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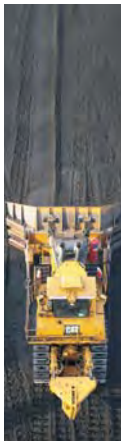
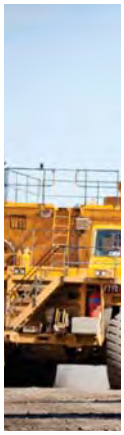
Duralie Open Pit Modification
Environmental Assessment





APPENDIX E

FLORA ASSESSMENT

YANCOAL
兖煤澳大利亚有限公司

Resource Strategies

DURALIE OPEN PIT MODIFICATION

FLORA ASSESSMENT

PREPARED BY
FLORASEARCH

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EXECUTIVE SUMMARY

A flora survey of the Duralie Coal Modification area and proposed offset area was conducted by FloraSearch over three days in April and May 2014.

Flora Communities and Species

One natural climax vegetation community was recorded in the Modification area (i.e. Spotted Gum – Grey Ironbark Forest) as well as one derived vegetation type (i.e. Derived Grassland). Two natural climax vegetation communities were recorded in the offset area (i.e. Spotted Gum – Grey Ironbark Forest and Grey Box – Forest Red Gum – Grey Ironbark Forest) as well as two derived vegetation types (Derived Grassland and Acacia Regeneration.

A total of 231 plant species was identified on quadrat plots and random meanders by the survey. Of these, 191 (82.7%) are native to the natural communities of the Study area and 40 (17.3%) are introduced.

The plant families with the highest numbers of native species (Attachment A) were the Grasses, family Poaceae (26 species); the Pea Flowers, Fabaceae subfamily Faboideae (15 species); the Daisies, Asteraceae (11 species); the Eucalypts and related genera in the family Myrtaceae (13 species); the Rushes and Sedges, Cyperaceae (12 species) and the Wattles, subfamily Mimosoideae (7 species). In all, some 67 families of native plants were represented.

Condition of the Vegetation

The condition of the vegetation is assessed in detail for two parts of the Modification area and the offset area. In general, the remnant native vegetation is in good to very good condition in the Modification area, with the derived grasslands considered to be in poor condition. Similarly, most of the remnant native vegetation in the offset area is considered to be in very good condition with small areas in moderate condition. Derived grassland and acacia regeneration in the offset area are in poor condition.

Threatened Species

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

Threatened Ecological Communities

No ecological communities listed as threatened in the schedules of the TSC Act or EPBC Act, were found in the Modification or offset areas.

Impacts

A total of 2.5 hectares (ha) of native vegetation and derived grasslands would be removed by the Modification.

Impact Avoidance, Mitigation and Offset

The changes to the limit of the open pit are required to improve geotechnical stability, and therefore, additional disturbance associated with these changes to the open pit limit cannot be avoided without potentially impacting the long-term stability of the open pit low walls.

The relocation of existing water diversion infrastructure adjacent to the Clareval pit has been designed to occur within derived grassland wherever possible to avoid additional disturbance of native vegetation. In addition, the relocated water diversion infrastructure has been designed to avoid disturbance of Plant Community Type 3 (Grey Myrtle – Flintwood Dry Rainforest).

Mitigation measures applicable to flora developed for the DCM are:

- vegetation clearance procedures;
- weed control and prevention; and
- bushfire prevention.

Biodiversity values would be maintained and improved in the region in the long-term with a proposed offset area. The proposed offset has a number of features that ensure it meets the 'maintain and improve' test. These include:

- The offset removes an area of native vegetation from the deleterious effects of livestock grazing, thereby allowing it to recover and improve over time.
- Cleared agricultural lands within the offset would be revegetated with local trees and shrubs appropriate to the positions in the landscape being replanted.
- The offset area replicates, as far as practicable, the vegetation communities on the Modification area, thereby maintaining biodiversity in the region.
- The new offset area adjoins an existing reserved offset area thereby enhancing the viability of each and nature conservation over the region as a whole.

Conclusions

It is concluded that the Modification would not have a significant impact on flora species, populations, ecological communities or critical habitat for the following reasons:

- The 2.5 ha of native vegetation and derived grasslands that would be removed for the Modification is offset with 12.5 ha of similar native vegetation and derived grasslands close by.
- The offset supports good samples of the dominant native vegetation communities within the Modification disturbance areas and has a greater diversity of vegetation communities than occur within the Modification area.
- It is concluded that the offset area meets the NSW Office of Environment and Heritage offset principles and would result in a net improvement in regional biodiversity values.
- The area of native vegetation to be cleared represents a very small proportion of the extant native vegetation in the local area and wider region.
- Mitigation strategies are considered adequate to control risks to native flora arising from weed invasion, dust and fires.
- The Assessment demonstrated the Modification is highly unlikely to impact significantly on any threatened flora species, or their habitats that may potentially occur on the Modification area.
- The Modification would have no impact on threatened populations, threatened ecological communities or critical habitat, as none occurs on the Modification area.
- The main cumulative impact on native flora is a further small depletion of vegetation communities that have been heavily cleared historically for agriculture in the region.

1 INTRODUCTION

The Duralie Coal Mine (DCM) is located approximately 10 kilometres (km) north of the village of Stroud and approximately 20 km south of Stratford in the Gloucester Valley in New South Wales (NSW) (Figure 1). Operations at the DCM originally commenced in 2003.

The DCM currently operates in accordance with the conditions of Project Approval (08_0023) granted by the NSW Land and Environment Court in November 2011 (as modified in November 2012).

Duralie Coal Pty Ltd (DCPL) requires a modification to the DCM Project Approval (08_0203) (the Modification).

The main activities associated with the Modification include:

- Minor changes to the surface extent of the currently approved open pits to improve geotechnical stability, including a reduction in low wall angles of the Clareval open pit and the removal of the pillar between the Clareval and Weismantel Pits and the associated relocation of existing water diversion infrastructure adjacent to the Clareval pits. The additional surface development extent associated with the Modification (i.e. the Modification disturbance area) is shown on Figure 2.
- Changes to the open pit shells, including an increased maximum pit depth, to reflect the results of recent geological exploration.
- Revised mining sequence (i.e. progression of mining in the Clareval and Weismantel open pits) to account for the revised pit shells and associated dumping requirements.
- Increased waste emplacement height in the central portion of the waste emplacