium* spp. grassland, roadsides and cultivated areas (paddocks). Soils are black, dark grey or red-brown (specified as shallow, stony soil over basalt for one collection) and reddish clay-loam or medium clay soils. The flowering and fruiting period is mainly October to January, with a few plants collected in flower or fruit until May.	Low
Platyzoma microphyllum	Braid Fern	E	-	Recorded in NSW only in the Yetman district. The species is widespread across northern Australia, from WA to the Northern Territory, eastern Queensland and just into central-northern NSW. Grows in sandy or swampy soils, or in clay soils adjacent to streams and lagoons and subject to periodic flooding.	Low
Polygala linariifolia	Native Milkwort	E	-	North from Copeton Dam and the Warialda area to southern Queensland; also found on the NSW north coast near Casino and Kyogle, and there is an isolated population in far western NSW near Weebah Gate, west of Hungerford. This species also occurs in Western Australia. Sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of *Eucalyptus caleyi,* Tumbledown Red Gum (*Eucalyptus dealbata*) and *Callitris* spp., and in yellow podsolic soil on granite in layered open forest. Flowers from spring to summer.	None
Pomaderris queenslandica	Scant Pomaderris	E	-	Widely scattered but not common in north-east NSW and in Queensland. It is only known from a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolatai, and also from several locations on the NSW north coast. Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	None
Prostanthera cineolifera	Singleton Mint Bush	V	V	Restricted to only a few localities near Walcha, Scone and St Albans. Grows in open woodlands on exposed sandstone ridges. Usually found in association with shallow or skeletal sands. Fire response is unknown, but other *Prostantheras* spp. are fire sensitive, with recruitment occurring from the soil seed bank following a fire. Life span is unknown but is expected to be in the vicinity of 10-20 years while the estimated minimum time to produce seed is approximately 3-4 years.	None
Pseudanthus ovalifolius	Oval-leafed Pseudanthus	E	-	Recorded in the Torrington area on the New England Tablelands and in Ben Boyd National Park. There have been no southern records since 1978. It is also found in scattered localities from central western Victoria to Gippsland and in Tasmania. In the south the species is found in near coastal dry sclerophyll forest growing in sandy soil. Flowering occurs in September and October. In the north, *Pseudanthus ovalifolius* grows in rocky outcrop areas on granite and flowers during summer.	None

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Pterostylis cobarensis	Greenhood Orchid	V	V	Known chiefly from the Nyngan-Cobar-Bourke district in the far western plains of NSW. Recorded districts include Narrabri, Nyngan, Cobar, Nymagee, Mt Gundabooka, Mt Grenfel and Mutawintji National Park. There are also records from the Darling Downs district of Queensland. Habitats are eucalypt woodlands, open mallee or Callitris shrublands on low stony ridges and slopes in skeletal sandy-loam soils. Flowers from September to November.	Low
Pultenaea parrisiae	Parris' Bush-pea	V	V	This species is known only from far north-east Gippsland (in Victoria) and three sites in NSW (Wadbilliga Trig area and two sites south of Nalbaugh). Parris' Bush-pea grows in moist heathlands in loam soils, sometimes at the margins of woodlands. Also in riparian vegetation.	None
Rulingia procumbens	-	V	V	Endemic to NSW, mainly confined to the Dubbo-Mendooran-Gilgandra region, but also in the Pilliga and Nymagee areas. Recent collections made from the Upper Hunter region, and additional populations found in Goonoo SCA in response to the 2007 fires. Fruiting period is summer to autumn. Flowers from August to December. The species is often found as a pioneer species of disturbed habitats. It has been recorded colonising disturbed areas such as roadsides, the edges of quarries and gravel stockpiles and a recently cleared easement under power lines.	Low
Rytidosperma vickeryae	Perisher Wallaby-grass	E	-	Perisher Wallaby-grass is restricted to Kosciuszko National Park with a solitary outlying record in Vickery State Forest some 650 km to the north. It has been recorded in the Perisher valley and nearby creeks that drain into the Snowy River. An outlying population has been recorded at Happy Jacks Plain. Commonly grows in Sphagnum moss in montane peatland communities or along stream edges.	Low
Swainsona murrayana	Slender Darling-pea	V	V	Slender Darling-pea is found in grassland, herbland, and open Black-box woodland, often in depressions. This species grows in heavy grey or brown clay, loam, or red cracking clays. It is often associated with low chenopod shrubs, wallaby-grass, and spear grass. The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated.	**Moderate** Habitat exists within the study area, however *S. murrayana* has not previously been recorded in the locality
Swainsona sericea	Silky Swainson-pea	V	-	Silky Swainson-pea has been recorded from the Northern Tablelands to the Southern Tablelands and further inland on the slopes and plains. There is one isolated record from the far north-west of NSW. Its stronghold is on the Monaro. Also found in South Australia, Victoria and Queensland. Found in Natural Temperate Grassland and Snow Gum Woodland on the Monaro. Found in Box-Gum Woodland in the Southern Tablelands and South West Slopes. Sometimes found in association with cypress-pines *Callitris* spp. Habitat on plains unknown. Regenerates from seed after fire.	Low

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood
		TSC Act	EPBC Act		
Tasmannia glaucifolia	Fragrant Pepperbush	V	V	A scattered distribution on the eastern edge of the New England Tablelands, including Ben Halls Gap and Point Lookout. Also found on Barrington and Gloucester Tops. Usually grows in or near Antarctic Beech Nothofagus moorei rainforest along streams in mountain areas at altitudes of between 1200 and 1500 m altitude. Also occurs in tall scrub, on seepage lines in tall eucalypt forest and in grassy woodland.	None
Tasmannia purpurascens	Broad-leaved Pepperbush	V	V	Restricted to Barrington Tops, Gloucester Tops and Ben Halls Gap on the Northern Tablelands of NSW. Broad-leaved Pepperbush grows in tall, moist eucalypt forest, sub-alpine woodland and cool temperate rainforest.	None
Thesium australe	Austral Toadflax	V	V	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland.	Low
Tylophora linearis	-	V	E	*Tylophora linearis* has rarely been collected and is known from eight localities in the Dubbo area and Mt Crow near Barraba in NSW, and "Myall Park" near Glenmorgan in Queensland. This species is conserved within Goobang National Park, Eura State Forest, Goonoo State Forest, Pilliga West State Forest and Coolbaggie Nature Reserve. *Tylophora linearis* grows in dry scrub, open forest and woodlands.	**Moderate** Habitat exists within the study area, however *T. linearis* has not previously been recorded in the locality
Zieria ingramii	Keith's Zieria	E	E	Known only from Goonoo Goonoo State Forest, about 40 km north-east of Dubbo. An old record exists from a locality east of Mogriguy on the Mendooran Road, however searches of the area have not relocated the species. Grows in dry sclerophyll forest on light sandy soils. All known populations have been recorded in Eucalyptus-Callitris woodland or open forest with a shrubby to heathy understorey. Mostly from gentle slopes in red-brown and yellow-brown sandy loams, often with a rocky surface. Flowering time is in spring and plants bear fruit in summer. Plants can produce flowers and fruits any time between July and March.	None

[1] Threatened flora species status under the NSW Threatened Species Conservation Act, 1995 (TSC Act) and/or Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (current at 23 August 2012).

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

Appendix D: Flora Recorded from the Study Area

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Dicots					
Acanthaceae	*Brunoniella australis*	Blue Trumpet	Native	-	-
Acanthaceae	*Rostellularia adscendens*	-	Native	-	-
Aizoaceae	*Galenia pubescens*	Galenia	Introduced	-	-
Aizoaceae	*Zaleya galericulata*	Hogweed	Native	-	-
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	Native	-	-
Amaranthaceae	*Alternanthera pungens*	Khaki Weed	Introduced	-	-
Amaranthaceae	*Alternanthera* sp. A	Lesser Joyweed	Native	-	-
Apiaceae	*Ammi majus*	Bishop's-weed	Introduced	-	-
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	Introduced	-	-
Apiaceae	*Daucus glochidiatus*	Native Carrot	Native	-	-
Apiaceae	*Eryngium paludosum*	Long Eryngium	Native	-	-
Apocynaceae	*Alstonia constricta*	Bitter Bark	Native	-	-
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	Native	-	-
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	Introduced	-	-
Asteraceae	*Aster subulatus*	Wild Aster, Bushy Starwort	Introduced	-	-
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	Introduced	-	-
Asteraceae	*Bidens subalternans*	Greater Beggar's Ticks	Introduced	-	-
Asteraceae	*Brachyscome melanocarpa*	Black-seeded Daisy	Native	-	-
Asteraceae	*Calotis cuneifolia*	Purple Burr-daisy	Native	-	-
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	Native	-	-
Asteraceae	*Cassinia laevis*	Cough Bush	Native	-	-
Asteraceae	*Centaurea melitensis*	Maltese Cockspur	Introduced	-	-
Asteraceae	*Centaurea solstitialis*	St Barnaby's Thistle	Introduced	-	-
Asteraceae	*Centipeda thespidioides*	Desert Sneezeweed	Native	-	-
Asteraceae	*Chondrilla juncea*	Skeleton Weed	Introduced	-	-
Asteraceae	*Chrysocephalum semipapposum*	Yellow Buttons	Native	-	-
Asteraceae	*Cirsium vulgare*	Spear Thistle	Introduced	-	-
Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	Introduced	-	-
Asteraceae	*Cymbonotus lawsonianus*	Bears-ear	Native	-	-
Asteraceae	*Eclipta platyglossa*	-	Native	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Asteraceae	*Euchiton sphaericus*	-	Native	-	-
Asteraceae	*Gamochaeta coarctata*	-	Introduced	-	-
Asteraceae	*Glossocardia bidens*	Cobbler's Tack	Native	-	-
Asteraceae	*Hedypnois rhagadioloides*	Cretan Weed	Introduced	-	-
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	Introduced	-	-
Asteraceae	*Hypochaeris microcephala*	White Flatweed	Introduced	-	-
Asteraceae	*Hypochaeris radicata*	Catsear, Flatweed	Introduced	-	-
Asteraceae	*Lactuca serriola*	Prickly Lettuce	Introduced	-	-
Asteraceae	*Lagenophora stipitata*	-	Native	-	-
Asteraceae	*Leiocarpa tomentosa*	Woolly Plover-daisy	Native	-	-
Asteraceae	*Pluchea dentex*	Bowl Daisy	Native	-	-
Asteraceae	*Senecio pinnatifolius*	Variable Groundsel	Native	-	-
Asteraceae	*Senecio prenanthoides*	-	Native	-	-
Asteraceae	*Senecio quadridentatus*	Cotton Fireweed	Native	-	-
Asteraceae	*Sonchus asper*	Prickly Sowthistle	Introduced	-	-
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	Introduced	-	-
Asteraceae	*Taraxacum officinale*	Dandelion	Introduced	-	-
Asteraceae	*Tragopogon porrifolius*	Salsify	Introduced	-	-
Asteraceae	*Triptilodiscus pygmaeus*	Common Sunray	Native	-	-
Asteraceae	*Vittadinia cuneata*	Fuzzweed	Native	-	-
Asteraceae	*Vittadinia dissecta*	Dissected New Holland Daisy	Native	-	-
Asteraceae	*Vittadinia muelleri*	-	Native	-	-
Asteraceae	*Vittadinia pterochaeta*	Winged New Holland Daisy	Native	-	-
Asteraceae	*Vittadinia sulcata*	-	Native	-	-
Asteraceae	*Xanthium occidentale*	Noogoora Burr, Cockle Burr	Introduced	-	-
Asteraceae	*Xerochrysum bracteatum*	Golden Everlasting	Native	-	-
Boraginaceae	*Echium plantagineum*	Paterson's Curse	Introduced	-	-
Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope	Introduced	-	-
Boraginaceae	*Heliotropium europaeum*	Potato Weed	Introduced	-	-
Brassicaceae	*Capsella bursa-pastoris*	Shepherd's Purse	Introduced	-	-
Brassicaceae	*Lepidium africanum*	-	Introduced	-	-
Brassicaceae	*Lepidium bonariense*	-	Introduced	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Brassicaceae	*Lepidium fasciculatum*	-	Native	-	-
Brassicaceae	*Lepidium monoplocoides*	Winged Peppercress	Native	E	E
Brassicaceae	*Lepidium pseudohyssopifolium*	Peppercress	Native	-	-
Brassicaceae	*Rapistrum rugosum*	Turnip Weed, Giant Mustard	Introduced	-	-
Brassicaceae	*Rorippa eustylis*	-	Native	-	-
Brassicaceae	*Rorippa laciniata*	-	Native	-	-
Brassicaceae	*Sisymbrium erysimoides*	Smooth Mustard	Introduced	-	-
Brassicaceae	*Sisymbrium irio*	London Rocket	Introduced	-	-
Cactaceae	*Opuntia stricta*	Common Prickly Pear	Introduced	-	-
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	Introduced	-	-
Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell	Native	-	-
Campanulaceae	*Wahlenbergia gracilis*	Sprawling/Australian Bluebell	Native	-	-
Campanulaceae	*Wahlenbergia stricta*	Australian Bluebell	Native	-	-
Capparaceae	*Capparis mitchellii*	Wild Orange	Native	-	-
Caryophyllaceae	*Arenaria leptoclados*	Lesser Thyme-leaved Sandwort	Introduced	-	-
Caryophyllaceae	*Paronychia brasiliana*	Chilean Whitlow Wort	Introduced	-	-
Caryophyllaceae	*Petrorhagia nanteuilii*	-	Introduced	-	-
Caryophyllaceae	*Silene gallica*	-	Introduced	-	-
Caryophyllaceae	*Spergularia rubra*	Sandspurry	Introduced	-	-
Caryophyllaceae	*Stellaria flaccida*	-	Native	-	-
Casuarinaceae	*Casuarina cristata*	Belah	Native	-	-
Casuarinaceae	*Casuarina pauper*	Black Oak, Belah	Native	-	-
Celastraceae	*Maytenus cunninghamii*	Yellow-berry Bush	Native	-	-
Chenopodiaceae	*Atriplex spinibractea*	Spiny-fruit Saltbush	Native	-	-
Chenopodiaceae	*Dysphania pumilio*	-	Native	-	-
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	Native	-	-
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	Native	-	-
Chenopodiaceae	*Einadia trigonos*	Fishweed	Native	-	-
Chenopodiaceae	*Maireana enchylaenoides*	Wingless Bluebush	Native	-	-
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	Native	-	-
Chenopodiaceae	*Salsola kali*	-	Native	-	-
Chenopodiaceae	*Sclerolaena birchii*	Galvanized Burr	Native	-	-
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	Native	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Clusiaceae	*Hypericum gramineum*	Small St. John's Wort	Native	-	-
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	Native	-	-
Convolvulaceae	*Dichondra repens*	Kidney Weed	Native	-	-
Convolvulaceae	*Dichondra* sp. A	-	Native	-	-
Convolvulaceae	*Evolvulus alsinoides*	-	Native	-	-
Crassulaceae	*Crassula sieberiana*	Australian Stonecrop	Native	-	-
Euphorbiaceae	*Beyeria viscosa*	Pinkwood	Native	-	-
Euphorbiaceae	*Chamaesyce dallachyana*	-	Native	-	-
Fabaceae	*Acacia deanei*	Green Wattle, Deane's Wattle	Native	-	-
Fabaceae	*Acacia decora*	Western Silver Wattle	Native	-	-
Fabaceae	*Acacia maidenii*	Maiden's Wattle	Native	-	-
Fabaceae	*Acacia oswaldii*	Umbrella Wattle	Native	-	-
Fabaceae	*Acacia pendula*	Weeping Myall, Boree	Native	-	-
Fabaceae	*Desmodium brachypodum*	Large Tick-trefoil	Native	-	-
Fabaceae	*Desmodium varians*	Slender Tick-trefoil	Native	-	-
Fabaceae	*Glycine clandestina*	-	Native	-	-
Fabaceae	*Glycine microphylla*	Small-leaf Glycine	Native	-	-
Fabaceae	*Glycine tabacina*	-	Native	-	-
Fabaceae	*Glycine tomentella*	Woolly Glycine	Native	-	-
Fabaceae	*Lotus cruentus*	Red-flowered Lotus	Native	-	-
Fabaceae	*Medicago minima*	Woolly Burr Medic	Introduced	-	-
Fabaceae	*Medicago polymorpha*	Burr Medic	Introduced	-	-
Fabaceae	*Neptunia gracilis*	Native Sensitive Plant	Native	-	-
Fabaceae	*Rhynchosia minima*	-	Native	-	-
Fabaceae	*Senna barclayana*	Smooth Senna	Native	-	-
Fabaceae	*Senna* sp. 'zygophylla'	-	Native	-	-
Fabaceae	*Swainsona cadellii*	-	Native	-	-
Fabaceae	*Swainsona galegifolia*	Smooth Darling-pea	Native	-	-
Fabaceae	*Trifolium angustifolium*	Narrow-leaved Clover	Introduced	-	-
Fabaceae	*Trifolium arvense*	Haresfoot Clover	Introduced	-	-
Fabaceae	*Trifolium dubium*	Yellow Suckling Clover	Introduced	-	-
Fabaceae	*Zornia dyctiocarpa*	Zornia	Native	-	-
Gentianaceae	*Centaurium erythraea*	Common Centaury	Introduced	-	-
Gentianaceae	*Schenkia spicata*	Spike Centaury	Native	-	-
Geraniaceae	*Erodium crinitum*	Blue Storksbill, Blue Crowfoot	Native	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Geraniaceae	*Geranium solanderi*	Native Geranium	Native	-	-
Goodeniaceae	*Goodenia cycloptera*	-	Native	-	-
Goodeniaceae	*Goodenia glabra*	-	Native	-	-
Goodeniaceae	*Goodenia hederacea*	Forest Goodenia	Native	-	-
Haloragaceae	*Haloragis heterophylla*	Rough Raspwort	Native	-	-
Lamiaceae	*Ajuga australis*	Australian Bugal	Native	-	-
Lamiaceae	*Marrubium vulgare*	White Horehound	Introduced	-	-
Lamiaceae	*Mentha diemenica*	Slender Mint	Native	-	-
Lamiaceae	*Oncinocalyx betchei*	-	Native	-	-
Lamiaceae	*Salvia plebeia*	Austral Sage	Native	-	-
Lamiaceae	*Scutellaria humilis*	Dwarf Skullcap	Native	-	-
Linaceae	*Linum marginale*	Native Flax, Wild Flax	Native	-	-
Lobeliaceae	*Pratia concolor*	Poison Pratia	Native	-	-
Loranthaceae	*Amyema maidenii*	-	Native	-	-
Loranthaceae	*Amyema pendulum*	-	Native	-	-
Malvaceae	*Abutilon oxycarpum*	Straggly Lantern-bush	Native	-	-
Malvaceae	*Malvastrum americanum*	Spiked Malvastrum	Introduced	-	-
Malvaceae	*Malvastrum coromandelianum*	Prickly Malvestrum	Native	-	-
Malvaceae	*Modiola caroliniana*	Red-flowered Mallow	Introduced	-	-
Malvaceae	*Sida corrugata*	Corrugated Sida	Native	-	-
Malvaceae	*Sida cunninghamii*	Ridged Sida	Native	-	-
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	Introduced	-	-
Malvaceae	*Sida spinosa*	-	Introduced	-	-
Malvaceae	*Sida trichopoda*	Hairy Sida	Native	-	-
Myoporaceae	*Eremophila debilis*	Winter Apple, Amulla	Native	-	-
Myoporaceae	*Myoporum montanum*	Western Boobialla, Water Bush	Native	-	-
Myrsinaceae	*Anagallis arvensis*	Scarlet Pimpernel	Introduced	-	-
Myrtaceae	*Eucalyptus albens*	White Box	Native	-	-
Myrtaceae	*Eucalyptus blakelyi*	Blakely's Red Gum	Native	-	-
Myrtaceae	*Eucalyptus camaldulensis*	River Gum, River Red Gum	Native	-	-
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	Native	-	-
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	Native	-	-
Myrtaceae	*Eucalyptus melliodora*	Yellow Box	Native	-	-
Myrtaceae	*Eucalyptus pilligaensis*	Narrow-leaved Grey Box	Native	-	-
Myrtaceae	*Eucalyptus populnea*	Bimble Box, Poplar Box	Native	-	-
Nyctaginaceae	*Boerhavia dominii*	Tarvine	Native	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Oleaceae	*Jasminum lineare*	Desert Jasmine	Native	-	-
Oleaceae	*Notelaea microcarpa*	Native Olive	Native	-	-
Onagraceae	*Epilobium billardierianum*	-	Native	-	-
Oxalidaceae	*Oxalis perennans*	-	Native	-	-
Oxalidaceae	*Oxalis pes-caprae*	-	Introduced	-	-
Phyllanthaceae	*Phyllanthus virgatus*	-	Native	-	-
Plantaginaceae	*Plantago debilis*	-	Native	-	-
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues, Plantain	Introduced	-	-
Plantaginaceae	*Plantago turrifera*	-	Native	-	-
Polygonaceae	*Fallopia convolvulus*	Black Bindweed	Introduced	-	-
Polygonaceae	*Persicaria lapathifolia*	Pale Knotweed	Native	-	-
Polygonaceae	*Rumex brownii*	Swamp Dock	Native	-	-
Polygonaceae	*Rumex crispus*	Curled Dock	Introduced	-	-
Polygonaceae	*Rumex tenax*	Shiny Dock	Native	-	-
Portulacaceae	*Calandrinia eremaea*	-	Native	-	-
Portulacaceae	*Portulaca oleracea*	Pigweed, Purslane	Native	-	-
Ranunculaceae	*Ranunculus lappaceus*	Common Buttercup	Native	-	-
Ranunculaceae	*Ranunculus sessiliflorus*	Small-flowered Buttercup	Native	-	-
Rubiaceae	*Asperula subulifolia*	-	Native	-	-
Rubiaceae	*Galium propinquum*	Maori Bedstraw	Native	-	-
Rubiaceae	*Opercularia diphylla*	-	Native	-	-
Rubiaceae	*Psydrax odorata*	Shiny-leaved Canthium, Iamboto	Native	-	-
Rutaceae	*Correa reflexa*	Green Correa, Native Fuschia	Native	-	-
Rutaceae	*Geijera parviflora*	Wilga	Native	-	-
Sapindaceae	*Alectryon oleifolius*	Western Rosewood, Bonaree	Native	-	-
Sapindaceae	*Alectryon subdentatus*	-	Native	-	-
Sapindaceae	*Atalaya hemiglauca*	Whitewood	Native	-	-
Sapindaceae	*Dodonaea sinuolata*	-	Native	-	-
Sapindaceae	*Dodonaea viscosa*	Sticky Hop-bush	Native	-	-
Scrophulariaceae	*Misopates orontium*	Lesser Snapdragon	Introduced	-	-
Scrophulariaceae	*Verbascum virgatum*	Twiggy Mullein, Green Mullein	Introduced	-	-
Solanaceae	*Datura stramonium*	Common Thornapple	Introduced	-	-
Solanaceae	*Lycium ferocissimum*	African Boxthorn	Introduced	-	-
Solanaceae	*Nicotiana suaveolens*	Native Tobacco	Native	-	-
Solanaceae	*Solanum brownii*	Violet Nightshade	Native	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Solanaceae	*Solanum campanulatum*	-	Native	-	-
Solanaceae	*Solanum esuriale*	Quena	Native	-	-
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	Introduced	-	-
Solanaceae	*Solanum parvifolium*	-	Native	-	-
Stackhousiaceae	*Stackhousia muricata*	Western Stackhousia	Native	-	-
Thymelaeaceae	*Pimelea curviflora*	-	Native	-	-
Thymelaeaceae	*Pimelea neo-anglica*	Poison Pimelea	Native	-	-
Urticaceae	*Urtica incisa*	Stinging Nettle	Native	-	-
Verbenaceae	*Grandularia aristigera*	Mayne's Pest	Introduced	-	-
Verbenaceae	*Phyla nodiflora*	Lippia	Introduced	-	-
Verbenaceae	*Verbena bonariensis*	Purpletop	Introduced	-	-
Verbenaceae	*Verbena macrostachya*	-	Native	-	-
Monocots					
Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily	Native	-	-
Anthericaceae	*Thysanotus tuberosus*	Common Fringe Lily	Native	-	-
Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily	Native	-	-
Asphodelaceae	*Bulbine semibarbata*	Native Leek	Native	-	-
Commelinaceae	*Commelina cyanea*	Native Wandering Jew	Native	-	-
Cyperaceae	*Carex inversa*	-	Native	-	-
Cyperaceae	*Cyperus concinnus*	Trim Flat-sedge	Native	-	-
Cyperaceae	*Cyperus fulvus*	Sticky Sedge	Native	-	-
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	Native	-	-
Cyperaceae	*Eleocharis plana*	Flat Spike-sedge	Native	-	-
Cyperaceae	*Eleocharis pusilla*	-	Native	-	-
Cyperaceae	*Fimbristylis dichotoma*	Common Fringe-sedge	Native	-	-
Juncaceae	*Juncus aridicola*	-	Native	-	-
Juncaceae	*Juncus pauciflorus*	-	Native	-	-
Juncaceae	*Juncus remotiflorus*	-	Native	-	-
Juncaceae	*Juncus usitatus*	-	Native	-	-
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush	Native	-	-
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	Native	-	-
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	Many-flowered Mat-rush	Native	-	-
Orchidaceae	*Caladenia fuscata*	Dusky Fingers	Native	-	-
Orchidaceae	*Microtis unifolia*	Common Onion Orchid	Native	-	-
Phormiaceae	*Dianella caerulea*	Blue Flax-lily	Native	-	-
Poaceae	*Aristida acuta*	-	Native	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Poaceae	*Aristida jerichoensis*	Jericho Wiregrass	Native	-	-
Poaceae	*Aristida personata*	Purple Wire-grass	Native	-	-
Poaceae	*Aristida vagans*	Threeawn Speargrass	Native	-	-
Poaceae	*Austrodanthonia bipartite*	Wallaby Grass	Native	-	-
Poaceae	*Austrodanthonia pilosa*	Smooth-flower Wallaby Grass	Native	-	-
Poaceae	*Austrodanthonia racemosa*	-	Native	-	-
Poaceae	*Austrostipa aristiglumis*	Plains Grass	Native	-	-
Poaceae	*Austrostipa bigeniculata*	-	Native	-	-
Poaceae	*Austrostipa scabra*	Speargrass	Native	-	-
Poaceae	*Austrostipa verticillata*	Slender Bamboo Grass	Native	-	-
Poaceae	*Avena fatua*	Wild Oats	Introduced	-	-
Poaceae	*Bothriochloa decipiens*	Red Grass	Native	-	-
Poaceae	*Bromus alopecuros*	-	Introduced	-	-
Poaceae	*Bromus catharticus*	Prairie Grass	Introduced	-	-
Poaceae	*Bromus diandrus*	Great Brome	Introduced	-	-
Poaceae	*Bromus inermis*	Awnless Brome	Introduced	-	-
Poaceae	*Chloris gayana*	Rhodes Grass	Introduced	-	-
Poaceae	*Chloris truncata*	Windmill Grass	Native	-	-
Poaceae	*Chloris virgata*	Feathertop Rhodes Grass	Introduced	-	-
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	Native	-	-
Poaceae	*Cynodon dactylon*	Couch	Native	-	-
Poaceae	*Dichanthium sericeum*	Queensland Bluegrass	Native	-	-
Poaceae	*Dichelachne micrantha*	Shorthair Plumegrass	Native	-	-
Poaceae	*Digitaria ammophila*	Silky Umbrella-grass	Native	-	-
Poaceae	*Digitaria brownii*	Cotton Panic Grass	Native	-	-
Poaceae	*Digitaria hystrichoides*	Curley Umbrella Grass	Native	-	-
Poaceae	*Digitaria parviflora*	Small-flowered Finger Grass	Native	-	-
Poaceae	*Elymus scaber*	-	Native	-	-
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers	Native	-	-
Poaceae	*Enneapogon nigricans*	Niggerheads	Native	-	-
Poaceae	*Enteropogon acicularis*	-	Native	-	-
Poaceae	*Enteropogon ramosus*	Curly Windmill Grass	Native	-	-
Poaceae	*Eragrostis alveiformis*	-	Native	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Poaceae	*Eragrostis elongata*	Clustered Lovegrass	Native	-	-
Poaceae	*Eragrostis lacunaria*	Purple Love-grass	Native	-	-
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	Native	-	-
Poaceae	*Eriochloa pseudoacrotricha*	Early Spring Grass	Native	-	-
Poaceae	*Eulalia aurea*	Silky Browntop	Native	-	-
Poaceae	*Hordeum leporinum*	Barley Grass	Introduced	-	-
Poaceae	*Hyparrhenia hirta*	Coolatai Grass	Introduced	-	-
Poaceae	*Iseilema membranaceum*	Small Flinders Grass	Native	-	-
Poaceae	*Lachnagrostis filiformis*	-	Native	-	-
Poaceae	*Leptochloa asthenes*	-	Native	-	-
Poaceae	*Lolium perenne*	Perennial Ryegrass	Introduced	-	-
Poaceae	*Microlaena stipoides*	Weeping Grass	Native	-	-
Poaceae	*Panicum effusum*	Hairy Panic	Native	-	-
Poaceae	*Panicum simile*	Two-colour Panic	Native	-	-
Poaceae	*Paspalidium constrictum*	Knottybutt Grass	Native	-	-
Poaceae	*Paspalidium jubiflorum*	Warrego Grass	Native	-	-
Poaceae	*Paspalum dilatatum*	Paspalum	Introduced	-	-
Poaceae	*Paspalum distichum*	Water Couch	Native	-	-
Poaceae	*Phalaris minor*	Lesser Canary Grass	Introduced	-	-
Poaceae	*Poa sieberiana*	-	Native	-	-
Poaceae	*Pseudoraphis spinescens*	Mud Grass	Native	-	-
Poaceae	*Rytidosperma eriantha*	-	Native	-	-
Poaceae	*Sorghum leiocladum*	Wild Sorghum	Native	-	-
Poaceae	*Sporobolus caroli*	Fairy Grass, Yakka Grass	Native	-	-
Poaceae	*Sporobolus creber*	Western Rat-tail Grass	Native	-	-
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass	Native	-	-
Poaceae	*Themeda australis*	Kangaroo Grass	Native	-	-
Poaceae	*Themeda avenacea*	Native Oatgrass	Native	-	-
Poaceae	*Tragus australianus*	Small Burrgrass	Native	-	-
Poaceae	*Tripogon loliiformis*	Fiveminute Grass	Native	-	-
Poaceae	*Urochloa panicoides*	Urochloa Grass	Introduced	-	-
Poaceae	*Vulpia bromoides*	Squirrel Tail Fescue	Introduced	-	-
Poaceae	*Walwhalleya subxerophyllum*	Gilgai Grass	Native	-	-
Ferns					
Marsileaceae	*Marsilea drummondii*	Common Nardoo	Native	-	-

Family	Species	Common Name	Native/ Introduced	Conservation Status[1]	
				TSC Act	EPBC Act
Marsileaceae	*Marsilea hirsuta*	Nardoo	Native	-	-
Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	Native	-	-
Pteridaceae	*Cheilanthes sieberi*	-	Native	-	-
Conifers					
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	Native	-	-

[1] Threatened flora species status under the TSC Act and/or EPBC Act (current at 23 August 2012)
E = Endangered

Appendix E: Assessment of Impacts on Threatened Species and Ecological Communities Under Division 4.1 State Significant Development of the EP&A Act (Seven Part Tests)

Endangered Ecological Communities

Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions (Myall Woodland)

Introduction

The endangered ecological community (EEC), *Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions* (Myall Woodland) as listed on the TSC Act, is present within the southern portion of the Project mining area (Figure 6). The following description is from the NSW Final Determination for the EEC (NSW Scientific Committee, gazetted 15 July 2005):

> *"Myall Woodland is scattered across the eastern parts of alluvial plains of the Murray-Darling river system. Typically, the ecological community occurs on red-brown earths and heavy textured grey and brown alluvial soils within a climatic belt receiving between 375 and 500 mm mean annual rainfall. The structure of the community varies from low woodland and low open woodland to low sparse woodland or open shrubland, depending on site quality and disturbance history. The tree layer grows up to a height of about 10 metres and invariably includes* Acacia pendula *(weeping myall) as one of the dominant species or the only tree species present. The understorey includes an open layer of chenopod shrubs and other woody plant species and an open to continuous groundcover of grasses and herbs. The structure and composition of the community varies, particularly with latitude, as chenopod shrubs are more prominent south of the Lachlan River district, while other woody species and summer grasses are more common further north. In some areas the shrub stratum may have been reduced or eliminated by clearing or heavy grazing."*

Within the study area, this EEC is characterised by a dominant low overstorey of *Acacia pendula* (weeping myall) to 8 m high, an absent mid-storey and shrub layer, and a degraded and sparse groundcover. The degraded mid-storey and groundcover is a result of heavy grazing and use as a shelter area by cattle. The vegetation community is described in Section 2.2.2 of this report.

A programme would be implemented to retain and manage vegetation along a portion of Stratford Creek, including the Weeping Myall EEC (Section 6.1; Figure 28). The perimeter of the area would be fenced with a stock proof fence to facilitate regeneration of the native vegetation. Although the Myall Woodland in the Project area has low resilience it will be possible to regenerate the community through weed management and planting.

Assessment of Significance

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

Not applicable.

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

Not applicable.

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

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

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

Extent of impact on local occurrence

Approximately 80 ha of the Myall Woodland EEC occurs within the Project study area. An examination of the vegetation communities that align to the Myall Woodland EEC within the Namoi vegetation mapping (Ecological Australia 2009) shows that approximately 60 ha exists within a 20 km radius from a mid-point between the Project mining area and the Private Haul Road and Highway Overpass location (this roughly covers a 10 km radius from each site). Therefore at least 140 ha of this EEC occurs within 20 km of the Project and this is considered the local occurrence of the EEC in this study.

Approximately 1 ha (0.7 per cent) of the local occurrence of the Myall Woodland EEC would be removed by the Project. The Myall Woodland to be removed is considered to have low resilience and condition (refer to Section 2.2.2).

It is not considered that the Project would have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Composition of local occurrence

This assessment of impact of the Project on Myall Woodland relates to the removal of 1 ha of the EEC and not its modification. Therefore (ii) above is not applicable.

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

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

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

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

Extent of habitat

Approximately 1 ha of Myall Woodland would be removed by the Project as an unavoidable impact. The Myall Woodland to be removed is considered to have low resilience and condition.

Fragmentation and isolation

The connectivity of Myall Woodland is along a very shallow flood channel flowing east to west across a southern portion of the study area and meets the Namoi River. This connectivity is fragmented, with the current distribution in the locality representing a history of land clearance. Therefore, the Project is considered unlikely to affect the habitat connectivity of Myall Woodland. The land affected by the Project was historically cleared and subject to some (light) grazing pressure and movement of stock. Fire has been largely excluded from the site.

Importance of habitat to be removed

The habitat to be removed is considered to have low resilience and is in a degraded state due to cattle grazing and sheltering. The portion of the local occurrence to be removed is considered to be of relatively low importance to the survival of the EEC within the locality.

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

No Critical Habitat, as listed on the TSC Act, would be affected by the Project.

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

No recovery plan exists for this EEC.

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

The relevant key threatening processes to Myall Woodland and the potential impacts of the Project include:

- Clearing of native vegetation. Approximately 1 ha of Myall Woodland would be removed by the Project as an unavoidable impact.

- Invasion of native plant communities by exotic perennial grasses. Exotic perennial grasses are known in the Project area and surrounds and it is anticipated that the area of occupation of these grasses will increase as a result of the Project.

The action proposed may exacerbate two key threatening processes, although they are both pre-existing within the study area. These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

White Box Yellow Box Blakely's Red Gum Woodland (Box – Gum Woodland)

Introduction

The endangered ecological community (EEC), *White Box - Yellow Box - Blakely's Red Gum Woodland* (Box – Gum Woodland), as listed on the TSC Act, is present as two isolated remnant patches within the Project mining area and also at the Project Private Haul Road and Highway Overpass. The smaller patch (3 ha) lies within the proposed pit and would be completely removed, while the Project layout has been designed to avoid the larger patch (5 ha). This EEC dominates the Haul Road development site west of Gunnedah and an additional 3 ha of this would be removed by the proposed Haul Road re-alignment in this location. Within the study area this EEC exists in a relatively natural state and, therefore, as a single condition class. Weed cover typically remained low throughout this vegetation community. The following description is from the NSW Final Determination for the EEC (NSW Scientific Committee, gazetted 15 March 2002):

> *"... White Box Yellow Box Blakely's Red Gum Woodland is found on relatively fertile soils on the tablelands and western slopes of NSW and generally occurs between the 400 and 800 mm isohyets extending from the western slopes, at an altitude of c. 170m to c. 1200 m, on the northern tablelands (Beadle 1981). The community occurs within the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands and NSW South Western Slopes Bioregions.*
>
> *White Box Yellow Box Blakely's Red Gum Woodland includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations - Eucalyptus albens (White Box), Eucalyptus melliodora (Yellow Box) or Eucalyptus blakelyi (Blakely's Red Gum). Grass and herbaceous species generally characterise the ground layer. In some locations, the tree overstorey may be absent as a result of past clearing or thinning and at these locations only an understorey may be present. Shrubs are generally sparse or absent, though they may be locally common."*

Assessment of Significance

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

Not applicable.

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

Not applicable.

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

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

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

Extent of impact on local occurrence

An examination of the vegetation communities that align to the Box – Gum grassy woodland EEC within the Namoi vegetation mapping (Ecological Australia 2009) shows that approximately 6,530 ha exists within a 20 km radius from a mid-point between the Project mining area and the Haul Road location (this roughly covers a 10 km radius from each site). This is considered the local occurrence of the EEC in this study.

Within this area a total of 6 ha of Box – Gum Woodland would be removed by the Project, including 3 ha at the proposed Project mining area and a further 3 ha in the vicinity of the proposed Haul Road west of Gunnedah. In both locations the Box – Gum Woodland to be removed is considered to have good resilience.

An additional 5 ha has been avoided by re-design of the Project following site specific vegetation mapping at the Project mining area. This area of Box – Gum Woodland is also considered to be in good condition.

The removal of 6 ha of the local occurrence of Box – Gum Woodland represents 0.09 per cent of the local occurrence of the EEC as defined above. This is considered to be a negligible impact.

It is not considered that the Project would have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Composition of local occurrence

This assessment of impact of the Project on Box – Gum Woodland relates to the removal of 6 ha of the EEC and not its modification. Therefore (ii) above is not applicable.

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

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

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

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

Extent of habitat

Approximately 3 ha of Box – Gum Woodland would be removed by the Project and a further 3 ha would be removed in the vicinity of the proposed Haul Road deviation west of Gunnedah. In both locations the Box – Gum Woodland to be removed is considered to have good resilience.

An additional 5 ha has been avoided by re-design of the Project following site specific vegetation mapping. This area of Box – Gum Woodland is also considered to be in good condition and would improve in condition with minimal input.

The loss of 6 ha represents 0.07 per cent of the local occurrence of this EEC, which is considered a negligible loss.

Fragmentation and isolation

The connectivity of Box – Gum Woodland on the Project mining area is fragmented. Therefore, the Project is unlikely to affect the connectivity of the EEC in this location, particularly given that the largest patch would be conserved and managed.

The Box - Gum Woodland in the vicinity of the Haul Road west of Gunnedah is well connected to the north-west and south-east along the Kamilaroi Highway road reserve. The proposed re-alignment of the Haul Road would be located so as to minimise disturbance to standing trees and areas of good condition native pasture. It is therefore unlikely that the proposed Haul Road re-alignment would disrupt the connectivity of this EEC in any significant way.

Importance of habitat to be removed

The habitat to be removed is considered to be of low importance due to the negligible impact on the local occurrence of the EEC and, at the Vickery site, its lack of connectivity through the locality.

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

No Critical Habitat, as listed on the TSC Act, would be affected by the Project.

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

No recovery plan exists for Box-Gum Woodland.

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

The relevant key threatening processes to Yellow Box – White Box –Blakely's Red Gum Woodland and the potential impacts of the Project include:

- Clearing of native vegetation. Approximately 6 ha of Yellow Box – White Box –Blakely's Red Gum Woodland would be removed by the Project.

- Invasion of native plant communities by exotic perennial grasses. Exotic perennial grasses are known in the Project area and surrounds and it is anticipated that the area of occupation of these grasses may increase as a result of the Project.

The action proposed may exacerbate two key threatening processes, although they are pre-existing within the study area. These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River

Introduction

The endangered ecological community (EEC), Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River, as listed on the FM Act, is considered to exist within the Namoi River and its tributaries and floodplains downstream of the junction with the Manilla River at Manilla (DPI 2012). The Project has the potential to affect this ecological community in the vicinity of the proposed Haul Road west of Gunnedah, which is within the Namoi River floodplain, through the potential indirect alteration of the hydrological regime.

Assessment of Significance

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

Not applicable.

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

Not applicable.

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

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

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

Extent of impact on local occurrence

An examination of the vegetation communities that align to the Aquatic Ecological Community EEC within the Namoi vegetation mapping (Ecological Australia 2009) shows that approximately 366 ha exists within a 20 km radius from a mid-point between the Project mining area and the Haul Road location (this roughly covers a 10 km radius from each site). This is considered the local occurrence of the EEC in this study.

This impact assessment relates only to the potential indirect impact of the Project on the Aquatic Ecological Community EEC in terms of its potential effect on hydrological regimes. There is no component of the extent of the local occurrence of the EEC that will be directly affected by the Project.

Therefore, it is not considered that the Project would have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Composition of local occurrence

The final recommendation for the EEC, Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (DPI 2012) determines that the EEC exists downstream of the junction of the Namoi and Manilla Rivers at Manilla, and includes all natural creeks, rivers, streams, lagoons, billabongs, anabranches and associated flow diversions and floodplains. The Haul Road re-alignment is clearly located on a floodplain of the Namoi River and so this EEC is considered to be indirectly impacted by it.

It is not anticipated that the re-aligned Haul Road would exacerbate any pre-existing impacts on this EEC in the locality, given that the existing Kamilaroi Highway and agricultural land uses are adjacent to this community. However, on-site mitigation measures during and after construction, particularly in relation to sediment and erosion control, would ensure that any potential impact is minimised.

Therefore it is not considered that the Project would substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

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

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

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

Extent of habitat

The Aquatic Ecological Community EEC is considered to exist downstream of the junction of the Namoi and Manilla Rivers at Manilla, and includes all natural creeks, rivers, streams, lagoons, billabongs, anabranches and associated flow diversions and floodplains. The Project mining area does not impact on any of these features and it is not anticipated that the re-aligned Haul Road would exacerbate any pre-existing impacts on this EEC in the locality. This is especially so, given that the existing Kamilaroi Highway and agricultural land uses are adjacent to this community.

Fragmentation and isolation

The land affected by the re-alignment of the proposed Haul Road west of Gunnedah was historically cleared and does not seem to be subject to recent grazing pressure or movement of stock, although it is heavily disturbed by motorcycle tracks. Fire has been largely excluded from the site. The site is likely to be subject to semi-regular flood inundation and this is unlikely to change as a result of the Project. It is considered unlikely that the re-alignment of the proposed Haul Road would affect the flooding pulses of the Namoi River floodplain, certainly no more than the existing bridge over the river in this location, or the Kamilaroi Highway that runs parallel to it. Further, it is unlikely that the proposed Haul Road would lead to fragmentation or isolation of the EEC.

Importance of the habitat to be potentially modified

Given that any potential indirect impact to the Aquatic Ecological Community EEC is unlikely to exacerbate existing impacts on the EEC within the locality, and that none of the EEC will be removed by the Project, the importance of the habitat to be potentially modified is considered to be low.

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

No Critical Habitat, as listed on the TSC Act, would be affected by the Project.

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

No recovery plan exists for the EEC.

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

The relevant listed key threatening processes relevant to this Aquatic Ecological Community EEC include:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.
- Invasion of native plant communities by exotic perennial grasses. Exotic perennial grasses are known in the Project area and surrounds and the cover of these species will increase a result of the Project.

The action proposed may exacerbate two key threatening processes, although they are pre-existing within the study area. These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Threatened Flora

Dichanthium setosum (Bluegrass)

Introduction

NB: descriptive and ecological information taken from the OEH and/or the SEWPaC on-line threatened species databases unless otherwise stated.

Dichanthium setosum (Bluegrass) is an upright grass less than 1 m tall. It has mostly hairless leaves about 2-3 mm wide. The flowers are densely hairy and are clustered together along a stalk in a cylinder-shape. The flower-clusters grow in pairs at the end of an 8 cm-long stem and appear mostly during summer.

D. setosum occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas.

The species is associated with heavy basaltic black soils and red-brown loams with clay subsoil and can be found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. Specimens have regularly been collected from disturbed open grassy woodlands on the northern tablelands, where the habitat has been variously grazed, nutrient-enriched and water-enriched. It is open to question whether the species tolerates or is promoted by a certain amount of disturbance, or whether this is indicative of the threatening processes behind its depleted habitat. Locally common or found as scattered clumps in broader populations.

Associated species include *E. albens, E. melanophloia, E. melliodora, E. viminalis, Myoporum debile, Aristida ramosa, Themeda triandra, Poa sieberiana, Bothriochloa ambigua, Medicago minima, Leptorhynchos squamatus, Lomandra* aff. *longifolia*, *Ajuga australis, Calotis hispidula, Austrodanthonia* spp., *Dichopogon* spp., *Brachyscome* spp., *Vittadinia* spp., *Wahlenbergia* spp. and *Psoralea* spp.

Preferred soil habitat (i.e. heavy basaltic black soils and red-brown loams with clay subsoil) for *D. setosum* was not recorded in the Project area (after McKenzie Soil Management, 2012).

Targeted searches for this threatened species (among others) were carried out in November 2011, during suitable conditions to detect the speices (a period of high rainfall that suited the setting of grass flowers and seed). The conditions at the time of survey were ideal for grass surveys and those species recorded were robust, mature and flowering. *D. setosum* was not recorded within the study area during the field surveys. It is considered that if the species was present in the study area it would have been detected due to the extensive flora survey effort. Also of note, the species has not been previously recorded within 50 km of the study area (Figure 8).

Assessment of Significance

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

A viable local population of *D. setosum* is not considered to exist within the study area. Therefore the Project would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

No preferred soil habitat for this species (i.e. heavy basaltic black soils and red-brown loams with clay subsoil) (after McKenzie Soil Management, 2012) was recorded in the Project area. *D. setosum* was not recorded within the study area during the field surveys and the species has not been previously recorded within 50 kilometres of the study area. Therefore, there is no known extent of habitat within the study area.

The species was considered to have a moderate likelihood of occurrence prior to the field survey due to the prevalence of heavy basaltic black soils and red-brown loams with clay subsoil within an adjacent to the study area. However, it was demonstrated by McKnezie Soil Management that these soil types were absent within the study area.

The proposal is unlikely to have an effect on the extent or connectivity of the habitat for *D. setosum* given that the species has not been previously recorded within 50 kilometres of the study area (Figure 8).

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

Critical Habitat, as defined by the TSC Act, has not been declared for *D. setosum*. There is no critical habitat listed on the NSW Critical Habitat register (OEH 2013) in the Project area or surrounds.

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

At the time of this assessment no recovery plan had been published for *D. setosum*.

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

The relevant listed key threatening processes to *D. setosum* include:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.

Although the species was not recorded and no preferred soil habitat for this species occurs in the Project area, the action will result in the operation of these two key threatening processes relavant to this species.

Conclusion

The proposal is considered unlikely to have a significant impact on *D. setosum* given that no preferred soil habitat for this species occurs in the Project area. *D. setosum* was not recorded within the study area during the field surveys and the species has not been previously recorded within 50 kilometres of the study area.

Digitaria porrecta (Finger Panic Grass)

Introduction

NB: descriptive and ecological information taken from the OEH and/or the SEWPaC on-line threatened species databases unless otherwise stated.

Digitaria porrecta (Finger Panic Grass) is a loosely tufted grass growing to 60 cm tall. Its grey leaves are 2 - 3 mm wide with sharp hairs along the middle. The flowers are clustered together along a stalk in a cylinder shape. These flower clusters, which appear during summer, spread stiffly from the flowering stem, with the lower flower clusters arranged in a whorl of four to six, each up to 30 cm long.

Finger panic grass occurs in NSW and Queensland in native grassland, woodlands or open forest with a grassy understorey, on richer soils. In NSW it is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran.

In NSW, the most frequently recorded associated tree species are *Eucalyptus albens* and *Acacia pendula*. Common associated grasses and forbs in NSW sites include *Austrostipa aristiglumis*, *Enteropogon acicularis*, *Cyperus bifax*, *Hibiscus trionum* and *Neptunia gracilis*. The flowering season is summer or late summer, from mid-January to late February, with seeds maturing and falling from the plant soon after. The species is often found along roadsides and travelling stock routes where there is light grazing and occasional fire and it is a perennial tussock-forming grass that can vegetatively reproduce. Fire, livestock grazing and trampling and physical disturbance of habitat by road and farm machinery are types of disturbances known to occur at *D. porrecta* sites. Field observations indicate that the grass does continue to persist in such habitats, but the effect of the disturbances on the long-term capability of the species to maintain a viable population is unknown.

The total number of *D. porrecta* individuals in the wild is estimated at over 200 000 plants. Plants have been recorded as occurring occasionally and frequently in populations.

Potential habitat for *D. porrecta* occurs within the Project area within grassy woodland habitat and its derived grasslands. However the species has only been previously recorded on five occasions within 50 kilometres of the study area, though none closer than a 1995 record from north of Boggabri (14 kilometres to the north-west, Atlas of NSW Wildlife). The most recent record for the species, within 50 kilometres of the study area, is from the Klori travelling stock route in 2007, approximately 43 kilometres to the south-east of the study area (Atlas of NSW Wildlife).

D. porrecta has not been recorded within the study area. However, flora surveys undertaken for this Project were undertaken in November outside of the optimal survey period for this species (mid-January to late February). This would be addressed through pre-clearance surveys for the species.

Assessment of Significance

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

It is considered unlikely that a viable local population of the species exists within the study area given the species has only been infrequently recorded in the wider area (five records within 50 kilometres of the study area) and the nearest record for the species is 14 kilometres to the north-west, dating back to 1995 (Figure 8).

D. porrecta has not been recorded within the study area. However, flora surveys undertaken for this Project were undertaken in November outside of the optimal survey period for this species (mid-January to late February). As such, pre-clearance surveys would be undertaken for *D. porrecta* in suitable potential habitat between December and May 2014. The surveys would be undertaken by an appropriately qualified person. If *D. porrecta* is identified in the Project area during the pre-clearance surveys, the following management measures would be evaluated and applied, where practicable:

- evaluation of whether the occurrence can be avoided (e.g. moving a stockpile);
- further survey work to evaluation the complete extent of the population;
- further assessment of the impacts on the species based on the additional information;
- collection and propagation of seed/vegetative material for use in revegetation and rehabilitation; and/or
- conservation of Finger Panic Grass in an offset area or funds towards conservation of Finger Panic Grass in NSW.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

D. porrecta has not been recorded within the study area. Therefore, there is no known extent of habitat within the study area.

The species was considered to have a moderate likelihood of occurrence prior to the field survey due to the prevalence of associated flora such as *Eucalyptus albens*, *Acacia pendula* and *Austrostipa aristiglumis* within the study area. A total of 1,597.7 hectares of native vegetation would be cleared by the proposal, all of which represents habitat for the species. This clearance would not fragment habitat for the species.

Potential habitat for *D. porrecta* occurs within the Project area within grassy woodland habitat and its derived grasslands. Outside the Project area potential habitat for this species in the locality occurs in grassland, dry sclerophyll forests and grassy woodlands. The abundance of these habitat types in the locality is high and includes most of the locality.

The proposal would have an effect on the extent of the habitat for the species within the locality, but this is considered negligible compared to the habitat available for the species throughout the Namoi CMA. For these reasons, it is considered that connectivity of the habitat for *D. porrecta* would not be impacted and the habitat to be removed by the proposal is not important to the long term survival of *D. porrecta*.

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

Critical Habitat, as defined by the TSC Act, has not been declared for *D. porrecta*. There is no critical habitat listed on the NSW Critical Habitat register (OEH 2011) in the Project area or surrounds.

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

At the time of this assessment no recovery plan had been published for *D. setosum*.

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

The relevant listed key threatening processes to *D. porrecta* include:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses. Exotic perennial grasses are known in the project area and surrounds and it is anticipated that the area of occupation of these grasses would increase as a result of the proposal.

Although the species was not recorded in the Project area, the action will result in the operation of the two key threatening processes relevant to the species (if this species occurs in the locality).

Conclusion

The proposal is considered unlikely to have a significant impact on *D. porrecta* given the species has only been infrequently recorded in the wider area (five records within 50 kilometres of the study area) and the nearest record for the species is 14 kilometres to the north-west, dating back to 1995 (Figure 8).

Pre-clearance surveys would be undertaken for *D. porrecta* in suitable potential habitat between December and May 2014. If Finger Panic Grass is identified, management measures would be applied.

Lepidium monoplocoides (winged peppercress)

Introduction

Winged Peppercress (*Lepidium monoplocoides*) is an erect annual herb 15–20 cm high which can be smooth or have small tubercles (wart-like outgrowths). It is considered rare though widespread in semi-arid regions of NSW and also occurs in Victoria and South Australia (Harden 2000).

Within the locality, two occurrences of *L. monoplocoides* exist comprising an estimated total of 466 individuals. One of these occurrences will be removed by the Project, comprising an estimated 46 individuals (refer to Figure 9).

Assessment of Significance

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

L. monoplocoides flowers from late winter to spring but, as demonstrated during the field survey, is more easily detected during seed set when the pan-shaped siliquas (fruits) lighten in colour compared to the rest of the plant. The species is highly dependent on seasonal conditions and within the study area plants could be detected into the middle of January 2012. The number of plants at each site varies greatly with seasonal conditions, but sites tend to be small in area with local concentrations of the plant. The species has been recorded as uncommon to locally common, with hundreds of plants recorded at some sites.

Numbers of adult plants fluctuate from year to year and, like many annual species occurring in dry environments, some seed probably remains dormant in the soil for several years. During extended wet periods, the species can behave like a short-lived perennial plant and it appears that germination can be triggered by local flooding events.

As an annual species, the progression from germination through to establishment, maturation and flowering would be relatively rapid and certainly confined to a single season. The method of pollination is unknown, although as a member of the nectariferous family Brassicaceae (Harden 2000), it is likely that the species is pollinated by small insects, most likely bees, wasps or ants. It is unlikely that the Project would interfere with the ecology of such insect species locally, and therefore, is unlikely to affect the lifecycle of *L. monoplocoides* in this respect.

Seed dispersal is likely to be through a number of vectors that are associated with the clayey, sometimes moist substrate of *L. monoplocoides* habitat. Locally this is most likely to be through the attachment of seed-laden mud on hooves and feet of stock or wild animals, possibly including ducks and wading bird species, and therefore facilitating quite wide dispersal. Given the possibly large geographical extent of this movement of seed against the very localised nature of the population to be affected, it is considered unlikely that the Project would affect the lifecycle of the species in respect to its dispersal mechanisms.

Literature for the species suggests that it would not respond well to disturbance (Mavromihalis 2010). However, the occurrence in the Canyon Coal Mine rehabilitation area has clearly been subject to, at the very least, stock movement and some grazing, as evidenced by the presence of cow pats and hoof marks. Furthermore, the Canyon Coal Mine and Pilliga National Park populations are clearly within the disturbance area of vehicle tracks. Part of the Pilliga National Park population is clearly within an area of an altered soil profile caused by works related to the maintenance of asset protection areas.

The Project would permanently remove one of the two occurrences (i.e. 46 individuals of *L. monoplocoides*); however the lifecycle of the species within the locality is unlikely to be affected by the Project.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

L. monoplocoides is widespread in the semi-arid western plains regions of NSW. It occurs on seasonally moist to waterlogged sites, on heavy fertile soils, with a mean annual rainfall of around 300-500 mm. Predominant vegetation is usually an open woodland dominated by *Allocasuarina luehmannii* (bulloak) and/or eucalypts, particularly *Eucalyptus largiflorens* (black box) or *E. populnea* (poplar box).

It was estimated in this assessment and report (Section 3.2.2 and also refer to Figure 9), that 46 individuals of *L. monoplocoides* would be removed by the Project. This represents the loss of 9.9 per cent of the individuals within the locality (another 420 individuals are located approximately 2 km north of the study area).

The 46 individuals of *L. monoplocoides* that would be removed by the Project, inhabit an area of approximately 20 x 20 m (400 m^2) and the occurrence within the Canyon Coal Mine area inhabits an area of approximately 20 x 50 ms (1,000 m^2). Therefore the known local habitat for *L. monoplocoides* is approximately 1400 m^2. The single occurrence to be removed therefore represents 28 per cent of the known local habitat for the species. Therefore, the occurrences located during the field survey are, to date, the only known areas of habitat for the species within the locality, despite the intensive survey effort for the species within and adjacent to the study area (Figure 4).

It is considered possible that the two occurrences were, prior to the construction of the Canyon Coal Mine, linked across a natural landscape of derived native pasture through what is now the Canyon Coal Mine void. Given the patchy distribution of the species within the Namoi CMA and more broadly within NSW, and its likely dispersal mechanisms, it is unlikely that the Project would affect the connectivity of habitat for *L. monoplocoides*.

Whilst it is likely that fragmentation and isolation is not likely to affect *L. monoplocoides*, the habitat to be removed by the Project, within the locality, is considered important to the survival of the species as:

- The occurrence of *L. monoplocoides* to be removed is one of only two known occurrences within the locality;
- The occurrence to be removed by the Project represents 9.9 per cent of the known individuals within the locality; and

The occurrence to be removed represents 28 per cent of the known local habitat of the species.

Specific management measures for this species have been developed for the Project and are detailed in Section 6.1 and summarised below:

- Collection and propagation of seed over as many seasons as possible prior to mining.
- Installation of tubestock at recipient site (i.e. the occurrence located immediately west of the Canyon rehabilitation area).
- Translocation of soil profile from impacted *Lepidium monoplocoides* habitat (in and around the population) to nominated recipient site.
- Long-term conservation of the Canyon Coal Mine occurrence including fencing and signage of the area with a 20 m buffer.
- Translocating the occurrence of 46 individuals from within the Western Emplacement to the fenced protected area, detailed above point.

- Monitoring and performance evaluation adopted *L. monoplocoides* management actions including Whitehaven contribution to additional survey and monitoring of the species in Pilliga National Park. The northern Pilliga occurrence to be used as a 'Control'.

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

Critical Habitat, as defined by the TSC Act, has not been declared for *Lepidium*. There is no critical habitat listed on the NSW Critical Habitat register OEH (2011b) in the Project area or surrounds.

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

A range of recovery objectives are listed for the *L. monoplocoides*) under the *National Recovery Plan for the Winged Peppercress Lepidium monoplocoides* (Mavromihalis 2010).

Recovery objectives are as follows (Mavromihalis 2010):

- Determine distribution, abundance and population structure;
- Determine habitat requirements;
- Manage threats to populations;
- Identify key biological functions;
- Determine growth rates and viability of populations;
- Establish a seed bank; and
- Build community support for conservation.

Clearance of an occurrence of *L. monoplocoides* as part of the Project is not wholly consistent with the recovery objectives, however management measures (outlined in Question e) are consistent with determining distribution, abundance and population structure and managing threats to populations.

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

The relevant listed key threatening processes to *L. monoplocoides* include:

- Clearing of native vegetation. A total of 1,748 ha of native vegetation would be cleared by the Project (Table 16). Most of the native vegetation loss is associated with the open cut and Western Emplacement, also the Eastern Emplacement and Infrastructure Area to a smaller extent (Figure 2).
- Invasion of native plant communities by exotic perennial grasses. Exotic perennial grasses are known in the Project area and surrounds and it is anticipated that the area of occupation of these grasses will increase as a result of the Project.

The action proposed will exacerbate two key threatening processes. These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Conclusion

The Project would result in the removal of one of two known occurrences of *L. monoplocoides* within the locality; 46 individuals of the species (9.9 per cent of the known local population) and 28 per cent of the known local habitat for this species. It is therefore considered that the Project is likely to have a significant effect on the local population of *L. monoplocoides* such that the species would be placed at risk of extinction within the locality.

In light of this conclusion, a suite of amelioration measures have been proposed in order to ensure the on-going conservation and management of the species within the locality, including the in-perpetuity conservation of the 420 individuals in the Canyon Coal Mine area. This has been discussed in Section 6.

Threatened Fauna

Hollow Dependent Bat Species (Beccari's Freetail-bat, Eastern Freetail-bat, Corben's Long-eared Bat, Little Pied Bat and Yellow-bellied Sheathtail-bat)

Introduction

Beccari's Freetail-bat roosts commonly in tree hollows, but have also been found in caves in New Guinea and the roofs of houses in Queensland (Churchill 2008). Widely distributed across northern Australia from Western Australia to Queensland, extending south to the north-east corner of NSW. It occurs in a range of vegetation communities in northern Australia, from rainforests to open forests and woodlands, and are often recorded along watercourses.

Beccari's Free-tail bat has been recorded near the study area on one occasion from survey of the proposed Belmont Coal Project (now the Rocglen Coal Mine) located immediately east of Vickery State Forest, however the exact location was not recorded (RPS, 2010). There are no other records of the species from the Atlas of NSW Wildlife or from surveys conducted as part of the Project, although calls from the species have reportedly been detected around the Gunnedah area and this has been attributed to the presence of an isolated population of the species (Countrywide Ecological Services 2007; Reihold 2001). Calls of the species have also been recorded during studies around the Pilliga Nature Reserve, though no individuals have been caught despite the use of trapping during these studies (Brad Law, NSW D.P.I, 2012, pers. comm.). The pattern of recordings of the species within the region suggests a relatively sparse and potentially isolated population at the southern and eastern limits of its distribution. It is possible that the species would forage and roost within the study area.

The Eastern Freetail Bat mainly roosts in tree hollows, however it has also been recorded roosting under bark or in man-made structures (OEH 2012b). The Eastern Freetail Bat breeds in late spring to mid-summer (Churchill 2008). This species occurs from Cape York, south along the Great Dividing Range and to its east and into Victoria on the coast and along the Murray River (Churchill 2008). This species was not recorded during recent surveys from within or near the study area (Countrywide Ecological Services 2007, 2011; RPS 2010), although there is a single record of the species from the Atlas of NSW Wildlife which is approximately 10 km south-west of the study area. The pattern of recordings of the species within the region suggests a relatively sparse population at the western limits of its distribution. It is possible that the species would forage and roost within the study area.

The Corben's Long-eared Bat roosts in tree hollows, crevices, and under loose bark. Overall, the distribution of the south-eastern form coincides approximately with the Murray Darling Basin, with the Pilliga Scrub region being the distinct stronghold for this species. It inhabits a variety of vegetation communities, including: mallee, bulloke (*Allocasuarina leuhmannii*) and box - eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland.

This species was not recorded during recent surveys from within or near the study area (Countrywide Ecological Services 2007; RPS 2010; Cenwest 2011) and whilst records from the Atlas of NSW Wildlife are numerous and widespread throughout the region (approximately 40 within a 50 km radius), records around the study area are sparse. Individuals of this species would potentially roost and forage within the study area, although it is unlikely that there are large number of this species inhabiting the area.

The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria. It occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. It roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. One record of this species occurs from Vickery State Forest (Atlas of NSW Wildlife). Individuals of this species are likely to roost in tree hollows and forage within the study area.

The Yellow-bellied Sheathtail Bat inhabits a wide range of habitats including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert (Churchill 2008). The distribution of the Yellow-bellied Sheathtail Bat includes the eastern coast of NSW. The Yellow-bellied Sheathtail Bat roosts in tree hollows in a wide range of habitats and has been found to utilise multiple roost sites. This species has also been found in the abandoned nests of Sugar Gliders (Richards 1995). Breeding occurs between August and March (Churchill 2008). This species occurs through all of Queensland, NSW, NT, Victoria and half of WA and SA. This species was recorded during recent surveys from within and near the study area (Countrywide Ecological Services 2007, 2011; RPS 2010), including during the current study, and records from the Atlas of NSW Wildlife are numerous and widespread (approximately 80 within a 50 km radius). Individuals of this species are likely to roost and forage within the study area.

The local population for the above species is considered to constitute those individuals within approximately a 10 km radius of the study area, which corresponds to approximated regular foraging movements for these species.

Based on the availability of potential roosting habitat for these species in the study area the Project may remove or disturb up to 1,900 hollows of varying sizes. In addition to the hollows, the development footprint provides areas of preferred foraging habitat for these bats comprising primarily disturbed woodland. The woodland habitat within the Project area is moderately common within the locality. Other habitat, such as grassland habitat, can be used by these species for foraging but is not preferred foraging habitat.

Assessment of Significance

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

For these hollow roosting bat species, all undisturbed parts of the Project area represent potential foraging habitat (Figure 19). Dams and other water bodies provide potential drinking areas. Woodland habitat in the Project area provides preferred breeding and roosting habitat for the four bat species discussed within this assessment, however, all hollow-bearing trees and trees with exfoliating bark or dense foliage in the Project area

have some potential to act as roosting habitat. This reflects the ability of these species to inhabit a range of roost types, at least on a temporary basis.

Certain potential roost sites (hollow-bearing trees with favourable characteristics) have the potential to act as maternity sites which support key life cycle components for these species, including breeding, gestation, and the birth and rearing of young. Therefore, clearing of hollow-bearing trees within the Project area has the potential to impact key life cycle components for hollow roosting bat species, through disruption of breeding, gestation and the birthing and rearing of young.

Up to 1,900 hollows would be removed by the Project, representing up to 4.8% of those in the locality. Additionally, 273 ha of preferred roosting and foraging habitat (Woodland) would be removed by the Project. The woodland habitat represents up to 4.8% of that present within the locality. The preferential removal of hollow-bearing trees during summer to autumn would minimise potential disturbance during periods of hibernation, birth and rearing of young (within any potential maternity colonies), which are times when bats would be most vulnerable.

Beccari's Freetail-bat, Eastern Freetail-bat, Corben's Long-eared Bat and Little Pied Bat all appear to have a low abundance within the locality and therefore the removal of any maternity roost within the locality has the potential to affect a significant proportion of the local population of the species, if they are roosting within the study area in large numbers. However, given that no individuals of these species were recorded during two surveys of the Project area, it appears unlikely that maternity roost removal for these species would occur. Roost removal for the Yellow-bellied Sheathtail-bat is less likely to impact a significant proportion of the local populations of these species as they appear to occur at higher densities within the locality.

Should roost removal occur, all of these species are likely to have some capacity to establish new roosting sites within the locality given the abundance of tree hollows present, provided bats are excluded from potential roost habitat before it is removed. It should be noted however that the factors governing roost selection are poorly understood.

Considering the existing significant area of remnant woodland habitat in Vickery and Boonalla CCA Zone 3 State Conservation Area it is considered unlikely that the Project would impact the Beccari's Freetail-bat, Eastern Freetail-bat, Corben's Long-eared Bat, Little Pied Bat or Yellow-bellied Sheathtail-bat such that a viable local population of these species is placed at risk of extinction, provided that clearing of potential habitat trees is done at an appropriate time of year and includes measures to exclude bats from potential roost sites prior to their removal.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

Up to 1,900 hollows would be removed by the Project, representing up to 4.8% of those estimated in the locality. Additionally, 273 ha of preferred foraging habitat (Woodland) and 1,284 ha of potential foraging habitat (Native Grassland) would be removed by the Project. The woodland habitat represents up to 4.8% of that present within the locality.

The woodland habitat for these bat species occurs mostly in the east of the study area adjacent to Vickery State Forest and extends into the study area as thin strips along two drainage lines (Figure 19). This habitat is directly linked to Vickery State Forest, which, although relatively large (1,942 ha), has limited connectivity with other vegetation in the region. The nearest similar habitat to the study area outside Vickery State Forest is Boonalla CCA Zone 3 State Conservation Area, which is approximately 3.5 km to the east and separated mostly by farming land. The only other vegetated corridor in the locality is a thin strip of trees along the Namoi River, but there are no vegetated corridors extending to the south-west from the study area to the Namoi River.

The areas between the Namoi River and the Project area and, to a lesser degree, Boonalla CCA Zone 3 State Conservation Area contain isolated habitat trees and small patches of regenerating woodland that would provide limited habitat connectivity between these areas. Although existing connectivity is poor, connectivity between the Namoi River and Vickery State Forest and retained areas within the Project area would be decreased through the presence of open-cut mining and emplacement areas south and west of Vickery State Forest. Potential movement pathways to and from Vickery State Forest from the north and south-east would be unaffected, which is connected directly.

Bats are highly mobile and any impacts on connectivity as a result of the Project are unlikely to prevent hollow roosting bats from accessing different parts of the locality.

Given the lack of records for Beccari's Freetail-bat, Eastern Freetail-bat, Corben's Long-eared Bat and Little Pied Bat within and around the Project area, the habitat within the area does not appear to be of particularly high importance. If maternity roosts were present for any of these species within the Project area, this could be important to the survival of the species within the locality, however this appears to be unlikely. Records of Yellow-bellied Sheathtail Bat indicate that the species occurs throughout the locality and wider region and therefore habitat within the Project area does not appear to be of particularly high importance to the long-term survival of this species within the locality.

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

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

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

None of the above threatened bats are the subject of dedicated recovery plans. The Project is consistent with a number of priority actions for these species (OEH, 2012a) considering the progressive rehabilitation of the post-mine landforms to provide potential habitat for these species in the medium to long-term (woodland) and the proposal to conserve significant areas of potential habitat for these species in the offset area.

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

The relevant listed key threatening processes to these species include:

- Clearing of native vegetation. The proposed development would result in the removal of 273 ha of Woodland habitat and 1,284 ha of Native Grassland.
- Loss of hollow-bearing trees. The proposed development would result in the removal of up to 1,900 hollow-bearing trees
- Removal of dead wood and dead trees.

These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Squirrel Glider

The Squirrel Glider inhabits mature or old growth box, box-ironbark woodlands and river red gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. This species prefers mixed species stands with a shrub or *Acacia* mid-storey. It requires abundant tree hollows for refuge and nest sites. All information pertaining to this species in the impact assessment below has been derived from OEH (2012b). The Squirrel Glider has previously been recorded from within a patch of vegetation adjacent to the Namoi River and a large block of extant vegetation (approximately 120 ha), at the junction of Bluevale Road and Johnston Road, in the far south-west of the study area (Cenwest 2011). This vegetation is poorly connected to the remainder of the study area, as habitat between these areas comprises predominantly isolated paddock trees. The species has not been recorded in any other location within the study area or its surrounds, either during this survey or others (i.e. Countrywide Ecological Services 2007; RPS 2010), or through database searches, and it is unlikely the species is present within the subject site. If present, it is expected that occurrence of the Squirrel Glider within the study area would be limited to a small proportion of the population within the locality and most likely represent juveniles moving from areas of better habitat.

The local population for the above species is considered to constitute those individuals within a 10 km radius of the study area, which corresponds to medium term dispersal patterns movements for this species.

Based on the availability of potential nesting habitat for this species in the study area the Project may remove or disturb up to 1,900 trees with hollows of varying sizes. In addition to the hollows, the development footprint provides areas of open potential sub-optimal foraging habitat for the Squirrel Glider within woodland habitat, however these are poorly connected to known habitat for the species. Woodland habitat of similar quality is moderately common and widespread in the locality. Approximately 273 ha of potential woodland habitat would be removed by the Project.

Assessment of Significance

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

Squirrel Gliders have not been observed within the areas of impact or surrounds and were not recorded during the field surveys. Potential foraging habitat within the study area is sub-optimal as it generally lacks a shrubby mid-canopy.

The development footprint provides up to 1,900 hollow-bearing trees (up to 4.8% in the locality), which could potentially be utilised for breeding, nesting and roosting by the Squirrel Glider.

The removal of hollow-bearing trees within the proposed development area is unlikely to impact the local population such that the species is likely to be placed at risk of extinction as only a small proportion of the existing local population is expected to inhabit the Project area, if at all. The potential habitat within the study area does not constitute high quality foraging habitat, being for the most part poorly consolidated and at least moderately disturbed.

As such, the Project is unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

Based on the average number of hollow-bearing trees within the woodland habitat type in the study area (4.6 hollow-bearing trees per ha) it is estimated that approximately 26,000 hollow-bearing trees are present within the locality: Vickery State Forest (9,000); woodland adjacent to Vickery State Forest (1,800); Boonalla CCA Zone 3 State Conservation Area (10,500); and, woodland adjacent and to the north of Boonalla CCA Zone 3 State Conservation Area (4,700). This is likely to be an under-estimate of hollow-bearing trees in the locality given that it doesn't consider small patches of woodland, road reserves or isolated paddock trees. Based on these figures the Project would remove up to 4.8% of hollow-bearing trees in the locality.

It is considered that woodland habitat within the Project area provides potential low quality roosting, foraging or movement habitat for Squirrel Glider. Woodland habitat occurs mostly in the east of the study area adjacent to Vickery State Forest and extends into the study area as thin strips along two drainage lines (Figure 2). This habitat is directly linked to Vickery State Forest, which although relatively large (1,942 ha), has limited connectivity with other vegetation in the region. The nearest similar habitat to the study area, outside Vickery State Forest is Boonalla CCA Zone 3 State Conservation Area, is approximately 3.5 km to the east and is mostly isolated by farming land and recent open-cut mining within the Rocglen Coal Mine. The only other vegetated corridor in the locality is a thin strip of trees along the Namoi River, but there are no consolidated vegetated corridors extending to the south-west from the study area to the Namoi River. The areas between the Project area and the Namoi River and, to a lesser degree, Boonalla CCA Zone 3 State Conservation Area contain isolated habitat trees and small patches of regenerating woodland that provide very limited habitat connectivity for the Squirrel Glider between these areas.

Existing connectivity to and from Vickery State Forest to retained areas within the Project area, as well as the existing patch of remnant vegetation near the location of the Squirrel Glider observation, would be decreased through an increase in the presence of open-cut mining and emplacement areas south and west of Vickery State Forest. Existing linkages between these areas are currently tenuous. Potential movement pathways to and from Vickery State Forest from the north and south-east would remain as is, which constitutes isolated habitat trees and small patches of regenerating woodland.

The habitat to be removed within the Project area represents relatively poor quality habitat for the Squirrel Glider and is unlikely to provide connectivity for the population recorded near the Namoi River with potential habitat within Vickery State Forest. Present records for Squirrel Glider within the locality are confined to the area of vegetation around the Namoi River vegetated corridor. There are no records of this species within Vickery State Forest or adjacent vegetated areas.

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

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

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

The Squirrel Glider is not subject to a dedicated recovery plan. The Project is consistent with a number of priority actions for these species (OEH, 2012a) considering the progressive rehabilitation of the post-mine landforms to provide potential habitat for these species in the medium to long-term (woodland) and the proposal to conserve significant areas of potential habitat for these species in the offset area.

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

The relevant listed key threatening processes to the Squirrel Glider include:

- Clearing of native vegetation. The proposed development would result in the removal of 273 ha of Woodland habitat and 1,284 ha of Grassland.
- Loss of hollow-bearing trees. The proposed development would result in the removal of up to 1,900 hollow-bearing trees, less than 5% of these present in the locality.

The action proposed will exacerbate two key threatening processes for these species. These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Large Forest Owls (Barking Owl, Masked Owl, Powerful Owl)

Introduction

Masked Owls require three essential elements during their life cycle; roosting and den trees, foraging habitats, and accessibility to mating partners. Masked Owls inhabit a diverse range of dry eucalypt forest and woodland, especially adjacent to grassland or clearings. Typical home range has been estimated at 1,122 to 1,178 ha (Kavanagh et al. 1995). Key roosting and nesting habitat must contain tall or dense mature trees with suitable hollows. Favoured nesting hollows are near-vertical spouts or large hollows in trunks of large eucalypts (Higgins 1999). They forage mainly upon terrestrial prey in adjoining open habitat, occasionally preying upon arboreal or scansorial mammals (Higgins 1999). Rats form a large part of their diet (OEH 2012b).

Powerful Owls are the largest of Australia's owls and, accordingly, require a large amount of land for foraging. As stated in the recovery plan for large forest owls (DEC 2006) the home range of this species can be from 300 to 1500 ha. The size of the range is likely to be dependent on prey density (Debus and Chafer 1994). The most common food source is arboreal mammals; however the prey may depend on local availability and the preferences of a particular pair of owls (DEC 2006). Kavanagh (1997) suggested that the breeding roost, essentially several different trees, was used for many months of the year. Higgins (1999) explains further that before nesting, a pair may be seen on one of their roost sites between 10-20 m apart from one another, the female will then move into the nesting hollow alone and the male take up roost nearby (generally within a 50 m radius of the nest but can be much more).

The Barking Owl is generally found in open forests, woodlands, swamp woodlands and dense scrub. They can also be found in the foothills and timber along watercourses in otherwise open country.

Masked Owls have been recorded within the Liverpool Plains bioregion on four occasions, with two of these records within the Boonalla CCA Zone 3 State Conservation Area (Atlas of NSW Wildlife). Although a possible sighting was made during this study, this was discounted, and other recent surveys within and around the Project area have not recorded the species (Cenwest Environmental Services 2007, 2011; RPS 2010; Cenwest Environmental Services 2011). The Barking Owl has been recorded within the Liverpool Plains bioregion on 11 occasions but there are no known records from the locality. The Powerful Owl has been recorded within the Liverpool Plains bioregion on eight occasions, however there are no known records from the locality. It was considered that the study area contains potential foraging and very limited roosting (one tree) habitat for all of these owl species.

The local population for the above species is considered to constitute those individuals within a 10 km radius of the study area, which corresponds to regular foraging movements for these species.

Based on the availability of potential nesting habitat for these species in the study area the Project would remove one potential roosting tree. In addition to the potential hollow nesting tree, the development footprint provides potential foraging habitat for these owl species. The woodland habitat within the Project area is moderately common and widespread in the locality.

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

The development footprint provides one tree with a hollow large enough to be utilised for breeding and roosting by these owl species. Preferred foraging habitat is also present in the form of woodland, of which 273 ha would be removed.

The removal of a single potential roost tree and surrounding foraging habitat is unlikely to impact the local population such that the species is likely to be placed at risk of extinction as only a small proportion of the existing local population (if any) would use the roost habitat. The potential habitat within the study area does not constitute high quality foraging habitat, as it is at least moderately disturbed and supports a low density of prey species. As such, the Project is unlikely to have an adverse effect on the lifecycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

The Project would result in the removal of 273 ha of potential sub-optimal foraging habitat for these species. This woodland habitat represents up to 4.8% of that present within the locality.

The woodland habitat occurs mostly in the east of the study area adjacent to Vickery State Forest and extends into the study area as thin strips along two drainage lines (Figure 20). This habitat is directly linked to Vickery State Forest, which although relatively large (1,942 ha), has limited connectivity with other vegetation in the region. The nearest similar habitat to the study area, outside Vickery State Forest is Boonalla CCA Zone 3 State Conservation Area, is approximately 3.5 km to the east and is mostly isolated by farming land. The only other vegetated corridor in the locality is a thin strip of trees along the Namoi River, but there are no consolidated vegetated corridors extending to the south-west from the study area to the Namoi River.

The areas between the Project area and the Namoi River and, to a lesser degree, Boonalla CCA Zone 3 State Conservation Area contain isolated habitat trees and small patches of regenerating woodland that would provide limited habitat connectivity. Although existing connectivity is poor, connectivity between the Namoi River and Vickery State Forest and retained areas within the Project area would be decreased through the presence of open-cut mining and emplacement areas south and west of Vickery State Forest. Potential movement pathways to and from Vickery State Forest from the north and south-east would be unaffected, which is connected directly.

The forest owls assessed are highly mobile and any impacts on connectivity as a result of the Project are unlikely to prevent these species from accessing different parts of the locality.

Given the lack of records and roosting habitat for large forest owls within and around the Project area, the habitat within the area does not appear to be of high importance to the long-term survival of these species.

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

No Critical Habitat, as listed on the TSC Act, would be affected by the Project. There is no Critical Habitat listed on the NSW Critical Habitat register OEH (2011b) in the Project area or surrounds.

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

The NSW Large Forest Owls Recovery Plan (DEC 2006) is relevant to Masked Owl and Powerful Owl. A draft recovery plan is in place for the Barking Owl (NPWS 2003). The Project is not considered inconsistent with the objectives of these recovery plans. Additionally, the Project is consistent with priority actions for these species (OEH, 2012a) considering the progressive revegetation of post-mine landforms to provide potential habitat for the species in the medium to long-term (woodland) and the proposal to conserve significant areas of potential habitat for this species in the offset area.

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

The relevant listed key threatening processes to these owl species include:

- Clearing of native vegetation. The proposed development would result in the removal of 273 ha of Woodland habitat and 1,284 ha of Grassland.
- Loss of hollow-bearing trees. The proposed development would result in the removal of up to 1,900 hollow-bearing trees, less than 5% of those present within the locality.
- Removal of dead wood and dead trees.

These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Woodland Birds (Brown Treecreeper [eastern subspecies]), Diamond Firetail, Gilbert's Whistler, Painted Honeyeater, Speckled Warbler, Varied Sittella)

The Brown Treecreeper (eastern subspecies) is found in eucalypt woodlands (including box-gum woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range. It mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey and sometimes with one or more shrub species. This species is also found in mallee and river red gum forest bordering wetlands with an open understorey of *Acacia* spp., saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer. Fallen timber is generally an important habitat component for foraging. The Brown Treecreeper (eastern subspecies) has previously been recorded in the locality, including within Vickery State Forest (OEH, 2012a). Suitable habitat within the study area for this species includes woodland and grassy woodland.

The Diamond Firetail feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Found in grassy eucalypt woodlands, including box-gum woodlands and snow gum woodlands. Also occurs in open forest, mallee, natural temperate grassland, and in secondary grassland derived from other communities. The Diamond Firetail has previously been recorded in the study area, during this and previous surveys. Suitable habitat for this species on the study area includes woodland and native grassland.

The Gilbert's Whistler has been recorded in mallee shrublands, but it also occurs in box-ironbark woodlands, cypress pine and belah woodlands and river red gum forests, though at this stage it is only known to use this habitat along the Murray, Edwards and Wakool Rivers. Within the mallee the species is often found in association with an understorey of spinifex and low shrubs including wattles, hakeas, sennas and hop-bushes. The Gilbert's Whistler has previously been recorded adjacent to the study area on Rocglen Coal Mine (RPS 2010), although this is considerably outside its normal range. The exact location of this record was not supplied. Suitable habitat for this species in the study area includes woodland.

The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the species, and almost all breeding, occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. It inhabits boree, brigalow and box-gum woodlands and box-ironbark forests. The Painted Honeyeater has been previously recorded within the Liverpool Plains bioregion on four occasions. However the Painted Honeyeater has not been recorded within approximately 15 km of the Project area (Figure 15c). Suitable habitat for this species in the study area includes woodland.

The Speckled Warbler lives in a wide range of eucalypt dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. The Speckled Warbler has previously been recorded in the study area (current study and Cenwest 2011). Suitable habitat for this species in the study area includes woodland.

The Varied Sittella inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy groundcover or both, in all climatic zones of Australia (Higgins and Peter 2002). Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature eucalypts with hollows. The Varied Sittella has previously been recorded in the study area (Cenwest 2011). Suitable habitat for this species in the study area includes woodland and, to a lesser degree, grassy woodland.

The local populations for the above species are considered to constitute those individuals within a 10 km radius of the study area, which includes Vickery State Forest, Boonalla State Conservation Area and parts of the Namoi River.

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

The development footprint provides up to 1,900 hollow-bearing trees (conservatively up to 4.8% in the locality), which may be utilised for breeding by the Brown Treecreeper (eastern subspecies) only. The Project is likely to remove a large amount of potential nesting habitat for the Brown Treecreeper, (eastern subspecies) although a small proportion of available habitat in the locality. The extent of removal of potential nesting habitat is unlikely to place the local population at risk of extinction given the large areas of potential habitat remaining throughout the locality.

Nesting habitat for the other woodland bird species within the locality is less limiting, thus affecting these species to a lesser degree. Given the large areas of potential habitat remaining throughout the locality, the extent of removal of potential nesting habitat is unlikely to have an adverse effect on the lifecycle of these species such that a viable local population of these species is likely to be placed at risk of extinction.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

Hollow-bearing trees constitute nesting habitat for the Brown Treecreeper (eastern subspecies) only. Up to 1,900 hollows would be removed by the Project, conservatively representing up to 4.8% of those in the locality. Depending on habitat foraging preferences for each species (Figures 17, 18, 21 and 22), 329 ha (Gilberts Whistler), 437 ha (Brown Treecreeper, Painted Honeyeater, Varied Sittella) and 1,414 ha (Diamond Firetail) would be removed by the Project. Conservatively up to 4.8% of Woodland habitat for these species would be impacted in the locality, while the proportion of open grassy woodland and grassland habitat affected would be much less. Given that Vickery State Forest and its fringing woodland provide Woodland habitat for all these species, the relative loss of habitat within the immediate vicinity of the Project is still relatively small (11%).

The woodland habitat for these species occurs mostly in the east of the study area adjacent to Vickery State Forest and extends into the study area as thin strips along two drainage lines (Figure 14). This habitat is directly linked to Vickery State Forest, which although relatively large (1,942 ha), has limited connectivity with other vegetation in the region. The nearest similar habitat to the study area, outside Vickery State Forest, is Boonalla CCA Zone 3 State Conservation Area approximately 3.5 km to the east and is mostly isolated by farming land. The only other vegetated corridor in the locality is a thin strip of trees along the Namoi River, but there are no consolidated vegetated corridors extending to the south-west from the study area to the Namoi River.

The areas between the Project area and the Namoi River and, to a lesser degree, Boonalla CCA Zone 3 State Conservation Area contain isolated habitat trees and small patches of regenerating woodland that would provide limited habitat connectivity between these areas. Existing connectivity is poor, connectivity between the Namoi River, Vickery State Forest and the Project area is currently poor and would be decreased by Project developments. However, potential movement pathways to and from Vickery State Forest from the north and south-east would be unaffected.

These bird species are mostly highly mobile and the small impacts on connectivity as a result of the Project are unlikely to decrease these species ability to access different parts of the locality, including between Vickery State Forest and the Namoi River.

Given the large areas of comparable habitat, and potential nesting habitat for Brown Treecreeper (eastern subspecies), throughout the locality, the areas to be removed or isolated from the Project are not considered to be of high importance to the survival of these species within the locality.

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

No Critical Habitat, as listed on the TSC Act, would be affected by the Project. There is no Critical Habitat listed on the NSW Critical Habitat register OEH (2011b) in the Project area or surrounds.

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

No dedicated recovery plan exists for any of these species. Additionally, the Project is consistent with priority actions for these species (OEH, 2012a) considering the progressive revegetation of post-mine landforms to provide potential habitat for the species in the medium to long-term (woodland) and the proposal to conserve significant areas of potential habitat for this species in the offset area.

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

The relevant listed key threatening processes to these woodland bird species include:

- Clearing of native vegetation. The proposed development would result in the removal of 273 ha of Woodland habitat and 1,284 ha of Grassland habitat.
- Loss of hollow-bearing trees. The proposed development would result in the removal of up to 1,900 hollow-bearing trees, which conservatively represents 4.8% of those present in the locality.

These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Conclusion

The Project is unlikely to significantly impact local populations of any of these bird species. Whilst there would be a loss of 273 ha of known Woodland habitat from the Project, which conservatively represents up to 4.8% of similar habitat in the locality, there would be no loss of connectivity to nearby habitat patches such as Boonalla State Conservation Area or the Namoi River, although the current limited habitat connectivity between Vickery State Forest and the Namoi River would be less direct. Also, given that Vickery State Forest and its fringing woodland provide Woodland habitat for all these species, the relative loss of habitat within the immediate vicinity of the Project is still relatively small (11%).

Woodland Birds - Grey-crowned Babbler (eastern subspecies), Hooded Robin (south-eastern form)

In NSW, the eastern sub-species of the Grey-crowned Babbler (eastern subspecies) occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. It inhabits open box-gum woodlands on the slopes, and box-cypress pine and open box woodlands on alluvial plains. In eastern Australia it occurs in open forests and woodlands dominated by eucalypts, including ironbarks or spotted gums, or in mixed associations, such as Bimble Box-cypress pine-Belah communities. It requires an open shrub layer with sparse ground cover and fallen timber and leaf litter. The Grey-crowned Babbler (eastern subspecies) is relatively common in the study area and was recorded within the Project area and immediate surrounds, including Vickery State Forest (Figure 16).

The Hooded Robin (south-eastern form) prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Also occurs in tall dry woodlands dominated by eucalypts, such as Grey Box, Yellow Box-Blakley's Red Gum, or mixed White Box-Buloke-Acacia-Callitris associations. It also occurs in box-ironbark forests. In NSW and Queensland mostly recorded from eucalypt woodlands, ranging from open (10-30% cover) to quite dense forest (50-70% cover) and from a sparse (<10%) to dense (70-90%) understorey. The Hooded Robin (south-eastern form) has previously been recorded in the study area (Cenwest 2011) and nearby in Boonalla State Conservation Area.

Suitable habitat for both of these species in the study area includes woodland and native grassland where there are habitat trees, including woodland within Vickery State Forest. Although this species has a preference for open woodland, the woodland within the adjacent Vickery State Forest has a relatively open shrub layer with fallen timber and leaf litter, and would provide habitat for these species. The Grey-crowned Babbler has a preference for open forests and woodlands on plains and are less likely to use the rugged areas of Vickery State Forest. However, the hilly areas within Vickery State Forest are mostly restricted to a central spine running north-south, with the western, north-eastern and southern sections containing relief similar to that in the neighbouring foothills and plains. The elevation of land in the Project area rises from its lowest point of 260 m in the south and west, to 280-320 m at the Vickery State Forest boundary and 400-470 m in the centre of the State Forest. For example, in the south-west section of Vickery State Forest the land rises approximately 50 m over a distance of 2 km. These figures demonstrate that much of Vickery State Forest has similar topography to the areas of suitable habitat that would be impacted by the Project.

The local populations for the above species are considered to constitute those individuals within a 10 km radius of the study area, which includes Vickery State Forest, Boonalla State Conservation Area and parts of the Namoi River.

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

The Project would impact 437 ha of foraging and nesting habitat for these species, which represents up to 4.8% of that available within the locality. Given the relatively large areas of potential nesting habitat remaining throughout the locality, the extent of removal of potential nesting habitat is unlikely to have an adverse effect on the lifecycle of these species such that a viable local population of these species is likely to be placed at risk of extinction.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

Approximately 437 ha of foraging habitat would be removed by the Project. It is estimated that approximately 5,643 ha of Woodland habitat for these species is present within the locality based on the following: Vickery State Forest (1,942 ha); Woodland adjacent to Vickery State Forest (381 ha); Boonalla CCA Zone 3 State Conservation Area (2,300 ha); and, woodland adjacent and to the north of Boonalla CCA Zone 3 State Conservation Area (1,020 ha).

This is likely to be an under-estimate of Woodland habitat in the locality given that it does not consider small patches of vegetation, road reserves or scattered paddock trees. Therefore, conservatively up to 4.8% of Woodland habitat for these species would be impacted in the locality, while the proportion of open grassy woodland habitat affected would be much less. Given that Vickery State Forest and its fringing woodland provide Woodland habitat for both these species, the relative loss of habitat within the immediate vicinity of the Project is still relatively small (11%).

The woodland habitat for these species occurs mostly in the east of the study area adjacent to Vickery State Forest and extends into the study area as thin strips along two drainage lines (Figure 14). This habitat is directly linked to Vickery State Forest, which although relatively large (1,942 ha), has limited connectivity with other vegetation in the region. The nearest similar habitat to the study area, outside Vickery State Forest, is Boonalla CCA Zone 3 State Conservation Area approximately 3.5 km to the east and is mostly isolated by farming land, although revegatation works by Whitehaven are improving this link. The only other vegetated corridor in the locality is a thin strip of trees along the Namoi River, but there are no consolidated vegetated corridors extending to the south-west from the study area to the Namoi River.

The areas between the Project area and the Namoi River and, to a lesser degree, Boonalla CCA Zone 3 State Conservation Area contain isolated habitat trees and small patches of regenerating woodland that would provide limited habitat connectivity between these areas. Existing connectivity between the Namoi River and Vickery State Forest is currently poor and would be decreased further by the Project in the short-term. However, proposed rehabilitation works to the north and south of the Project area would improve existing connectivity in the medium to long-term. Potential movement pathways to and from Vickery State Forest from the north and south-east would be unaffected by the Project.

These bird species are mostly highly mobile and the small short-term impacts on connectivity as a result of the Project are unlikely to decrease these species ability to access different parts of the locality, including between Vickery State Forest and the Namoi River.

Given the large areas of comparable habitat throughout the locality, the areas to be removed or isolated by the Project are not considered to be of high importance to the survival of these species within the locality.

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

No Critical Habitat, as listed on the TSC Act, would be affected by the Project. There is no Critical Habitat listed on the NSW Critical Habitat register OEH (2011b) in the Project area or surrounds.

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

No dedicated recovery plan exists for either of these species. Additionally, the Project is consistent with priority actions for these species (OEH, 2012a) considering the progressive revegetation of post-mine landforms to provide potential habitat for the species in the medium to long-term (woodland) and the proposal to conserve significant areas of potential habitat for this species in the offset area.

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

The relevant listed key threatening processes to these woodland bird species include:

- Clearing of native vegetation. The proposed development would result in the removal of 273 ha of Woodland habitat and 1,284 ha of Grassland habitat.

These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Conclusion

The Project is unlikely to significantly impact local populations of any of these bird species. Whilst there would be a loss of 273 ha of known Woodland habitat from the Project, which conservatively represents up to 4.8% of similar habitat in the locality, there would be no loss of connectivity to nearby habitat patches such as Boonalla State Conservation Area or the Namoi River, although the current limited habitat connectivity between Vickery State Forest and the Namoi River would be less direct. Also, given that Vickery State Forest and its fringing woodland provide Woodland habitat for all these species, the relative loss of habitat within the immediate vicinity of the Project is still relatively small (11%).

Parrots and Cockatoos (Glossy Black-cockatoo, Little Lorikeet, Superb Parrot, Turquoise Parrot)

Introduction

The Glossy Black-cockatoo is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. It inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1,000 m in which stands of she-oak species occur (black she-oak, forest she-oak and drooping she-oak or belah). The Glossy Black-cockatoo has been previously recorded within the Liverpool Plains bioregion on 11 occasions and *Casuarina cristata* (belah) is present within woodland habitat in the study area, although sparsely. Suitable habitat for this species in the study area includes woodland habitat.

The Little Lorikeet is distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. They mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (OEH 2012b). The Little Lorikeet has been previously recorded within the Liverpool Plains bioregion on numerous occasions (OEH 2012a). Suitable habitat for this species in the study area includes woodland habitat.

The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. It lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. They nest in tree hollows, logs or posts, from August to December. The Turquoise Parrot has previously been recorded in the study area (Cenwest 2011; RPS 2010). Suitable habitat for this species in the study area includes woodland and native grassland.

The Superb Parrot is found throughout eastern inland NSW. On the south-western slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. They inhabit box-gum, box-cypress pine and boree woodlands and river red gum forest. Suitable habitat for this species in the study area includes woodland.

The local population for the above species is considered to constitute those individuals within a 10 km radius of the study area.

Based on the availability of potential nesting habitat for these species in the study area, the Project may remove or disturb up to 1,900 trees with hollows of varying sizes, although the core breeding area for the Superb Parrot is outside the study area. In addition to nesting habitat, the development footprint provides potential foraging habitat for all these species. Woodland and native grassland habitat for these species is common and widespread in the locality.

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

The development footprint provides up to 1,900 hollow-bearing trees, which may be utilised for breeding and roosting by these Psittacid species. The Project is likely to remove a large amount of potential nesting habitat for these Psittacid species, albeit a small proportion of potential habitat in the locality, but has limited potential to directly impact breeding events if tree removal is undertaken in winter. Given the large areas of potential habitat remaining throughout the locality, the extent of removal of potential nesting habitat is unlikely to have an adverse effect on the life cycle of these species such that a viable local population of these species is likely to be placed at risk of extinction.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

Hollow-bearing trees constitute nesting habitat for these Psittacid species. Up to 1,900 hollows would be removed by the Project, representing up to 4.8% of those in the locality. Depending on habitat foraging preferences for each species (Figures 17, 18 and 25), between 255 ha and 436 ha of potential habitat would be removed by the Project. The woodland habitat to be removed for these species constitutes an estimated maximum of 4.8% of that within the locality, including habitat within Vickery and Boonalla CCA Zone 3 State Conservation Areas.

The woodland habitat for these species occurs mostly in the east of the study area adjacent to Vickery State Forest and extends into the study area as thin strips along two drainage lines (Figure 14). This habitat is directly linked to Vickery State Forest, which although relatively large (1,942 ha), has limited connectivity with other vegetation in the region. The nearest similar habitat to the study area outside Vickery State Forest is in Boonalla CCA Zone 3 State Conservation Area, which is approximately 3.5 km to the east and is mostly isolated by farming land. The only other vegetated corridor in the locality is a thin strip of trees along the Namoi River, but there are no consolidated vegetated corridors extending to the south-west from the study area to the Namoi River.

The areas between the Project area and the Namoi River and, to a lesser degree, Boonalla CCA Zone 3 State Conservation Area contain isolated habitat trees and small patches of regenerating woodland that would provide limited habitat connectivity. Although existing connectivity is poor, connectivity between the Namoi River and Vickery State Forest and retained areas within the Project area would be decreased through the presence of open-cut mining and emplacement areas south and west of Vickery State Forest. Potential movement pathways to and from Vickery State Forest from the north and south-east would be unaffected, which is connected directly.

These bird species are highly mobile and the minor impacts to connectivity as a result of the Project are unlikely to prevent these species accessing different parts of the locality.

Given the large areas of comparable habitat and potential nesting habitat for these Psittacid species throughout the locality, the areas to be removed or isolated from the Project are not considered to be of particular importance to the long-term survival of these species within the locality.

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

No Critical Habitat, as listed on the TSC Act, would be affected by the Project. There is no Critical Habitat listed on the NSW Critical Habitat register OEH (2011b) in the Project area or surrounds.

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

Based on the dedicated National Recovery Plan for the Superb Parrot (Baker-Gabb 2011), the Project is not considered inconsistent with the objectives of this recovery plan.

No dedicated recovery plan exists for any other of these species. However, the Project is consistent with priority actions for these species (OEH, 2012a) considering the progressive revegetation of post-mine landforms to provide potential habitat for the species in the medium to long-term (woodland) and the proposal to conserve significant areas of potential habitat for this species in the offset area.

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

The relevant listed key threatening processes to these parrot and cockatoo species include:

- Clearing of native vegetation. The proposed development would result in the removal of 273 ha of Woodland habitat and 1,284 ha of Grassland.
- Loss of hollow-bearing trees. The proposed development would result in the removal of up to 1,900 hollow-bearing trees, less than 5% of those within the locality.

These key threatening processes are assessed, and mitigation measures (including offsetting) are provided in Sections 5 and 6, respectively.

Raptors (Grey Falcon, Little Eagle, Spotted Harrier, Square-tailed Kite)

Introduction

The Grey Falcon is usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. It also occurs near wetlands where surface water attracts prey. The Grey Falcon has previously been recorded in the study area (RPS 2010), however the exact location of this record was not supplied. Suitable habitat for this species in the study area includes grassland and, to a lesser degree, woodland and grassy woodland.

The Little Eagle is most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. It may nest in farmland, woodland and forest in tall trees (Marchant and Higgins 1993). The Little Eagle has previously been recorded in the study area (Cenwest 2011). Suitable habitat for this species in the study area includes grassland and, to a lesser degree, woodland and grassy woodland.

The Spotted Harrier occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. The Spotted Harrier has previously been recorded in the locality on numerous occasions (BirdLife Australia Atlas). Suitable habitat for this species in the study area includes grassland and grassy woodland.

The Square-tailed Kite typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993). In NSW it is often associated with ridge and gully forests dominated by *Eucalyptus longifolia*, *Corymbia maculata*, *E. elata* or *E. smithii* (OEH 2012b). Individuals appear to occupy large hunting ranges of more than 100 km^2. They require large living trees for breeding, particularly near water with surrounding woodland or forest close by for foraging. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993). The Square-tailed Kite has previously been recorded in the locality (BirdLife Australia Atlas), including at Tarrawonga Coal Mine approximately 12 km to the north. Suitable habitat for this species in the study area includes woodland.

The local population for the above species is considered to constitute those individuals within a 10 km radius of the study area.

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

Woodland and grassland habitats provide foraging habitat for the Square-tailed Kite, Grey Falcon, Spotted Harrier and Little Eagle.

Breeding habitat for these raptor species is relatively limited in the study area as large trees, particularly those on ridge tops or watercourses, are uncommon. Larger trees for nesting for these species are more common within Vickery State Forest and along the Namoi River.

Given the limited breeding habitat within the Project area and that available foraging habitat is relatively common throughout the locality it is considered unlikely that a viable local population of any of these species is likely to be impacted such that a local population is placed at risk of extinction.

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

Not applicable.

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

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

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

Not applicable.

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

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

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

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

Large trees, particularly those on ridge tops or watercourses, constitute nesting habitat for these raptor species and these are uncommon on the study area Depending on habitat foraging preferences for each species (Figure 24), between 257 ha and 437 ha would be removed by the Project.

The woodland habitat for these species occurs mostly in the east of the study area adjacent to Vickery State Forest and extends into the study area as thin strips along two drainage lines (Figure 14). This habitat is directly linked to Vickery State Forest, which although relatively large (1,942 ha), has limited connectivity with other vegetation in the region. The nearest similar habitat to the study area outside Vickery State Forest is Boonalla CCA Zone 3 State Conservation Area, which is approximately 3.5 km to the east and mostly isolated by farming land. The only other vegetated corridor in the locality is a thin strip of trees along the Namoi River, but there are no consolidated vegetated corridors extending to the south-west from the study area to the Namoi River.

The areas between the Project area and the Namoi River and, to a lesser degree, Boonalla CCA Zone 3 State Conservation Area contain isolated habitat trees and small patches of regenerating woodland that would provide limited habitat connectivity between these areas. Although existing connectivity is poor, connectivity between the Namoi River and Vickery State Forest and retained areas within the Project area would be decreased through the presence of open-cut mining and emplacement areas south and west of Vickery State Forest. Potential movement pathways to and from Vickery State Forest from the north and south-east would be unaffected, which is connected directly.

These raptor species are all highly mobile and the minor impacts to connectivity as a result of the Project are unlikely to prevent these species accessing different parts of the locality.

Given the large areas of comparable habitat and potential nesting habitat for these raptor species throughout the locality, the areas to be removed or isolated from the Project are not considered to be of high importance to the survival of these species within the locality.

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

No Critical Habitat, as listed on the TSC Act, would be affected by the Project. There is no Critical Habitat listed on the NSW Critical Habitat register OEH (2011b) in the Project area or surrounds.

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

No dedicated recovery plan exists for any of these species. However, the Project is consistent with priority actions for these species (OEH, 2012a) considering the progressive revegetation of post-mine landforms to provide potential habitat for the species in the medium to long-term (woodland) and the proposal to conserve significant areas of potential habitat for this species in the offset area.

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

The relevant listed key threatening processes for these bird species include:

- Clearing of native vegetation. The proposed development would result in the removal of 273 ha of Woodland habitat and 1,284 ha of Grassland.

- Loss of hollow-bearing trees. The proposed development would result in the removal of up to 1,900 hollow-bearing trees, less than 5% of those within the locality.

The action proposed will exacerbate two key threatening processes for these species.

Conclusion

The Project would result in the removal of between 257 and 437 ha of known and potential habitat for these species, although very few large trees suitable for nesting would be removed.

Appendix F: Threatened Fauna Likelihood of Occurrence

All unreferenced habitat information was obtained from the OEH threatened species profiles (OEH, 2012b).

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Botaurus poiciloptilus	Australasian Bittern	E	E	The Australasian Bittern is widespread but uncommon over south-eastern Australia. In New South Wales (NSW) they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleoacharis* spp.).	Low
Alectura lathami	Australian Brush-turkey population (Nandewar and Brigalow Belt South Bioregions)	EP	-	A population of the Australian Brush-turkey is known from the Nandewar and Brigalow Belt South Bioregions. Recent records for the species show the population to range from north-east of Warialda, to Narrabri, approximately 115 kilometres (km) to the south-west, and occur within the local government areas of Yallaroi, Bingara, Narrabri, Barraba and Moree Plains. The majority of records are from Mount Kaputar National Park and nearby Deriah State Forest, with a smaller cluster of records from Warialda State Forest. In NSW the inland vegetation community preferred by the Australian Brush-turkey is a dry rainforest community that is found within the Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions Endangered Ecological Community.	Low
Ninox connivens	Barking Owl	V	-	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey 1997).	**Moderate** (11 previous records within the Liverpool Plains (Part B) IBRA sub-bioregion)
Mormopterus beccarii	Beccari's Freetail-bat	V	-	Widely distributed across northern Australia from Western Australia to Queensland, extending south to the north-east corner of NSW. A range of vegetation communities in northern Australia, from rainforests to open forests and woodlands, and are often recorded along watercourses. They can also occur in towns and cities. Roost mainly in tree hollows but relatively large colonies have been found under house roofs in urban areas in Queensland.	**Known** (RPS 2010, exact location not supplied)
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*) and Forest Red Gum (*E. tereticornis*). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees.	Low

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.	Low
Oxyura australis	Blue-billed Duck	V	-	The Blue-billed Duck is endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 km away. It is generally only during summer or in drier years that they are seen in coastal areas. The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation.	**Known** (Cenwest Environmental Services 2011)
Litoria booroolongensis	Booroolong Frog	E	E	The Booroolong Frog is present along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Streams range from small slow-flowing creeks to large rivers. Adults occur on or near cobble banks and other rock structures within stream margins and shelter under rocks or amongst vegetation near the ground on the stream edge. The species occurs along streams in both forested areas and open pasture. The Booroolong Frog sometimes basks in the sun on exposed rocks near flowing water during summer.	Low
Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	V	V	Occurs in dry sclerophyll open forest and woodland associated with outcrops of granite, basalt, sandstone and metamorphic rocks. The majority of sites are associated with granite outcrops. Surveys conducted in north-eastern NSW indicate that geckos may show a preference for easterly aspects and the base of rock scarps. The composition of vegetation appears to have little influence on the occurrence of geckos. Shelter sites include rocks, decaying logs, bark, and litter in rocky rubble. Shelter sites are usually laying on a litter substrate and shaded by nearby vegetation. Litter depth at shelters located during CRA surveys varied between 1 and 10 centimetres (cm).	Low
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	**High** (Previously recorded within locality, Atlas of NSW Wildlife)
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge and Close 1995).	Low

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Stagonopleura guttata	Diamond Firetail	V	-	Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities.	**Known** (current study, Cenwest Environmental Services 2011)
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Roost in caves and man made habitats and under road culverts (Strahan 1995). Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill 2008). Two observations have been made of roosts in stem holes of living eucalypts (Phillips 1995). There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Strahan 1995). This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites (Strahan 1995).	**Known** (recorded with probable certainty during current study)
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits (Allison and Hoye 1995, Churchill 2008).	**High** (Previously recorded within the locality, Atlas of NSW Wildlife)
Pachycephala inornata	Gilbert's Whistler	V	-	Recorded in Mallee shrublands, but also occurs in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests, though at this stage it is only known to use this habitat along the Murray, Edwards and Wakool Rivers. Within the mallee the species is often found in association with an understorey of spinifex and low shrubs including wattles, hakeas, sennas and hop-bushes.	**Known** (RPS 2010, exact location not supplied)
Calyptorhynchus lathami	Glossy Black-cockatoo	V	-	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*), Drooping She-oak (*A. verticillata*) occur or Belah (*Casuarina cristata*).	**Moderate** (11 previous records within the Liverpool Plains (Part B) IBRA sub-bioregion and *Casuarina cristata* present within the study area)

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Nyctophilus corbeni	Corben's Long-eared Bat	V	-	Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. Inhabits a variety of vegetation communities, including Mallee, Bulloke (*Allocasuarina leuhmanni*) and Box Eucalyptus dominated communities, but it is distinctly more common in Box/Ironbark/Cypress Pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark.	**Moderate** (19 previous records within the Liverpool Plains (Part B) IBRA sub-bioregion)
Falco hypoleucos	Grey Falcon	E	-	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.	**Known** (RPS 2010, exact location not supplied)
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress Pine and open Box Woodlands on alluvial plains.	**Known** (current study, Cenwest Environmental Services 2011, OEH 2012a)
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	Prefers lightly wooded country, usually open eucalypt woodland, Acacia scrub and Mallee, often in or near clearings or open areas.	**Known** (Cenwest Environmental Services 2011)
Phascolarctos cinereus	Koala	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed *et al.* 1990).	**High** (Previously recorded within locality, Atlas of NSW Wildlife) (OEH 2012b)
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye and Dwyer 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 2008). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 2008).	**Moderate** (possibly recorded during the current study, 34 previous records within the Liverpool Plains (Part B) IBRA sub-bioregion)

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Hieraaetus morphnoides	Little Eagle	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees (Marchant and Higgins 1993).	**Known** (Cenwest Environmental Services 2011)
Glossopsitta pusilla	Little Lorikeet	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.	**High** (Previously recorded within locality, Atlas of NSW Wildlife) (OEH 2012b)
Chalinolobus picatus	Little Pied Bat	V	-	The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria. Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings.	**Known** (Previously recorded from Vickery State Forest)
Leipoa ocellata	Malleefowl	E	V	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300 - 450 millimetres [mm]) mean annual rainfall) areas. Utilises mallee with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey. Less frequently found in other eucalypt woodlands, such as Inland Grey Box, Ironbark or Bimble Box Woodlands with thick understorey, or in other woodlands such dominated by Mulga or native Cypress Pine species.	None
Tyto novaehollandiae	Masked Owl	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997; Higgins 1999).	**Moderate** (Four previous records within the Liverpool Plains [Part B] IBRA sub-bioregion,)
Grantiella picta	Painted Honeyeater	V	-	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests.	**Moderate** (Four previous records in the Liverpool Plains [Part B] IBRA sub-bioregion)

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Rostratula benghalensis	Painted Snipe (Australian subspecies)	E	V	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowal, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Low
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	Found mainly in dry eucalypt forests and woodlands, cypress woodland and occasionally in rainforest or moist eucalypt forest. Favours streamside areas, particularly in drier habitats.	**Moderate** (Four previous records in Liverpool Plains [Part B] IBRA sub-bioregion)
Pseudomys pilligaensis	Pilliga Mouse	V	V	The Pilliga Mouse is found in greatest abundance in recently burnt moist gullies, areas dominated by broombush and areas containing an understorey of Burrow's Wattle (*Acacia burrowii*) with a White Bloodwood (*Corymbia trachyphloia*) overstorey. Topography includes rolling landscapes with low relief on sandy soil and sandstone ridges. This species occurs in an area of low-nutrient deep sands with mean annual rainfall of approximately 750 mm.	Low
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (*Themeda australis*). Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks.	Low
Ninox strenua	Powerful Owl	V	-	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within Red Turpentine in tall open forests and Black She-oak within open forests (Debus, 1994; Debus, 1994). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett, 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons, 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons, 1997).	**Moderate** (Previous records within Liverpool Plains [Part B] IBRA sub-bioregion)

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Anthochaera phrygia	Regent Honeyeater	CE	E	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. This species population has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests.	Low
Chthonicola sagittata	Speckled Warbler	V	-	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	**Known** (current study, Cenwest Environmental Services 2011)
Circus assimilis	Spotted Harrier	V	-	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	**Moderate** (Eight previous records within Liverpool Plains [Part B] IBRA sub-bioregion)
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Spotted-tailed Quolls are found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.	**Moderate** (18 previous records within the Liverpool Plains [Part B] IBRA sub-bioregion)
Lophoictinia isura	Square-tailed Kite	V	-	This species typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993). In NSW it is often associated with ridge and gully forests dominated by Wollybutt (*Eucalyptus longifolia*), Spotted Gum (*Corymbia maculata*), River Peppermint (*E. elata*) or Ironbark Perppermint (*E. smithii*). Individuals appear to occupy large hunting ranges of more than 100 square kilometres. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993).	**Moderate** (Previously recorded at Tarrawonga mine-site, 10 km to the north)

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Geophaps scripta	Squatter Pigeon	E	V	The Squatter Pigeon (southern) occurs mainly in grassy woodlands and open forests that are dominated by eucalypts. It has also been recorded in sown grasslands with scattered remnant trees, disturbed habitats (i.e. around stockyards, along roads and railways, and around settlements), acacia growth and remains common in heavily-grazed country north of the Tropic of Capricorn. The species is commonly observed in habitats that are located close to bodies of water. In New South Wales, the Squatter Pigeon (southern) is thought to have formerly occurred in sites that, today, consist of eucalypt woodlands that are intersected with patches of acacia and stands of cypress pine and that have a ground cover of grasses and herbs.	Low
Petaurus norfolcensis	Squirrel Glider	V	-	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range (Suckling 1995). Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Quin 1995). There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps (Gibbons and Lindenmayer 1997). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al* 1988). Endangered population in the Wagga Wagga Local Government Area.	**Known** (Cenwest Environmental Services 2011)
Polytelis swainsonii	Superb Parrot	V	V	The Superb Parrot is found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. Inhabits Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest.	**Moderate** (Two previous records within the Liverpool Plains [Part B] IBRA sub-bioregion)
Lathamus discolor	Swift Parrot	E	E	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey 1997).	Low
Neophema pulchella	Turquoise Parrot	V	-	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	**Known** (Cenwest Environmental Services 2011, OEH, 2012a)

Scientific Name	Common Name	Conservation Status[1]		Habitat	Likelihood of Occurrence
		TSC Act	EPBC Act		
Daphoenositta chrysoptera	Varied Sittella	V	-	Inhabits wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy ground cover or both, in all climatic zones of Australia (Higgins and Peter 2002). Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature eucalypts with hollows.	**Known** (Cenwest Environmental Services 2011)
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	**Known** (possibly recorded during the current study, Cenwest Environmental Services 2011, OEH, 2012a)

[1] Threatened fauna species/population status under the TSC Act and/or EPBC Act (current at 23 August 2012).
V = Vulnerable, E = Endangered, EP = Endangered Population, CE = Critically Endangered.

Appendix G: Fauna Recorded from the Study Area

Family	Common Name	Scientific Name	Detection Method	Conservation Status[1]	
				TSC Act	EPBC Act
Fish					
Poeciliidae	Mosquitofish	*Gambusia holbrooki*		-	-
Amphibians					
Myobatrachidae	Long-thumbed Frog	*Limnodynastes fletcheri*	W	-	-
	Ornate Burrowing Frog	*Limnodynastes ornatus*	W	-	-
	Spotted Grass Frog	*Limnodynastes tasmaniensis*	W	-	-
	Crucifix Toad	*Notaden bennettii*	W	-	-
	Wrinkled Toadlet	*Uperoleia rugosa*	W	-	-
Hylidae	Water-holding Frog	*Cyclorana platycephala*	W	-	-
	Green Tree Frog	*Litoria caerulea*	O	-	-
	Broad-palmed Frog	*Litoria latopalmata*	O	-	-
	Peron's Tree Frog	*Litoria peronii*	O	-	-
	Desert Tree Frog	*Litoria rubella*	W	-	-
Reptiles					
Gekkonidae	Thick-tailed Gecko	*Underwoodisaurus milii*	O	-	-
Scincidae	Robust Ctenotus	*Ctenotus robustus*	O	-	-
	Copper-tailed Skink	*Ctenotus taeniolatus*	O	-	-
	Tree Skink	*Egernia striolata*	O	-	-
Agamidae	Jacky Lizard	*Amphibolurus muricatus*	O	-	-
	Bearded Dragon	*Pogona barbata*	O	-	-

Family	Common Name	Scientific Name	Detection Method	Conservation Status[1]	
				TSC Act	EPBC Act
Birds					
Phasianidae	Brown Quail	*Coturnix ypsilophora*	O	-	-
Anatidae	Plumed Whistling-Duck	*Dendrocygna eytoni*	O	-	-
	Black Swan	*Cygnus atratus*	O	-	-
	Australian Wood Duck	*Chenonetta jubata*	O	-	-
	Pacific Black Duck	*Anas superciliosa*	O	-	-
	Grey Teal	*Anas gracilis*	O	-	-
	Hardhead	*Aythya australis*	O	-	-
Podicipedidae	Australasian Grebe	*Tachybaptus novaehollandiae*	O	-	-
	Great Crested Grebe	*Podiceps cristatus*	O	-	-
Threskiornithidae	Australian White Ibis	*Threskiornis molucca*	O	-	-
	Straw-necked Ibis	*Threskiornis spinicollis*	O	-	-
	Yellow-billed Spoonbill	*Platalea flavipes*	O	-	-
Ardeidae	White-necked Heron	*Ardea pacifica*	O	-	-
	Great Egret	*Ardea modesta*	O	-	M
	White-faced Heron	*Egretta novaehollandiae*	O	-	-
Anhingidae	Darter	*Anhinga melanogaster*	O	-	-
Falconidae	Australian Kestrel	*Falco cenchroides*	O	-	-
	Australian Hobby	*Falco longipennis*	O	-	-
	Brown Falcon	*Falco berigora*	O	-	-
	Grey Falcon	*Falco hypoleucos*	O	-	-

Family	Common Name	Scientific Name	Detection Method	Conservation Status[1]	
				TSC Act	EPBC Act
Accipitridae	Wedge-tailed Eagle	*Aquila audax*	O	-	-
Rallidae	Eurasian Coot	*Fulica atra*	O	-	-
Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	O	-	-
Charadriidae	Masked Lapwing	*Vanellus miles*	O	-	-
	Black-fronted Dotterel	*Elseyornis melanops*	O	-	-
Columbidae	Common Bronzewing	*Phaps chalcoptera*	O	-	-
	Crested Pigeon	*Ocyphaps lophotes*	O	-	-
	Peaceful Dove	*Geopelia placida*	O	-	-
	Bar-shouldered Dove	*Geopelia humeralis*	O	-	-
Psittacidae	Galah	*Eolophus rosicapilla*	O	-	-
	Little Corella	*Cacatua sanguine*	O	-	-
	Sulphur-crested Cockatoo	*Cacatua galerita*	O	-	-
	Cockatiel	*Nymphicus hollandicus*	O	-	-
	Eastern Rosella	*Platycercus adscitus*	O	-	-
	Blue Bonnet	*Northiella haematogaster*	O	-	-
	Red-rumped Parrot	*Psephotus haematonotus*	O	-	-
	Bourke's Parrot	*Neopsephotus bourkii*	O	-	-
	Australian King-Parrot	*Alisterus scapularis*	O	-	-
Cuculidae	Black-eared Cuckoo	*Chalcites osculans*	O	-	-
	Channel-billed Cuckoo	*Scythrops novaehollandiae*	O	-	-
Strigidae	Southern Boobook	*Ninox novaeseelandiae*	W	-	-

Family	Common Name	Scientific Name	Detection Method	Conservation Status[1]	
				TSC Act	EPBC Act
Podargidae	Tawny Frogmouth	*Podargus strigoides*	O	-	-
Aegothelidae	Australian Owlet-nightjar	*Aegotheles cristatus*	W	-	-
Apodidae	White-throated Needletail	*Hirundapus caudacutus*	O	-	M
Coraciidae	Dollarbird	*Eurystomus orientalis*	O	-	-
Alcedinidae	Laughing Kookaburra	*Dacelo novaeguineae*	O	-	-
Climacteridae	White-throated Treecreeper	*Cormobates leucophaea*	O	-	-
Maluridae	Superb Fairy-wren	*Malurus cyaneus*	O	-	-
Pardalotidae	Striated Pardalote	*Pardalotus striatus*	O	-	-
Acanthizidae	Speckled Warbler	*Chthonicola sagittata*	O	V	-
	Weebill	*Smicrornis brevirostris*	O	-	-
	Brown Thornbill	*Acanthiza pusilla*	O	-	-
	Chestnut-rumped Thornbill	*Acanthiza uropygialis*	O	-	-
	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	O	-	-
Meliphagidae	White-plumed Honeyeater	*Lichenostomus penicillatus*	O	-	-
	Noisy Miner	*Manorina melanocephala*	O	-	-
	Little Friarbird	*Philemon citreogularis*	O	-	-
	Noisy Friarbird	*Philemon corniculatus*	O	-	-
	Striped Honeyeater	*Plectorhyncha lanceolata*	W	-	-
	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	O	-	-
	Red Wattlebird	*Anthochaera carunculata*	O	-	-
Petroicidae	Eastern Yellow Robin	*Eopsaltria australis*	O	-	-

Family	Common Name	Scientific Name	Detection Method	Conservation Status[1]	
				TSC Act	EPBC Act
	Red-capped Robin	*Petroica goodenovii*	O	-	-
Pomatostomidae	Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	O	V	-
Pachycephalidae	Rufous Whistler	*Pachycephala rufiventris*	O	-	-
	Grey Shrike-thrush	*Colluricincla harmonica*	O	-	-
Dicruridae	Grey Fantail	*Rhipidura albiscapa*	O	-	-
	Willie Wagtail	*Rhipidura leucophrys*	O	-	-
	Magpie-lark	*Grallina cyanoleuca*	O	-	-
	Restless Flycatcher	*Myiagra inquieta*	O	-	-
Artamidae	Grey Butcherbird	*Cracticus torquatus*	O	-	-
	Pied Butcherbird	*Cracticus nigrogularis*	O	-	-
	Australian Magpie	*Gymnorhina tibicen*	O	-	-
	Pied Currawong	*Strepera graculina*	O	-	-
	White-browed Woodswallow	*Artamus leucorynchus*	O	-	-
	Dusky Woodswallow	*Artamus cyanopterus*	O	-	-
Campephagidae	White-bellied Cuckoo-shrike	*Coracina papuensis*	O	-	-
	White-winged Triller	*Lalage tricolor*	O	-	-
Corvidae	Australian Raven	*Corvus coronoides*	O	-	-
Corcoracidae	White-winged Chough	*Corcorax melanorhamphos*	O	-	-
	Apostlebird	*Struthidea cinerea*	O	-	-
Sturnidae	Common Starling*	*Sturnus vulgaris*	O	-	-
	Common Myna*	*Arridotherses tristis*	O	-	-

Family	Common Name	Scientific Name	Detection Method	Conservation Status[1]	
				TSC Act	EPBC Act
Hirundinidae	Welcome Swallow	*Hirundo neoxena*	O	-	-
	Fairy Martin	*Petrochelidon ariel*	O	-	-
Zosteropidae	Silvereye	*Zosterops lateralis*	O	-	-
Dicaeidae	Mistletoebird	*Dicaeum hirundinaceum*	O	-	-
Motacillidae	Australasian Pipit	*Anthus australis*	O	-	-
Estrildidae	**Diamond Firetail**	***Stagonopleura guttata***	O	V	-
Mammals					
Tachyglossidae	Short-beaked Echidna	*Tachyglossus aculeatus*	O	-	-
Phalangeridae	Common Brushtail Possum	*Trichosurus vulpecula*	O,H	-	-
Macropodidae	Eastern Grey Kangaroo	*Macropus giganteus*	O	-	-
	Euro	*Macropus robustus*	O	-	-
	Red-necked Wallaby	*Macropus rufogriseus*	O	-	-
Emballonuridae	**Yellow-bellied Sheathtail-bat**	***Saccolaimus flaviventris***	A(Po)	V	-
Molossidae	Inland Freetail-bat	*Mormopterus* sp. 3	A(D)	-	-
	Southern Freetail-bat	*Mormopterus planiceps*	A(D)	-	-
	White-striped Freetail-bat	*Tadarida australis*	A(D)	-	-
Vespertilionidae	**Eastern Bentwing-bat**	***Miniopterus schreibersii oceanensis***	A(Pr)	V	-
	Long-eared Bat	*Nyctophilus* sp.	A(D)	-	-
	Large-eared Pied Bat	***Chalinolobus dwyeri***	A(Po)	V	-
	Gould's Wattled Bat	*Chalinolobus gouldii*	A(D)	-	-
	Chocolate Wattled Bat	*Chalinolobus morio*	A(Po)	-	-

Family	Common Name	Scientific Name	Detection Method	Conservation Status[1]	
				TSC Act	EPBC Act
	Inland Broad-nosed Bat	*Scotorepens balstoni*	A(D)	-	-
	Little Broad-nosed Bat/ Central-eastern Broad-nosed Bat (calls indistinguishable)	*Scotorepens greyii/Scotorepens* sp.	A	-	-
	Little Forest Bat	*Vespadelus vulturnus*	A(D)	-	-
Muridae	Rat	*Rattus* sp.	H	-	-
Canidae	Domestic Dog*	*Canis lupus familiaris*	O	-	-
	Red Fox*	*Vulpes vulpes*	O	-	-
Felidae	Cat*	*Felis catus*	O	-	-
Leporidae	Brown Hare*	*Lepus capensis*	O	-	-
	Rabbit*	*Oryctolagus cuniculus*	O	-	-
Suidae	Pig*	*Sus scrofa*	O	-	-
Bovidae	European Cattle*	*Bos Taurus*	O	-	-
	Goat*	*Capra hircus*	O	-	-

[1] Threatened fauna species status under the TSC Act and/or EPBC Act (current at 23 August 2012).
V=Vulnerable, E=Endangered, M=Migratory.

Note: Nomenclature consistent with Commonwealth Scientific and Industrial Research Organisation (2006) *CSIRO List of Australian Vertebrates: A Reference with Conservation Status.*

Key: O=observed; W=heard; H=hair analysis; A=Anabat recording (D=definite; Pr=Probable; Po=possible).

* Introduced species.

Appendix H: Aquatic Assessment (CoastEcology)

NICHE EH

Vickery Coal Project

Aquatic Assessment

Job No: 120221
Date: 2 November 2012

COAST ECOLOGY

Environmental Assessment

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Aquatic Assessment, Whitehaven Coal Mining Pty Ltd

Issue	Date	Description	Author	Reviewed By
A	05/06/2012	Draft	KM	Rhidian Harrington (Niche)
B	11/06/2012	Final	KM	Rhidian Harrington (Niche)
C	19/06/2012	Final	KM	Resource Strategies
D	03/07/2012	Final	KM	Resource Strategies
E	06/07/2012	Final	KM	Resource Strategies
F	09/07/2012	Final	KM	Resource Strategies
G	06/09/2012	Final	KM	Resource Strategies

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Executive Summary

Coast Ecology was engaged by Niche Environment and Heritage Pty Ltd, on behalf of Whitehaven Coal Mining Pty Ltd (Whitehaven), to prepare an aquatic assessment of the proposed Vickery Coal Project (the Project). The Study Area covers an area of approximately 2,605 hectares north of Gunnedah, adjacent to the Vickery State Forest.

A habitat assessment and aquatic survey (macroinvertebrates, amphibians and fish) was undertaken on 29 February and 1 March 2012, along with a desktop study.

The Study Area contains a number of first and second order drainage lines, although none are named watercourses and most are low lying areas with no defined channel or creek bed. Only two of the drainage lines in the Study Area contained potential aquatic habitat suitable for sampling.

Three threatened species listed under the Fisheries Management Act (FM Act) have previously been recorded in the Namoi Catchment Management Authority (CMA): Eel-tailed Catfish endangered population; Murray Hardyhead and Silver Perch. Murray Cod is listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act, 1999* and has also been recorded previously in the Namoi CMA. Following habitat assessments, one endangered population (Eel-tailed Catfish) and one endangered ecological community (EEC) Lowland Darling River EEC, were considered to have potential habitat within the Study Area. An assessment of significance of impact pursuant to the FM Act concluded that the proposal was unlikely to have a significant impact on the endangered population and EEC with potential habitat in the Study Area. Other listed threatened aquatic species did not have potential habitat within the Study Area due to a lack of specific habitat requirements for some species, and the highly ephemeral nature of the creeks located in the Study Area. No threatened species were recorded during surveys.

Of the physiochemical data recorded from each site, DO%, pH, NO_X, TN and PO^-_4 (FRP-filterable reactive phosphate) were outside of the recommended guidelines (for slightly disturbed upland rivers in south-east Australia; Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) for both North Creek and South Creek (with one exception). Macroinvertebrate sampling recorded one or two taxa that have sensitivity to pollution, however the overall Stream Invertebrate Grade Number – Average Level (SIGNAL) scores for each creek line was low, indicating a dominance of pollution tolerant macroinvertebrates. The Ephemeropta, Plecoptera and Tricoptera group of macroinvertebrates were poorly represented at both sample locations. Only the exotic Eastern Gambusia (*Gambusia holbrooki*) and large numbers of Green Tree Frog (*Litoria caerulea*) tadpoles were collected from bait traps and dip netting.

Based on physiochemical data, macroinvertebrate assemblages and the absence of native fish, the creek lines within the Study Area were classed as being in poor health with limited aquatic habitat opportunities.

Assuming appropriate erosion and sediment control measures are put in place (preventing surface flows to the Namoi River) and based on advice that the Project will not result in significant drawdown of the Namoi River or groundwater impacts, it is considered that the Project will be unlikely to have a significant impact to the aquatic environment of the Namoi River system.

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1.0 Introduction

1.1 Background

Whitehaven Coal Mining Pty Ltd (Whitehaven) proposes to expand their open cut coal mining operations into approximately 2,605 hectares (ha) of land north of Gunnedah, adjacent to Vickery State Forest, known as the Vickery Coal Project (the Project).

During previous site assessment by Niche Environment and Heritage Pty Ltd (Niche), the unnamed drainage lines across the Study Area (the Project area and immediate surrounds) were observed to be dry, although following heavy rainfall in February 2012, two drainage lines within the Study Area were reportedly holding water (hereafter referred to as South Creek and North Creek) (Niche, 2012). Subsequently, an aquatic survey (macroinvertebrates, amphibians and fish) was undertaken on 29 February and 1 March 2012. Surveys were undertaken two weeks prior to the commencement of the recommended Australian River Assessment System (AUSRIVAS) sampling period for macroinvertebrates as there was concern that the creeks would dry out prior to the AUSRIVAS sampling period beginning. No other areas of potential aquatic habitat that warranted sampling were identified within the Study Area.

1.2 Objectives

The objectives were to:

- assess the water quality and condition of two ephemeral creeks (North Creek and South Creek) within the Study Area;
- undertake macroinvertebrate survey and assess taxa richness, (Ephemeropta, Plecoptera and Tricoptera (EPT) richness and EPT ratio and Stream Invertebrate Grade Number – Average Level (SIGNAL) site score;
- undertake amphibian (tadpole) surveys using bait traps, opportunistic observation and sweep netting (undertaken as part of macroinvertebrate sampling) to gain an understanding of amphibian distribution in these ephemeral systems following rainfall; and
- undertake fish surveys using bait traps to gain an understanding of fish fauna present in these ephemeral systems following rainfall.

1.3 Project

The development of the Project (Figure 2) would consist of the open pit, with an eastern and western emplacement area either side of the pit. The eastern emplacement area would be located directly east of the main ephemeral creek (South Creek), while the open pit would be located immediately west of this creek (Figure 2).

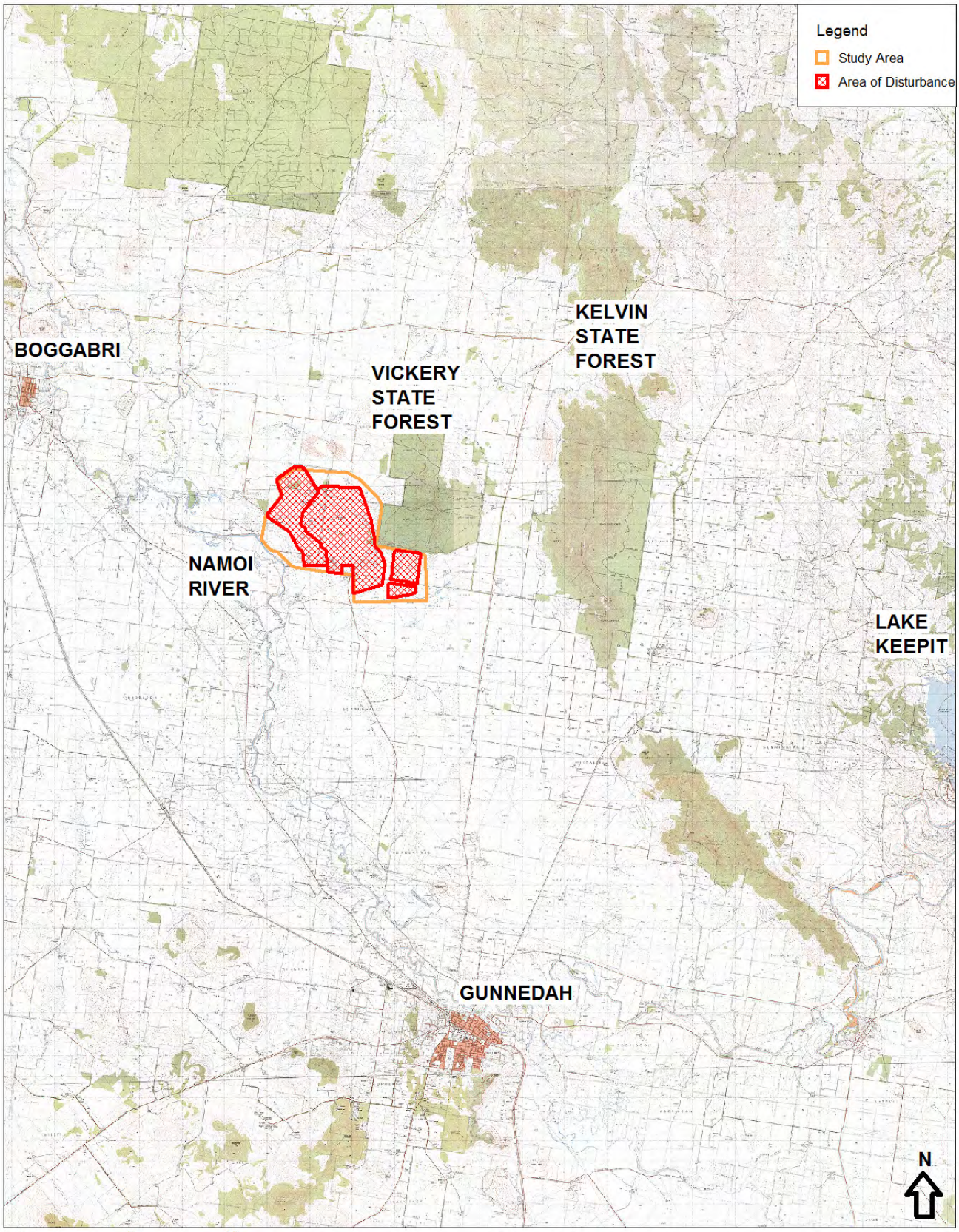

Figure 1. Project Area
Vickery Coal Project Aquatic Assessment (Source: Land and Property Management Authority 1:25,000 Map Series)

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2.0 Site Description

The Namoi River Basin is located west of the Great Dividing Range in northern New South Wales (NSW), forming part of the Barwon-Darling River system. It is bound by the Nandewar Range to the north, the Great Diving Range to the east and the Warrumbungle Range to the south. Extending over 350 kilometres (km) from the head of the McDonald River westward to Walgett, the basin covers some 43,000 square kilometres (km^2) (Snowy Mountain Engineering Company, 2003). The catchments of the Mooki River, Coxs Creek and the Namoi River between Keepit Dam and Boggabri form the region known as the Liverpool Plains. The Namoi River has a catchment area of 17,000 km^2 at the town of Gunnedah.

The Study Area is located approximately 25 km north of Gunnedah and approximately 13 km east of Boggabri in the Gunnedah Basin, NSW (Figure 1). The Study Area is bound in the north-east by Vickery State Forest, the Namoi River to the south-west, with farmland surrounding the Project (Figure 1). Whitehaven owns the land that is the subject of this assessment.

A number of first and second order drainage lines traverse the Study Area (Figure 1), however none are named watercourses and most are low lying areas with no defined channel or creek bed. The drainage lines are ephemeral, only holding water following flooding events (as occurred in February 2012). Only two of the drainage lines within the Study Area had any water available for sampling. The others were considered not suitable for sampling and contained limited aquatic habitat.

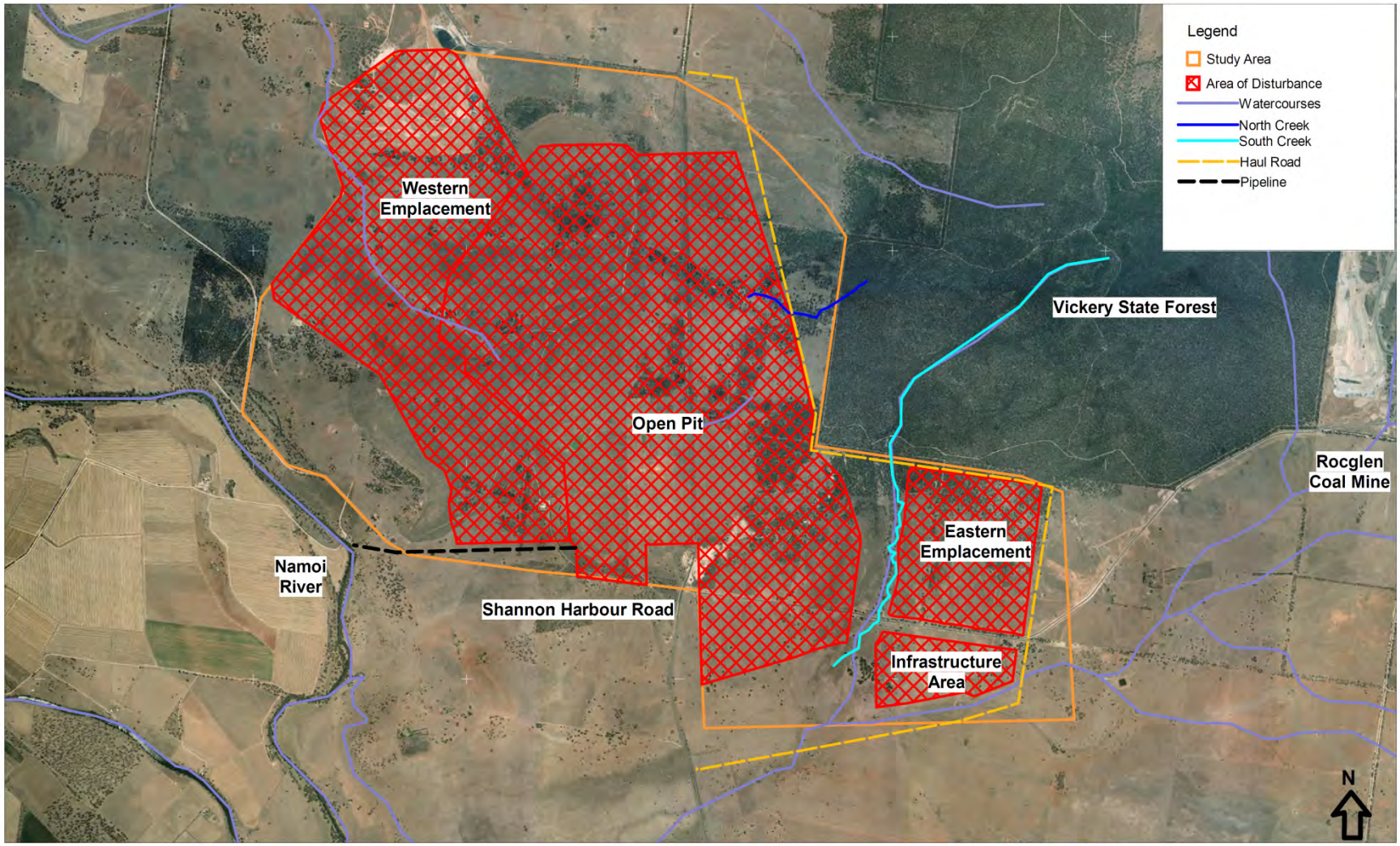
The Study Area covers an area of approximately 2,605 ha consisting mostly of grassland, but with derived woodlands adjacent to Vickery State Forest and along the drainage lines. The south-east section of the Study Area is mostly grassland on floodplains. Within this agricultural landscape, there are trees lining some of the drainage lines and scattered throughout the Study Area. The lower stratum vegetation is dominated by grasses, including many exotic species. Approximately 34 farm dams and an old mine diversion dam containing water were scattered across the Study Area and ranged in size from 0.03 to 2.0 ha. The largest dam (mine diversion dam), which was located in the central southern area of the Study Area, approximately 200 metres (m) east of Bluevale Road, provided the best habitat as it had small areas of fringing macrophytic vegetation. Most of the dams are surrounded by agricultural or rehabilitated land that is dominated by grasslands with some scattered trees present.

The two ephemeral creeks (North Creek and South Creek) investigated as part of this aquatic assessment (Figure 2) had a defined channel, albeit shallow, and were slow flowing and lacked significant habitat features such as pools, snags or reed beds. There were riffle sections, however at the time of survey, there was insufficient water flowing over these sections to provide good quality aquatic habitat. Following substantial rainfall, water flowing across the Study Area eventually flows into the Namoi River. However, during times of little rainfall, isolated pools are cut off from the main river system, and eventually dry up.

Although the Study Area falls just outside the northern boundary of the Carroll to Boggabri Floodplain Management Plan area (Department of Natural Resources [DNR], 2006), some parts of the Study Area are characterised by floodplains. The recharging and flushing of floodplains following heavy rainfall allows fish movement in and out of floodplain habitats. Some species of fish, such as Silver Perch (*Bidyanus bidyanus*), Golden Perch (*Macquaria ambigua*), Bony Herring (*Nematalosa erebi*) and Spangled Perch (*Leiopotherapon unicolour*), can spawn on the inundated floodplain and its channels and once hatched, the pelagic larvae develop rapidly. Successful fish recruitment is greatly enhanced by flood conditions (NSW Department of Primary Industries [DPI], 1999).

2.1 Weather and Survey Timing

Aquatic surveys were undertaken from 29 February to 1 March, 2012. As discussed, the creeks sampled within the Study Area are highly ephemeral, flowing only after substantial rainfall. Gunnedah experienced high rainfall in January and February 2012 (102.0 millimetres [mm] and 177.4 mm respectively) compared to the average for January and February (71.3mm and 66.5 mm respectively: recorded from Gunnedah Pool: Bureau of Meteorology [BOM], 2012a). February 2012 was Gunnedah's wettest February since 1971. The high rainfall that has been experienced in various locations across NSW in 2011 and the beginning of 2012 are associated with the impacts of La Niña events and have resulted in several flooding events across the state (BOM, 2012b). The weather at the time of sampling was warm and mostly sunny with light winds (Table 1).



Coast Ecology

0 1,000 2,000
metres

Figure 2. Project Layout
Vickery Coal Project Aquatic Assessment
(Source: Google Earth)

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Table 1. Weather Conditions during Sampling Events

Date	Max T (˚C)	Min T (˚C)	24 hr sunrise	24 hr sunset	Rainfall (mm)	Wind	Comments
29/02/12	16.8	31.6	06:18	19:04	0	9.00 am Calm 3.00 pm 20 km/hr north-northwest	Warm, mostly sunny day, calm winds in the morning increasing in the afternoon
01/03/12	16.5	31.8	06:19	19:03	0	9.00 am Calm 3.00 pm 30 km/hr north-northwest	Warm, mostly sunny day, calm winds in the morning increasing in the afternoon

Source: Gunnedah Airport/Gunnedah Soil Conservation Service (BOM, 2012a).

3.0 Methods

Prior to undertaking field surveys, database searches were conducted for threatened species previously recorded in the local area or Namoi Catchment Management Area (CMA) so that these threatened species and their habitat requirements could be assessed.

3.1 Database Searches

The following database searches were conducted on 28 February 2012:

- Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) Protected Matters Search Tool for Matters of National Environmental Significance (NES) listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)(SEWPaC, 2012);
- The DPI record viewer for threatened species listed under the *Fisheries Management Act, 1994* (FM Act) (DPI, 2012a); and
- The Office of Environment and Heritage (OEH) Wildlife Atlas was not searched for records of threatened aquatic species as these are covered by the FM Act and are listed on the DPI records viewer.

3.2 Habitat Assessment

During the site inspection, an assessment of the habitat potential of the two creeks was undertaken. A description of each creek is provided below. Only two of the drainage lines present within the Study Area were sampled due to others having no suitable habitat for sampling and containing no to very poor aquatic habitat.

3.2.1 South Creek

South Creek is an ephemeral drainage line approximately 5.4 km in length, which runs north to south through the south-east portion of the Study Area (Figure 2). It is usually dry, running only after heavy rainfall (Plate 1). As discussed in Section 2.1, the region experienced the highest monthly rainfall in over 40 years, which resulted in the presence of flowing creeks, but still only limited pooling of water within the Study Area occurred. At the time of the surveys flows were low and sections of the Creek had stopped flowing (Plate 2). The few remaining pools had limited flow and were becoming lentic environments.

The catchment of South Creek is immediately upstream of the Study Area and entirely contained within Vickery State Forest. The left and right bank of South Creek within the Study Area is characterised by pasture, with grazing cattle accessing the creek along its length.

The creek bed consisted largely of gravel and peddles with some cobbles, with an increased percentage of the sand content in the pools. The average width of the creek was 1 m, with a mode depth (the most common depth found within the habitat at the site) of approximately 100 mm. Three areas of pooling were observed along South Creek, the deepest pool being associated with a road culvert and had a depth of approximately 1 m.

The instream vegetation consisted of native and exotic grasses/shrubs although some macrophyte vegetation such as Rush (*Juncus* sp.), Sedge (*Cyperus* sp., *Eleocharis* sp.) and Mat-rush (*Lomandra* sp.) were observed. Riparian vegetation consisted of native and exotic grass, with scattered trees dominated by White Cypress Pine (*Callitris glaucophylla*), with occasional occurrences of Eucalypt spp. There was little trailing bank vegetation or bank overhang.

Plate 1 shows a typical section of South Creek within the Study Area. Further upstream within the Study Area, the creek dries out (Plate 2). There were only three areas where water had pooled within the Study Area (Plates 3 - 5). In general, the creek line did not contain suitable habitat for sampling fish or macroinvertebrates as there was insufficient depth, hence only one pool associated with the road culvert was sampled. A visual assessment of disturbance related to human activities (following AUSRIVAS protocol) indicated that there was little disturbance to the water quality, based on infrequent observations of oily films and foam. Visual assessment of the instream habitat indicated a moderate level of disturbance based on sediment deposits and exotic weed species in the creek bed, while the riparian vegetation was described as highly disturbed due to the high level of weed invasion and the absence of a riparian zone in many areas.

Plate 1. Typical view of South Creek

Plate 2. South Creek was dry in the northern portion of the Study Area

Plate 3. South Creek - pooled water on the southern side of the road (Bait Trap 1)

Plate 4. South Creek - pooled water on the northern side of road (Macroinvertebrate Sample 1 and Bait Trap 2).

Plate 5. South Creek - pond 20 m upstream of the road (Bait Trap 3)

3.2.2 North Creek

The bed of North Creek is approximately 1.3 km in length and it flows from east to west across the central-eastern portion of the Study Area. This ephemeral creek is more temporary in nature in comparison with South Creek, and again, is only present following heavy rainfall as experienced in February 2012.

The creek is a shallow depression through pasture land (Plate 6), its bed consisting of paddock grasses and weeds. As with South Creek, the catchment of North Creek immediately upstream of the Study Area is contained wholly within Vickery State Forest. The left and right bank of the creek within the Study Area is characterised by pasture and scattered regenerating trees, with grazing cattle accessing the creek along its length.

The average width of the creek is 0.5 m, with a mode depth of 100 mm. There was only one area of pooled water within the Study Area at the time of sampling, the depth of this pool being approximately 600 mm (Plate 7). The bed in the pool consisted mainly of gravel and sand. Trees were present in low density, consisting mainly of White Cypress Pine (*Callitris glaucophylla*), with occasional occurrences of Eucalypt spp. As the Creek is ephemeral, the macrophyte vegetation also consisted of exotic and native weeds and grasses. There were limited macrophyte species observed along this creek.

A visual assessment of disturbance related to human activities (following AUSRIVAS protocol) indicated that the water quality had a moderate level of disturbance based on a brown colouration of the water. A visual assessment of the instream habitat and riparian zone indicated a high level of disturbance, mainly due to the presence of exotics and the proximity of grazing of cattle.

Plate 6. Typical section of North Creek

Plate 7. Pond on North Creek (Macroinvertebrate Sample 2 collected here)

3.3 Sample locations

Macroinvertebrate sampling was conducted at one location within each of the two creeks where sufficient water was present and bait traps were deployed at three locations in South Creek. The grid coordinates for each sample location are provided in Table 2 and shown in Figure 3.

Table 2. Co-ordinate Locations of Sampling Sites

Location	Site	Eastings	Northings	Description
South Creek	Macroinvertebrates	233830	6590585	Macroinvertebrate sampling was conducted in a pool on the northern side of Shannon Harbour Road near the culvert (Plate 4).
	Bait Trap 1	233820	6590532	Bait trap A was located immediately adjoining the culvert on the southern side of Shannon Harbour Road in a shallow pool (500 mm deep; Plate 3).
	Bait Trap 2	233829	6590588	Bait trap B was located in the same pool as macroinvertebrate sampling (Plate 4).
	Bait Trap 3	233847	6590631	Bait trap C was located within a pool approximately 20 m north of bait trap B (Plate 5).
North Creek	Macroinvertebrates	232658	6593607	Macroinvertebrate sampling was conducted at the end of North Creek where an artificial bank had created a deeper section (Plate 7). There were no areas suitable for deployment of bait traps due to insufficient water depth for trap placement and the high density of tadpoles which have prevented successful fish trapping.

3.4 Water Quality Assessment

The following water quality parameters were measured at each sample site (three replicate measures) using a Yeokal 611 probe:

- temperature (°C);
- conductivity (microSiemens per centimetre [µS/cm]);
- pH;
- dissolved oxygen (DO milligrams per litre [mg/L]); and
- turbidity (Nephelometric Turbidity Units [NTU]).

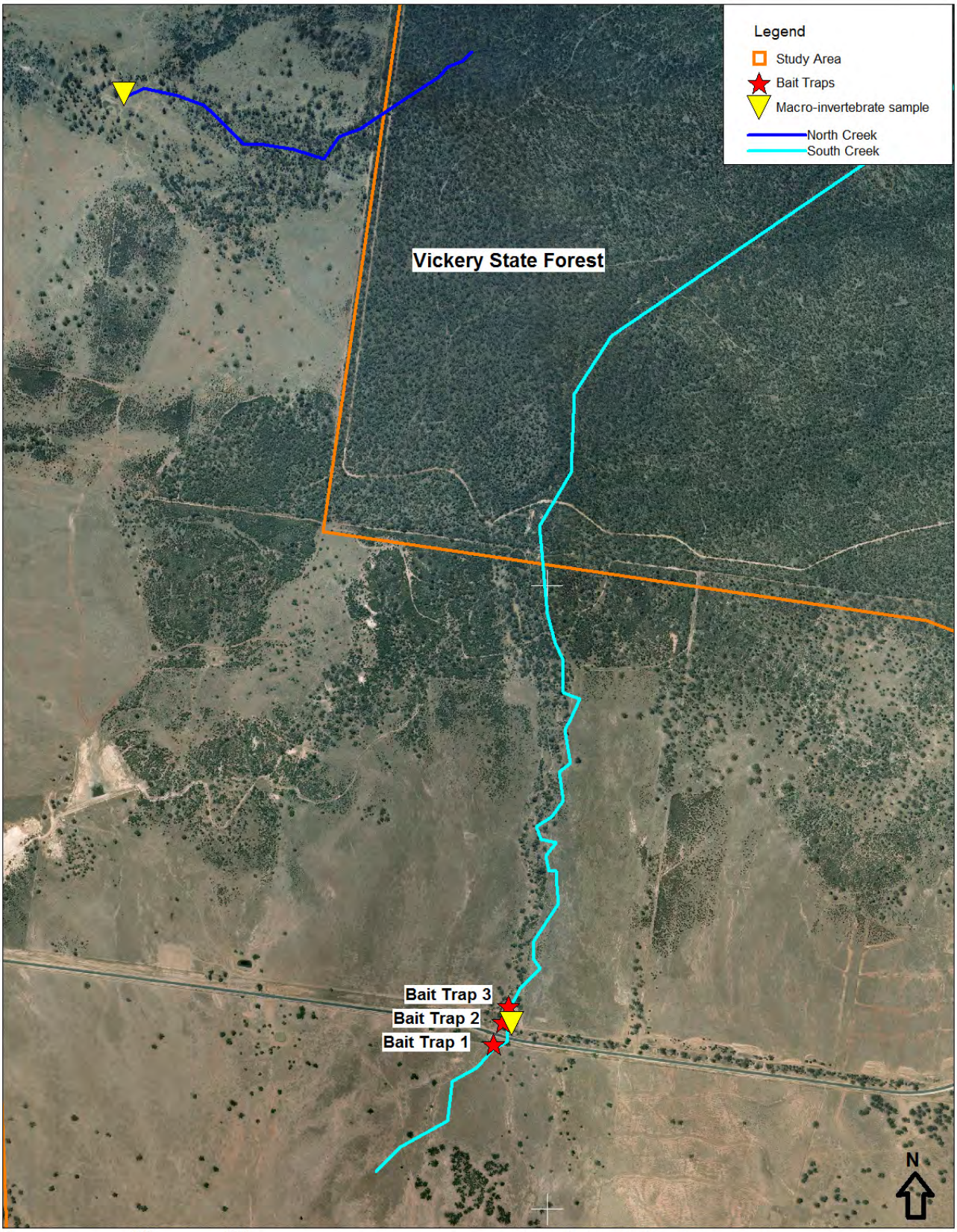

Figure 3. Aquatic Sample Locations
Vickery Coal Project Aquatic Assessment
(Source: Google Earth)

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Alkalinity was measured using a hand held titration cell for titrimetric analysis, while Phosphate (PO_4^- parts per million [ppm]) and Nitrate/nitrite (NO_3/NO_2 ppm) were sampled using pre-treated bottles which were stored on ice and sent on the day of collection to be analysed by a National Association of Testing Authorities Australia (NATA) accredited laboratory.

Water quality data is compared with the Australian and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) default trigger values for physical and chemical stressors for protection of upland rivers in southeast Australia. These default values relate to slightly disturbed ecosystems (ANZECC and ARMCANZ, 2000). The pools sampled are non-flowing ponds and no data is available for such ecosystems, thus care must be taken in the interpretation of results when comparing values to the ANZECC guidelines.

3.5 Macroinvertebrate Survey

One macroinvertebrate sample was collected from each creek. Site selection was limited to areas containing sufficient depth for sampling.

The AUSRIVAS sampling assessment sheets were used at each site. AUSRIVAS is a rapid assessment methodology for assessing river health using predictive models based on biological samples (macroinvertebrates) and environmental data collected from a river site. However, not all creeks within NSW fall within the models parameters.

The suitability of locations within the Study Area for a strictly AUSRIVAS approach to macroinvertebrate sampling was limited due to the ephemeral nature of the creeks. Using AUSRIVAS models, it is preferable to sample from both riffle and edge habitats. A riffle habitat is an area of broken water with rapid current that has some cobble or boulder substratum. Edge habitat is an area along the creek bank with little or no flow. Suitable areas for sampling edge habitats include an alcove or backwater with abundant benthic leaf-litter, fine organic/silt deposits, macrophyte beds, overhanging banks and areas with trailing bank vegetation. These areas are often indicated by the presence of surface-dwelling insects (Turak et al, 2004).

Although riffle sections were present along both creeks, there was insufficient water depth for sampling. Similarly, there were limited areas in each creek for sampling edge habitat due to a lack of water depth and hence, areas of pooled water were the only available edge habitat for macroinvertebrate sampling.

Macroinvertebrates were collected from edge habitat at both locations following AUSRIVAS protocol for collection and processing. Samples were live picked in the field and preserved in 70% ethanol. Macroinvertebrates were then identified in the laboratory to family or sub-order level.

3.5.1 Macroinvertebrate Data Analysis

A number of analyses were performed on the data to indicate stream health and aquatic macroinvertebrate diversity.

The SIGNAL score is a biotic index of pollution tolerance or sensitivity within that taxonomic group. A grade 10 indicates a high sensitivity to pollution. A diverse community of high grade taxa indicates a healthy ecosystem. A grade of 1 indicates a greater tolerance of pollution. A community with high numbers of a few low grade taxa indicates a degraded aquatic habitat (Chessman, 2003). To calculate the SIGNAL score, each type of macroinvertebrate was first given a SIGNAL grade, which indicates its tolerance or intolerance to pollution. These grades were available from the "Identification and ecology of Australian freshwater invertebrates" website (The Murray-Darling Freshwater Research Centre, 2010).

Secondly, the SIGNAL site score is calculated as the total sum of the SIGNAL grades of the different types of macroinvertebrates collected divided by the total number of different types of macroinvertebrates collected with an available SIGNAL grade.

The EPT index is based on the insect orders that contain a majority of pollution sensitive taxa (Lenat, 1988). All genera of EPT were identified and then the number of distinct taxa counted as an indicator of ecosystem health: the higher the number, the healthier the aquatic ecosystem. The ratio of EPT to the number of taxa was also calculated as another measure of ecosystem health.

3.6 Fish Survey

Although non-specific fish monitoring was conducted using replicated bait trapping, insufficient water depth, meant that bait traps were only able to be deployed at three locations along South Creek. Any fish collected during dip net (250 micrometre mesh) surveys were also identified. Bat traps were baited with a mix of chicken feed and sardines. Fish unable to be identified in the field and released were to be euthanized for later identification.

3.7 Amphibian Survey

Tadpole surveys were conducted in conjunction with the macroinvertebrate and fish surveys. Any tadpoles collected in bait traps or the mesh dip were preserved for later identification if they could not be identified in the field.

4.0 Results

4.1 Database Searches

Database searches of the SEWPaC EPBC Act Protected Matters and DPI record viewer for records under the FM Act, were conducted for the Namoi CMA (Section 3.1). The threatened species results were narrowed down based on habitat requirements and potential to occur within the Study Area.

The SEWPaC EPBC Act Protected Matters search tool (Section 3.1) reported one threatened aquatic fish species (Murray Cod [*Maccullochella peelii*]) (SEWPaC, 2012), while the DPI database (Section 3.1) reported three threatened aquatic species within the Namoi CMA (DPI, 2012a). In addition, an input to Director General Requirements, a letter from DPI (2011) Aquaculture, Conservation and Marine Parks, identified an additional two threatened species from the Border Rivers/Gwydir CMA catchment to the north for inclusion in the assessment along with one Endangered Ecological Community (EEC). A description and habitat requirements of threatened species, populations and communities identified in database searches, and with potential to occur within the Study Area, are provided below and summarised in Table 3.

Table 3 provides a list of all threatened species identified for assessment in Section 4.2. An assessment of the habitat potential of the Study Area for these threatened species is based on the descriptions and habitat requirements discussed above for each species.

4.1.1 Eel-tailed Catfish

The Fisheries Scientific Committee, established under Part 7A of the FM Act, has made a final determination to list the Eel-tailed Catfish (*Tandanus tandanus*) in the Murray/Darling Basin as an Endangered Population in Part 2 Schedule 4 of the FM Act. Excluded from this determination are the listed impoundments; Ben Chifley Dam, Burrendong Dam, Chaffey Dam, Copeton Dam, Keepit Dam, Pindari Dam, Split Rock Dam, Windamere Dam and Wyangala Dam (NSW Fisheries Scientific Committee, 2008).

Eel-tailed Catfish are naturally distributed throughout the Murray-Darling Basin and in the eastern drainages in NSW north of Newcastle. Eel-tailed Catfish numbers in the Murray-Darling Basin have declined due to a range of impacts including invasive species, habitat degradation, cold water pollution and fishing pressures, and are now virtually absent from the Murray, Murrumbidgee and Lachlan catchments.

Table 3. Threatened Species, populations and EEC's recorded within the locality

Scientific Name	Common Name	Status		Source	Habitat Potential
		EPBC Act	FM Act		
Tandanus tandanus	Eel-tailed Catfish	-	EP	DPI, 2011 DPI, 2012a	Possible. The farm dams located within the Study Area provides some habitat potential for this population.
Maccullochella peelii	Murray Cod	V	-	DPI, 2011 SEWPaC, 2012 DPI, 2012a	Unlikely. The habitat of the Study Area is considered sub-optimal for this species as it lacks boulders, undercut banks and overhanging vegetation, it is highly ephemeral and lacks suitable depth to support this species.
Craterocephalus fluviatilis	Murray Hardyhead	E	CE	DPI, 2012a	Unlikely. The Study Area may contain suitable habitat for this species following rainfall, although as the creeks are ephemeral, the habitat is only temporary. As such, it is considered unlikely that a population of such a rare species could survive in this temporary environment
Bidyanus bidyanus	Silver Perch	-	V	DPI, 2011 DPI, 2012a	Unlikely. The Study Area does not contain suitable habitat for this species as it lacks fast-flowing, open waters
Ambassis agassizii	Olive Perchlet	-	EP	DPI, 2011	Unlikely. Not previously recorded in Namoi CMA
Mogurnda adspersa	Purple Spotted Gudgeon	-	E	DPI, 2011	Unlikely. Not previously recorded in Namoi CMA
Lowland Darling River Endangered Ecological Community	Lowland Darling EEC	-	E	DPI, 2011	Likely. Occurs within the defined area of this EEC

Conservation status current as at 20 June 2012.

V = Vulnerable; E = Endangered; EP= Endangered Population; CE = Critically Endangered.

They can grow up to 900 mm and 7 kilograms (kg), although fish over 2 kg are exceptional. Their colour ranges from grey to brown dorsally or laterally, usually mottled with dark brown to black blotching with a whitish underbelly. Larger fish have less mottling and can be greener in colour, fading to white below.

Eel-tailed Catfish build a nest in areas of still water to breed and their reproduction is not temperature reliant. Eel-tailed Catfish feed on zooplankton, small fish, shrimps and insects. Catfish are relatively inactive and do not migrate for spawning, unlike other inland species such as Golden Perch or Murray Cod.

Eel-tailed Catfish is non-migratory and lives in a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons, and although it inhabits flowing streams, it prefers sluggish or still waters. It can be found in clear to turbid waters, and over substrates ranging from mud to gravel and rock. It is rare in natural riverine habitats, but can be found in farm dams throughout inland NSW and southern Queensland. Moderate remnant populations occur in the Macquarie catchment upstream of Warren, the Castlereagh catchment upstream of Mendooran, the Namoi catchment upstream of Wee Waa, the Gwydir catchment upstream of Moree and the Border Rivers catchment upstream of Goondiwindi. It is a benthic species that lives, feeds and breeds near the bottom. It is a carnivore that feeds on crustaceans (mainly yabbies and shrimp), molluscs, aquatic insects and small fish (NSW Fisheries Scientific Committee, 2008).

There have been a number of recorded occurrences of this species within the Namoi catchment, both historical records and recent (2009) records (DPI, 2012a). The habitat of North and South Creek is considered sub-optimal for this species due to its highly ephemeral nature and lack of suitable depth to support this species, however the many farm dams located within the Study Area may provide habitat for this species. An assessment of significance has been included in Appendix A of this report.

4.1.2 Murray Cod

The Murray Cod (*Maccullochella peelii*) has been listed as a vulnerable species under the EPBC Act. The Murray Cod is not listed as threatened in NSW, but is identified as a member of the listed endangered ecological community in the FM Act.

Murray Cod, also referred to as cod or codfish, are a member of the family Percichthyidae and have a relatively large, elongate and deep body. They have small eyes and a short snout, which has a distinct concave profile. The mouth is large with a protruding lower jaw. Murray Cod possess a cream to olive green colour with dark grey to greenish blotches over the head and body. The ventral surface (belly) is generally white in colour. These cod are voracious feeders and predators. Their diet consists of fish, crustaceans, water birds, frogs, turtles and terrestrial animals such as mice and snakes. Murray cod reach a maximum size of about 1.8 m and 113 kg. The majority of Murray Cod caught in recent years have been between 50 and 70 centimetres (cm) in length and weighed less than 10 kg.

Murray Cod were once abundant throughout the Murray-Darling river system, but overfishing and environmental changes have drastically reduced their numbers. The species has been selectively stocked in other river systems in NSW, Victoria and Western Australia, but has generally failed to establish itself in those areas. Murray Cod generally prefer slow flowing, turbid water in streams and rivers, favouring deeper water around boulders, undercut banks, overhanging vegetation and logs. Small numbers are still present in the Nepean River (NSW) and Yarra River (Victoria).

There have been a number of recorded occurrences of this species within the Namoi catchment, both historical records and recent (2009) records (DPI, 2012a). However, the aquatic habitat of the Study Area is considered sub-optimal for this species as it lacks boulders, undercut banks and overhanging vegetation, it is highly ephemeral and lacks suitable depth to support this species.

4.1.3 Murray hardyhead

Murray Hardyhead (*Craterocephalus fluviatilis*) is listed as Endangered in the EPBC Act and Critically Endangered under the FM Act.

Murray hardyhead is a species of small freshwater fish, native to inland parts of south-eastern Australia. They were once widespread and abundant in the Murray and Murrumbidgee river systems in southern NSW and northern Victoria, but they have suffered a serious population decline and now seem to be limited to a few sites, mainly in northern Victoria. There are very few recent records of Murray Hardyhead in NSW (DPI, 2008).

Murray Hardyhead grow to about 72 mm in length. They range from silver to dark gold in colour, with a pale silvery belly and a silver mid-lateral stripe. Their eyes and gill covers are bright silver, and the top of the head and snout are slightly darker. The scales are almost circular, and barely overlap. Murray Hardyhead are similar in appearance to several other closely related species. Small individuals of any of these species can sometimes also be mistaken for Southern Smelts or Eastern Gambusia (DPI, 2008).

Murray Hardyhead live along the edges of slow-flowing lowland rivers, as well as in lakes, billabongs and backwaters. They are often found amongst aquatic weeds, in both fresh and quite saline waters. This species most likely feeds on aquatic insects and crustaceans, and possibly also some plant material. Spawning occurs in the warmer months, from about October to February. The eggs are randomly dispersed amongst aquatic vegetation (DPI, 2008).

There has only been one record of this species in the Namoi CMA from 1976 at Borah Creek (DPI, 2012a). The Study Area may contain suitable habitat for this species following rainfall, although as the creeks are ephemeral, the habitat is only temporary. As such, it is considered unlikely that a population of such a rare species could survive in a temporary environment.

4.1.4 Silver Perch

The Fisheries Scientific Committee, established under Part 7A of FM Act, has made a final determination to list the Silver Perch *(Bidyanus bidyanus*) as a Vulnerable species under Schedule 5.

Silver Perch were once widespread and abundant throughout most of the Murray-Darling river system. They have now declined to low numbers or disappeared from most of their former range. Only one remaining secure and self-sustaining population occurs in NSW in the central Murray River downstream of Yarrawonga weir, as well as several anabranches and tributaries (DPI, 2005).

Silver Perch usually reach 30-40 cm and 0.5-1.5 kg, but have been recorded up to 8 kg. Silver perch are a moderate to large freshwater fish native to the Murray-Darling river system. Silver perch are oval shaped with a small head that can become beak-like in larger fish. The colour can be grey, greenish, gold or silvery, darker on the back and paler on the sides, with a white belly. Juveniles may be mottled with vertical dark bars. Silver perch closely resemble two other Terapontid species found in adjoining drainages of the Murray-Darling system; the Welch's Grunter (*Bidyanus welchi*) and the Barcoo Grunter (*Scortum barcoo*) (DPI, 2005).

Silver Perch seem to prefer fast-flowing, open waters, especially where there are rapids and races. They are omnivorous, feeding on small aquatic insects, molluscs, earthworms and green algae. Males reach sexual maturity at three years of age, when around 25 cm in length, and females at five years, when around 29 cm. Adults migrate upstream in spring and summer to spawn. Juveniles also sometimes move upstream in response to rising water temperatures and levels. Females can shed 300,000 or more semi-buoyant eggs of about 2.75 mm in diameter. The eggs develop in a few days to become feeding larvae that drift downstream (DPI, 2005).

There are some records for this species in the Namoi CMA, the most recent being in the Namoi River in 2005 (DPI, 2012a). The Study Area does not contain suitable habitat for this species as it lacks fast-flowing, open waters.

4.1.5 Olive Perchlet

The western population of the Olive Perchlet (*Ambassis agassizii*) is listed as an endangered population in NSW under the FM Act.

Olive Perchlet are a small native fish that occur in both eastern and western drainages in NSW, but these populations may be genetically distinct.

The western population of the Olive Perchlet was once widespread throughout the Murray-Darling system of South Australia, Victoria, western NSW and southern Queensland. This population has suffered a serious decline and is now found only at a few sites in the Darling River drainage. The species is extinct in Victoria and has not been found in South Australia since 1983.

Olive Perchlet have an oval shaped body with a moderately large mouth, very large eyes and a forked tail. They are usually semi-transparent, with dark-edged scales forming a distinct pattern. The fins are generally clear, although there is often a broad, blackish band along the edges of the pelvic and anal fins. Olive Perchlet can grow to about 70-80 mm but are more commonly less than 60 mm.

Olive Perchlet inhabit rivers, creeks, ponds and swamps. They are usually found in slow-flowing or still waters, often near overhanging vegetation or amongst logs, dead branches and boulders. They often congregate around suitable shelter (snags and vegetation) during the day but disperse during the night to feed. Olive Perchlet feed mainly on micro-crustaceans and insects, including larvae. Males and females reach sexual maturity in one year. Spawning occurs in November and December when water temperatures reach about 23 degrees Celsius (°C) (DPI, 2012b).

While the Study Area may have temporary habitat for this species, a population of Olive Perchlet are unlikely to exist in the ephemeral drainage lines within the Study Area due to their very temporary nature. In addition, Olive Perchlet have not been recorded in the Namoi CMA (DPI, 2012). The nearest records are from the Border Rivers/Gwydir CMA, the most recent in 2008 from Mole River (DPI, 2012a).

4.1.6 Purple Spotted Gudgeon

The Fisheries Scientific Committee, established under Part 7A of the FM Act, has made a final determination to omit Purple Spotted Gudgeon (*Mogurnda adspersa*) from Part 2 of Schedule 4 Endangered Populations of the Act and insert it into Part 1 of Schedule 4 Endangered Species of the FM Act.

Purple Spotted Gudgeon occur in inland drainages of the Murray-Darling basin as well as coastal drainages of northern NSW and Queensland. The western population of the Purple Spotted Gudgeon was previously widespread in the Murray, Murrumbidgee and Lachlan River systems and tributaries of the Darling, but has experienced a significant decline in recent times. Purple Spotted Gudgeon are now extremely rare in inland NSW, having been recorded from this area only once since 1983.

Purple Spotted Gudgeon are small and robust with a rounded head, a relatively small mouth and a rounded tail. They are generally dark chocolate in colour along the back, fading to pale fawn on the belly, with a number of distinguishing markings. These include black to grey patches on the sides, which are surrounded by numerous white and red spots that brighten during breeding. The fins are yellow in colour, darkening towards the extremities. Purple Spotted Gudgeon generally grow to between 7 and 12 cm in length.

Purple Spotted Gudgeon are found in slow-moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks or large woody debris (snags). They feed mainly on insect larvae, but also consume worms, tadpoles, small fish and some plant matter. Males reach maturity at about 4.5 cm and females at about 5 cm in length. Females can spawn several times. The adhesive eggs are deposited in a cluster on a hard surface and hatch after 3-8 days.

While the Study Area may provide temporary habitat for this species, a population of Purple Spotted Gudgeon are unlikely to exist in the ephemeral drainage lines within the Study Area due to their very temporary nature. In addition, Purple Spotted Gudgeon have not been recorded in the Namoi CMA (DPI, 2012a). The nearest records are from the Border Rivers/Gwydir CMA, the most recent in 2005 from Halls Creek (DPI, 2012a).

4.1.7 Lowland Darling River Endangered Ecological Community

The *Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River* is listed as an EEC under the FM Act. The listing of this EEC has several legal implications, including the establishment of heavy penalties for harming (without appropriate authority) species or habitats that form part of the community. Potential impacts on the ecological community must be considered during development assessment processes.

The Darling River aquatic ecological community occurs in a lowland riverine environment characterised by meandering channels and a variety of habitats that form an integral part of the river system, including deep channels and pools, wetlands, gravel beds and floodplains. The complex river morphology provides a multitude of aquatic habitats that play a critical role in the life cycles of the species comprising the community. In its natural state, many of the water-bodies in this area are characterised by variable and unpredictable patterns of high and low flows. This variability in environmental conditions has led to adaptations in native aquatic flora and fauna. For example, many fish species rely on the seasonal flow pattern for successful reproduction (DPI, 2007).

The Darling River endangered ecological community includes all native fish and aquatic invertebrates within all natural creeks, rivers, streams and associated lagoons, billabongs, lakes, anabranches (a secondary channel that diverts from and re-joins the river), flow diversions to anabranches and the floodplains of the Darling River within NSW, and including Menindee Lakes and the Barwon River. Specifically, these areas include the main Barwon-Darling channel from Mungindi (Queensland-NSW border) to the confluence with the Murray River, the arid zone intermittent intersections streams (Warrego, Culgoa, and Narran Rivers), Border Rivers (Macintyre, Severn and Dumaresq Rivers) and regulated tributaries (Gwydir, Namoi, Macquarie, Castlereagh, and Bogan Rivers). Excluded from the definition are man-made/artificial canals, water distribution and drainage works, farm dams and off-stream reservoirs.

The floodplain and creeks within the study area are tributaries of the Namoi River downstream of its junction with the Manilla River and fall within the area of this EEC. The impact of developments or activities that require consent or approval (in accordance with the *Environmental Planning and Assessment Act 1979*) must be assessed and considered by consent or determining authorities. Where such actions are likely to result in a significant impact on a threatened species or its habitat, a detailed species impact statement must be prepared. An assessment of significance for this EEC is provided in Appendix A of this report.

4.2 Threatened Species/populations

Three threatened species listed under the FM Act have previously been recorded in the Namoi CMA (DPI, 2012a):

1. Eel-tailed Catfish endangered population;
2. Murray Hardyhead; and
3. Silver Perch.

Murray Cod is listed as Vulnerable under the EPBC Act however it has been recorded previously within the Namoi CMA (DPI, 2012a). Olive Perchlet endangered population and Purple Spotted Gudgeon, also listed as endangered under the FM Act, have been recorded in the Border Rivers/Gwydir CMA to the north of the Namoi CMA. Typically, these species would not require assessment as they have not been recorded within the Namoi CMA, however they were listed for inclusion in the aquatic assessment by DPI (DPI, 2011).

Eel-tailed Catfish have potential habitat within the farm dams located in the Study Area and the Study Area falls within the definition of the *Lowland Darling River EEC*. An assessment of significance is provided in Appendix A for the Eel-tailed Catfish endangered population and the Lowland Darling River EEC. The remaining threatened species did not contain potential habitat within the study Area due to a lack of specific habitat requirements for some species, and the highly ephemeral nature of the Creeks located in the Study Area.

4.3 Water Quality Assessment

Of the physiochemical data recorded from each site (Table 4), ANZECC & ARMCANZ (2000) guidelines provides default trigger values for DO%, pH, NO_X, TN (Total Nitrogen) and PO^-_4 (FRP). The values for all five of these parameters were outside of the recommended guidelines (for slightly disturbed upland rivers in south-east Australia) for both North Creek and South Creek (with one exception).

The DO% recorded at South Creek was only 8% while the North Creek was 55%. Both readings are well below the 90-110% range provided in the guidelines, although as discussed, the sample locations were lentic pools with little flowing water and as such, DO% would be expected to be lower than those of a flowing creek. However, these readings indicate a stagnant environment. The amount of DO% that a given volume of water can hold is a function of atmospheric pressure, water temperature and the amount of other substances dissolved in the water. In addition, low DO% values result from excessive algae growth caused by high levels of phosphorus and/or nitrogen.

At both sample locations, TN and PO_{-4} (FRP) exceeded the recommended concentrations from the guidelines by very large factors, particularly TN. The likely source of these high nutrient levels is animal manure and/or the addition of fertilisers during past agricultural practices.

The pH at South Creek was slightly more acidic (lower) than the lower limit for pH recommended in the guidelines, while North Creek was within the accepted range.

Thus, at the sample locations within the two creeks sampled, there were high nutrient levels, low DO% and slightly acidic (South Creek only) waters. This is attributed to the ephemeral nature of the creeks, the proximity of cattle grazing and general static nature of the pools sampled. It should be noted that water quality was not recorded from the flowing parts of the creeks due to insufficient depth for collection or insertion of the water quality probe.

Table 4. Physiochemical Water Quality Data for Each Sample Site (29 February 2012)

Date	Site	Temperature (˚C)	Salinity (ppt)	Conductivity (µS/cm)	Turbidity (NTU)	DO (%)	pH	Alkalinity ($mgCaCO_3/L$)	ORP (mV)	SS (mg/L)	NO_X (mg/L)	TKN (mg/L)	TN (mg/L)	PO^-_4 (mg/L)
	ANZECC Trigger Value/ Range[1]					**90-110**	**6.5-7.5**				**0.015**		**0.025**	**0.015**
29/02/12	South Creek	23.96	0.18	305	9.6	8.0	6.48	13	288	<5	0.03±0.00	0.97±0.03	0.97±0.03	0.07±0.00
29/02/12	North Creek	30.44	0.23	422	9.2	55.0	6.97	20	289	7.67±0.33	0.01±0.00	1.5±0.03	1.47±0.03	0.04±0.00

[1] ANZECC and ARMCANZ (2000) Trigger values for slightly disturbed upland rivers in south-east Australia.

Data are ± s.e.; DO=Dissolved Oxygen; SS=Suspended solids; NO_X-Nitrite and Nitrate as N; TKN=Total Kjeddahl Nitrogen; TN=Total Nitrogen as N; PO^-_4=Reactive Phosphorus as P; ORP = Oxidation Reduction Potential.

4.4 Macroinvertebrates

The macroinvertebrate taxa and SIGNAL score per sample location is presented in Table 5 and a data analysis is summarised in Table 6.

Table 5. Macroinvertebrate Taxa and SIGNAL Score per Sample location

Taxon code	Family	SIGNAL 2	Abundance		Signal Score	
			South Creek	North Creek	South Creek	North Creek
KG079999	Planorbidae	2	8	18	2	2
LO999999	Oligochaeta	2	1	N/A	2	0
MM999999	Acarina	6	2	3	6	6
OH999999	Ostracoda	NA	18	4	NA	NA
QC099999	Dytiscidae	2	18	16	2	2
QC110399	Spercheidae (part of Hydrophilidae sometimes)	2	2	N/A	2	0
QC119999	Hydrophilidae	2	2	9	2	2
QC139999	Hydraenidae	3	2	3	3	3
QD079999	Culicidae	1	2	N/A	1	0
QD249999	Stratiomyidae	2	N/A	3	0	2
QDAE9999	Tanypodinae	4	25	6	4	4
QDAJ9999	Chironominae	3	11	61	3	3
QE029999	Baetidae	5	7	N/A	5	0
QH569999	Veliidae	3	N/A	1	0	3
QH619999	Nepidae	3	1	1	3	3
QH659999	Corixidae	2	19	21	2	2
QH679999	Notonectidae	1	1	1	1	1
QO029999	Coenagrionidae	2	3	N/A	2	0
QO059999	Lestidae	1	N/A	1	0	1
QO169999	Hemicorduliidae (Formerly Corduliidae)	5	4	N/A	5	0
QO179999	Libellulidae	4	5	N/A	4	0
QT259999	Leptoceridae	6	N/A	9	0	6
	unident Odonate	NA	3	N/A	NA	0

N/A = not sampled.

NB. Families are ordered based on AUSRIVAS taxon codes. Highlighted values contain relatively high signal scores.

Table 6. Summary Table of Taxa, EPT Richness, EPT Ratio and SIGNAL Score at Each Sampling Site

	Taxa richness	EPT richness	EPT ratio	SIGNAL 2
South Creek	18	1	0.06	2.72
North Creek	15	1	0.07	2.53

The taxa richness and composition of the macroinvertebrate assemblages did vary slightly between sample locations. A total of 19 taxa were identified from the South Creek sample and 15 taxa from the North Creek sample. Taxa that showed a relatively high dominance and constancy across both sites were Dytiscidae and Corixidae, both of which have a low SIGNAL score (2), indicating a greater tolerance to pollution. South Creek recorded high numbers Tanypodinae in comparison the North Creek and Baetidae and Hemicorduliidae were recorded only in South Creek. The latter two taxa have a SIGNAL score of 5 indicating a sensitivity to pollution. North Creek had very large numbers of Chironominae, and Leptoceridae were present in North Creek samples and not South Creek. The Leptoceridae have a SIGNAL score of 6, the highest recorded during this survey. Thus, while each sample location did have one or two taxa that have a sensitivity to pollution, the overall SIGNAL scores for each sample location was low, indicating a dominance of pollution tolerant macroinvertebrates. The EPT group of macroinvertebrates were poorly represented at both sample locations.

4.5 Fish

Non-specific fish surveys using bait traps were highly effective at catching large numbers of tadpoles, however only one fish, the invasive Eastern Gambusia (*Gambusia holbrooki*) (Plate 8) was collected in a bait trap. The high density of tadpoles in the remaining pools restricted effective fish trapping. No fish were collected during macroinvertebrate dip net surveys. The threatened Murray Hardyhead (*Craterocephalus fluviatilis*) is similar in appearance to *G. holbrooki*, although the later lacks a mid-lateral stripe.

Plate 8. Eastern Gambusia (*Gambusia holbrooki*) collected in Bait Trap 2 within South Creek.

4.6 Amphibians

Large numbers of tadpoles were collected during both macroinvertebrate dip netting and in bait traps. Approximately 100 tadpoles of varying size classes were collected per bait trap (Plates 9 and 10).

Tadpoles were identified by Niche's herpetologist, Dr Frank Lemckert, as the Green Tree Frog (*Litoria caerulea*).

Plate 9. A sample of tadpoles collected during the surveys

Plate 10. Green Tree Frog (*Litoria caerulea*) in the later stages of metamorphosis collected during surveys

5.0 Impact Assessment

The Office of Environment and Heritage prepares rural floodplain management plans, which are statutory plans under Part 8 of the *Water Act 1912*, which is administered by the NSW Office of Water. Although a Flood Management Plan has been prepared from Carroll to Boggabri (Department of Natural Resources, 2006), the Study Area is outside (albeit adjoining) the Carroll to Boggabri area. However, potential impacts from the Project on adjoining floodplains and the Namoi River are considered below.

At the time of preparation of this report, a hydrological study had not been finalised. The following assumptions have been made for the purpose of this assessment:

1. There will be no change to base-flow inputs or water quality in the Namoi River.
2. There will be negligible drawdown in the near surface aquifers surrounding the Project, which are more likely to be used by vegetation.
3. There will be no diversion of South Creek.
4. There will be releases of water (rainfall runoff) from the sediment dams around the mine in accordance with EPLs.
5. There will be no release of mine pit water or runoff from hard stands or the infrastructure area.
6. Diversion of North Creek would be directed to the north into the Driggle Draggle Creek catchment.

In addition to the above, measures to be implemented to reduce potential impacts of the extraction of water from the Namoi River on threatened fish species include:

1. Installing a suitable self-cleaning screen that would reduce intake of fish eggs and larvae at the pump inlet.
2. Starting the pump slowly and then ramping up its velocity to a level that reduces the likelihood of any fish in the vicinity of the inlet being drawn into the pump.
3. Regular cleaning of the screen to dislodge trapped organisms.

The specific details of the above measures would be developed in consultation with NOW.

The Project would directly impact on drainage lines within the Study Area including North Creek, and it has the potential to indirectly impact South Creek through bank de-stabilisation and increased turbidity. These creek lines are only 1st or 2nd order streams of poor health and limited habitat potential. However, following flooding, they have potential to link up with the Namoi River via surface flows across the floodplain. Appropriate erosion and sediment control measures will be required prior to the commencement of works to ensure that any potential runoff from the Project does not reach the Namoi River via surface flows following flooding. It is also recommended that water quality (surface and groundwater) be routinely monitored to ensure excess chemicals relating to mining activities are not leaving the site. The parameters for monitoring, monitoring locations and the frequency of monitoring should be addressed in detail in a hydrological study.

Based on these assumptions and the inclusion of the above recommendations, the Project is considered unlikely to have a significant impact to the aquatic flora and fauna of the Namoi River system. Due to the absence of known and/or potential habitat for some threatened aquatic species, and based on the assessment of significance for Eel-tailed Catfish and Lowland Darling River EEC, the Project is unlikely to have a significant impact on threatened aquatic species.

6.0 Conclusions

Two ephemeral creeks (North Creek and South Creek) were assessed within the Study Area. Macroinvertebrate sampling and physiochemical water quality data were collected in an area of pooled water within each creek. Fish surveys were undertaken as part of the dip netting used in macroinvertebrate sampling along with opportunistic sightings and bait trapping. Bait trapping was undertaken only in South Creek as there was insufficient water depth in North Creek for this type of survey technique.

Following a habitat assessment and a review of the threatened species databases (DPI, 2012a; SEWPaC, 2012), it was concluded that the two ephemeral creeks within the Study Area did not contain suitable habitat for any threatened aquatic species previously recorded in the Namoi CMA. The farm dams within the Study Area do however provide habitat for the Eel-tailed Catfish endangered population which is listed under the FM Act, and the Study Area falls within the definition of the Lowland Darling River EEC. An assessment of significance concluded that the proposal is unlikely to have a significant impact on this endangered population and EEC.

The water quality within the pools sampled was poor, with elevated nutrients, low dissolved oxygen levels and slightly acidic waters. The poor water quality is likely the result of agricultural land use in the immediate vicinity, along with the highly ephemeral, lentic state of the pools within the creeks.

Overall, the macroinvertebrate assemblages within each sample location recorded moderate species richness, with South Creek recording 19 taxa and North Creek recording 15 taxa. The SIGNAL site scores within each sample location were low despite each site containing 1-2 taxa that were pollution sensitive. EPT richness was also low at both locations.

Only Eastern Gambusia (*Gambusia holbrooki*) were collected in bait traps in South Creek. This species, originally from south-eastern America, is now widespread in fresh, coastal and inland waters of NSW, Victoria and South Australia, where it out-competes native fish species. Due to its hardy nature, it is often the only fish species found in degraded environments.

Based on the habitat assessment, physiochemical water quality data, macroinvertebrate assemblages and the absence of native fish in locations sampled, the quality and general health of the two ephemeral creeks within the Study Area is considered poor. Due to this absence of suitable potential habitat, the Project would not have a significant impact on threatened aquatic species, populations or communities.

While advice has been given that the Project would not result in a drawdown of the Namoi River or impact on groundwater, it is recommended that appropriate erosion and sediment control measures be in place prior to commencement of works to ensure that runoff from the Project cannot reach the Namoi River via surface flows during flooding events.

7.0 Acknowledgements

Fieldwork was carried out by Dr Kristy McQueen (habitat assessment, water quality, macroinvertebrates and fish). Macroinvertebrate identification was undertaken by John Gooderham (The Waterbug Company) and amphibian (tadpole) identification by Dr Frank Lemckert (Niche). The report was prepared by Kristy McQueen.

Logistical support was provided by Trevor Jones, Environmental Field Officer, Whitehaven.

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9.0 Appendix A Assessment of Significance

An *Assessment of Significance* pursuant to Section 5A of the EP&A Act has been prepared for the following threatened aquatic population and EEC listed under the FM Act:

1. Eel-tailed Catfish (*Tandanus Tandanus*) Endangered Population; and
2. Lowland Darling River Endangered Ecological Community.

The likelihood of the Project significantly affecting threatened species, populations or their habitats listed under the TSC Act has been assessed by addressing the following factors:

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

N/A

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

Eel-tailed Catfish Endangered Population

Eel-tailed catfish are naturally distributed throughout the Murray-Darling Basin and in the eastern drainages in NSW north of Newcastle. Eel-tailed catfish numbers in the Murray-Darling Basin have declined due to a range of impacts including invasive species, habitat degradation, cold water pollution and fishing pressures, and are now virtually absent from the Murray, Murrumbidgee and Lachlan catchments.

They can grow up to 900 mm and 7 kg, although fish over 2 kg are exceptional. Their colour ranges from grey to brown dorsally or laterally, usually mottled with dark brown to black blotchings with a whitish underbelly. Larger fish have less mottling and can be greener in colour, fading to white below.

Eel-tailed catfish build a nest in areas of still water to breed and their reproduction is not temperature reliant. Eel-tailed Catfish feed on zooplankton, small fish, shrimps and insects. They are relatively inactive and do not migrate for spawning, unlike other inland species such as golden perch or Murray cod.

Eel-tailed catfish is non-migratory and lives in a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons, and although it inhabits flowing streams, it prefers sluggish or still waters. It can be found in clear to turbid waters, and over substrates ranging from mud to gravel and rock. It is rare in natural riverine habitats, but can be found in farm dams throughout inland NSW and southern Queensland. Moderate remnant populations occur in the Macquarie catchment upstream of Warren, the Castlereagh catchment upstream of Mendooran, the Namoi catchment upstream of Wee Waa, the Gwydir catchment upstream of Moree and the Border Rivers catchment upstream of Goondiwindi. It is a benthic species that lives, feeds and breeds near the bottom. It is a carnivore that feeds on crustaceans (mainly yabbies and shrimp), molluscs, aquatic insects and small fish (NSW Fisheries Scientific Committee, 2008).

There have been a number of recorded occurrences of this species from within the Namoi catchment, both historical records and recent (2009) records. Records are from named rivers and creeks within the Namoi catchment (DPI, 2012). The habitat of the unnamed creeks located within the Study Area are considered sub-optimal for this species due to their highly ephemeral nature and lack of suitable depth to support this species however a number of farm dams within the Study Area may provide habitat for this species. The farm dams within the study Area will be cleared under the current proposal.

These dams are in isolation and are not linked to broader areas of potential habitat for this species. As this species is non-migratory and is usually solitary (although juveniles sometimes form loose aggregations; Allen et al, 2002), these isolated dams are considered unlikely to have maintained a viable population of this species over time. As such, it is considered that the proposal is unlikely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

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

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

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

Lowland Darling River Endangered Ecological Community

The Darling River aquatic ecological community occurs in a lowland riverine environment characterised by meandering channels and a variety of habitats that form an integral part of the river system, including deep channels and pools, wetlands, gravel beds and floodplains. The complex river morphology provides a multitude of aquatic habitats that play a critical role in the life cycles of the species comprising the community. In its natural state, many of the water-bodies in this area are characterised by variable and unpredictable patterns of high and low flows. This variability in environmental conditions has led to adaptations in native aquatic flora and fauna. For example, many fish species rely on the seasonal flow pattern for successful reproduction (NSW DPI, 2007).

The Darling River endangered ecological community includes all native fish and aquatic invertebrates within all natural creeks, rivers, streams and associated lagoons, billabongs, lakes, anabranches (a secondary channel that diverts from and re-joins the river), flow diversions to anabranches and the floodplains of the Darling River within NSW, and including Menindee Lakes and the Barwon River. Specifically, these areas include the main Barwon-Darling channel from Mungindi (Qld-NSW border) to the confluence with the Murray River, the arid zone intermittent intersections streams (Warrego, Culgoa, and Narran Rivers), Border Rivers (Macintyre, Severn and Dumaresq Rivers) and regulated tributaries (Gwydir, Namoi, Macquarie, Castlereagh, and Bogan Rivers). Excluded from the definition are man-made/artificial canals, water distribution and drainage works, farm dams and off-stream reservoirs (DPI, 2007).

The floodplain and creeks within the study area are tributaries of the Namoi River downstream of its junction with the Manilla River and fall within the area of this EEC. The farm dams within the Study Area are excluded from the definition of this EEC. The 1st and 2nd order creeks that occur within the Study area are ephemeral in nature and only flow following heavy rainfall. Following site inspection, the two main creek lines within the Study Area were found to have limited aquatic habitat potential and were not considered to contain potential habitat for any of the listed threatened species previously recorded in the Namoi CMA. In addition, the Study Area occurs outside of the boundary of the Carroll to Boggabri Floodplain Management Plan area (Department of Natural Resources [DNR], 2006), and as such it is not considered to form an important part of the floodplain environment of the Namoi River. Based on the lack of quality aquatic habitat within the Study Area, the proposal is unlikely to have an adverse effect on the extent or to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

N/A

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

i. the extent to which habitat is likely to be removed or modified as a result of the action proposed;

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

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

Eel-tailed Catfish Endangered Population

Up to 34 farm dams ranging in size from 0.03 to 2.0 ha occur in the Study Area, however in the broader local area, large numbers of farm dams exist. The available habitat within the Study Area is already isolated and fragmented from each other and as the dams do not have connectivity to each other or the Namoi River, the habitat to be removed is not considered to be important in terms of the long-term survival of population.

Lowland Darling River Endangered Ecological Community

The proposal will alter approximately 1,604 ha of land with emplacements and open pit as part of the mining operations. However as discussed, the aquatic habitat within the Study Area is considered to be limited and the extent of this EEC to be removed or modified relates to the infilling of approximately 400 m of North Creek, which at the time of inspection, was mostly dry or consisted of a shallow drainage ditch (Plate 6). The 1st and 2nd order creeks within the Study Area either originate within the Study Area or in the case of the North Creek and South Creek investigated, they have a small upstream catchment, however at the time of inspection, the creeklines outside of the Study Area were dry. As such, the proposal is unlikely to fragment or isolate upstream habitat as it is either non-existent or dry.

The quality of the EEC habitat within the Study Area is considered to be low, with limited aquatic habitat potential for threatened aquatic species. Thus, the proposal is unlikely to alter important habitat that is essential to the long-term survival of this ecological community in the locality.

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

No recovery plan has been prepared for the Eel-tailed catfish population. The threat abatement plan *Removal of large woody debris from NSW rivers and streams* has Eel-tailed Catfish listed as a species that may use large woody debris for refuge, however the proposal is unlikely to impact this plan.

The main threats listed by the NSW Scientific Committee (2008) as causing the decline of this population are:

I. historic commercial fishing;

II. loss of habitat (lakes, billabongs, lagoons) through river regulation;

III. interactions with introduced species, such as carp (*Cyprinus carpio*);

IV. loss of habitat and spawning sites through siltation;

V. reduced success of spawning and recruitment, and loss of habitat due to alterations to flow patterns and flooding regimes;

VI. reduced habitat and loss of temperature spawning cues due to cold-water discharge from the base of large dams and high-level weirs;

VII. loss of aquatic plants; and

VIII. chemical pollution, including agricultural pesticides.

The proposal does not constitute any of the above threats.

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

The proposal does not constitute, or is part of, a key threatening process. Nor is it likely to result in the operation of, or increase the impact of, a key threatening process listed under the FM Act or TSC Act.

Appendix I: Comparison of the area of vegetation communities impacted at the Project and conserved at the Willeroi East Offset Area

Code	Vegetation Community	EEC	RBVT Code	Keith Class	Keith Formation	Project Impact (ha)	Willeroi East (ha)	Difference (ha)
1	Narrow-leaved Ironbark - White Cypress Pine Shrubby open forest	Not an EEC	NA228	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	0	418	418
2	White Box - White Cypress Pine Shrubby Woodland	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	0	50	50
2a	White Box - White Cypress Pine - Cypress Regeneration	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	188	121	-67
2b	White Box - White Cypress Pine - Semi-cleared	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	107	567	460
2c	White Box - White Cypress Pine - Derived Native Pasture	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	488	72	-416
2e	White Box - White Cypress Pine - Derived Shrubland	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	0	22	22
2f	White Box - White Cypress Pine - Mature Cypress Forest	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	9	0	-9

Code	Vegetation Community	EEC	RBVT Code	Keith Class	Keith Formation	Project Impact (ha)	Willeroi East (ha)	Difference (ha)
3	White Box grassy woodland	White Box Yellow Box Blakely's Red Gum Woodland	NA226	Western Slopes Grassy Woodlands	Grassy Woodlands	3	0	-3
3c	White Box grassy woodland - Derived Native Pasture	White Box Yellow Box Blakely's Red Gum Woodland	NA226	Western Slopes Grassy Woodlands	Grassy Woodlands	0	136	136
5	Bracteate Honeymyrtle low riparian forest	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	36	36
5b	Bracteate Honeymyrtle low riparian forest – Semi-cleared regenerating	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	24	24
5c	Bracteate Honeymyrtle low riparian forest - Derived Native Pasture	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	13	13
7b	Silver-leaved Ironbark - White Box - White Cypress Pine – Semi-cleared	Not an EEC	NA 232	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	80	0	-80
7c	Silver-leaved Ironbark - White Box - White Cypress Pine - Derived Native Pasture	Not an EEC	NA 232	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	165	0	-165

Code	Vegetation Community	EEC	RBVT Code	Keith Class	Keith Formation	Project Impact (ha)	Willeroi East (ha)	Difference (ha)
7e	Silver-leaved Ironbark - White Box - White Cypress Pine - Mature Cypress Woodland	Not an EEC	NA 232	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	25	0	-25
8	Yellow Box - Blakely's Red Gum Grassy Woodland	White Box Yellow Box Blakely's Red Gum Woodland	NA237	Western Slopes Grassy Woodlands	Grassy Woodlands	3	0	-3
8c	Yellow Box - Blakely's Red Gum - Derived Native Pasture	White Box Yellow Box Blakely's Red Gum Woodland	NA237	Western Slopes Grassy Woodlands	Grassy Woodlands	0	20	20
9	River Oak – River Red Gum riparian forest	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	19	19
9c	River Oak – River Red Gum - Derived Native Pasture	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	7	7
10	Rough-barked Apple riparian open forest	Not an EEC	NA197	New England GW	Grassy Woodlands	0	3	3
10a	Rough-barked Apple riparian - Regeneration	Not an EEC	NA197	New England GW	Grassy Woodlands	0	10	10
11	Semi-evergreen vine thicket	Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	NA199	Dry Rainforests	Rainforests	0	19	19

Code	Vegetation Community	EEC	RBVT Code	Keith Class	Keith Formation	Project Impact (ha)	Willeroi East (ha)	Difference (ha)
12	Trachyte outcrop shrubland	Not an EEC	NA240	Northern Montane Heaths	Heathlands	0	10	10
19c	Plains Grass – Blue Grass Derived Native Pasture	Not an EEC	NA181	Western Slopes Grasslands	Grasslands	3	0	-3
20a	Poplar Box Grassy Woodland - Derived Woodland	Not an EEC	NA185	Pilliga Outwash DSFs	Dry Sclerophyll Forests (Shrub/grass subformation)	46	0	-46
20c	Poplar Box Grassy Woodland - Derived Native Pasture	Not an EEC	NA185	Pilliga Outwash DSFs	Dry Sclerophyll Forests (Shrub/grass subformation)	628	0	-628
21	Weeping Myall low Shrubland	Weeping Myall Woodlands	NA219	Riverine Plain Woodlands	Semi-arid Woodlands (Grassy subformation)	1	0	-1
22	Mixed Marsh Sedgeland	Not an EEC	NA201	Inland Floodplain Swamps	Freshwater Wetlands	2	0	-2
23	River Red Gum Riverine Woodland	Not an EEC	NA193	Inland Riverine Forests	Forested Wetlands	0	0	0
24	Red Stringybark shrubby open forest - Semi-cleared and Regenerating	Not an EEC	NA112	New England Grassy Woodlands	Grassy Woodlands	0	97	97
Total						**1,748**	**1,644**	**-104**

Appendix J: Comparison of threatened fauna known and predicted to occur at the Project mining area and the Willeroi East Offset Area

Threatened Fauna	Threatened fauna recorded at the Project or immediately surrounds	Threatened fauna with potential to occur at the Project	Threatened fauna recorded at the Willeroi East Offset Area or immediate surrounds	Threatened fauna predicted at the Willeroi East Offset Area or habitat present[1]
Barking Owl		✓		✓
Beccari's Freetail-bat	✓	✓		
Black-chinned Honeyeater (eastern subspecies)				✓
Blue-billed Duck	✓			
Border Thick-tailed Gecko			✓	✓
Brown Treecreeper (eastern subspecies)		✓	✓	✓
Corben's Long-eared Bat		✓		✓
Diamond Firetail	✓	✓	✓	✓
Eastern Bentwing-bat	✓		✓	✓
Eastern Cave Bat				✓
Eastern False Pipistrelle				✓
Eastern Freetail-bat		✓		✓
Gilbert's Whistler	✓	✓		
Glossy Black-cockatoo		✓		✓
Greater Broad-nosed Bat			✓	✓
Grey Falcon	✓	✓		
Grey-crowned Babbler (eastern subspecies)	✓	✓		✓
Grey-headed Flying-fox				✓
Hooded Robin (south-eastern form)	✓	✓	✓	✓
Koala		✓		✓
Large-eared Pied Bat				✓
Little Eagle	✓	✓		✓

Threatened Fauna	Threatened fauna recorded at the Project or immediately surrounds	Threatened fauna with potential to occur at the Project	Threatened fauna recorded at the Willeroi East Offset Area or immediate surrounds	Threatened fauna predicted at the Willeroi East Offset Area or habitat present[1]
Little Lorikeet		✓	✓	✓
Little Pied Bat	✓	✓		
Masked Owl		✓		✓
Pale-headed Snake		✓		
Painted Honeyeater		✓		✓
Powerful Owl		✓		
Regent Honeyeater				✓
Speckled Warbler	✓	✓	✓	✓
Spotted Harrier		✓	✓	✓
Spotted-tailed Quoll		✓		
Square-tailed Kite		✓		✓
Squirrel Glider	✓	✓		✓
Superb Parrot		✓		
Turquoise Parrot	✓	✓	✓	✓
Varied Sittella	✓	✓		✓
Yellow-bellied Sheathtail-bat	✓	✓		✓

[1] Species predicted in Revised Biometric Vegetation Types through the Threatened Species Profiles Database embedded in the BioBanking Credit Calculator and/or considered to have a moderate to high likelihood of occurrence at the site (refer to Niche [2012a, 2012b] reports for both offset sites). Indicative BioBanking scenarios were run for both the Willeroi East and Roseglass Offset Areas as far as was required to derive the threatened species predicted list. Full BioBanking Credit calculations were not conducted.

Appendix K: Willeroi East Offset Area Flora and Fauna Assessment

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WILLEROI EAST OFFSET AREA

FLORA AND FAUNA ASSESSMENT

August 2012

DOCUMENT CONTROL

Business Unit	Niche Environment and Heritage, Central Coast/Hunter Office		
Project No.	1214		
Document Description	Flora and fauna survey of potential offset site (Willeroi East Offset Area) for the Vickery Coal Project.		
	Name	**Signed**	**Date**
Supervising Manager(s)	Rhidian Harrington		2 August 2012

Person managing this document	**Person(s) writing this document**
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External Review	**Name**
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Internal Review	**Name**
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Document Status	**Date**
Final	2 August 2012

Prepared for:	**Organisation**
Danny Young	Whitehaven Coal Limited Level 28, 259 George Street Sydney NSW 2000

Front Cover Photograph: Willeroi East Offset Area

EXECUTIVE SUMMARY

Niche Environment and Heritage were commissioned by Whitehaven Coal Limited (Whitehaven) to conduct a flora and fauna survey of the eastern portion of the Willeroi property (Willeroi East) in order to determine its suitability as an offset site for the proposed open-cut mining operation known as the Vickery Coal Project (the Project).

Willeroi East is located approximately 40 kilometres (km) north-east of Boggabri and 60 km north of Gunnedah, New South Wales (NSW). The property is owned by Whitehaven and is situated in the Gunnedah Basin, within the Namoi Catchment Management Area.

Methodology

Native vegetation surveys were then completed by two botanists over seven days between 27 and 28 March 2012 and 1 and 6 April 2012, and fauna surveys were undertaken on two occasions over 7 days and 6 nights in March and April 2012. Desktop analysis and field surveys included:

- preliminary vegetation mapping using aerial photography;
- full floristic plots;
- rapid data points;
- threatened flora random meanders;
- threatened fauna habitat assessment; and
- targeted threatened fauna surveys (camera trapping, spot-lighting, ANABAT recorders, call playback, herpetological searches, hair tubes and bird survey).

Preliminary database searches for potential threatened species, communities and/or populations likely to occur within the study area were conducted to inform the survey design.

Threatened Biodiversity

The following Endangered Ecological Communities (EECs) as listed on the *Threatened Species Conservation Act, 1995* (TSC Act) and/or *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) were detected within the study area;

- Semi-evergreen Vine Thicket is equivalent to *Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions* which is listed under the EPBC Act.
- Yellow Box - Blakely's Red Gum Derived Native Pasture is equivalent to *White Box Yellow Box Blakely's Red Gum Woodland* listed as Endangered under the TSC Act and Critically Endangered under the EPBC Act.
- White Box Grassy Woodland Derived Native Pasture is equivalent to *White Box Yellow Box Blakely's Red Gum Woodland* listed as Endangered under the TSC Act and Critically Endangered under the EPBC Act.

One threatened flora species listed under the TSC Act was recorded during the field survey, Silky Swainson-pea (*Swainsona sericea*).

A total of 10 threatened species listed under the TSC Act were recorded during the current study: Diamond Firetail (*Stagonopleura guttata*), Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*), Little Lorikeet (*Glossopsitta pusilla*), Speckled Warbler (*Pyrrholaemus saggitatus*), Spotted Harrier (*Circus assimilis*), Turquoise Parrot (*Neophema pusilla*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) and Eastern Cave Bat (*Vespadelus troughtoni*). In addition to those species recorded, 19 threatened species are considered to have a moderate to high likelihood of occurrence within the study area.

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1 INTRODUCTION

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Whitehaven Coal Mining Limited (Whitehaven) to conduct a flora and fauna survey of the eastern portion of the Willeroi property (Willeroi East) in order to determine its suitability as an offset site for the proposed open-cut mining operation known as the Vickery Coal Project (the Project).

The Willeroi East property is owned by Whitehaven. A separate study has already been conducted for the western potion of the property, which forms part of an offset proposal for the proposed Tarrawonga Coal Mine. This report constitutes a flora and fauna survey of the eastern portion of the property.

1.1 Definitions and Abbreviations

CMA – Catchment Management Area

EEC – Endangered Ecological Community

LGA – Local Government Area

OEH – New South Wales (NSW) Office of Environment and Heritage (previously NSW Department of Environment, Climate Change and Water [DECCW])

SEWPaC – Commonwealth Department of Sustainability, Environment, Water, Population and Communities (previously Department of the Environment, Water, Heritage and the Arts [DEWHA])

TSC Act – NSW *Threatened Species Conservation Act 1995*

EP&A Act – NSW *Environmental Planning and Assessment Act 1979*

EPBC Act – Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

1.2 Objectives

The key objectives of this report are to:

- describe and map vegetation communities and habitats within the study area (i.e. the eastern portion of the Willeroi property "Willeroi East");
- assess the significance of flora and fauna in Willeroi East, including the significance of their habitats and wildlife corridors; and
- describe and map threatened species, populations and ecological communities listed on the TSC Act that are known or likely to occur within Willeroi East.

1.3 Description of the Study Area

Willeroi East is located approximately 40 kilometres (km) north-east of Boggabri and 60 km north of Gunnedah, NSW (Figure 1). The property is owned by Whitehaven.

Willeroi East is situated in the Gunnedah Basin, within the Maules Creek sub-catchment of the Namoi CMA.

The study area occurs in the east of the North West Slopes Botanical Division (Anderson 1968; Harden [Ed.] 1990, 1992, 1993, 2000, 2002) close to the southern side of the Nandewar Range extension of the Northern Tablelands Botanical Division. It also lies just within the western side of the Nandewar Bioregion near the border with Brigalow Belt South Bioregion as defined originally by Thackway and Cresswell (1995). The Nandewar Bioregion occupies much of the higher parts of the North West Slopes of NSW from the upper Hunter Valley into southern Queensland. It occupies approximately 2.7 million ha, with approximately 2.07 million hectares (ha) in NSW.

Willeroi East is located approximately 17 km to the north of the Project.

A portion of the property (1,671 hectares), hereafter referred to as the study area, was investigated in the current study as a potential offset site for the Project. Another portion of the property to the west was subject to previous flora and fauna investigations and does not form part of this assessment.

The topography of the study area is generally rugged, with steep terrain and ridgetop environments occupying the eastern portion of the study area, and flatter areas generally towards the west.

A portion of the study area has been subject to grazing, logging and clearing of native vegetation. A number of old stock sheds are located on the property and a network of farm trails. A number of farm dams are scattered across the property.

The flatter areas of the property are predominantly cleared with mature natives trees and shrubs occupying the watercourses and steeper slopes of the property.

Evidence of feral animals such as goats, pigs, rabbits and foxes were observed in the study area.

The study area is part of a large expanse of connected vegetation, extending from approximately 25 km to the south-west, through to Mount Kaputar National Park to the immediate north-west (Figure 1).

The main watercourse in the study area is Maules Creek, which occurs along the western border of the study area. Maules Creek is a small tributary of the Namoi River. Throughout the study area a number of drainage lines feed into Maules Creek.

Altitudes in the study area range from 400 metres (m) Australian Height Datum (AHD) to 900 m AHD in the south-eastern portion.

The terrain varies from gently sloping in the cleared areas of the west to very steep on the peaks of the escarpment to the east and south.

2 METHODOLOGY

2.1 Literature and Database Review

Available literature relevant to the current study include:

- Vegetation of the Willeroi Offset Area (FloraSearch, 2011); and
- Willeroi Fauna Survey Report (Cenwest, 2011).

Both of the above reports relate to the western portion of the Willeroi property which is outside of the current study area although immediately adjacent.

Threatened species with the potential to occur within the study area were examined through searches of the following databases:

- NSW National Parks and Wildlife Service Atlas of NSW Wildlife (OEH, 2012);
- EPBC Act Protected Matters Search Tool (SEWPaC, 2012); and
- BirdLife Australia Atlas (Birdlife Australia, 2012).

2.2 Threatened Species Likelihood of Occurrence

A list of potential threatened species of the study area was determined through review of the literature and databases described in Section 2.1. The list of threatened flora and fauna compiled from these sources were then subjected to further consideration in light of the species and habitat types recorded during the field surveys to determine a list of threatened species likely to occur within the study area (Appendix 1).

One of five categories for 'likelihood of occurrence' (Table 1) were assigned to each of the threatened species which may potentially occur within the study area after consideration of a number of criteria such as known records, presence or absence of important habitat features on the subject site, results of the field surveys and professional judgement. This process was completed on an individual species basis.

Table 1: Likelihood of Occurrence Assessment Criteria.

Likelihood rating	Criteria
Known	The species was observed within the study area
High	It is likely that a species inhabits or utilises habitat within the study area
Moderate	Potential habitat for a species occurs on the site. Adequate field survey would determine if there is a 'high' or 'low' likelihood of occurrence for the species within the study area
Low	It is unlikely that the species inhabits the study area
None	The habitat within the study area is unsuitable for the species

2.3 Aerial Photography Interpretation

Vegetation was mapped in a Geographical Information System (GIS) system, using interpretation of digital ortho-rectified aerial photography and Global Positioning System-located field vegetation observations, which was compared to existing vegetation mapping at appropriate scales (typically 1:4,000 to 1:8,000). Photo-interpretation of vegetation communities relies on crown/canopy colour, crown-shadow shape, canopy pattern and topographic association. The digitised polygons were codified with a floristic community specific to the site. These communities were subsequently aggregated and aligned with Revised Biometric Vegetation Types (RBVTs), Keith Formation, Keith Class and EEC type. Updating of the vegetation map layer was done progressively throughout the field survey. Polygon areas are reported in hectares.

2.4 Native Vegetation Survey Methodology

2.4.1 Floristic Plots

In order to classify the vegetation of the site, cover scores using a rating system of 1 through to 6 were applied to each species recorded in a 20 x 20 m floristic plot. The floristic and cover abundance data was collected in order to run a full floristic cluster analysis. The analysis was carried out using the multivariate software PATN™ to inform decisions relating to the vegetation communities present on the site. Combined with the Rapid Data Points (RDPs), this analysis provided a high level of rigor to the assessment.

The survey of native vegetation was completed by two botanists over seven days between 27th and 28th March 2012 and 1st April and 6th of April 2012. The Floristic plot numbers are provided in Table 2 and illustrated in Figure 2. Niche completed 83 plots in native vegetation types sampled from across the study area.

Table 2. Floristic Plot Survey Effort

Niche Code	Niche Type	Total (ha)	Plots Conducted
1	Narrow-leaved Ironbark - White Cypress Pine Shrubby Open Forest	418	12
2	White Box - White Cypress Pine Shrubby Woodland	50	5
2a	White Box - White Cypress Pine Cypress Regeneration	121	7
2b	White Box - White Cypress Pine Semi-cleared	567	11
2c	White Box - White Cypress Pine Derived Native Pasture	72	3
2e	White Box - White Cypress Pine Derived Shrubland	22	3
3c	White Box Grassy Woodland Derived Native Pasture	136	9
5	Bracteate Honeymyrtle Low Riparian Forest	36	3
5b	Bracteate Honeymyrtle Low Riparian Forest Semicleared Regenerating	24	3
5c	Bracteate Honeymyrtle Low Riparian Forest Derived Native Pasture	13	1
8c	Yellow Box - Blakely's Red Gum Grassy Woodland Derived Native Pasture	20	2
9	River Oak – River Red Gum Riparian Forest	19	3

Niche Code	Niche Type	Total (ha)	Plots Conducted
9c	River Oak – River Red Gum Derived Native Pasture	7	2
10	Rough-barked Apple Riparian Open Forest	3	0
10a	Rough-barked Apple Riparian Regeneration	10	2
11	Semi-evergreen Vine Thicket	19	3
12	Trachyte Outcrop Shrubland	10	3
24	Red Stringybark Shrubby Open Forest Semi-Cleared and Regenerating	97	7
Se	Scald Erosion	27	4
	TOTAL	**1,671**	**83**

2.4.2 Rapid Data Points

The use of the RDP survey methodology for ground-truthing vegetation mapping is recognised as best-practice in the consulting industry (Sivertsen, 2009).

The collection of RDPs is a method that enables rapid yet accurate vegetation mapping for spatial analysis. Variability in vegetation distribution cannot be fully predicted using remote sensing and GIS and, therefore, ground-truthing vegetation types through field surveys is essential. RDPs are summaries of floristic information recorded at specific points in the field and are used to compliment full floristic plot information. RDPs were noted on data sheets, field base-mapping (A3 sheets) or a separate note-pad, and later transferred to GIS. Information recorded included:

- dominant species, estimated cover and height for each layer of vegetation present usually including canopy, mid-storey, shrubs and ground-cover;
- vegetation condition (Niche uses a measure of 'ecosystem resilience' as a function of disturbance) and other notes regarding habitat and other important features; and
- physical attributes of the site (vegetation structure, soil type, elevation, slope, aspect, physiographical position) are also recorded and photographs taken for later reference.

All safely accessible tracks and roads across the study area were driven and mapping units recorded on printed A3 maps. Those areas inaccessible by vehicle were walked on foot to ensure that all vegetated parts of the study area were assessed. Polygons were drawn around areas of vegetation and a vegetation type assigned. Subsequently, the remaining data for RDPs was collected at each of the plot locations and the digital mapping updated accordingly.

2.4.3 Multi-variate Analysis

After collation in, and export from, the Yeti database, all floristic plots were subject to a multi-variate analysis using the PATN™ program. Data from each of the floristic plots were

entered into a PATN™ software package to determine similarities in vegetation across the study area. A dendrogram was generated to illustrate the floristic similarities.

The location of the floristic plots and rapid assessment plots were overlayed onto an aerial photograph of the study area for interpretation.

2.5 Flora Survey Methodology

2.5.1 Threatened Plant Random Meander

A threatened plant random meander was conducted targeting threatened plant species with the potential to occur within the study area. A random meander allows optimal coverage of the study area and target species. The minimum amount of time for the random meander is 0.5 hours per plot per stratification unit. The flora and native vegetation field survey was conducted over seven days and included the random meander transects between each of the floristic plots. The threatened flora random meander conducted within the study area was considered more than adequate to meet the minimum survey requirement.

2.5.2 Plant Taxonomy

Plant taxonomy used was consistent with the nomenclature of the *Flora of New South Wales* (Harden 1992; 1993; 2000; 2002), except where more recent revisions have been published in recognised scientific journals and accepted by the National Herbarium of New South Wales (as per their PlantNet web site http://plantnet.rbgsyd.nsw.gov.au/). All floristic data were entered into the Yeti database to allow data manipulation and export for species lists and analysis.

2.6 Fauna Survey Methodology

2.6.1 Fauna Survey Effort

Field surveys were undertaken on two occasions over 7 days and 6 nights in March and April 2012 as tabled below (Table 3), with some monitoring equipment left out between field survey visits. The survey design targeted threatened species previously found within 50 km of the study area and with a reasonable chance of occurring on the basis of available habitat types.

Field surveys incorporated targeted survey, opportunistic observations and broad habitat assessment. Survey techniques and effort are presented in Table 3 and Table 4 were based upon the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC, 2004) and *Threatened species survey and assessment guidelines: field survey methods for fauna - Amphibians* (DECC, 2009).

Commonwealth survey guidelines for threatened birds, bats, frogs, mammals and reptiles were also referred to (SEWPaC, 2010a, 2010b, 2010c, 2011a, 2011b).

Table 3: Fauna Field Survey Effort at Willeroi East

Activity	Effort	Units	27/03/12	28/03/12 to 15/04/12	16/04/12	17/04/12	18/04/12	19/04/12	20/04/12	21/04/12
Camera Traps										
Cameras 1 - 8 (Central – Vine Thicket)	168	nights	8	152	8	-	-	-	-	-
Cameras 9 – 12 (Northern Central)	16	nights	-	-	4	4	4	4		
Cameras 13 – 16 (Central)	16	Nights	-	-		4	4	4		
Cameras 13 - 16 (South West – Open Woodland and Forest)	12	nights	-	-	-	-	4	4	4	-
Cameras 13 - 16 (Central West - Cyperus Regrowth)	12	nights	-	-	-	-	4	4	4	-
Total Effort	**224**	**nights**								
Bat Echolocation Recorders										
Anabat 1 (Central – Open Woodland)	4	nights	1	3						-
Anabat 2 (South West – Forest)	3	nights	-	-	-		1	1	1	-
Anabat 3 (Various Locations)	5	hours	-	-	1	1	1	1	1	-
Total Effort	**12**	**nights**								
Hair Tubes										
Hair Tubes 1-20 (Northern Central)	80	nights	-	No Field Survey Remote Recording Devices Only	20	20	20	20	-	-
Hair Tube 21-40 (Central)	60	nights	-		-	20	20	20	-	-
Hair Tube 41-60 (Central West)	60	nights	-		-	20	20	20	-	-
Hair Tube 61-80 (South West)	60	nights	-				20	20	20	-
Total Effort	**260**	**nights**								
Spotlighting (primarily on foot with some driving)	**8.5**	hours	-		1.75	2	-	2.75	1.75	-
Nocturnal Frog Survey	**4**	hours	-		0.5	1		1.5	1	-
Diurnal Reptile Searches	**4**	hours					1.75	1.75		0.5
Bird Survey	**8.5**	hours	0.5		2	-	2	0.5	1	2.5
Call Playback and Listening for Owls/Nocturnal Mammals	**6.5**	hours	-		1	2	-	1.5	1.5	0.5

Table 4: Targeted Fauna Survey Methods at Willeroi East

Method	Details
Infra-red camera traps	Target species - Spotted-tailed Quoll, Brush-tailed Rock Wallaby and other ground-dwelling omnivores/scavengers. Motion sensing camera traps were placed at ground level at each trapping site. A PVC tube baited with sardines or a mixture of honey, oats and peanut butter was placed in front of the camera traps. Upon recovery, the pictures were individually analysed and animals were identified to the lowest possible taxonomic level.
Hair tubes	Target fauna – Ground dwelling and Arboreal mammals. PVC hair tubes were attached to trees with electrical tape and secured under logs or other debris on the ground at each site. Double sided tape was only adhered to the upper and lateral inner surface of the tubes so as to limit the incidence of 'by catch'. Tubes were baited with a mixture of honey, oats and peanut butter. Hair samples were sent to Barbara Triggs for analysis.
Ultrasonic call recording for bats	Three Wildlife Acoustics SM2 Bat detector units were deployed along identified flyways and around watercourses.
Diurnal bird surveys	Approximate 2 ha bird surveys were conducted across the study area. Birds were identified with the use of 10 x 42 binoculars or from their calls. Where possible surveys were conducted close to dawn or dusk when bird activity is greatest.
Spotlighting	Spotlighting surveys targeting owls and arboreal mammals were performed either on foot or via a vehicle around roads and tracks of the study area and throughout the subject site.
Call playback and Owl Listening	Target species - Powerful Owl, Barking Owl, Masked, Squirrel Glider and Koala. Listening for owls was conducted immediately prior to sunset and sunrise. Call-playback sites were established across the study area to enable maximum coverage. After an initial listening period of up to 30 minutes, calls of the target species were broadcast through a 10 watt megaphone for five minutes followed by a five minute listening period and a period of spotlighting.
Reptile Searches	Herpetological surveys included diurnal targeted searches under rocks, timber, logs and tree bark in identified potential habitat throughout the study area.
Frog chorus survey and aquatic habitat surveys.	Frogs were listened for at farm dams and permanent and ephemeral drainage lines throughout the study area. Active searching for frogs using spotlights was also conducted around watercourses.

Habitat assessments were conducted via floristic plots throughout the study area and along fauna transects. Habitat characteristics and parameters that were assessed included:

- aspect/slope of the site;
- dominant vegetation, floristic composition and structure;
- composition of ground layer (bare earth, litter, fungi, moss, lichen, etc.);
- presence and relative abundance of key habitat features (e.g. tree hollows, large logs, exfoliating rock, flowering resources, aquatic features);
- condition and disturbance factors; and
- vegetation age structure.

2.6.2 Fauna Habitat Condition Assessment

The three criteria used to define habitat condition are described as follows:

Good: The site is likely to contain vegetation with good structure, and contain a high number of indigenous species. Logs and litter layer are intact and undisturbed. Hollow bearing trees likely to be present, and nesting, feeding and roosting resources available. Richness and diversity of native fauna are likely to be present.

Moderate: The site is likely to contain a moderate number of indigenous species, ground logs and litter moderately intact and undisturbed. There is a moderate availability of nesting, feeding and roosting habitat available. Richness and diversity of native fauna is likely to be present.

Poor: The site is likely to contain a low number of indigenous species with poor community structure. Litter and log layer disturbed or modified. Low level of breeding, nesting and feeding resources available. Low richness and diversity of native fauna likely to be present.

2.7 Limitations

Coverage of the site was difficult due to the rugged terrain and lack of vehicular access. Fauna survey was therefore concentrated around representative patches of vegetation that were reasonably accessible. There was limited spatial coverage of the eastern part of the study area.

Some plant species are cryptic and can only be detected when flowering at certain times of the year and some fauna species are migratory or nomadic and may occur only seasonally or sporadically within the study area. Habitat assessments are an efficient method of assessing the likelihood of occurrence for these threatened species as they do not require individual species to be surveyed for, only their habitat need be present on a site. Habitat assessments can be considered to be a more conservative method of assessment as a species is assumed to be present if its habitat is present. The survey period was outside of peak activity and breeding periods for some frog species, which is likely to have resulted in limited detection of frog species. However, no threatened frog species were considered likely to be present regardless of survey conditions.

3 RESULTS

3.1 Native Vegetation

The vegetation communities within the study area were composed of 10 parent vegetation types. Collectively 19 vegetation communities were identified as different condition states across the 10 types.

The alignment of these vegetation types with EECs, RBVTs, Keith Formations and Keith Classes has been provided in Table 5. The approximate area of each vegetation type impacted by the Project and within Willeroi East has also been provided in the Appendix 2.

Figure 3 illustrates the extent and distribution of the vegetation communities present within the study area. Figure 4 illustrates the presence of EECs within the study area.

The following section describes the vegetation communities present in study area (Table 5).

Table 5. Vegetation Community Alignment and Area

Code	Vegetation Community	EEC status	RBVT Code	RBVT	Keith Class	Keith Formation	Area (ha)
1	Narrow-leaved Ironbark - White Cypress Pine Shrubby Open Forest	Not an EEC	NA228	White Cypress Pine Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	418
2	White Box - White Cypress Pine Shrubby Woodland	Not an EEC	NA225	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	50
2a	White Box - White Cypress Pine Cypress Regeneration	Not an EEC	NA225	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	121
2b	White Box - White Cypress Pine Semi-cleared	Not an EEC	NA225	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	567
2c	White Box - White Cypress Pine Derived Native Pasture	Not an EEC	NA225	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	72
2e	White Box - White Cypress Pine Derived Shrubland	Not an EEC	NA225	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	22
3c	White Box Grassy Woodland Derived Native Pasture	White Box Yellow Box Blakely's Red Gum Woodland	NA226	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Western Slopes Grassy Woodlands	Grassy Woodlands	136

Code	Vegetation Community	EEC status	RBVT Code	RBVT	Keith Class	Keith Formation	Area (ha)
5	Bracteate Honeymyrtle Low Riparian Forest	Not an EEC	NA191	River Oak riparian woodland of the Brigalow Belt South and Nandewar	Eastern Riverine Forests	Forested Wetlands	36
5b	Bracteate Honeymyrtle Low Riparian Forest Semi-cleared Regenerating	Not an EEC	NA191	River Oak riparian woodland of the Brigalow Belt South and Nandewar	Eastern Riverine Forests	Forested Wetlands	24
5c	Bracteate Honeymyrtle Low Riparian Forest Derived Native Pasture	Not an EEC	NA191	River Oak riparian woodland of the Brigalow Belt South and Nandewar	Eastern Riverine Forests	Forested Wetlands	13
8c	Yellow Box - Blakely's Red Gum Derived Native Pasture	White Box Yellow Box Blakely's Red Gum Woodland	NA237	Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion	Western Slopes Grassy Woodlands	Grassy Woodlands	20
9	River Oak – River Red Gum Riparian Forest	Not an EEC	NA191	River Oak riparian woodland of the Brigalow Belt South and Nandewar	Eastern Riverine Forests	Forested Wetlands	19
9c	River Oak – River Red Gum Derived Native Pasture	Not an EEC	NA191	River Oak riparian woodland of the Brigalow Belt South and Nandewar	Eastern Riverine Forests	Forested Wetlands	7
10	Rough-barked Apple Riparian Open Forest	Not an EEC	NA197	Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	New England GW	Grassy Woodlands	3
10a	Rough-barked Apple Riparian Regeneration	Not an EEC	NA197	Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	New England GW	Grassy Woodlands	10
11	Semi-evergreen Vine Thicket	Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	NA199	Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147)	Dry Rainforests	Rainforests	19
12	Trachyte Outcrop Shrubland	Not an EEC	NA240	Heathy shrubland on granitic outcrops of the central and western New England Tablelands	Northern Montane Heaths	Heathlands	10
24	Red Stringybark Shrubby Open Forest Semi-Cleared and Regenerating	Not an EEC	NA112	Blakely's Red Gum - Rough-barked Apple - Red Stringybark grassy open forest of the western New England Tablelands	New England Grassy Woodlands	Grassy Woodlands	97
Se	Scald Erosion	Not an EEC	-	-	-	-	27
						TOTAL AREA	**1,671**

Within the east of the study area, a number of escarpments are characterised by vegetation communities 12 (Trachyte Outcrop Shrubland) and 24 (Red Stringybark Shrubby Open Forest – Semi-cleared and Regenerating). The majority of the slopes off these escarpments, in the eastern portion of the study area, are vegetation community 1 (Narrow-leaved Ironbark – White Cypress Pine Shrubby Open Forest) which leads into the dominant vegetation community for the study area, vegetation community 2b (White Box – White Cypress Pine Semi-cleared). The north-western portion of the study area, floodplains, is mapped as vegetation community 3c (White Box Grassy Woodland Derived Native Pasture). The western side of the study area is bordered by Maules Creek which is flanked by vegetation communities 5 (Bracteate Honeymyrtle Low Riparian Forest), 9 (River Oak – River Red Gum Riparian Forest) and 10 (Rough-barked Apple Riparian Open Forest). The remaining vegetation communities represent minor portions of the study area and are dispersed throughout (Figure 3).

The overall condition of vegetation within the study area is Moderate to Good. The vegetation communities assessed to be in Poor to Moderate condition are portions of vegetation communities 5 (Bracteate Honeymyrtle Low Riparian Forest), 9 (River Oak – River Red Gum Riparian Forest) and 10 (Rough-barked Apple Riparian Open Forest) (Figure 3). Maules Creek has a range of aquatic values and is in moderate condition, with good bank condition in most places. However cattle access, clearing and vehicle access has damaged banks in some areas along with other indicators that lend small parts of these vegetation communities to being in poor condition. Variants assigned to vegetation communities (i.e. a, b, c and e) denote different forms or conditions of the relevant vegetation community. Sections 3.1.1 to 3.1.11 provide details on these vegetation communities.

Intoduced species were recorded in all vegetation communities in the study area. The greatest concentrations were on the lower areas of the study area, particularly along the creek and drainage lines. Three weed species listed as Noxious under the *Noxious Weeds Act 1992* (NW Act) for the Gunnedah LGA were recorded in the study area. These are discussed in Section 3.2. Noxious weeds were recorded within the dervived pasture, semi-cleared vegetation communities and draingage lines.

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

Community 1 predominantly occupies the eastern portion of the study area occurring on hilly terrain (Plate 1).

Dominant species of the community include the following:

Trees: *Eucalyptus crebra, Callitris glaucophylla* and *Eucalyptus albens*.

Shrubs: *Cassinia quinquefaria, Dodonaea viscosa, Melaleuca bracteata* and *Notelaea microcarpa*.

Grasses: *Austrodanthonia monticola, Cymbopogon refractus, Eragrostis leptostachya, Bothriochloa macra, Austrostipa scabra, Microlaena stipoides, Poa sieberiana*.

Ground Covers: *Desmodium brachypodum, Olearia elliptica, Adiantum aethiopicum, Lomandra longifolia, Oplismenus imbecillis, Bothriochloa macra, Aristida personata, Dichondra sp. A*.

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

Equivalent Keith Class/Keith Formation (Keith, 2004): Western Slopes Dry Sclerophyll Forests/Dry Sclerophyll Forests (Shrubby subformation).

Condition ranged from Moderate to Good throughout the study area.

Plate 1. Community 1: Narrow-leaved Ironbark – White Cypress Pine Shrubby Open Forest

3.1.2 Community 2. White Box - White Cypress Pine Shrubby Woodland

Community 2 has five variants occurring within the study area (Plate 2):

- Unit 2: White Box - White Cypress Pine Shrubby Woodland;
- Unit 2a: White Box – White Cypress Pine Shrubby Woodland Regeneration;
- Unit 2b: White Box – White Cypress Pine Shrubby Woodland Semi-cleared;
- Unit 2c: White Box – White Cypress Pine Shrubby Woodland Derived Native Pasture; and
- Unit 2e: White Box – White Cypress Pine Shrubby Woodland Derived Shrubland.

The community is the most dominant within the study area, occurring mainly on the steeper slopes. Dominant species of the community include the following:

Trees: *Eucalyptus albens, Eucalyptus crebra, Eucalyptus dealbata, Callitris glaucophylla.*

Shrubs: *Acacia decora, Cassinia quinquefaria, Dodonaea viscosa, Notelaea microcarpa.*

Grasses: *Aristida jerichoensis, Aristida personata Bothriochloa macra, Chloris truncata, Cymbopogon refractus, Dichelachne micrantha, Digitaria brownii, Eragrostis leptostachya, Echinopogon caespitosus, Panicum simile.*

Ground Covers: *Asperula conferta, Cheilanthes sieberi, Chrysocephalum semipapposum, Hydrocotyle laxiflora, Hypericum gramineum Lomandra longifolia, Mentha diemenica, Olearia elliptica, Pimelea neo-anglica, Pimelea simplex, Vittadinia muelleri, Wahlenbergia communis.*

Equivalent Biometric Vegetation Type (DECCW, 2008): White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions.

Equivalent Keith Class/Keith Formation (Keith, 2004): North-west Slopes Dry Sclerophyll Woodlands/Dry Sclerophyll Forests/Shrub/Grass subformation).

Condition ranged from Moderate to Good throughout the study area.

Plate 2. Community 2: White Box – White Cypress Shrubby Woodland.

3.1.3 Community 3c. White Box Grassy Woodland Derived Native Pasture

Community 3c occurs on gentle slopes.

Dominant species of the community include the following:

Trees: *Eucalyptus albens* and *Callitris glaucophylla*.

Shrubs: *Acacia decora, Cassinia quinquefaria, Dodonaea viscosa, Notelaea microcarpa*.

Grasses: *Aristida jerichoensis, Aristida personata Bothriochloa macra, Chloris truncata, Cymbopogon refractus, Dichelachne micrantha, Digitaria brownii, Eragrostis leptostachya, Echinopogon caespitosus,* and *Panicum simile*.

Ground Covers: *Asperula conferta, Cheilanthes sieberi, Chrysocephalum semipapposum, Hydrocotyle laxiflora, Hypericum gramineum Lomandra longifolia, Mentha diemenica, Olearia elliptica, Pimelea neo-anglica, Pimelea simplex, Vittadinia muelleri,* and *Wahlenbergia communis*.

Equivalent Biometric Vegetation Type (DECCW, 2008): White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions.

Equivalent Keith Class/Keith Formation (Keith, 2004): Western Slopes Grassy Woodlands/ Grassy Woodlands.

Endangered Ecological Assessment: White Box Yellow Box Blakely's Red Gum Woodland.

Condition ranged was Moderate in the study area (Plate 3).

Plate 3. Community 3c: White Box Grassy Woodland Derived Native Pasture

3.1.4 Community 5. Bracteate Honeymyrtle Low Riparian Forest

Community 5 occurs along drainage lines and creek lines in the study area. It has three variants within the study area:

- Unit 5: Bracteate Honeymyrtle Low Riparian Forest;
- Unit 5b: Bracteate Honeymyrtle Low Riparian Forest Semi-cleared Regenerating; and
- Unit 5c: Bracteate Honeymyrtle Low Riparian Forest Derived Native Pasture.

Dominant species of the community include the following:

Trees: *Alphitonia excelsa, Brachychiton populneus, Callitris glaucophylla, Eucalyptus albens, Eucalyptus crebra*, and *Eucalyptus dealbata.*

Shrubs: *Acacia decora, Acacia salicina, Calotis lappulacea, Desmodium varians, Dichondra sp. A, Einadia nutans, Glycine tabacina, Lomandra longifolia, Maireana microphylla, Olearia elliptica.*

Grasses: *Aristida personata, Austrodanthonia racemosa, Austrostipa scabra, Austrostipa verticillata, Bothriochloa macra, Chloris truncata, Chloris truncata, Cymbopogon refractus, Cynodon dactylon, Eragrostis leptostachya* and *Microlaena stipoides.*

Groundcover: *Calotis cuneifolia, Calotis lappulacea, Cyperus eragrostis, Desmodium varians, Dichondra sp. A, Einadia nutans, Glycine tabacina, Hydrocotyle laxiflora, Lactuca saligna, Lomandra longifolia, Maireana microphylla, Olearia elliptica, Vittadinia cuneata* and *Vittadinia muelleri.*

Equivalent Biometric Vegetation Type (DECCW, 2008): River Oak riparian woodland of the Brigalow Belt South and Nandewar.

Equivalent Keith Class/Keith Formation (Keith, 2004): Eastern Riverine Forests/Forested Wetlands.

Condition ranged from Poor to Moderate in the study area (Plate 4).

Plate 4. Community 5: Bracteate Honeymyrtle Low Riparian Forest

3.1.5 Community 8c. Yellow Box - Blakely's Red Gum Derived Native Pasture

Community 8c occurs on the gentle slopes.

Dominant species of the community include the following:

Trees: *Eucalyptus blakelyi, Eucalyptus melliodora* and *Brachychiton populneus.*

Groundcover: *Acaena novae-zelandiae, Ajuga australis, Calotis lappulacea, Carex inversa, Centaurea solstitialis, Convolvulus graminetinus, Dianella revoluta, Dichondra sp. A, Fimbristylis dichotoma, Galium migrans, Geranium solanderi, Hibbertia obtusifolia, Hydrocotyle laxiflora, Hypericum gramineum, Mentha diemenica, Oncinocalyx betchei, Pimelea neo-anglica, Pimelea simplex, Scutellaria humilis, Senecio quadridentatus, Solanum parvifolium, Swainsona galegifolia, Vittadinia cuneata* and *Wahlenbergia communis.*

Grasses: *Austrodanthonia monticola, Austrodanthonia racemosa, Bothriochloa decipiens, Cymbopogon refractus, Dichelachne micrantha, Echinopogon ovatus, Eragrostis leptostachya, Microlaena stipoides, Poa sieberiana* and *Sporobolus creber*.

Equivalent Biometric Vegetation Type (DECCW, 2008): Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion.

Equivalent Keith Class/Keith Formation (Keith, 2004): Western Slopes Grassy Woodlands/ Grassy Woodlands.

Endangered Ecological Community: White Box Yellow Box Blakely's Red Gum Woodland.

Condition ranged from Moderate to Good (Plate 5).

Plate 5. Community 8c: Yellow Box – Blakely's Red Gum Derived Native Pasture

3.1.6 Community 9. River Oak – River Red Gum Riparian Forest

Community 9 occurs along lower creeks lines throughout the study area. The community has two variants within the study area:

- Unit 9 River Oak – River Red Gum Riparian Forest; and
- Unit 9c River Oak – River Red Gum Derived Native Pasture.

Dominant species of the community include the following:

Trees: *Angophora floribunda, Callitris glaucophylla, Eucalyptus albens* and *Eucalyptus camaldulensis.*

Grasses: *Aristida personata, Austrodanthonia racemosa, Austrostipa verticillata, Bothriochloa decipiens, Bothriochloa macra, Chloris truncata, Cymbopogon refractus, Dichelachne micrantha, Digitaria brownii, Enneapogon nigricans, Microlaena stipoides, Panicum simile, Paspalum dilatatum* and *Poa sieberiana*.

Groundcover: *Acaena novae-zelandiae, Asperula conferta, Calotis lappulacea, Cheilanthes sieberi, Convolvulus graminetinus, Desmodium brachypodum, Dichondra sp. A, Geranium solanderi, Hibbertia obtusifolia, Hydrocotyle laxiflora, Hypericum gramineum, Lomandra multiflora, Olearia elliptica, Swainsona galegifolia, Vittadinia cuneata, Vittadinia muelleri, Wahlenbergia communis* and *Wahlenbergia luteola*.

Equivalent Biometric Vegetation Type (DECCW, 2008): River Oak riparian woodland of the Brigalow Belt South and Nandewar.

Equivalent Keith Class/Keith Formation (Keith, 2004): Eastern Riverine Forests/Forested Wetlands.

Condition ranged from Poor to Moderate throughout the study area (Plate 6).

Plate 6. Community 9: River Oak – River Red Gum Riparian Forest

3.1.7 Community 10. Rough-barked Apple Open Forest

Community 10 occurs towards the center of the study area. The community has two variations within the study area:

- ❒ Unit 10 Rough-barked Apple Riparian Open Forest; and
- ❒ Unit 10a Rough-barked Apple Riparian Regeneration.

Dominant species of the community include the following:

Trees: *Angophora floribunda, Brachychiton populneus* and *Eucalyptus albens*.

Shrubs: *Acacia implexa, Acacia leiocalyx, Brachychiton populneus, Dodonaea viscosa* and *Notelaea microcarpa.*

Grasses: *Cymbopogon refractus, Panicum simile,* and *Poa sieberiana.*

Groundcover: *Ajuga australis, Asperula conferta, Acaena novae-zelandiae, Centaurea solstitialis, Carex inversa, Desmodium brachypodum, Desmodium varians, Dichondra repens, Eustrephus latifolius, Geranium solanderi, Hibbertia obtusifolia, Hydrocotyle laxiflora, Hydrocotyle peduncularis, Pimelea neo-anglica, Pimelea simplex, Sigesbeckia orientalis, Swainsona galegifolia, Vittadinia muelleri* and *Wahlenbergia communis*.

Equivalent Biometric Vegetation Type (DECCW, 2008): Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion.

Equivalent Keith Class/Keith Formation (Keith, 2004): New England Grassy Woodland/Grassy Woodlands.

Condition ranged from Poor to Moderate throughout the study area (Plate 7).

Plate 7. Community 10: Rough-barked Apple Open Forest

3.1.8 Community 11. Semi-evergreen Vine Thicket

Community 11 occurred predominantly within the deeper gully sections of the study area.

Dominant species of the community include the following:

Trees: *Angophora floribunda, Eucalyptus albens* and *Ficus rubiginosa.*

Shrubs: *Acacia implexa, Bursaria spinosa, Cassinia quinquefaria, Dodonaea viscosa and Notelaea microcarpa.*

Groundcover: *Adiantum aethiopicum, Carex incomitata, Cheilanthes sieberi, Commelina cyanea, Correa reflexa, Crassula sieberiana, Desmodium gunnii, Galium migrans, Hardenbergia violacea, Plectranthus graveolens, Sigesbeckia australiensis, Urtica incisa* and *Veronica calycina.*

Climbers/Vines: *Clematis glycinoides, Clematis microphylla, Pandorea pandorana, Eustrephus latifolius.*

Grasses: *Aristida personata, Austrodanthonia monticola, Cymbopogon refractus, Dichanthium sericeum, Dichelachne micrantha, Digitaria brownii, Microlaena stipoides* and *Paspalidium gracile*.

Equivalent Biometric Vegetation Type (DECCW, 2008): Semi-evergreen vine thicket of basalt hills of the NSW north-western slopes (Benson 147).

Equivalent Keith Class/Keith Formation (Keith, 2004): Dry Rainforests/Rainforests.

Endangered Ecological Community: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions.

Vegetation condition was Moderate (Plate 8).

Plate 8. Community 11: Semi-evergreen Vine Thicket

3.1.9 Community 12. Trachyte Outcrop Shrubland

Community 12 was recorded onto of a ridge towards the far eastern portion of the study area.

Dominant species of the community include the following:

Trees: *Callitris endlicheri* and *Eucalyptus dealbata.*

Shrubs: *Acacia cheelii, Cassinia quinquefaria, Dodonaea sinuolata, Kunzea sp. D, and Notelaea microcarpa.*

Groundcover: *Alstonia constricta, Arthropodium milleflorum, Cheilanthes distans, Cheilanthes sieberi, Commelina cyanea, Crassula sieberiana, Cyperus fulvus, Desmodium brachypodum, Fimbristylis dichotoma, Galium migrans, Geranium solanderi, Hypericum gramineum, Lomandra filiformis, Olearia elliptica, Pandorea pandorana, Phyllanthus subcrenulatus, Phyllanthus virgatus, Pimelea neo-anglica, Tripogon loliiformis, Vittadinia cuneata* and *Vittadinia muelleri*.

Equivalent Biometric Vegetation Type (DECCW, 2008): Heathy shrubland on granitic outcrops of the central and western New England Tablelands.

Equivalent Keith Class/Keith Formation (Keith, 2004): Northern Montane Heaths/ Heathlands.

Vegetation condition was Moderate to Good (Plate 9).

Plate 9. Community 12: Trachyte Outcrop Shrubland

3.1.10 Community 24. Red Stringybark Shrubby Open Forest Semi-Cleared and Regenerating

Community 24 is an open forest with a regenerating shrubs and ground layer.

Dominant species of the community include:

Trees: *Angophora floribunda, Callitris endlicheri, Eucalyptus macrorhyncha, Eucalyptus macrorhyncha, Eucalyptus blakelyi* and *Eucalyptus youmanii*.

Shrubs: *Notelaea microcarpa* and *Brachychiton populneus*.

Ground cover: *Dichondra sp. A, Lomandra longifolia, Olearia elliptica and Olearia viscidula*.

Grasses: *Austrodanthonia monticola, Austrodanthonia racemosa, Cymbopogon refractus, Microlaena stipoides* and *Poa sieberiana*.

Equivalent Biometric Vegetation Type (DECCW, 2008): Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest of the western New England Tablelands.

Equivalent Keith Class/Keith Formation (Keith, 2004): New England Grassy Woodlands/ Grassy Woodlands.

Vegetation condition was Moderate (Plate 10).

Plate 10. Community 24: Red Stringybark Shrubby Open Forest and Semi-cleared and Regenerating

3.1.11 Scald/Erosion

Areas of scald and erosion were recorded towards the north west of the study area. Scald and erosion are the result of high level of clearing practices and agricultural land use, which over time has caused an increase in salinity levels in the soil.

Native species were sporadically scattered throughout areas of scald and erosion.

Native species recorded include the following:

Trees/Shrubs: *Acacia decora, Callitris glaucophylla, Dodonaea viscosa, Eucalyptus albens, Eucalyptus crebra* and *Eucalyptus dealbata.*

Groundcover: *Acaena novae-zelandiae, Arctotheca calendula, Aster subulatus, Calotis lappulacea, Desmodium brachypodum, Lomandra longifolia, Maireana microphylla, Pimelea neo-anglica, Sida corrugata, Vittadinia cuneata* and *Wahlenbergia communis.*

Grasses: *Aristida calycina, Aristida personata, Austrodanthonia caespitosa, Austrostipa scabra, Austrostipa verticillata, Bothriochloa macra, Chloris truncata, Cymbopogon refractus, Dichanthium sericeum, Eragrostis leptostachya, Microlaena stipoides, Poa sieberiana* and *Sporobolus creber.*

Equivalent Biometric Vegetation Type (DECCW, 2008): N/A.

Equivalent Keith Class/Keith Formation (Keith, 2004): N/A.

Vegetation condition was Poor (Plate 11).

Plate 11. Scald and Erosion within Study Area

3.2 Flora Survey Results

The compiled plant list from all 83 floristic plots is provided in Appendix 3 of this report. A total of 282 species were recorded, including 50 weeds (17 percent [%]). A total of 70 plant families were recorded. Plant families with the highest number of recorded species include: Asteraceae (47 species), Poaceae (43 species), Fabaceae (27 species), and Myrtaceae (13 species). One threatened flora as listed as vulnerable on the TSC Act was recorded by Dr John Hunter during the field survey, Silky Swainson-pea (*Swainsona sericea*).

The weeds listed in Table 6 were recorded in the study area and are listed as noxious on the NW Act for the Gunnedah LGA. Although not prominent, the presence of these species has some implications for the on-going management of native vegetation within the study area. Recorded exotic species not listed as Noxious include: *Bidens pilosa, Bidens subalternans, Cirsium vulgare, Conyza bonariensis, Gomphocarpus fruticosus, Hypochaeris radicata, Lactuca saligna, Rosa rubiginosa* and *Verbena bonariensis*. These species were more prominent within the lower lying areas, gentle slopes and adjacent to creek lines within the study area.

Table 6. Noxious Weeds Recorded within the Study Area

Noxious Weed	Class	Legal requirements
Prickly pear [*Opuntia species*]	4	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed
St. John's wort [H*ypericum perforatum*]	3	The plant must be fully and continuously suppressed and destroyed
Xanthium species	4	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction

3.3 Fauna Survey Results

A total of 93 animal species were recorded during the surveys comprising five frogs, 61 birds, 22 mammals and five reptiles (Appendix 4). Feral species were relatively abundant in most parts of the study area, with goats, deer, pigs and foxes observed directly or indirectly. There was a rich bird assemblage encompassing a number of rare or threatened species indicative of the variety of habitat types throughout the study area.

3.3.1 Fauna Habitat

The study area comprised mostly of woodland and forest, which occurred in the hilly eastern section of the property. The lower lying floodplain areas in the north-west of the study area had been cleared and represented derived native grasslands. Habitats within the site vary according to landscape position and previous land use, although all areas have been exposed to heavy grazing and browsing by cattle and feral herbivores. The fauna habitat types within the study site included (Figure 5): woodland and forest, riparian, vine thicket, heathland, derived grassland, cypress regrowth and dams.

Riparian

Riparian vegetation is in moderate to good condition, with condition along Maules Creek increasing from north to south. Some very large (1.8 m diameter at breast height) Red Gum, Angophora and Allocasuarina trees occur occasionally along the creek and these contain some large hollows which are generally absent from other areas.

There are some areas or high weed infestation close to Maules Creek. Maules Creek has a range of aquatic values and is in moderate condition. The bed is predominantly stony or sandy with rocky bars present. There are a series of shallow pools and riffle zones. Instream woody debris are common and bank condition is good in most places, although cattle access, clearing and vehicle access has damaged banks in some areas. There are likely high nutrient loads present as evidenced by the presence of occasional algal mats.

Along smaller creeks the condition is generally poorer. Canopy cover along these watercourses is less continuous and they appear to have experienced higher disturbance. Tributaries to Maules Creek are ephemeral in nature and presently offer limited aquatic values. There are some well established large trees along the banks in some areas with large logs and small to medium hollow bearing trees and stags present occasionally. Aquatic macrophytes are generally absent.

This habitat type is comprised of vegetation communities 9, 10, 10a, 5 and 5b (Figure 3).

Native Grassland

The majority of land along the lower lying floodplain areas has previously been cleared and represented a derived native grassland. Within the south there is more advanced regeneration and apparently less frequent disturbance. In some areas there is a moderate concentration of small and medium hollow bearing trees and large logs, in other areas however these features are uncommon or absent. In general there is a lack of understorey and midstorey vegetation, likely owing to the presence of cattle and or introduced pests. A number of large erosion scalds were present within the native grasland in the west of the offset area.

This habitat type is comprised of vegetation communities 3c, 2c, 5c, 8c and 9c (Figure 3).

Cypress Regeneration

This habitat type occurred as small isolated patches, generally between the Grassland and Woodland habitats. Cypress Regeneration is dominated almost entirely by thick stands of

immature (3-5 m) White Cypress Pine. Structural layers are absent and the ground cover was mostly absent.

This habitat type is comprised of vegetation community 2a (Figure 3).

Woodland and Forest

These habitat types occurred in the eastern hilly sections of the study area contained moderate to good condition vegetation with occasional large logs and small and medium-sized hollows. Tree development and old trees with hollows are limited by the shallow soils. Rocky outcrops and surface rocks occur occasionally, although there is limited exfoliating rock. Shrubs and understorey vegetation is generally limited. There appears to be frequent disturbance by goats in these areas, which would diminish condition improvement.

The Forest habitat type is comprised of vegetation communities 1 and 2, and the Open Woodland habitat type is comprised of vegetation communities 2b and 24 (Figure 3).

Vine Thicket

The steep rocky outcrops scatted throughout the hills contained small areas of Vine Thicket at their base. These offer some additional habitat not present elsewhere, although they are highly populated and disturbed by goats.

This habitat type is comprised of vegetation community 11 (Figure 3).

Heathland

Heathland was recorded as a natural vegetation type on the top of ridges in the eastern portion of the study area. The vegetation within Heathland habitat on top of the ridges was very sparse, with the ground layer dominated by exposed rock.

This habitat type is comprised of vegetation communities 2e and 12 (Figure 3).

Dams

A number of small to medium sized farm dams containing water were scattered across the study area. Most of the dams are surrounded by agricultural or eroded land that is dominated by grasslands with some scattered trees present. Most of the dams had limited habitat value for vertebrate fauna, mostly frogs and water birds, as they lacked fringing or macrophytic vegetation.

Other Habitat Features

There is generally good connectivity throughout the site. There were limited flowering resources present at the time of field survey and this reflects the relatively low number of tree species present at the site. Previous clearing of undergrowth and stock access would have also limited the diversity and presence of shrubs which would contribute to greater and more perennial nectar resources. Aquatic resources beyond Maules Creek are generally absent with only occasional farm dams with poor habitat components offering additional aquatic habitat. Caves appear to be absent from the site, though some rock overhangs occur.

3.4 Threatened Biodiversity

3.4.1 Endangered Ecological Communities

Three vegetation communities within the study area are equivalent to EECs on the TSC or EPBC Acts:

- Semi-evergreen Vine Thicket is equivalent to *Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions* which is listed as Endangered under the TSC Act (vegetation community 11).
- Yellow Box - Blakely's Red Gum Derived Native Pasture is equivalent to *White Box Yellow Box Blakely's Red Gum Woodland* listed as Endangered under the TSC Act and Critically Endangered under the EPBC Act (vegetation communities 3c and 8c).
- White Box Grassy Woodland Derived Native Pasture is equivalent to *White Box Yellow Box Blakely's Red Gum Woodland* listed as Endangered under the TSC Act and Critically Endangered under the EPBC Act (vegetation community 3c).

Vegetation descriptions for each EEC are provided in Section 3.1.

The area each of these EECs occupy is provided in Section 4.4.

3.4.2 Threatened Flora

A total of 20 threatened flora listed on the TSC Act, or their habitats, were considered in this assessment (Appendix 1). One threatened plant species was recorded during the current survey; Silky Swainson-pea (*Swainsona sericea*). Of these 20 species, *Pomaderris queenslandica, Dichanthium setosum* and *Thesium australe* are considered to have a moderate likelihood of occurrence within the study area (Table 7).

One threatened flora species, *Swainsona sericea* was recorded in the study area (Table 7; Figure 6).

Table 7. Threatened Flora Recorded or Likely to Occur in the Study Area

Species	EPBC Act	TSC Act	Likelihood of Occurrence
Pomaderris queenslandica	-	E	Moderate
Dicanthium setosum	V	V	Moderate
Swainsona sericea (Silky Swainson-pea)	-	V	Recorded
Thesium australe (Austral Toadflax)	V	V	Moderate

Pomaderris queenslandica has potential to occur in the study area. The species has been reported by Royal Botanic Gardens Sydney and OEH to occur in Leard State Forest and Mount Kaputar National Park. The species has potential to occur within Red Stringybark Shrubby Open Forest, Rough-barked Apple Riparian Open Forest and Semi-evergreen Vine Thicket in the study area.

Dicanthium setosum has potential to occur within disturbed areas such as regenating and open woodland, grassy roadside remnants and disturbed pasture within the study area.

Thesium australe occurs in small populations scattered across the western slopes, tablelands and coast of NSW. The species has been recorded in Mount Kaputar National Park. Potential habitat exists in the dry sclerophyll forests within the study area.

3.4.3 Threatened Fauna

A total of 56 threatened fauna species were highlighted from a review of relevant databases (Appendix 1). A total of 29 of these species listed under the TSC Act are considered to have a moderate to known likelihood of occurrence within the study area.

A total of 10 threatened species were recorded during the current survey comprising bird and bat species, although not all were recorded within the study are or immediate surrounds (Figure 6). Fifteen threatened vertebrate fauna species were located during a field survey of the adjacent Willeroi West property (Cenwest, 2011). A total of 29 species (Table 8) are considered to have a moderate to high likelihood of occurrence within the study area either because of nearby records from the Atlas of NSW Wildlife or because they were recorded from recent surveys adjacent to the study area (Cenwest, 2011) and have potential habitat within the study area.

Table 8. Threatened Fauna Recorded or with a Moderate to High Likelihood of Occurrence within the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Location	Comments
Reptiles					
Underwoodisaurus sphyrus	Border Thick-tailed Gecko	V	V	Willeroi West	Recorded under granite exfoliation at Willeroi West (Cenwest, 2011).
Birds					
Melithreptus gularis gularis	Black-chinned Honeyeater	V	-	Willeroi West	Recorded near southern boundary of Willeroi West property (Cenwest, 2011).
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	Study Area/ Willeroi West	Single sighting outside of site study area approximately 1.3 km away along access road. Recorded at several locations at Willeroi West (Cenwest, 2011).
Stagonopleura guttata	Diamond Firetail	V	-	Study Area/ Willeroi West	Widespread over site the study area observed relatively frequently. Recorded at Willeroi West property (Cenwest, 2011).
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	Willeroi West	Six observed near Maules Creek in Willeroi West (Cenwest, 2011).
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	Study Area/ Willeroi West	Two sightings one on site in northern part, uncommon. Recorded in Willeroi West property (Cenwest, 2011).
Glossopsitta pusilla	Little Lorikeet	V	-	Study Area/ Willeroi West	Up to twelve birds observed on one occasion feeding on white box flowers, which were sparse. Also observed flying over sitethe study area. Recorded in WIlleroi West (Cenwest, 2011).
Pyrrholaemus saggitatus	Speckled Warbler	V	-	Study Area	Observed once on hillslopes in a mixed flock of woodland birds in the study area.

Scientific Name	Common Name	TSC Act	EPBC Act	Location	Comments
Neophema pulchella	Turquoise Parrot	V	-	Study Area/ Willeroi West	Observed flying around site relatively frequently commonly encountered on access road in study area. Widespread. This species appeared to be widespread across the Willeroi West property (Cenwest, 2011).
Daphoenositta Chrysoptera	Varied Sittella	V	-	Willeroi West	Recored in Willeroi West near Maules Creek (Cenwest, 2011).
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	N/A	Moderate – some foraging habitat available.
Hieraaetus morphnoides	Little Eagle	V	-	N/A	Moderate – scattered records around study area
Ninox connivens	Barking Owl	V	-	N/A	Moderate – regional records
Tyto novaehollandiae	Masked Owl	V	-	N/A	Moderate – potential occasional foraging though low density of prey species.
Grantiella picta	Painted Honeyeater	V	-	N/A	Moderate – potential foraging habitat but not recorded during recent survey.
Anthochaera phrygia	Regent Honeyeater	CE	E,M	N/A	Moderate – not recorded during survey but highly mobile in response to seasonal flowering.
Circus assimilis	Spotted Harrier	V	-	N/A	Moderate – potential foraging habitat could be used irregularly, recorded outside of study area (10 km).
Lophoictinia isura	Square-tailed Kite	V	-	N/A	Moderate – potential foraging habitat could be used irregularly.
Mammals					
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	V	-	Study Area/ Willeroi West	Recorded from forested hillslopes within the study area, and recorded by Cenwest (2011) in Willeroi West.
Vespadelus troughtoni	Eastern Cave Bat	V	-	Study Area/ Willeroi West	Recorded from forested hillslopes within the study area. Recorded in WIlleroi west (Cenwest, 2011).
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Willeroi West	Recorded with low confidence at Willeroi west (Cenwest, 2011).
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Study Area/ Willeroi West	Recorded from forested hillslopes within the study area. Recorded with low confidence at Willeroi west (Cenwest, 2011).
Mormopterus norfolkensis	Eastern Free-tail bat	V	-	Willeroi West	Recorded in Willeroi west (Cenwest, 2011).
Petaurus norfolcensis	Squirel Glider	V	-	Willeroi West	One record near southern boundary of WIlleroi West (Cenwest, 2011).
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	N/A	Moderate – could use study area for seasonal foraging.
Phascolarctos cinereus	Koala	V	V	N/A	Moderate – some preferred feed trees present or move through habitat. Records around study area moderately common.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	N/A	Moderate – records from around study area and wide ranging foraging possible.
Nyctophilus corbeni/ timorensis	South-eastern/Greater Long-eared Bat	V	V	N/A	Moderate – records around study area moderately common. Nyctophylus sp. recorded during survey.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	N/A	Moderate – records around study area moderately common, widely foraging species

Potential habitat has been mapped on Figures 5 to 15 for those threatened species listed in Table 8. Species have been grouped to similar habitat requirements.

4 VEGETATION COMPARISON WITH THE PROJECT

4.1 Comparison of Physical Characteristics between Willeroi East and the Project

A comparison between features of the study area and the Project are displayed in Table 9.

Both properties are located within the Gunnedah LGA within the Namoi CMA. The Project is located approximately 20 km to the south-west of Willeroi East.

Willeroi East is significantly higher in altitude than the Project, which affects its weather, especially rainfall and temperature. Willeroi East is expected to have higher rainfall than the Project and lower temperatures.

There are also differences in topography with Willeroi East having steeper, more dissected terrain over much of its area.

Table 9. Comparison of Physical Features between Willeroi East and the Project

Feature	Willeroi East	The Project
Altitude	400-850 m AHD.	250-340 m AHD.
Temperature	Mean maximum of 24.4 degrees Celsius (°C) per annum. Mean minimum of 8.3°C per annum.	Mean maximum of approx. 24.5°C per annum. Mean minimum of 12.1°C per annum.
Geology	Early to middle carboniferous sediments and volcanic.	Quaternary and Permian sediments.
Topography	Gently undulating to rugged.	Flat to undulating.
Soil Characteristics	Skeletal soils on hills with exposed bedrock; deeper soils on lower slopes and valley floors. Generally clay soils, but with stones on conglomerate substrates ((Pratt, 1998).	Relatively deep soils with and without pebbles and stones. Light dispersive soils on Permian substrates to heavier soils on Quaternary sediments.
LGA	Gunnedah.	Gunnedah.
CMA	Namoi.	Namoi.

4.2 Flora Species

The compiled plant list from all 83 floristic plots is provided in Appendix 3 of this report. A total of 282 species were recorded at Willeroi East, including 50 introduced species (21.5%). One threatened flora species was recorded during the field survey, Silky Swainson-pea (*Swainsonia sericea)*.

A total of 313 flora species from 34 floristic plots were recorded from the Project, including 74 introduced species (24%). Winged Peppercress (*Lepidium monoplocoides*), which is listed as endangered on the TSC and EPBC Acts, was the only threatened plant species recorded in the Project study area. A patch of 46 individuals of this species would be impacted, but 420 individuals are being offset on the Canyon Mine site, 2 km north-west of the Project. A comparison of these of recorded flora species is detailed in Table 10.

Table 10. Comparison of Recorded Flora Species

Feature	Willeroi East	The Project
Flora species recorded	282 species across 83 floristic plots.	313 species across 84 floristic plots.
Recorded threatened flora species	*Swainsonia sericea*	*Lepidium monoplocoides* (46 individuals counted).
Potential habitat for threatened flora species	Three threatened flora species have been given a moderate likelihood of occurrence.	Seven threatened flora species have been given a moderate to high likelihood of occurrence.
Weeds/Introduced species	50 introduced species (21.5% of species recorded).	74 introduced species (24% of species recorded).
Noxious weeds for the Gunnedah LGA	Three declared weeds were recorded. Two are listed as Category 4 weeds, and one Category 3.	Five declared weeds were recorded. Each of theses species is a Category 4 weed.

4.3 Comparison of Fauna and Habitat

Fauna recorded during the current survey is provided in Appendix 4 of this report. A total of 93 species were recorded. A total of 10 of the species were listed as threatened species under the TSC Act.

A total of 130 fauna species were recorded from the Project mining area, including 15 listed as threatened species under the TSC and EPBC Acts.

Eight habitat types were identified within the study area with woodland and forest habitat dominating Willeroi East. Nine broad habitat types were identified at the Project mining area and were dominated by native and exotic grassland, with disturbed woodlands and forest representing approximately a third of the disturbance area. It should be noted that the habitat at Willeroi East was generally of much better quality than the Project, the Project habitat being heavily disturbed by grazing and clearing.

Considering the results of field surveys, similar habitat types and close proximity between Willeroi East and the Project sites, it is considered that a very similar suite of threatened species or their habitat occurs at both sites. Although the Project contained two large dams (wetlands) and these are not represented at Willeroi East, they were of poor quality, being surrounded by cleared farmland land lacking macrophyitic vegetation.

A comparison of these of recorded fauna species and habitat is detailed in Table 11.

Table 11. Comparision of Recorded Fauna and Habitat

Feature	Willeroi East	The Project
Fauna species recorded	A total of 93 animal species were recorded during the surveys comprising five frogs, 61 birds, 22 mammals and five reptiles	One hundred and thirty vertebrate animal species were recorded during the field surveys including one fish, 10 frogs, five reptiles, 88 birds and 26 mammals.
Threatened fauna recorded	A total of 10 threatened fauna species were recorded at Willeroi East. Fifteen species were recorded at Willeroi West (Cenwest Environmental Services, 2011).	Ten threatened fauna species have been recorded at the Project.
Potential habitat for threatened fauna species	Sixteen threatened fauna species have been given a moderate likelihood of occurrence and 10 species have a known rating.	Twenty threatened fauna species have been given a moderate to high likelihood of occurrence and 10 species a known rating.
Fauna habitat recorded	Riparian, native grassland, cypress regeneration, open woodland and forest, vine thicket, Shrubland and dams.	Derived woodland, grassy woodland, cypress regeneration, grasslands, Shrubland, sedgeland and dams.

4.4 Comparison of Vegetation Communities

Vegetation communities at the Willeroi East and the Project are shown in Table 12.

Willeroi East contains 19 vegetation types, comprising of 10 parent types, whereas the Project contains 14 vegetation types and 7 parent types.

Both the sites share the following vegetation communities in common:

- Community 2a. White Box - White Cypress Pine Cypress Regeneration;
- Community 2b. White Box - White Cypress Pine Semi-cleared; and
- Community 2c. White Box - White Cypress Pine Derived Native Pasture.

However, the dominant vegetation types for each site differed. Dominant vegetation types at Willeroi East included:

- Community 1. Narrow-leaved Ironbark – White Cypress Pine Shrubby open forest (418 ha); and
- Community 2b. White Box - White Cypress Pine Semi-cleared (567 ha).

The Project does not contain any of the Community 1 vegetation, and 107 ha of Community 2b vegetation.

The majority of vegetation at the Project consists of:

- Community 2c. White Box - White Cypress Pine Derived Native Pasture (488 ha); and
- Community 20c. Poplar Box Grassy Woodland Derived Native Pasture (628 ha).

Noting that these two dominant communities are derived grasslands and not woodland, Willeroi East does not contain Community 2c.

Table 12.Vegetation Communities at Willeroi East and the Project

Veg Code	Vegetation Community	EEC	The Project (ha)	Willeroi East (ha)
1	Narrow-leaved Ironbark - White Cypress Pine Shrubby open forest	Not an EEC	0	418
2	White Box - White Cypress Pine Shrubby Woodland	Not an EEC	0	50
2a	White Box - White Cypress Pine Cypress Regeneration	Not an EEC	188	121
2b	White Box - White Cypress Pine Semi-cleared	Not an EEC	107	567
2c	White Box - White Cypress Pine Derived Native Pasture	Not an EEC	488	72
2e	White Box - White Cypress Pine Derived Shrubland	Not an EEC	0	22
2f	White Box - White Cypress Pine Mature Cypress Forest	Not an EEC	9	0
3	White Box Grassy Woodland	White Box Yellow Box Blakely's Red Gum Woodland	3	0
3c	White Box Grassy Woodland Derived Native Pasture	White Box Yellow Box Blakely's Red Gum Woodland	0	136
5	Bracteate Honeymyrtle Low Riparian Forest	Not an EEC	0	36
5b	Bracteate Honeymyrtle Low Riparian Forest Semi-cleared Regenerating	Not an EEC	0	24
5c	Bracteate Honeymyrtle Low Riparian Forest Derived Native Pasture	Not an EEC	0	13
7b	Silver-leaved Ironbark - White Box - White Cypress Pine Semi-cleared	Not an EEC	80	0
7c	Silver-leaved Ironbark - White Box - White Cypress Pine Derived Native Pasture	Not an EEC	165	0
7e	Silver-leaved Ironbark - White Box - White Cypress Pine Mature Cypress Woodland	Not an EEC	25	0
8	Yellow Box - Blakely's Red Gum Grassy Woodland	White Box Yellow Box Blakely's Red Gum Woodland	3	0
8c	Yellow Box - Blakely's Red Gum Derived Native Pasture	White Box Yellow Box Blakely's Red Gum Woodland	0	20
9	River Oak – River Red Gum Riparian Forest	Not an EEC	0	19
9c	River Oak – River Red Gum Derived Native Pasture	Not an EEC	0	7

Veg Code	Vegetation Community	EEC	The Project (ha)	Willeroi East (ha)
10	Rough-barked Apple Riparian Open Forest	Not an EEC	0	3
10a	Rough-barked Apple Riparian Regeneration	Not an EEC	0	10
11	Semi-evergreen Vine Thicket	Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	0	19
12	Trachyte Outcrop Shrubland	Not an EEC	0	10
19c	Plains Grass – Blue Grass Derived Native Pasture	Not an EEC	3	0
20a	Poplar Box Grassy Woodland Derived Woodland	Not an EEC	46	0
20c	Poplar Box Grassy Woodland Derived Native Pasture	Not an EEC	628	0
21	Weeping Myall Low Shrubland	Weeping Myall Woodlands	1	0
22	Mixed Marsh Sedgeland	Not an EEC	2	0
24	Red Stringybark Shrubby Open Forest Semi-cleared and Regenerating	Not an EEC	0	97
Se	Scald Erosion	Not an EEC	0	27
		Total	1,748	1,671

4.5 Comparison of EECs

EECs recorded within Willeroi East and the Project are shown in Table 13.

Two EECs were recorded at both Willeroi East and the Project.

Both sites contained White Box Yellow Box Blakely's Red Gum Woodland. Approximately 6 ha was recorded at the Project, compared to 156 ha at Willeroi East.

The Project contained 1 ha of Weeping Myall Woodlands, whilst Willeroi East contained 19 ha of Semi-evergreen Vine Thicket.

White Box Yellow Box Blakely's Red Gum Woodland and Semi-evergreen Vine Thicket at Willeroi East were overall in moderate condition. White Box Yellow Box Blakely's Red Gum Woodland at the Project was in moderate condition whilst Weeping Myall Woodlands ranged from poor to moderate.

Table 13. EECs Recorded at Willeroi East and the Project

Veg Code	Vegetation Community	EEC	The Project (ha)	Willeroi East (ha)
3	White Box Grassy Woodland	White Box Yellow Box Blakely's Red Gum Woodland	6	156
3c	White Box Grassy Woodland Derived Native Pasture			
8	Yellow Box - Blakely's Red Gum Grassy Woodland			
8c	Yellow Box - Blakely's Red Gum Derived Native Pasture			
11	Semi-evergreen Vine Thicket	Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	0	19
21	Weeping Myall Low Shrubland	Weeping Myall Woodlands	1	0
		Total	7	175

5 RECOMMENDATIONS

5.1 Key Management Actions

Management actions required for the site include exclusion of cattle, particularly from the creeks, and management control of feral goats, pigs and deer. Goats are the most predominant feral animal on the site but are limited to the slopes. Deer and pigs would graze and root in lower areas, but appear to be in lower numbers. A combined program to mange feral animals simultaneously would be the most efficient form of management. There would also likely be benefits of fox baiting within the site, though fox numbers do not appear to be currently high.

There are several areas of weed infestations and key weeds such as Coolatai grass could potentially be actively managed before they expand. Removal of grazing cattle and ferals and consequent regrowth of midstorey and canopy vegetation would assist in reducing weed spread. A detailed Biodiversity Management Plan would be required for the site as part of the offset package.

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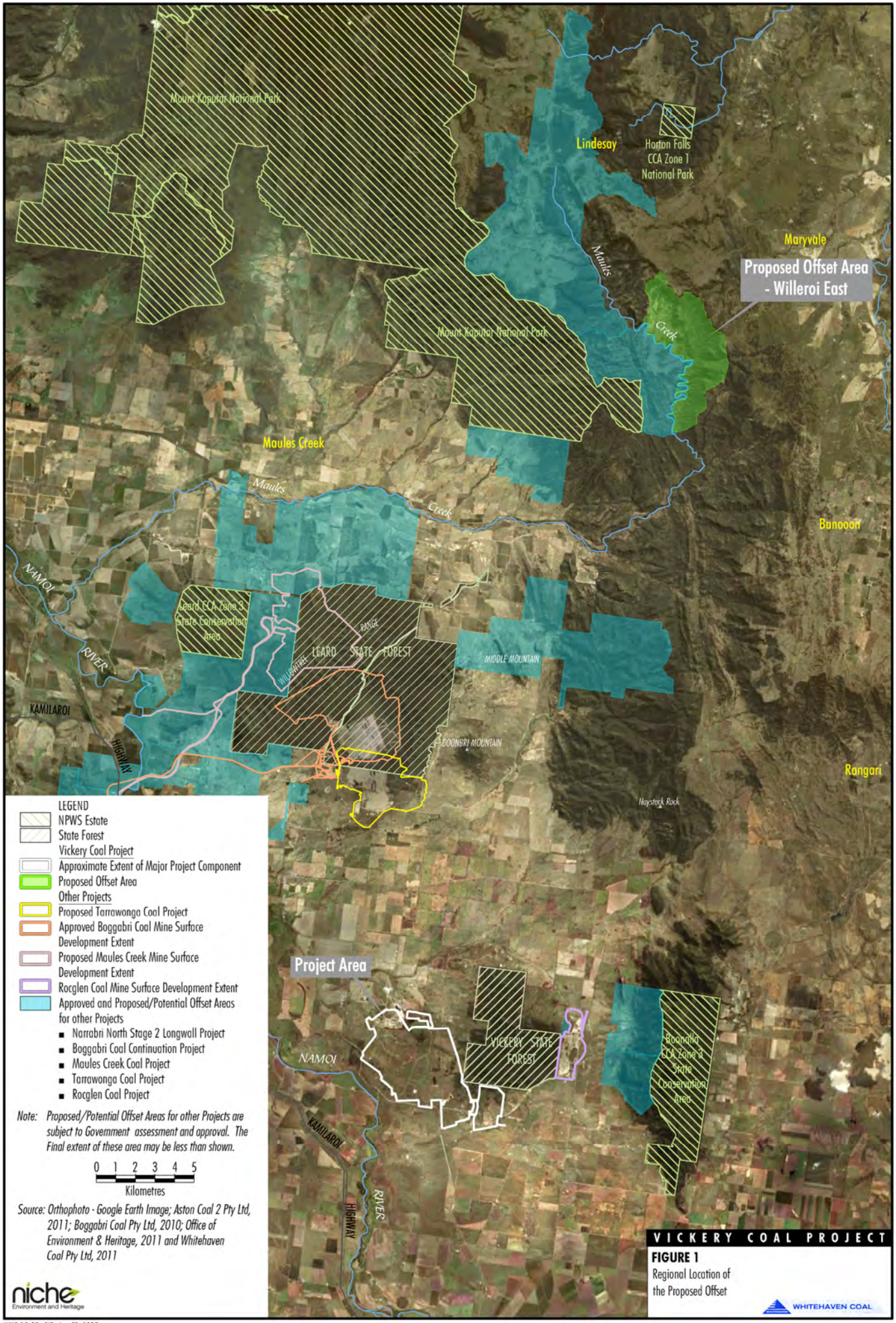
FIGURES



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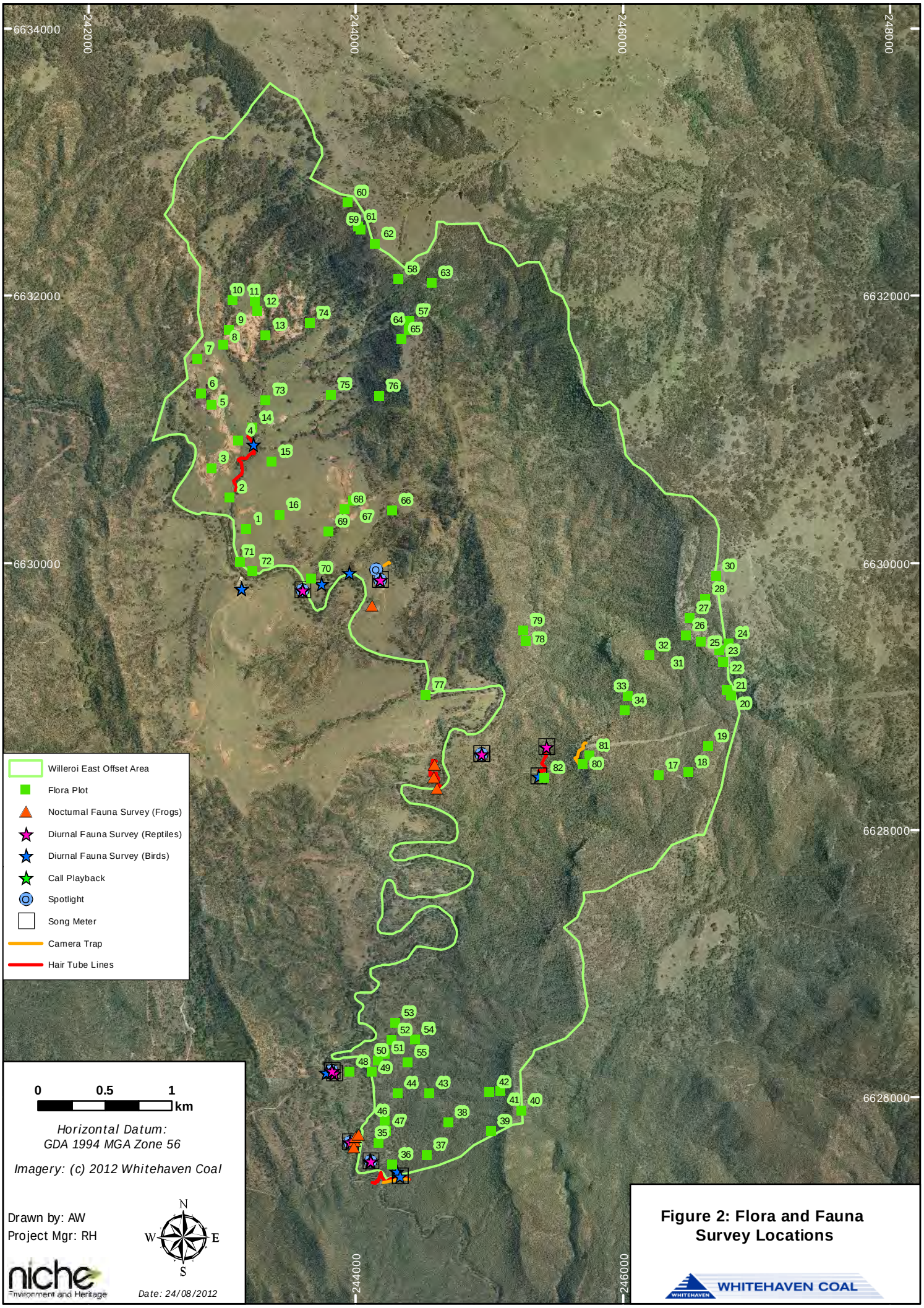

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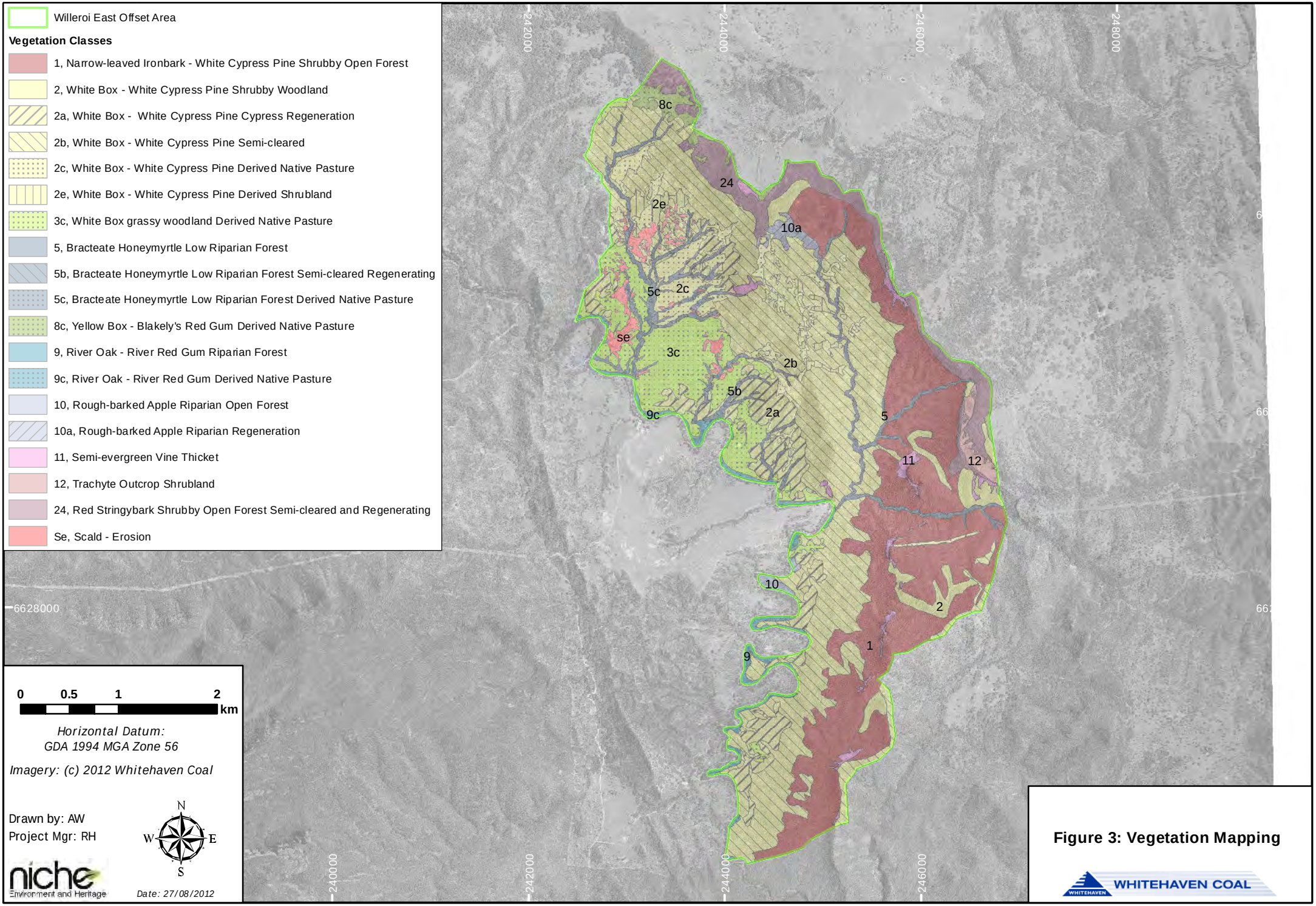

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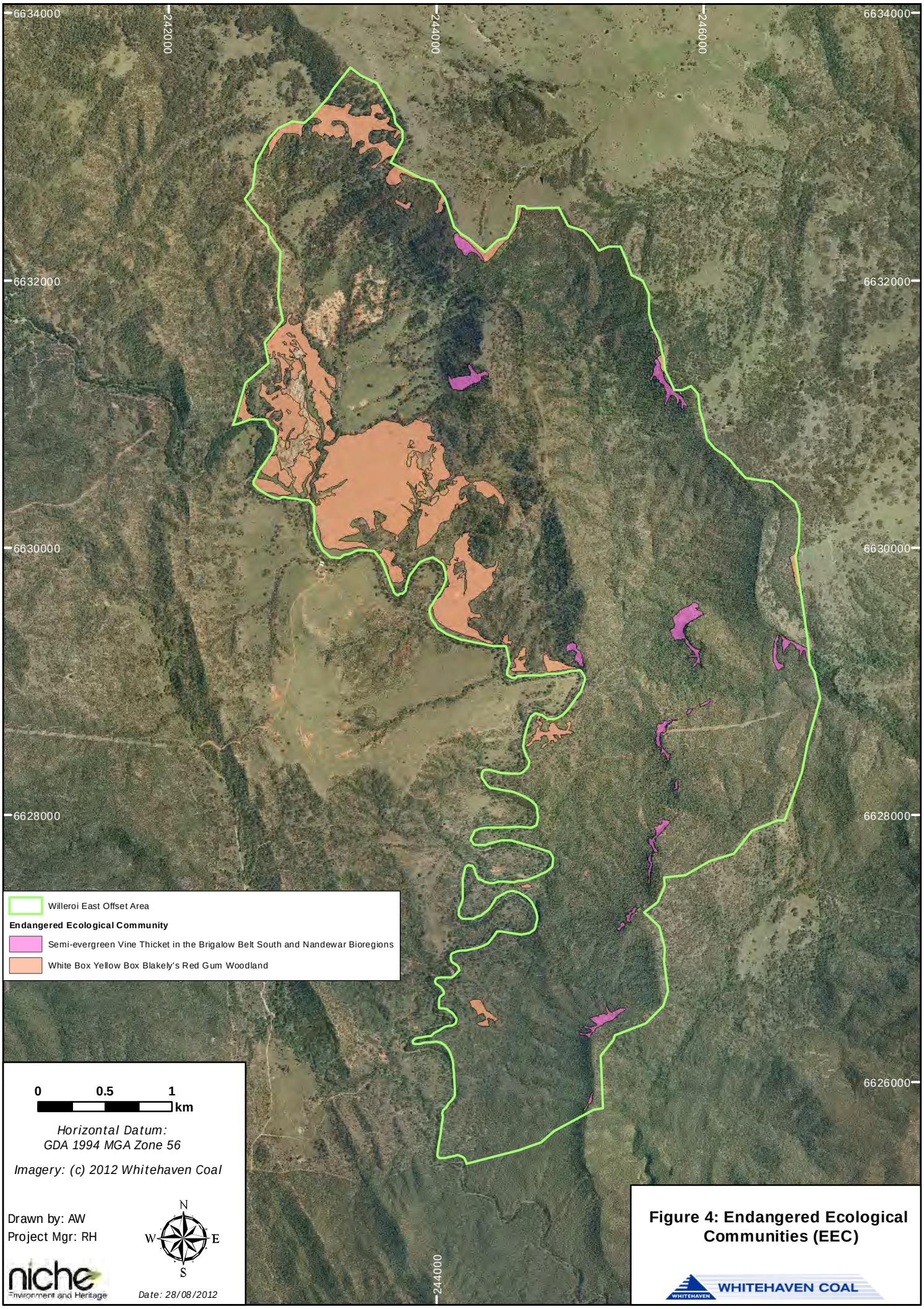

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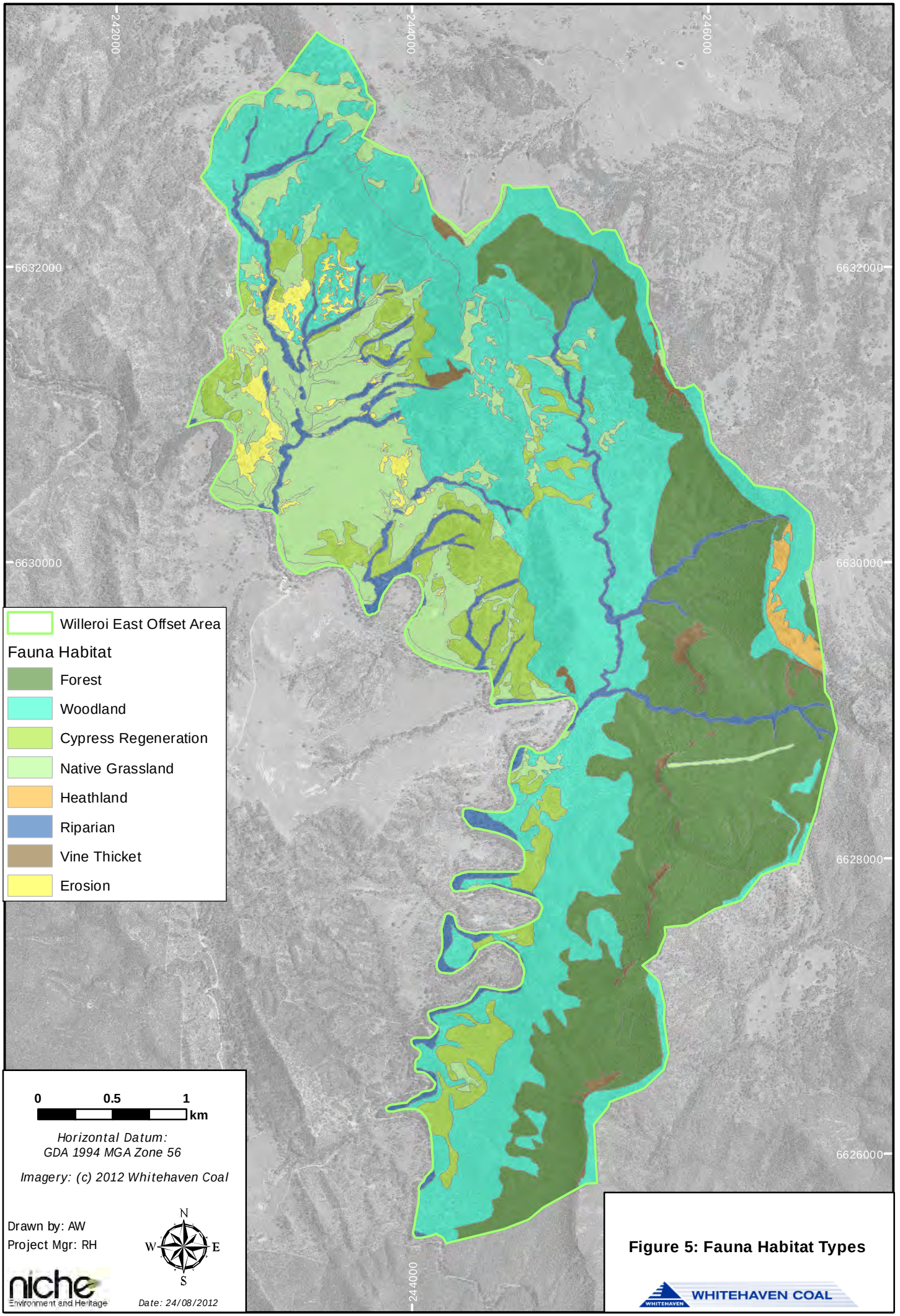

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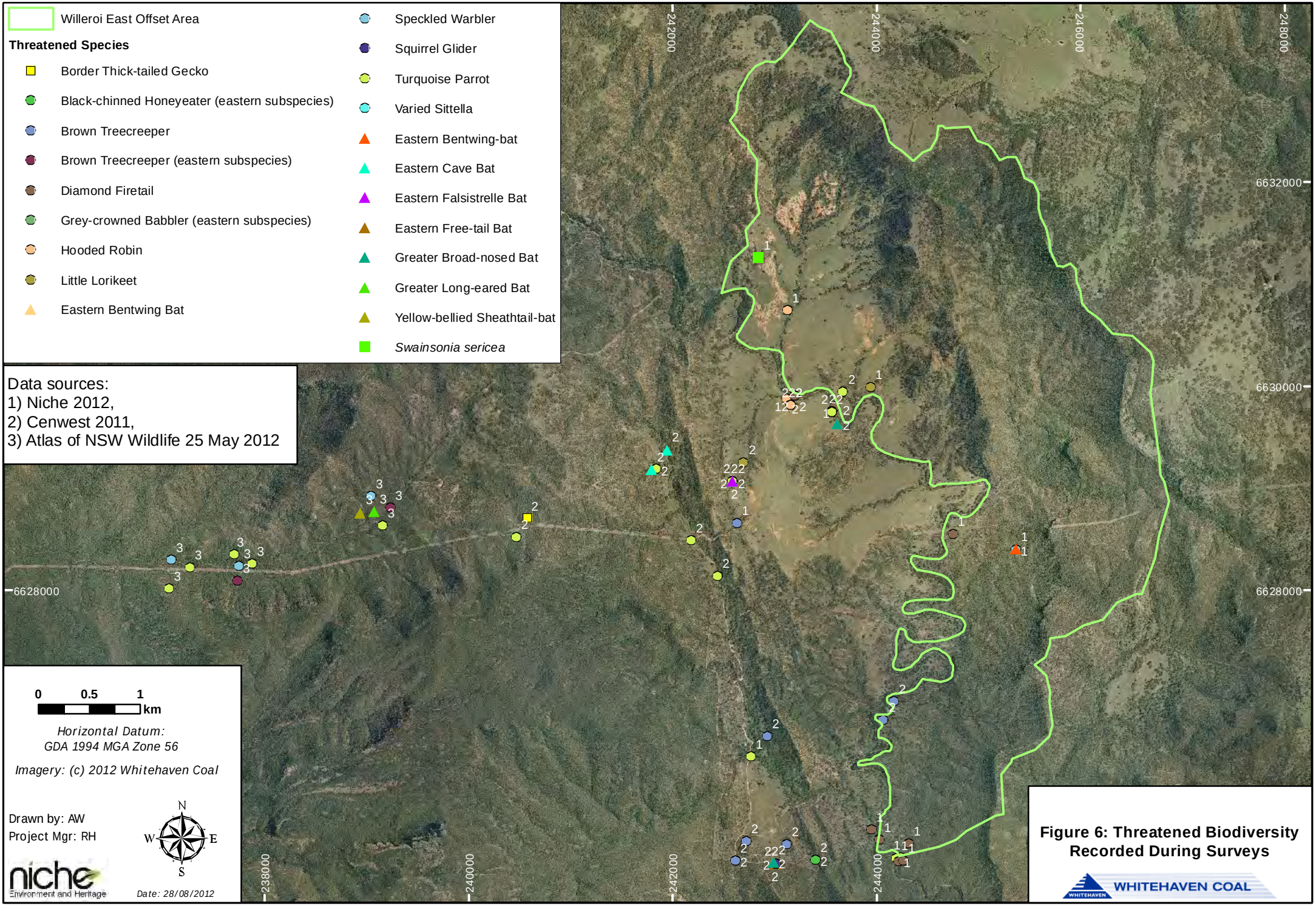

Figure 6: Threatened Biodiversity Recorded During Surveys

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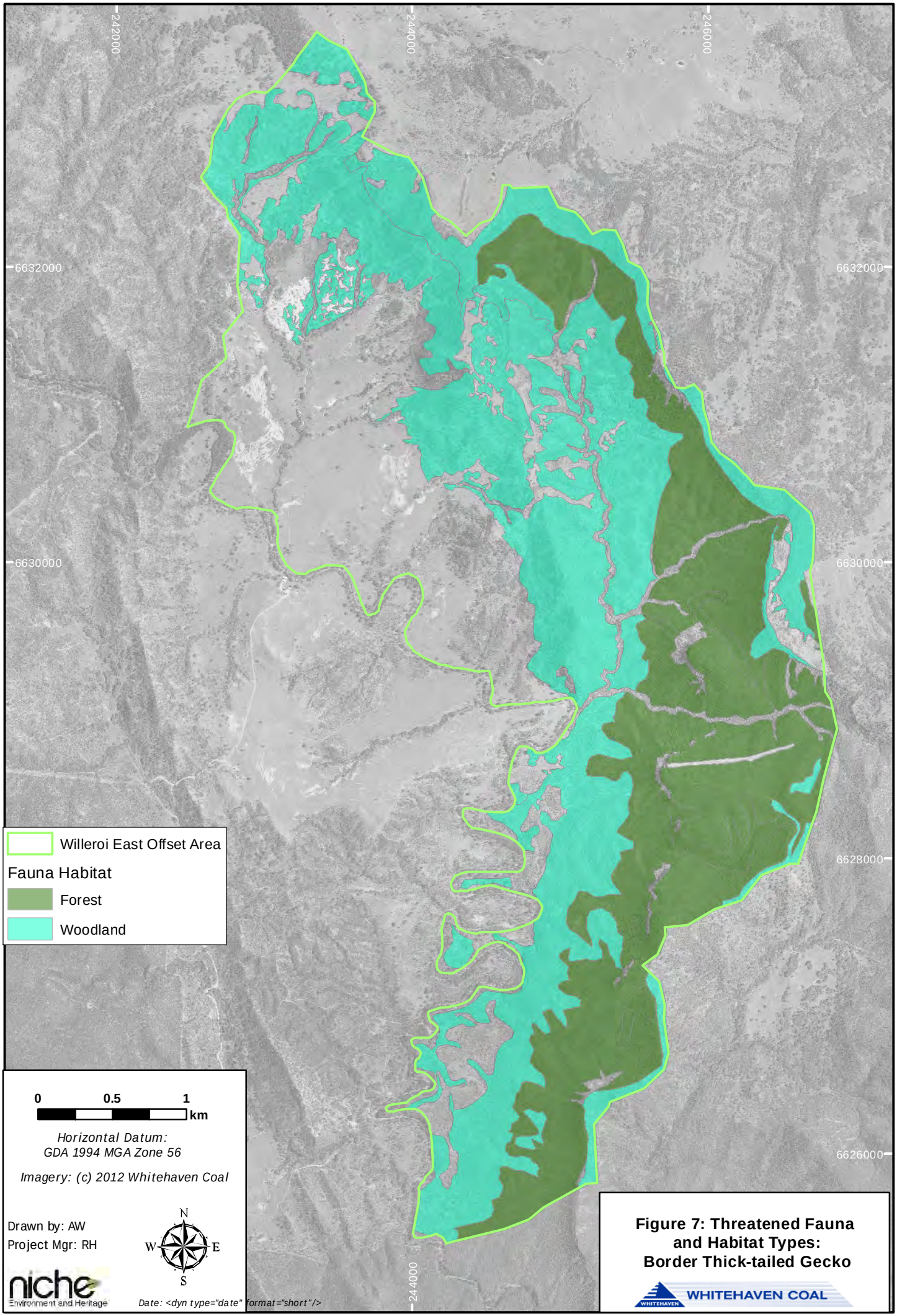

Figure 7: Threatened Fauna and Habitat Types: Border Thick-tailed Gecko

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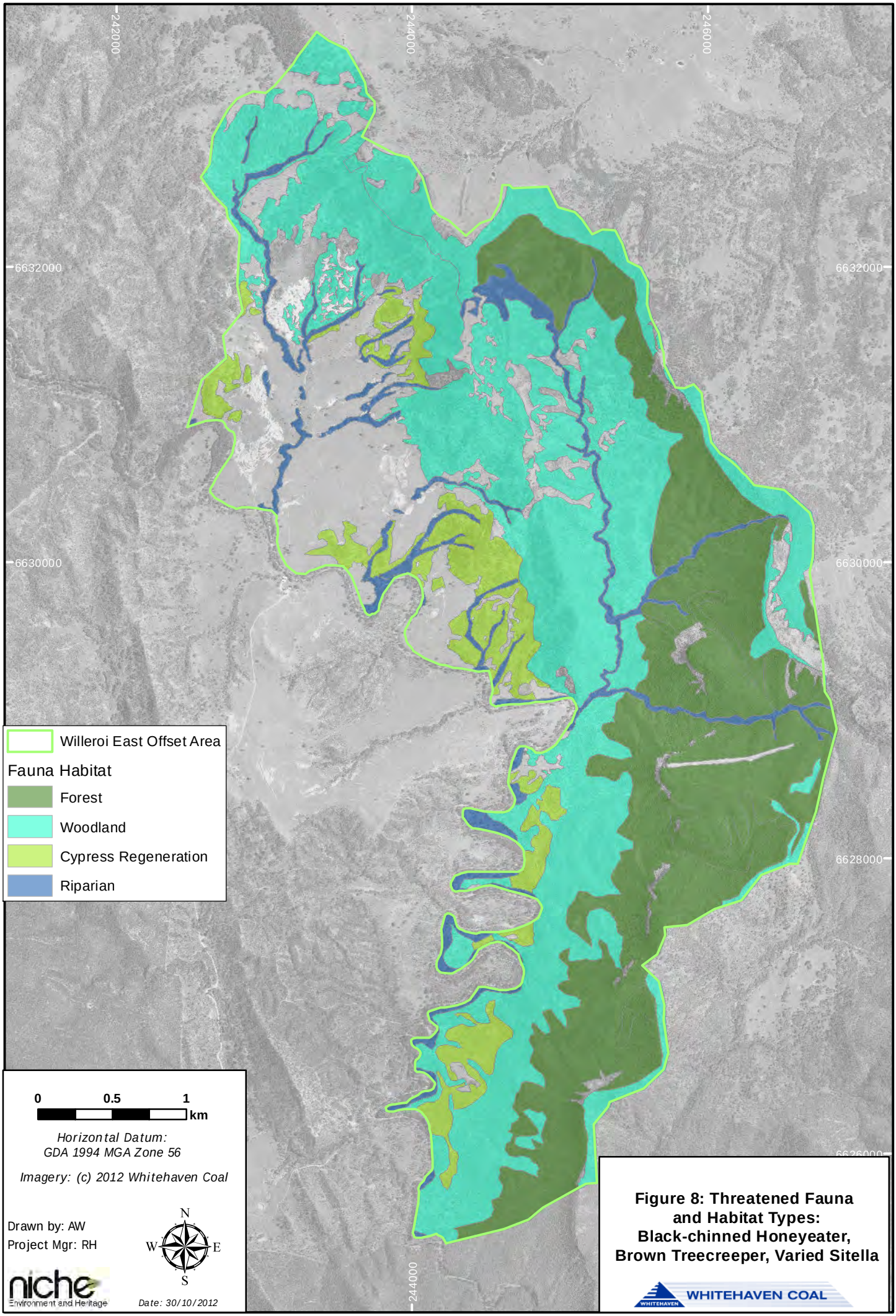

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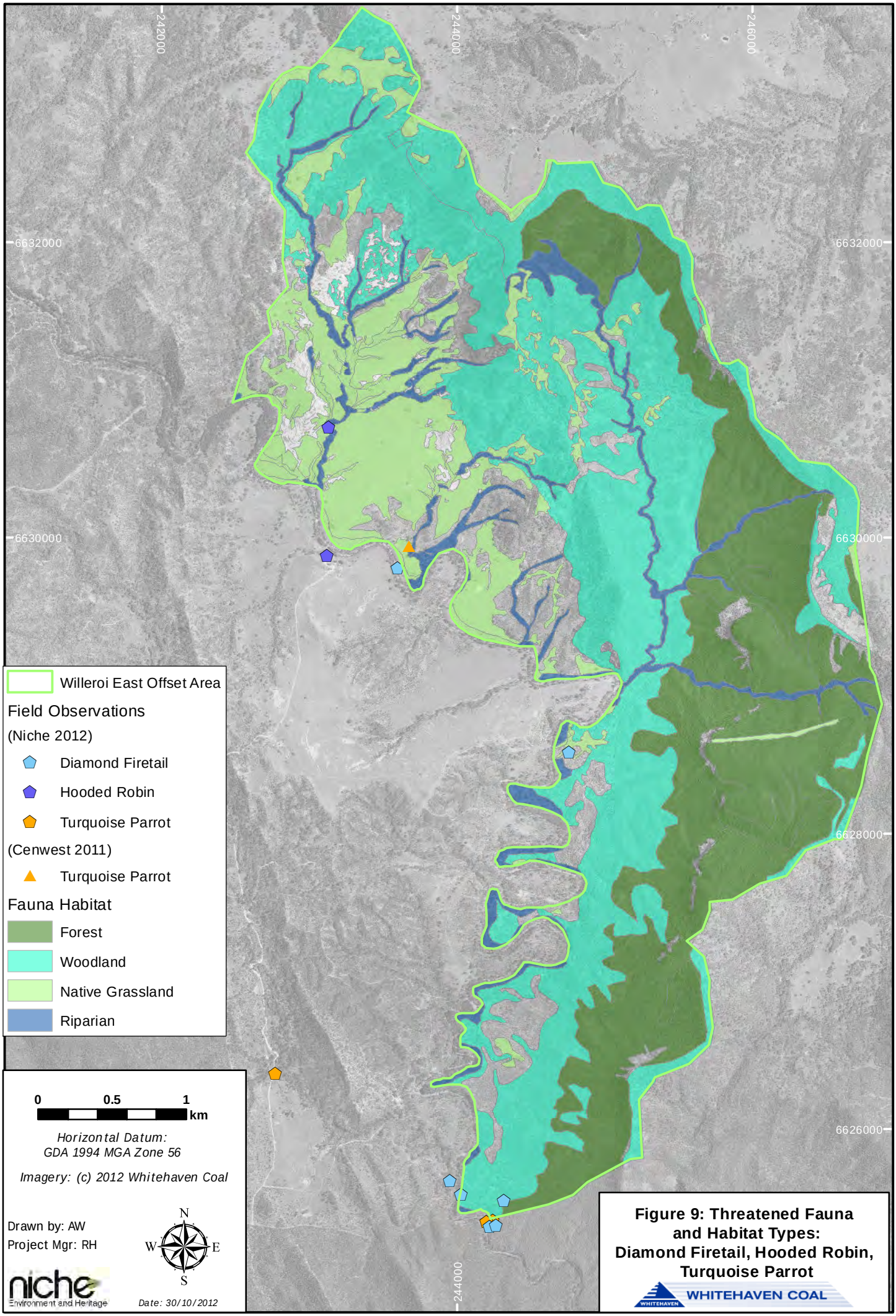

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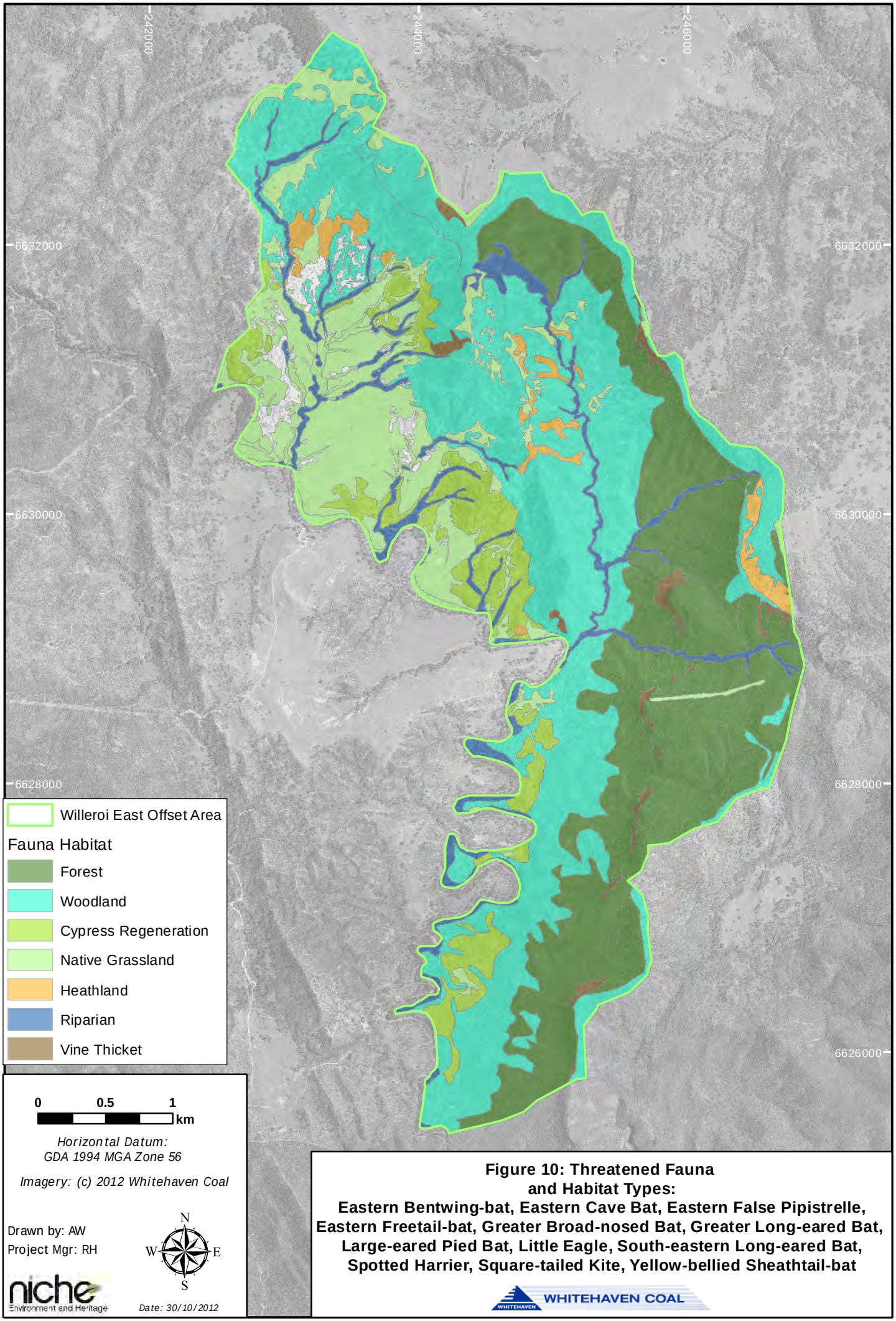

Figure 10: Threatened Fauna and Habitat Types: Eastern Bentwing-bat, Eastern Cave Bat, Eastern False Pipistrelle, Eastern Freetail-bat, Greater Broad-nosed Bat, Greater Long-eared Bat, Large-eared Pied Bat, Little Eagle, South-eastern Long-eared Bat, Spotted Harrier, Square-tailed Kite, Yellow-bellied Sheathtail-bat

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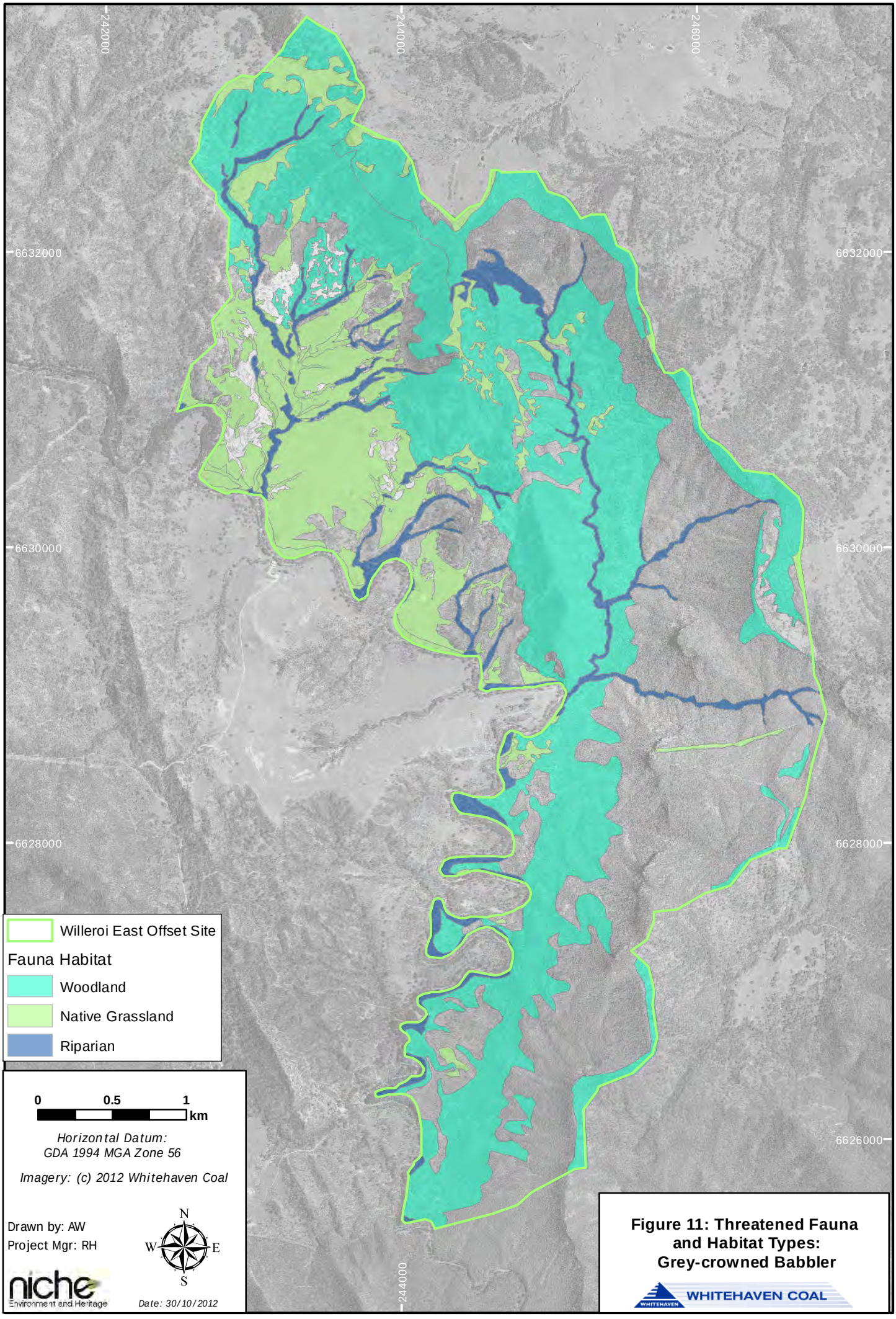

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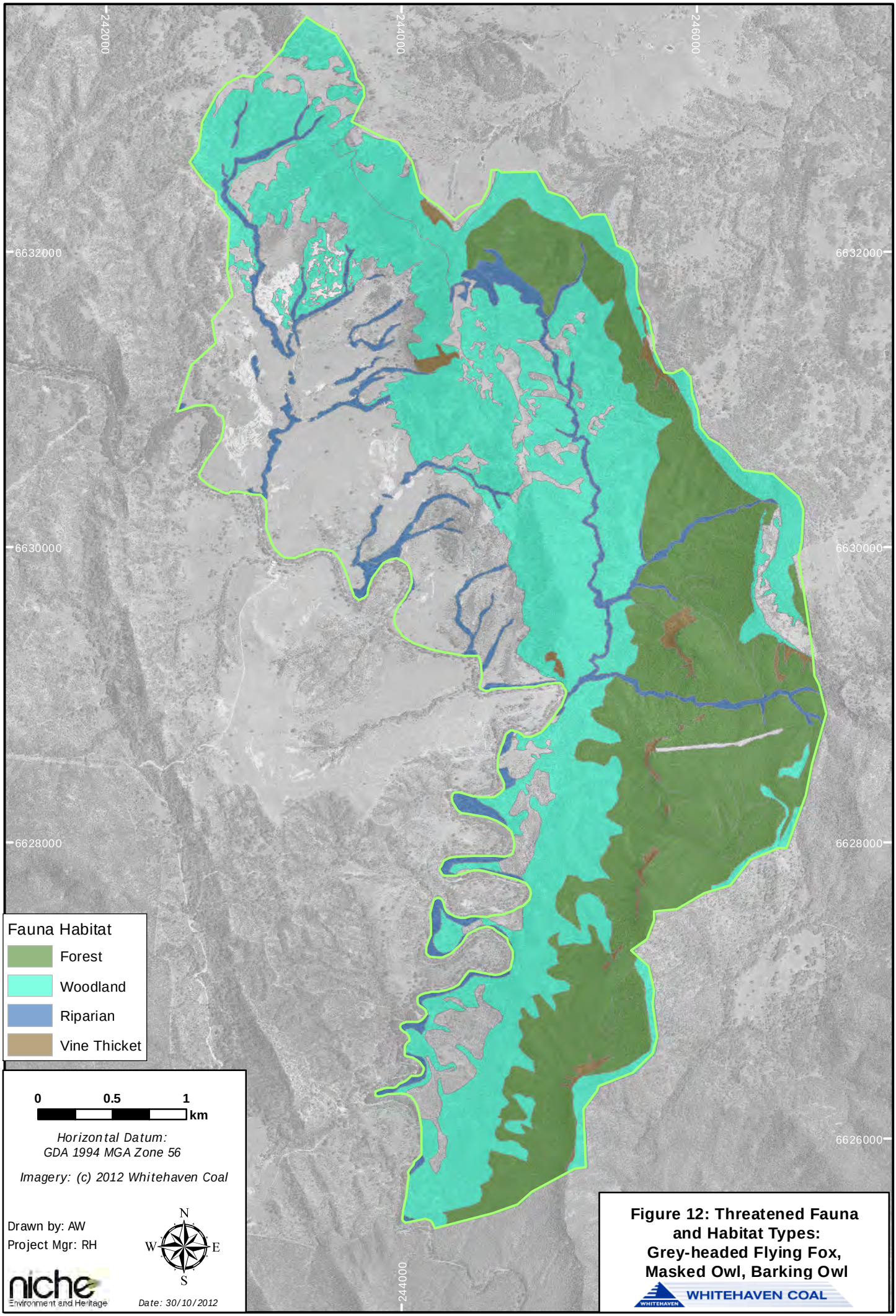

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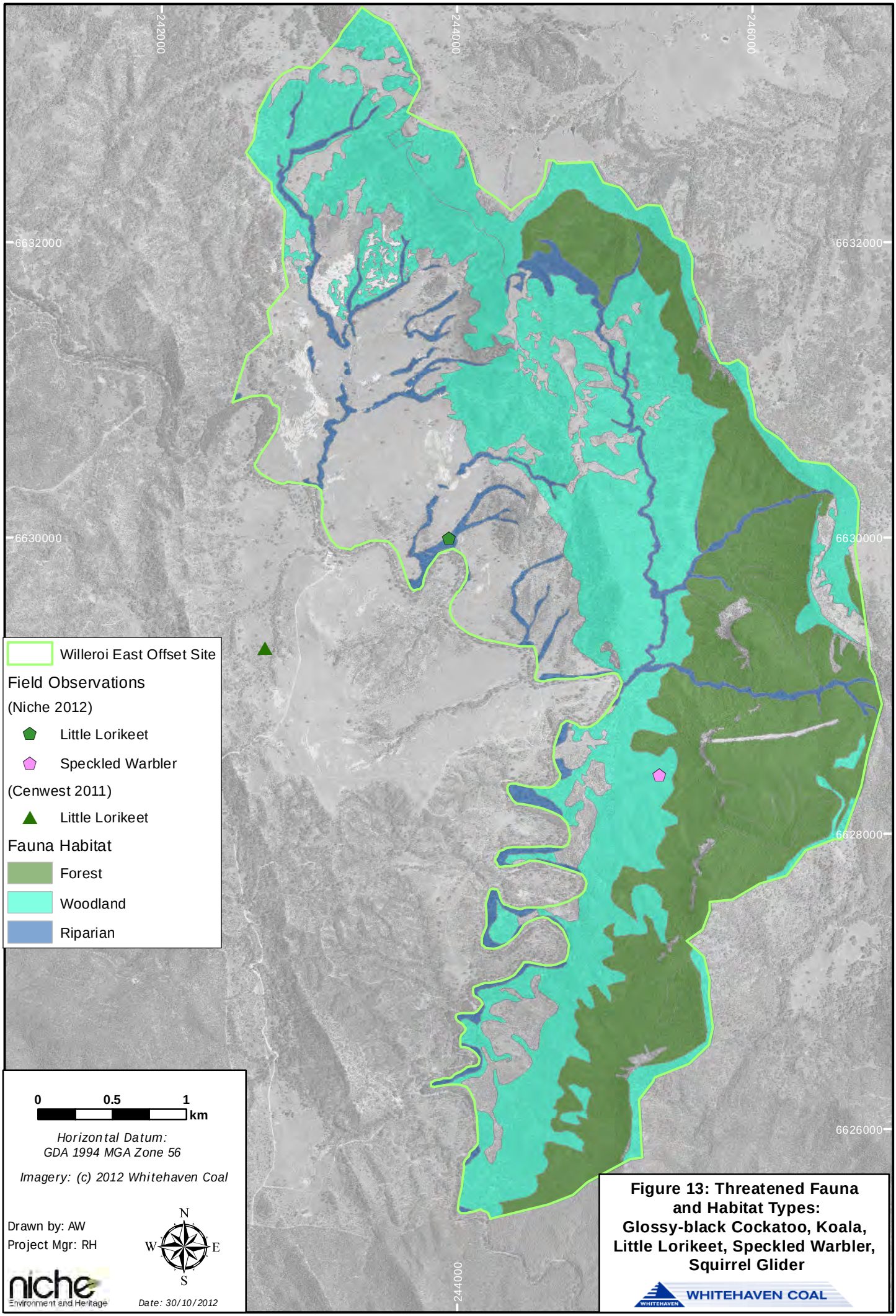

Figure 13: Threatened Fauna and Habitat Types: Glossy-black Cockatoo, Koala, Little Lorikeet, Speckled Warbler, Squirrel Glider

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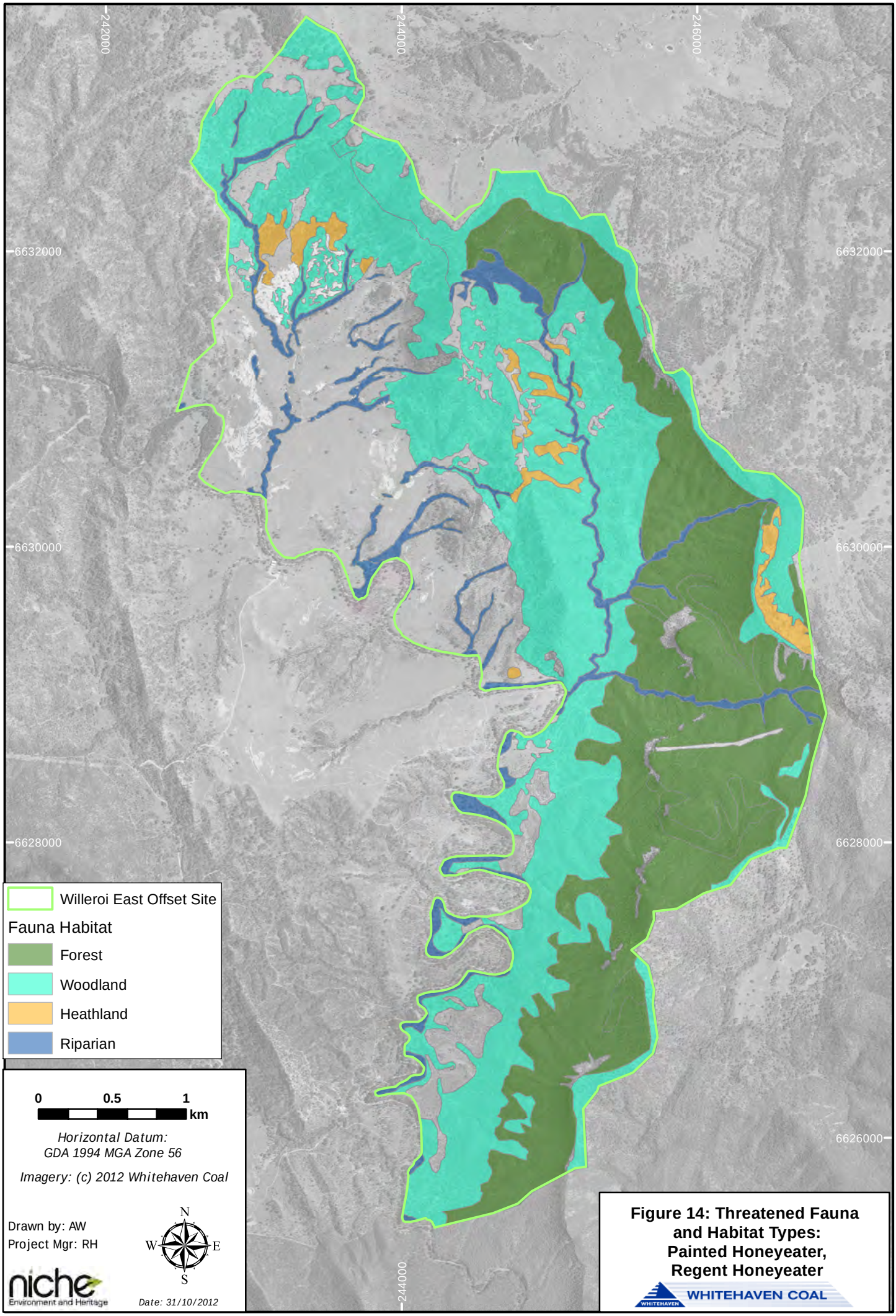

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APPENDICES

Appendix 1: Likelihood of Occurrence for Threatened Flora and Fauna within the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Flora					
Bertya opponens		V	V	Grows on slightly elevated ridges with moderately coarse, sandy soil.	Low
Boronia ruppii		E	-	Grows in eucalypt woodland, confined to Woodsreef, on serpentine.	Low
Cadellia pentastylis		V	V	Ooline occurs on the western edge of the NSW north-west slopes, from Mt Black Jack near Gunnadah to west of Tenterfield, and extends into Queensland to Carnarvon Range and Callide Valley, south-west of Rockhampton. Ooline grows in dry rainforest, semi-evergreen vine thickets and sclerophyll ecological communities, often locally dominant or as an emergent.	Low
Cyperus conicus		E	-	Grows in open woodland, on sandy soil; rare in Pilliga Scrub area and north-east of Narrabri.	Low
Dichanthium setosum		V	V	Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture.	Moderate
Digitaria porrecta		E	E	In NSW, it occurs from Graman and Croppa Creek (near Inverell), south to the Liverpool Plains near Coonabarabran and Werris Creek (33 sites). Finger Panic Grass usually occurs in grasslands on extensive basaltic plains, and in undulating woodlands and open forests with an underlying basaltic geology.	Low
Dodonaea stenophylla		PE	-	Shrubby woodland generally on sandy loamy soils, rare in this State, Bingara district.	Low
Geijera paniculata		E	-	Recorded from Rivertree, Lismore and Wardell districts. Grows in dry and subtropical rainforest.	Low
Hakea pulvinifera		E	E	Confined to a single population on a hard rocky hillside below Keepit Dam (Gunnedah); rare, apparently reproduces only by root suckers.	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Lepidium aschersonii		V	V	Found on ridges of gilgai clays dominated by Brigalow (*Acacia harpophylla*), with Austrodanthonia and/or *Austrostipa* spp. in the understorey. The species grows as a a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense Brigalow, with sparse grassy understorey and occasional heavy litter.	Low
Polygala linariifolia		E	-	Grows in dry sclerophyll communities from Warialda area to Weebah gate on the Queensland border.	Low
Pomaderris queenslandica		E	-	Rare in NSW. Specimens have been recorded from Mount Danger and Gloucester district. Species more widespread in Queensland. Recorded in moist eucalypt forest or sheltered woodlands with a shrubby understorey.	**Moderate**
Pterostylis cobarensis		V	V	Inhabits eucalypt woodland, open mallee, or *Callitris* shrubland on low stony ridges and slopes with skeletal sandy-loam soils. Associated species include *Eucalyptus morrisii, E. viridis, E. intertexta, E. vicina, Callitris glaucophylla, Geijera parviflora, Casuarina cristata, Acacia doratoxylon, Senna* spp. and *Eremophila* spp.	Low
Rulingia procumbens		V	V	In sandy sites mainly confined to the Dubbo - Mendooran - Gilgandra region, also in Pilliga and Nymagee areas; rare.	Low
Rytidosperma vickeryae		E	-	Grows on the edges of creeks on gravelly or rocky ground at high altitudes; in the Kosciusko area.	Low
Stenopetalum velutinum		PE	-	Presumed Extinct	None
Swainsona murrayana	Slender Darling-pea	V	V	Slender Darling-pea is found in grassland, herbland, and open Black-box woodland, often in depressions. This species grows in heavy grey or brown clay, loam, or red cracking clays. It is often associated with low chenopod shrubs, wallaby-grass, and spear grass. The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated.	Low
Swainsonia sericea	Silky Swainson-pea	V	-	Silky Swainson-pea is found in Natural Temperate Grassland and Snow Gum *Eucalyptus pauciflora* Woodland on the Monaro, Box-Gum Woodland in the Southern Tablelands and South West Slopes and sometimes in association with cypress-pine (*Callitris* sp). It regenerates from seed after fire. Silky Swainson-pea has been recorded from the Northern Tablelands to the Southern Tablelands and further inland on the slopes and plains. There is one isolated record from the far north-west of NSW. Its stronghold is on the Monaro. Also found in South Australia, Victoria and Queensland.	**Known**

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Thesium australe	Austral Toad-flax	V	V	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland.	**Moderate**
Tylophora linearis		V	E	Known from Goobang National Park, Eura State Forest, Goonoo SF, Pilliga West SF and Coolbaggie Nature Reserve. Tylophora linearis grows in dry scrub, open forest and woodlands associated with *Melaleuca uncinata, Eucalyptus fibrosa, E. sideroxylon, E. albens, Callitris endlicheri, C. glaucophylla, Allocasuarina luehmannii, Acacia hakeoides, A. lineata, Myoporum* spp., and *Casuarina* spp.	Low
Amphibians					
Litoria booroolongensis	Booroolong Frog	E	E	The Booroolong Frog is present along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Streams range from small slow-flowing creeks to large rivers. Adults occur on or near cobble banks and other rock structures within stream margins and shelter under rocks or amongst vegetation near the ground on the stream edge. The species occurs along streams in both forested areas and open pasture. The Booroolong Frog sometimes basks in the sun on exposed rocks near flowing water during summer.	Low – no recent records within 50 km
Reptiles					
Elseya belli	Bell's Turtle	V	V	Occurs in the upper reaches and smaller tributaries of major rivers flowing through granitic bedrock.	Low
Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	V	V	Occurs in dry sclerophyll open forest and woodland associated with outcrops of granite, basalt, sandstone and metamorphic rocks. The majority of sites are associated with granite outcrops.	**High – found recently at Willeroi West site**
Anomalopus mackayi	Five-clawed Worm-skink	E	V	On the floodplains within its range in north-eastern NSW, the Five-clawed Worm-skink occurs in grasslands and grassy, open woodlands on heavy black and grey, alluvial cracking clay soils from 135–200 m above sea level.	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	The Pale-Headed Snake has a patchy distribution from north-east Queensland to north east NSW. In NSW it occurs from the coast to the western side of the Great Divide as far south as Tuggerah (DECCW, undated). It is found mainly in dry eucalypt forests and woodlands, cypress woodland and occasionally in rainforest or moist eucalypt forest where it favours streamside areas, particularly in drier habitats.	Low
Birds					
Alectura lathami	Australian Brush-turkey population in the Nandewar and Brigalow Belt South Bioregions	EP	-	The population of the Australian Brush-turkey in the Nandewar and Brigalow Belt South Bioregions is both disjunct and at the western limit of the species' range in NSW. In NSW the inland vegetation type preferred by the Australian Brush-turkey is a dry rainforest community that is found within the Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions EEC.	Low
Leipoa ocellata	Malleefowl	E	V, M	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300 - 450 mm mean annual rainfall) areas. Utilises mallee with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey. Less frequently found in other eucalypt woodlands, such as Inland Grey Box, Ironbark or Bimble Box Woodlands with thick understorey, or in other woodlands such dominated by Mulga or native Cypress Pine species.	Low
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.	Low
Falco hypoleucos	Grey Falcon	E	-	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Lophoictinia isura	Square-tailed Kite	V	-	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins, 1993). In NSW it is often associated with ridge and gully forests dominated by *Eucalyptus longifolia*, *Corymbia maculata*, *E. elata* or *E. smithii*. Individuals appear to occupy large hunting ranges of more than 100 km^2. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins, 1993).	**Moderate – potential foraging habitat could be used irregularly**
Hamirostra melanosternon	Black-breasted Buzzard	V	-	The Black-breasted Buzzard is found sparsely in areas of less than 500 mm rainfall, from north-western NSW and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, avoiding only the Western Australian deserts.	Low – may occasionally use study area, but unlikely resident
Circus assimilis	Spotted Harrier	V	-	The Spotted Harrier occurs throughout the Australian mainland, except in densly forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	**Moderate – potential foraging habitat could be used irregularly**
Hieraaetus morphnoides	Little Eagle	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees (Marchant and Higgins, 1993).	**Moderate – scattered records around study area**
Rostratula australis	Painted Snipe (Australian subspecies)	E	V,M	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Geophaps scripta scripta	Squatter Pigeon (southern)	E	V	The Squatter Pigeon (southern) occurs mainly in grassy woodlands and open forests that are dominated by eucalypts. It has also been recorded in sown grasslands with scattered remnant trees, disturbed habitats (i.e. around stockyards, along roads and railways, and around settlements), acacia growth and remains common in heavily-grazed country north of the Tropic of Capricorn. The species is commonly observed in habitats that are located close to bodies of water. In NSW, the Squatter Pigeon (southern) is thought to have formerly occurred in sites that, today, consist of eucalypt woodlands that are intersected with patches of acacia and stands of cypress pine and that have a ground cover of grasses and herbs.	Low
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Inhabits forest with low nutrients, characteristically with key *Allocasuarina* spp. Tends to prefer drier forest types (NPWS, 1999) with a middle stratum of *Allocasuarina* below *Eucalyptus* or *Angophora*. Often confined to remnant patches in hills and gullies (Higgins, 1999). Breed in hollows stumps or limbs, either living or dead (Higgins and Davies, 1996). Endangered population in the Riverina.	**Moderate – some foraging habitat available**
Glossopsitta pusilla	Little Lorikeet	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (OEH, 2012).	**Known – recorded during survey**
Neophema pulchella	Turquoise Parrot	V	-	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	**Known – recorded from current survey**
Lathamus discolor	Swift Parrot	E	E	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw, 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields, 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey, 1997).	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Polytelis swainsonii	Superb Parrot	V	V	The Superb Parrot is found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. Inhabits Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest.	Low
Tyto novaehollandiae	Masked Owl	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins, 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins, 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons, 1997). Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons, 1997, Higgins, 1999).	**Moderate – potential occasional foraging though low density of prey species**
Ninox connivens	Barking Owl	V	-	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey, 1997).	**Moderate – previous regional records**
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	**Known**
Pyrrholaemus saggitatus	Speckled Warbler	V	-	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	**Known**

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Eucalypt woodlands within an approximate annual rainfall range of 400-700 mm	**Moderate – not recorded during survey but records around the study area are moderately common and recorded during recent survey to the west**
Anthochaera phrygia	Regent Honeyeater	CE	E,M	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests.	**Moderate – not recorded during survey but highly mobile in response to seasonal flowering**
Grantiella picta	Painted Honeyeater	V	-	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests.	**Moderate – potential foraging habitat but not recorded during recent survey**
Certhionyx variegatus	Pied Honeyeater	V	-	Widespread throughout acacia, mallee and spinifex scrubs of arid and semi-arid Australia. Occasionally occurs further east, on the slopes and plains and the Hunter Valley, typically during periods of drought. Inhabits wattle shrub (primarily Mulga, Acacia aneura), mallee, spinifex and eucalypt woodlands, usually when shrubs are flowering; feeds on nectar, predominantly from various species of emu-bushes (Eremophila spp.); also from mistletoes and various other shrubs (e.g. Brachysema spp. and Grevillea spp.); also eats saltbush fruit, berries, seed, flowers and insects.	Low
Epthianura albifrons	White-fronted Chat	V	-	Low vegetation in salty coastal and inland areas and crops. Runs along ground and is found in local flocks in winter.	Low
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	Occupy a wide range of Eucalypt woodlands, Acacia shrublands and open forests.	**Known – recorded during survey adjacent to subject site**

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Petroica phoenicea	Flame Robin	V	-	Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border (Pizzey 1997). The species is also found in Tasmania. The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January (Morcombe, 2003).	Low
Petroica boodang	Scarlet Robin	V	-	The Scarlet Robin is found from south-east Queensland to south-east South Australia and also in Tasmania and South West Western Australia. In NSW, it occurs from the coast to the inland slopes. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs.	Low
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains.	**Known – recorded in Willeroi west (Cenwest 2011)**
Daphoenositta chrysoptera	Varied Sittella	V	-	Inhabits wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy ground cover or both, in all climatic zones of Australia (Higgins and Peter, 2002). Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows.	**Moderate – recorded from adjacent survey (one record)**
Stagonopleura guttata	Diamond Firetail	V	-	Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum (*Eucalyptus pauciflora*) Woodlands. Also occurs in open forest, mallee, natural temperate grassland, and in secondary grassland derived from other communities.	**Known – numerous records from current survey**
Mammals					
Dasyurus maculatus maculatus	Spotted-tailed Quoll (south-east mainland population)	V	E	Spotted-tailed Quoll are found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Phascolarctos cinereus	Koala	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed *et al.*, 1990).	**Moderate – some preferred feed trees present or move through habitat. Records around study area moderately common**
Cercartetus nanus	Eastern Pygmy-possum	V	-	Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows, but can also construct its own nest (Turner, 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons, 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5 ha area over a 5 month period (Ward, 1990).	Low
Petaurus norfolcensis	Squirrel Glider	V	-	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range (Suckling, 1995). Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Quin, 1995). There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps (Gibbons, 1997). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al*., 1988). Endangered population in the Wagga Wagga LGA.	**Moderate – recorded recently to the west of study area (one record only)**
Macropus dorsalis	Black-striped Wallaby	E	-	Black-striped Wallaby populations are associated with open forest with thick regrowth brigalow, *Acacia harpophylla* or other shrub understory woodland, closed forest margins and dense wet sclerophyll forests with a viney understorey.	Low
Onychogalea fraenata	Bridled Nailtail Wallaby	PE	E	Open grassy eucalypt woodland dominated by poplar box, dense forest dominated by brigalow, transitional vegetation intermediate between the woodland and forest.	Low
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge, 1995).	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann, 1995) although some individuals may travel up to 70 km (Augee, 1999).	**Moderate – could use study area for seasonal foraging**
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill, 2008). Two observations have been made of roosts in stem holes of living eucalypts (Phillips, 1995). There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Menkhorst, 1995). This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites (Menkhorst, 1995).	**Known**
Vespadelus troughtoni	Eastern Cave Bat	V	-	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT.	**Known**
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	**Moderate – records around study area moderately common, widely foraging species.**
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits (Allison and Hoye, 1995; Churchill, 2008).	Low
Miniopterus australis	Little Bentwing-bat	V	-	Coastal north-eastern NSW and eastern Queensland (Churchill, 2008). Little Bent-wing Bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel 100s km from feeding home ranges to breeding sites (Law, 1996; Wilson, 1982). Little Bent-wing Bat has a preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects (DECCW, undated).	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Eastern Bent-wing Bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.	**Known**
Mormopterus norfolkensis	Eastern Free-tail Bat	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits (Allison and Hoye, 1995; Churchill, 2008).	**Known – recorded in Willeroi west (CenwestCenwest Environmental Services 2011)**
Nyctophilus corbeni/ timorensis	South-eastern/Greater Long-eared Bat	V	V	The South-eastern/Greater Long-eared Bat has a limited distribution that is restricted around the Murray-Darling Basin in south-eastern Australia. Even in this region its distribution is scattered and it is rarely recorded. It occurs in far eastern South Australia, in areas north of the Murray River, east of Canegrass Station and south of the Barrier Highway. These areas include the Riverland Biosphere Reserve, Danggali Conservation Park and the Birds Australia Gluepot Reserve. It is distributed throughout inland NSW except in the north-west area which is dominated by treeless plains. It can be found in the Hunter Valley, extending from central NSW to the eastern Hunter Valley coast. Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. Inhabits a variety of vegetation types, including mallee, bulloke *Allocasuarina leuhmanni* and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark.	**Moderate – records around study area moderately common. Nyctophylus sp. recorded during survey**
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye, 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill, 2008). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill, 2008).	**Moderate – records from around study area and wide ranging foraging possible**

Scientific Name	Common Name	TSC Act	EPBC Act	Description	Likelihood of Occurrence
Chalinolobus picatus	Little Pied Bat	V	-	The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria. Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings.	Low
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill, 2008). In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye, 1995). This species roosts in hollow tree trunks and branches (Churchill, 2008).	**Moderate** (Recorded with low confidence)
Pseudomys australis	Plains Rat	PE	V	The Plains Rat is primarily found in gibber (stone-covered) plains and mid slopes with boulders, small stones and gilgais (water soaks, depressions). In years of very good rainfall, this species occur on adjoining sandy plains.	Low
Pseudomys pilligaensis	Pilliga Mouse	V	V	The Pilliga Mouse is found in greatest abundance in recently burnt moist gullies, areas dominated by broombush and areas containing an understorey of *Acacia burrowii* with a *Corymbia trachyphloia* overstorey. Topography includes rolling landscapes with low relief on sandy soil and sandstone ridges. This species occurs in an area of of low-nutrient deep sands with mean annual rainfall of approximately 750 mm.	Low

Conservation status current as of 10 August 2012. Only species listed on the TSC Act are presented in this table.

Appendix 2: Vegetation Community Alignment

Code	Previous Vickery Code (Niche 2012)	Vegetation Community	EEC	RBVT Code	Keith Class	Keith Formation	The Project (ha)	Willeroi East Offset (ha)	Ratio
1	-	Narrow-leaved Ironbark - White Cypress Pine Shrubby open forest	Not an EEC	NA228	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	0	418	-
2	-	White Box - White Cypress Pine Shrubby Woodland	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	0	50	-
2a	2a	White Box - White Cypress Pine - Cypress Regeneration	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	188	121	0.6:1
2b	2b	White Box - White Cypress Pine - Semi-cleared	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	107	567	5:1
2c	2c	White Box - White Cypress Pine - Derived Native Pasture	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	488	72	0.2:1
2e	-	White Box - White Cypress Pine - Derived Shrubland	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	0	22	-
2f	2d	White Box - White Cypress Pine - Mature Cypress Forest	Not an EEC	NA225	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	9	0	0
3	4	White Box grassy woodland	White Box Yellow Box Blakely's Red Gum Woodland	NA226	Western Slopes Grassy Woodlands	Grassy Woodlands	3	0	0
3c	-	White Box grassy woodland - Derived Native Pasture	White Box Yellow Box Blakely's Red Gum Woodland	NA226	Western Slopes Grassy Woodlands	Grassy Woodlands	0	136	-

Code	Previous Vickery Code (Niche 2012)	Vegetation Community	EEC	RBVT Code	Keith Class	Keith Formation	The Project (ha)	Willeroi East Offset (ha)	Ratio
5	-	Bracteate Honeymyrtle low riparian forest	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	36	-
5b	-	Bracteate Honeymyrtle low riparian forest – Semi-cleared regenerating	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	24	-
5c	-	Bracteate Honeymyrtle low riparian forest - Derived Native Pasture	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	13	-
7b	1a	Silver-leaved Ironbark - White Box - White Cypress Pine – Semi-cleared	Not an EEC	NA 232	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	80	0	0
7c	1b	Silver-leaved Ironbark - White Box - White Cypress Pine - Derived Native Pasture	Not an EEC	NA 232	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	165	0	0
7e	-	Silver-leaved Ironbark - White Box - White Cypress Pine - Mature Cypress Woodland	Not an EEC	NA 232	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	25	0	0
8	9	Yellow Box - Blakely's Red Gum Grassy Woodland	White Box Yellow Box Blakely's Red Gum Woodland	NA237	Western Slopes Grassy Woodlands	Grassy Woodlands	3	0	0
8c	9c	Yellow Box - Blakely's Red Gum - Derived Native Pasture	White Box Yellow Box Blakely's Red Gum Woodland	NA237	Western Slopes Grassy Woodlands	Grassy Woodlands	0	20	-
9	-	River Oak – River Red Gum riparian forest	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	19	-

Code	Previous Vickery Code (Niche 2012)	Vegetation Community	EEC	RBVT Code	Keith Class	Keith Formation	The Project (ha)	Willeroi East Offset (ha)	Ratio
9c	-	River Oak – River Red Gum - Derived Native Pasture	Not an EEC	NA191	Eastern Riverine Forests	Forested Wetlands	0	7	-
10	-	Rough-barked Apple riparian open forest	Not an EEC	NA197	New England GW	Grassy Woodlands	0	3	-
10a	-	Rough-barked Apple riparian - Regeneration	Not an EEC	NA197	New England GW	Grassy Woodlands	0	10	-
11	-	Semi-evergreen vine thicket	Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	NA199	Dry Rainforests	Rainforests	0	19	-
12	-	Trachyte outcrop shrubland	Not an EEC	NA240	Northern Montane Heaths	Heathlands	0	10	-
19c	8c	Plains Grass – Blue Grass Derived Native Pasture	Not an EEC	NA181	Western Slopes Grasslands	Grasslands	3	0	0
20a	3a	Poplar Box Grassy Woodland - Derived Woodland	Not an EEC	NA185	Pilliga Outwash DSFs	Dry Sclerophyll Forests (Shrub/grass subformation)	46	0	0
20c	3c	Poplar Box Grassy Woodland - Derived Native Pasture	Not an EEC	NA185	Pilliga Outwash DSFs	Dry Sclerophyll Forests (Shrub/grass subformation)	628	0	0
21	5	Weeping Myall low Shrubland	Weeping Myall Woodlands	NA219	Riverine Plain Woodlands	Semi-arid Woodlands (Grassy subformation)	1	0	0
22	6	Mixed Marsh Sedgeland	Not an EEC	NA201	Inland Floodplain Swamps	Freshwater Wetlands	2	0	0

Code	Previous Vickery Code (Niche 2012)	Vegetation Community	EEC	RBVT Code	Keith Class	Keith Formation	The Project (ha)	Willeroi East Offset (ha)	Ratio
24	-	Red Stringybark shrubby open forest - Semi-cleared and Regenerating	Not an EEC	NA112	New England Grassy Woodlands	Grassy Woodlands	0	97	-
Total							**1,748**	**1,644**	**0.9:1**

Appendix 3: Plant Species List

		Vegetation Community Code															
Family	**Species**	**1**	**2**	**5**	**9**	**11**	**12**	**24**	**10a**	**2a**	**2b/2c**	**2e**	**3c**	**5b**	**5C**	**8C**	**9c**	**Se**
Acanthaceae	*Brunoniella australis*	X																
Acanthaceae	*Rostellularia adscendens*	X	X	X						X	X		X					
Adiantaceae	*Adiantum aethiopicum*	X				X		X			X							
Adiantaceae	*Cheilanthes distans*	X			X		X	X		X	X							
Adiantaceae	*Cheilanthes sieberi*	X	X	X	X	X	X	X		X	X	X	X	X				
Adiantaceae	*Pellaea nana*	X				X		X			X							
Amaranthaceae	*Alternanthera pungens**																X	
Amaranthaceae	*Nyssanthes diffusa*			X														
Anthericaceae	*Arthropodium milleflorum*	X	X			X	X				X		X					
Anthericaceae	*Dichopogon fimbriatus*							X										
Apiaceae	*Ammi majus**												X					
Apiaceae	*Daucus glochidiatus*	X	X							X			X					
Apiaceae	*Hydrocotyle peduncularis*								X									
Apiaceae	*Trachymene incisa*					X	X											
Apocynaceae	*Alstonia constricta*	X		X			X											
Apocynaceae	*Parsonsia eucalyptophylla*	X		X							X							
Asclepiadaceae	*Gomphocarpus fruticosus**			X	X			X			X		X	X		X	X	X
Asphodelaceae	*Bulbine semibarbata*																X	
Aspleniaceae	*Asplenium flavellifolium*	X				X												
Asteraceae	*Arctotheca calendula**			X														X
Asteraceae	*Aster subulatus**																	X
Asteraceae	*Bidens pilosa**	X	X		X	X		X		X	X	X	X	X			X	
Asteraceae	*Bidens subalternans**	X		X	X			X		X	X	X	X		X		X	
Asteraceae	*Calotis cuneifolia*			X						X	X							X
Asteraceae	*Calotis lappulacea*	X	X	X	X					X	X	X	X	X		X		X
Asteraceae	*Cassinia quinquefaria*	X	X			X	X	X		X	X	X	X	X				
Asteraceae	*Cassinia uncata*										X							
Asteraceae	*Centaurea melitensis**												X					X
Asteraceae	*Centaurea solstitialis**								X				X			X		X
Asteraceae	*Chrysocephalum apiculatum*	X								X	X							
Asteraceae	*Chrysocephalum semipapposum*											X	X					
Asteraceae	*Cirsium vulgare**		X	X	X				X				X	X	X		X	X
Asteraceae	*Conyza bonariensis**	X	X	X	X	X				X	X	X	X	X	X	X	X	X
Asteraceae	*Conyza parva**			X						X			X	X				
Asteraceae	*Conyza sumatrensis**	X	X		X		X			X		X				X		
Asteraceae	*Craspedia variabilis*	X																

		Vegetation Community Code																
Family	**Species**	**1**	**2**	**5**	**9**	**11**	**12**	**24**	**10a**	**2a**	**2b/2c**	**2e**	**3c**	**5b**	**5C**	**8C**	**9c**	**Se**
Asteraceae	*Cymbonotus lawsonianus*	X			X						X	X	X	X				
Asteraceae	*Euchiton sphaericus*					X		X	X	X	X		X	X				
Asteraceae	*Glossocardia bidens*	X	X		X			X	X	X	X		X					X
Asteraceae	*Hypochaeris glabra**			X							X		X	X				
Asteraceae	*Hypochaeris radicata**	X	X	X	X			X	X	X	X	X	X	X		X		X
Asteraceae	*Lactuca saligna**			X	X					X			X	X	X		X	X
Asteraceae	*Lactuca serriola**												X					
Asteraceae	*Lagenifera stipitata*		X					X										
Asteraceae	*Minuria integerrima*										X							
Asteraceae	*Minuria leptophylla*																	X
Asteraceae	*Olearia elliptica*	X	X	X	X	X	X	X	X	X	X	X	X	X				X
Asteraceae	*Olearia viscidula*							X										
Asteraceae	*Senecio bathurstianus*	X																
Asteraceae	*Senecio prenanthoides*							X										
Asteraceae	*Senecio quadridentatus*	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X
Asteraceae	*Sigesbeckia australiensis*	X	X			X				X	X							
Asteraceae	*Sigesbeckia orientalis*				X				X		X							
Asteraceae	*Solenogyne bellioides*										X							
Asteraceae	*Sonchus oleraceus**			X							X		X	X				X
Asteraceae	*Tagetes minuta**			X													X	
Asteraceae	*Taraxacum officinale**										X						X	X
Asteraceae	*Vernonia cinerea*	X	X							X	X							
Asteraceae	*Vittadinia cuneata*	X	X	X	X		X			X	X					X		X
Asteraceae	*Vittadinia dissecta*															X		
Asteraceae	*Vittadinia muelleri*			X	X		X	X	X	X	X	X	X		X			X
Asteraceae	*Vittadinia sulcata*										X							
Asteraceae	*Xanthium occidentale**													X			X	
Asteraceae	*Xanthium orientale**												X	X				X
Asteraceae	*Xanthium spinosum**																X	
Asteraceae	*Xerochrysum bracteatum*	X																
Bignoniaceae	*Pandorea pandorana*	X	X	X		X	X	X			X							
Boraginaceae	*Cynoglossum australe*									X								
Brassicaceae	*Lepidium bonariense**	X		X						X		X	X	X				X
Cactaceae	*Opuntia stricta**	X		X	X		X			X	X							
Campanulaceae	*Wahlenbergia aridicola*		X															
Campanulaceae	*Wahlenbergia communis*	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X
Campanulaceae	*Wahlenbergia luteola*	X	X		X	X	X	X		X	X							
Capparaceae	*Capparis mitchellii*												X					

		Vegetation Community Code																
Family	**Species**	**1**	**2**	**5**	**9**	**11**	**12**	**24**	**10a**	**2a**	**2b/2c**	**2e**	**3c**	**5b**	**5C**	**8C**	**9c**	**Se**
Caryophyllaceae	*Petrorhagia nanteuilii**	X								X			X					
Caryophyllaceae	*Spergularia rubra*									X			X					
Caryophyllaceae	*Stellaria flaccida*	X																
Casuarinaceae	*Casuarina cunninghamiana*										X			X				
Chenopodiaceae	*Atriplex spinibractea*																	X
Chenopodiaceae	*Einadia hastata*												X	X				
Chenopodiaceae	*Einadia nutans*	X		X		X		X					X	X				X
Chenopodiaceae	*Maireana brevifolia*																	X
Chenopodiaceae	*Maireana microphylla*			X						X			X	X	X		X	X
Chenopodiaceae	*Salsola kali*																	X
Chenopodiaceae	*Sclerolaena birchii*																	X
Clusiaceae	*Hypericum gramineum*	X			X		X	X	X	X	X	X	X			X		X
Clusiaceae	*Hypericum perforatum**								X			X						
Commelinaceae	*Commelina cyanea*	X				X	X							X			X	
Convolvulaceae	*Convolvulus graminetinus*				X							X				X		
Convolvulaceae	*Cuscuta campestris*												X					
Convolvulaceae	*Dichondra repens*							X	X	X							X	
Convolvulaceae	*Dichondra sp. A*	X	X	X	X	X		X		X	X		X	X	X	X	X	
Convolvulaceae	*Evolvulus alsinoides*	X																
Crassulaceae	*Crassula sieberiana*					X	X			X								
Cupressaceae	*Callitris endlicheri*						X	X		X								
Cupressaceae	*Callitris glaucophylla*	X	X	X	X					X	X	X	X	X				X
Cyperaceae	*Carex incomitata*	X	X			X				X	X							
Cyperaceae	*Carex inversa*	X	X						X	X			X	X		X		
Cyperaceae	*Cyperus eragrostis*	X		X							X		X					X
Cyperaceae	*Cyperus fulvus*	X				X	X			X		X						
Cyperaceae	*Cyperus gracilis*	X	X							X	X		X	X			X	
Cyperaceae	*Eleocharis acuta*										X							
Cyperaceae	*Eleocharis sphacelata*	X																
Cyperaceae	*Fimbristylis dichotoma*	X				X	X				X					X		
Cyperaceae	*Lepidosperma gunnii*																	
Cyperaceae	*Lepidosperma laterale*	X					X				X							
Cyperaceae	*Schoenus apogon*		X								X		X					
Cyperaceae	*Scleria mackaviensis*	X	X								X							
Dilleniaceae	*Hibbertia obtusifolia*	X	X		X			X	X	X	X	X	X			X		
Dilleniaceae	*Hovea heterophylla*	X																
Epacridaceae	*Melichrus urceolatus*	X			X			X	X	X	X		X					
Euphorbiaceae	*Chamaesyce drummondii*												X				X	X
Euphorbiaceae	*Phyllanthus*	X	X			X	X				X		X					

		Vegetation Community Code																
Family	**Species**	**1**	**2**	**5**	**9**	**11**	**12**	**24**	**10a**	**2a**	**2b/2c**	**2e**	**3c**	**5b**	**5C**	**8C**	**9c**	**Se**
	subcrenulatus																	
Euphorbiaceae	*Phyllanthus virgatus*	X					X											
Euphorbiaceae	*Pimelea curviflora*	X								X								X
Euphorbiaceae	*Poranthera microphylla*		X		X			X		X								
Fabaceae	*Acacia cheelii*						X											
Fabaceae	*Acacia conferta*										X		X					
Fabaceae	*Acacia decora*	X	X	X	X			X		X	X	X	X	X				X
Fabaceae	*Acacia implexa*					X		X	X									
Fabaceae	*Acacia leiocalyx*								X			X						
Fabaceae	*Acacia paradoxa*	X																
Fabaceae	*Acacia salicina*			X								X		X			X	
Fabaceae	*Desmodium brachypodum*	X	X	X	X	X	X	X	X	X	X	X	X	X				X
Fabaceae	*Desmodium gunnii*					X												
Fabaceae	*Desmodium varians*	X	X	X	X	X		X	X	X	X		X	X				
Fabaceae	*Glycine clandestina*	X						X		X		X		X				
Fabaceae	*Glycine microphylla*	X	X		X	X		X										
Fabaceae	*Glycine tabacina*	X		X					X		X		X					X
Fabaceae	*Hardenbergia violacea*	X				X		X										
Fabaceae	*Hovea lanceolata*												X					
Fabaceae	*Hydrocotyle laxiflora*		X	X	X			X	X	X	X	X	X	X	X	X		
Fabaceae	*Indigofera adesmiifolia*	X			X			X			X							
Fabaceae	*Lotus cruentus*									X	X							
Fabaceae	*Medicago minima**												X					X
Fabaceae	*Medicago polymorpha**			X							X	X	X	X				X
Fabaceae	*Melaleuca bracteata*	X		X							X						X	
Fabaceae	*Swainsona galegifolia*	X	X		X			X	X	X	X	X				X	X	
Fabaceae	*Swainsona sericea*												X					
Fabaceae	*Trifolium angustifolium**										X							
Fabaceae	*Trifolium arvense**												X			X		
Fabaceae	*Trifolium dubium**		X									X	X			X		X
Fabaceae	*Zornia dyctiocarpa*									X								
Gentianaceae	*Centaurium erythraea**									X	X							X
Gentianaceae	*Schenkia spicata*		X		X				X		X	X	X	X	X			X
Geraniaceae	*Erodium crinitum*																	X
Geraniaceae	*Geranium solanderi*	X	X	X	X		X	X	X	X	X	X	X	X		X		
Goodeniaceae	*Goodenia hederacea*	X								X								
Goodeniaceae	*Goodenia pinnatifida*																	X
Goodeniaceae	*Haloragis heterophylla*	X								X	X		X					
Haloragaceae	*Gonocarpus*																	

		Vegetation Community Code																
Family	**Species**	**1**	**2**	**5**	**9**	**11**	**12**	**24**	**10a**	**2a**	**2b/2c**	**2e**	**3c**	**5b**	**5C**	**8C**	**9c**	**Se**
	tetragynus																	
Juncaceae	*Juncus aridicola*												X		X			
Juncaceae	*Juncus remotiflorus*											X						
Juncaceae	*Juncus usitatus*		X															
Juncaceae	*Luzula flaccida*		X															
Lamiaceae	*Ajuga australis*	X						X	X	X	X		X	X		X		
Lamiaceae	*Mentha diemenica*		X		X			X	X		X	X	X	X		X		
Lamiaceae	*Plectranthus graveolens*					X												
Lamiaceae	*Salvia verbenaca**			X									X					X
Lamiaceae	*Scutellaria humilis*		X				X	X								X		
Linaceae	*Linum marginale*											X	X					
Lobeliaceae	*Isotoma anethifolia*					X												
Lobeliaceae	*Pratia concolor*												X					
Lomandraceae	*Lomandra cylindrica*							X										
Lomandraceae	*Lomandra filiformis*	X	X		X		X			X	X		X	X				
Lomandraceae	*Lomandra longifolia*	X		X	X	X		X		X	X	X	X	X	X		X	X
Lomandraceae	*Lomandra multiflora*	X	X		X			X		X	X		X					
Loranthaceae	*Amyema pendulum*				X					X				X				
Luzuriagaceae	*Eustrephus latifolius*	X	X	X		X		X	X		X		X	X				
Malvaceae	*Abutilon oxycarpum*				X									X			X	
Malvaceae	*Modiola caroliniana**			X											X			X
Malvaceae	*Sida corrugata*			X						X			X					X
Malvaceae	*Sida cunninghamii*	X								X								
Malvaceae	*Sida rhombifolia**			X									X				X	
Moraceae	*Ficus rubiginosa*	X		X		X												
Myoporaceae	*Myoporum montanum*																	X
Myrtaceae	*Angophora floribunda*	X			X	X		X	X	X	X	X	X	X				
Myrtaceae	*Eucalyptus albens*	X	X	X	X	X		X	X	X	X	X	X	X				X
Myrtaceae	*Eucalyptus andrewsii*							X										
Myrtaceae	*Eucalyptus blakelyi*				X			X		X				X		X		
Myrtaceae	*Eucalyptus camaldulensis*				X								X				X	
Myrtaceae	*Eucalyptus crebra*	X	X	X				X		X	X	X	X	X				X
Myrtaceae	*Eucalyptus dealbata*	X	X	X			X	X			X	X	X					X
Myrtaceae	*Eucalyptus macrorhyncha*							X										
Myrtaceae	*Eucalyptus melanophloia*	X									X							
Myrtaceae	*Eucalyptus melliodora*							X		X						X		
Myrtaceae	*Eucalyptus youmanii*							X										
Myrtaceae	*Kunzea sp. D*						X											
Myrtaceae	*Sannantha*					X												

		Vegetation Community Code																
Family	**Species**	**1**	**2**	**5**	**9**	**11**	**12**	**24**	**10a**	**2a**	**2b/2c**	**2e**	**3c**	**5b**	**5C**	**8C**	**9c**	**Se**
	cunninghamii																	
Nyctaginaceae	*Boerhavia dominii*	X								X	X			X				X
Oleaceae	*Jasminum lineare*				X					X	X		X	X				
Oleaceae	*Notelaea microcarpa*	X	X	X	X	X	X	X	X	X	X		X	X				
Onagraceae	*Epilobium billardierianum*			X	X					X	X		X				X	
Oxalidaceae	*Oxalis perennans*	X	X					X			X		X	X			X	
Phormiaceae	*Dianella caerulea*	X																
Phormiaceae	*Dianella revoluta*	X	X							X	X	X				X		
Phormiaceae	*Stypandra glauca*						X											
Pittosporaceae	*Bursaria spinosa*	X		X	X	X		X			X		X	X		X		
Plantaginaceae	*Plantago debilis*	X	X							X								
Plantaginaceae	*Plantago lanceolata**			X									X		X		X	X
Plantaginaceae	*Plantago varia*	X								X	X		X					
Poaceae	*Aristida calycina*			X						X	X		X					X
Poaceae	*Aristida jerichoensis*	X	X					X		X		X	X	X				X
Poaceae	*Aristida personata*	X	X	X	X	X	X	X		X	X	X	X	X			X	X
Poaceae	*Aristida vagans*		X					X										
Poaceae	*Austrodanthonia bipartita*						X											
Poaceae	*Austrodanthonia caespitosa*	X		X							X		X	X	X			X
Poaceae	*Austrodanthonia monticola*	X	X			X	X	X			X					X		
Poaceae	*Austrodanthonia racemosa*	X	X	X	X			X		X	X		X	X		X		
Poaceae	*Austrostipa scabra*	X		X	X		X	X		X	X		X	X				X
Poaceae	*Austrostipa verticillata*	X		X	X					X			X	X	X		X	X
Poaceae	*Bothriochloa decipiens*	X	X		X		X	X			X					X		
Poaceae	*Bothriochloa macra*	X	X	X	X				X	X	X	X	X	X	X		X	X
Poaceae	*Bromus catharticus**												X	X	X			
Poaceae	*Bromus inermis**																X	
Poaceae	*Chloris truncata*	X		X	X			X		X	X	X	X	X	X			X
Poaceae	*Cymbopogon refractus*	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X
Poaceae	*Cynodon dactylon*			X									X	X	X		X	X
Poaceae	*Dactyloctenium radulans*												X					
Poaceae	*Dichanthium sericeum*	X	X	X		X			X	X	X	X	X	X			X	X
Poaceae	*Dichelachne micrantha*	X	X		X	X	X	X		X	X	X	X			X	X	
Poaceae	*Digitaria breviglumis*						X											
Poaceae	*Digitaria brownii*	X		X	X	X					X	X	X				X	
Poaceae	*Digitaria parviflora*										X							
Poaceae	*Echinopogon caespitosus*		X									X	X		X			X
Poaceae	*Echinopogon ovatus*							X		X	X					X		

		Vegetation Community Code																
Family	**Species**	**1**	**2**	**5**	**9**	**11**	**12**	**24**	**10a**	**2a**	**2b/2c**	**2e**	**3c**	**5b**	**5C**	**8C**	**9c**	**Se**
Poaceae	*Enneapogon nigricans*	X	X		X					X	X		X					X
Poaceae	*Eragrostis elongata*	X								X	X		X					
Poaceae	*Eragrostis leptostachya*	X	X	X	X		X			X	X	X	X	X	X	X	X	X
Poaceae	*Eragrostis parviflora*												X					
Poaceae	*Eriochloa pseudoacrotricha*			X									X					
Poaceae	*Hyparrhenia hirta**			X					X	X		X	X	X			X	X
Poaceae	*Microlaena stipoides*	X	X	X	X	X	X	X		X	X		X	X		X	X	X
Poaceae	*Oplismenus imbecillis*	X									X							
Poaceae	*Panicum effusum*									X			X					
Poaceae	*Panicum simile*	X	X		X			X	X	X	X	X	X	X			X	
Poaceae	*Paspalidium constrictum*	X	X			X	X			X	X		X	X				
Poaceae	*Paspalidium gracile*	X	X			X												X
Poaceae	*Paspalum dilatatum**			X	X								X		X		X	X
Poaceae	*Poa sieberiana*	X	X	X	X		X	X	X	X	X	X	X	X		X		X
Poaceae	*Sorghum leiocladum*							X	X			X						
Poaceae	*Sporobolus creber*		X				X			X	X		X	X	X	X	X	X
Poaceae	*Themeda triandra*	X											X					
Poaceae	*Tripogon loliiformis*					X	X	X			X							X
Polygonaceae	*Polygonum plebeium*												X	X				X
Polygonaceae	*Rumex brownii*	X		X	X	X		X	X			X	X	X				
Polygonaceae	*Rumex crispus**												X					
Primulaceae	*Anagallis arvensis**			X														
Ranunculaceae	*Clematis glycinoides*	X	X			X		X										
Ranunculaceae	*Clematis microphylla*	X	X			X		X		X	X			X				
Rhamnaceae	*Alphitonia excelsa*			X														
Rosaceae	*Acaena novae-zelandiae*		X		X			X	X	X	X	X		X		X		X
Rosaceae	*Rosa rubiginosa**			X					X	X		X	X	X	X		X	X
Rosaceae	*Rubus parvifolius*	X		X														
Rubiaceae	*Asperula conferta*				X				X	X	X	X	X					
Rubiaceae	*Galium gaudichaudii*							X										
Rubiaceae	*Galium migrans*	X	X		X	X	X	X			X		X			X		
Rubiaceae	*Opercularia diphylla*										X							
Rubiaceae	*Pomax umbellata*										X							
Rutaceae	*Correa reflexa*	X			X	X		X										
Rutaceae	*Geijera parviflora*												X					
Santalaceae	*Santalum acuminatum*			X														
Sapindaceae	*Alectryon subdentatus*	X				X					X							
Sapindaceae	*Dodonaea sinuolata*						X											
Sapindaceae	*Dodonaea viscosa*	X	X	X		X			X	X	X	X	X	X			X	X

		Vegetation Community Code																
Family	**Species**	**1**	**2**	**5**	**9**	**11**	**12**	**24**	**10a**	**2a**	**2b/2c**	**2e**	**3c**	**5b**	**5C**	**8C**	**9c**	**Se**
Scrophulariaceae	*Verbascum thapsus**			X	X									X			X	
Scrophulariaceae	*Verbascum virgatum**												X					
Scrophulariaceae	*Veronica calycina*	X				X		X										
Scrophulariaceae	*Veronica plebeia*												X					
Solanaceae	*Solanum nigrum**			X														
Solanaceae	*Solanum parvifolium*							X								X		
Sterculiaceae	*Brachychiton populneus*	X	X	X	X			X	X	X	X		X	X		X		
Thymelaeaceae	*Pimelea linifolia*					X												
Thymelaeaceae	*Pimelea neo-anglica*	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X
Thymelaeaceae	*Pimelea simplex*	X	X	X	X	X		X	X	X	X	X	X	X		X	X	
Urticaceae	*Urtica incisa*		X	X	X	X		X			X		X					
Verbenaceae	*Oncinocalyx betchei*	X			X					X		X				X		
Verbenaceae	*Verbena bonariensis**			X	X					X		X	X	X			X	X
Verbenaceae	*Verbena macrostachya*			X							X							
Violaceae	*Viola betonicifolia*							X										
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*				X													

Conservation status current as of 11 July 2012. * introduced species

Appendix 4: Animal Species Recorded from the Study Area

Family	Common Name	Scientific Name	Legal Status[1]	Riparian	Woodland	Forest	Incidental within Study Area	Incidental Outside Study Area
Amphibians								
Hylidae	Verreaux's Frog	*Litoria verreauxii*	P		X			
Limnodynastidae	Eastern Banjo Frog	*Limnodynastes dumerilii*	P		X			
Myobatrachidae	Common Eastern Froglet	*Crinia signifera*	P	X				
Myobatrachidae	Bibron's Toadlet	*Pseudophryne bibronii*	P	X	X		X	
Myobatrachidae	Smooth Toadlet	*Uperoleia laevigata*	P		X		X	
Reptiles								
Diplodactylidae	Lesueur's Velvet Gecko	*Oedura lesueurii*	P	X	X			
Scincidae	Cream-striped Shinning-skink	*Cryptoblepharus virgatus*	P	X	X			
Scincidae	Copper-tailed Skink	*Ctenotus taeniolatus*	P	X	X			
Scincidae	Tree Skink	*Egernia striolata*	P			X		
Elapidae	Red-bellied Black Snake	*Pseudechis porphyriacus*	P				X	

Family	Common Name	Scientific Name	Legal Status[1]	Riparian	Woodland	Forest	Incidental within Study Area	Incidental Outside Study Area
Birds								
Phalacrocoracidae	Little Pied Cormorant	*Microcarbo melanoleucos*	P	X				
Ardeidae	White-faced Heron	*Egretta novaehollandiae*	P	X				
Accipitridae	Wedge-tailed Eagle	*Aquila audax*	P	X				
Accipitridae	Spotted Harrier	*Circus assimilis*	V					X
Falconidae	Nankeen Kestrel	*Falco cenchroides*	P	X			X	
Columbidae	Crested Pigeon	*Ocyphaps lophotes*	P	X				
Psittacidae	Galah	*Eolophus roseicapillus*	P		X			
Psittacidae	Sulphur-crested Cockatoo	*Cacatua galerita*	P	X	X			
Psittacidae	Little Lorikeet	*Glossopsitta pusilla*	V	X				
Psittacidae	Red-winged Parrot	*Aprosmictus erythropterus*	P		X		X	
Psittacidae	Crimson Rosella	*Platycercus elegans*	P	X				
Psittacidae	Eastern Rosella	*Platycercus eximius*	P	X	X			
Psittacidae	Turquoise Parrot	*Neophema pulchella*	V		X			X
Cuculidae	Fan-tailed Cuckoo	*Cacomantis flabelliformis*	P	X	X			
Cuculidae	Shining Bronze-Cuckoo	*Chalcites lucidus*	P				X	
Strigidae	Southern Boobook	*Ninox*	P		X	X		

Family	Common Name	Scientific Name	Legal Status[1]	Riparian	Woodland	Forest	Incidental within Study Area	Incidental Outside Study Area
		novaeseelandiae						
Tytonidae	Eastern Barn Owl	*Tyto javanica*	P		X			
Podargidae	Tawny Frogmouth	*Podargus strigoides*	P	X	X			
Aegothelidae	Australian Owlet-nightjar	*Aegotheles cristatus*	P	X				
Halcyonidae	Laughing Kookaburra	*Dacelo novaeguineae*	P		X		X	
Climacteridae	Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V					X
Climacteridae	White-throated Treecreeper	*Cormobates leucophaea*	P	X			X	
Maluridae	Superb Fairy-wren	*Malurus cyaneus*	P	X				
Pardalotidae	Spotted Pardalote	*Pardalotus punctatus*	P	X	X			
Pardalotidae	Striated Pardalote	*Pardalotus striatus*	P			X		
Acanthizidae	White-browed Scrubwren	*Sericornis frontalis*	P	X				
Acanthizidae	Speckled Warbler	*Pyrrholaemus saggitatus*	V			X		
Acanthizidae	Brown Thornbill	*Acanthiza pusilla*	P			X		
Acanthizidae	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	P			X		
Meliphagidae	Brown Honeyeater	*Lichmera indistincta*	P	X				
Meliphagidae	White-plumed Honeyeater	*Lichenostomus penicillatus*	P	X	X			

Family	Common Name	Scientific Name	Legal Status[1]	Riparian	Woodland	Forest	Incidental within Study Area	Incidental Outside Study Area
Meliphagidae	Noisy Friarbird	*Philemon corniculatus*	P	X				
Meliphagidae	Striped Honeyeater	*Plectorhyncha lanceolata*	P	X				
Meliphagidae	Noisy Miner	*Manorina melanocephala*	P				X	
Meliphagidae	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	P	X				
Meliphagidae	Red Wattlebird	*Anthochaera carunculata*	P	X				
Petroicidae	Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	V	X				
Petroicidae	Eastern Yellow Robin	*Eopsaltria australis*	P		X			
Pachycephalidae	Eastern Shrike-tit	*Falcunculus frontatus frontatus*	P		X			
Pachycephalidae	Golden Whistler	*Pachycephala pectoralis*	P		X			
Pachycephalidae	Rufous Whistler	*Pachycephala rufiventris*	P				X	
Pachycephalidae	Grey Shrike-thrush	*Colluricincla harmonica*	P	X	X			
Dicruridae	Grey Fantail	*Rhipidura albiscapa*	P	X	X			
Dicruridae	Willie Wagtail	*Rhipidura leucophrys*	P	X	X			
Dicruridae	Magpie-lark	*Grallina cyanoleuca*	P	X				

Family	Common Name	Scientific Name	Legal Status[1]	Riparian	Woodland	Forest	Incidental within Study Area	Incidental Outside Study Area
Campephagidae	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	P		X		X	
Oriolidae	Olive-backed Oriole	*Oriolus sagittatus*	P		X			
Artamidae	Masked Woodswallow	*Artamus personatus*	P				X	
Artamidae	Dusky Woodswallow	*Artamus cyanopterus*	P		X			
Cracticidae	Grey Butcherbird	*Cracticus torquatus*	P	X	X			
Cracticidae	Pied Butcherbird	*Cracticus nigrogularis*	P				X	
Cracticidae	Australian Magpie	*Cracticus tibicen*	P	X	X			
Cracticidae	Pied Currawong	*Strepera graculina*	P	X	X	X		
Corvidae	Australian Raven	*Corvus coronoides*	P	X	X			
Muscicapidae	Restless Flycatcher	*Myiagra inquieta*	P				X	
Muscicapidae	Satin Flycatcher	*Myiagra cyanoleuca*	P	X				
Hirundinidae	Welcome Swallow	*Hirundo neoxena*	P	X	X			X
Zosteropidae	Silvereye	*Zosterops lateralis*	P	X				
Estrildidae	Double-barred Finch	*Taeniopygia bichenovii*	P	X				
Estrildidae	Red-browed Finch	*Neochmia temporalis*	P				X	
Estrildidae	Diamond Firetail	*Stagonopleura guttata*	V	X	X			
Mammals								
Dasyuridae	Yellow-footed	*Antechinus flavipes*	P		X			

Family	Common Name	Scientific Name	Legal Status[1]	Riparian	Woodland	Forest	Incidental within Study Area	Incidental Outside Study Area
	Antechinus							
Macropodidae	Common Wallaroo	*Macropus robustus*	P			X	X	
Macropodidae	Eastern Grey Kangaroo	*Macropus giganteus*	P	X			X	
Phalangeridae	Common Brushtail Possum	*Trichosurus vulpecula*	P		X			
Pseudocheiridae	Common Ringtail Possum	*Pseudocheirus peregrinus*	P	X				
Rhinolophidae	Eastern Horseshoe-bat	*Rhinolophus megaphyllus*	P		X			
Vespertilionidae	Gould's Wattled Bat	*Chalinolobus gouldii*	P			X		
Vespertilionidae	Chocolate Wattled Bat	*Chalinolobus morio*	P		X		X	
Vespertilionidae	Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V			X		
Vespertilionidae	Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V			X		
Vespertilionidae	Long-eared bat	*Nyctophilus sp.*	P		X			
Vespertilionidae	Little Broad-nosed Bat	*Scotorepens greyii*	P		X	X		
Vespertilionidae	Eastern Cave Bat	*Vespadelus troughtoni*	V			X		
Vespertilionidae	Little Forest Bat	*Vespadelus vulturnus*	P			X		
Vespertilionidae	Unidentified Eptesicus	*Vespadelus sp.*	P		X	X		

Family	Common Name	Scientific Name	Legal Status[1]	Riparian	Woodland	Forest	Incidental within Study Area	Incidental Outside Study Area
Molossidae	Mastiff-bat	*Mormopterus sp.*	P			X		
Molossidae		*Mormopterus 'Species 4'*	P			X		
Molossidae	White-striped Freetail-bat	*Tadarida australis*	P			X		
Muridae	Black Rat	*Rattus rattus**	U	X				
Suidae	Pig	*Sus scrofa**	U	X				
Bovidae	European cattle	*Bos taurus**	U	X				
Bovidae	Goat	*Capra hircus**	U				X	
Cervidae	Unidentified Deer	*Cervus sp.**	U	X				

KEY: * = introduced species; highlighted cells = listed as vulnerable under TSC Act; V = Vulnerable; P = Protected; U = Unprotected.

No species listed under the EPBC Act were recorded.

[1]Conservation status current as of 11 July 2012.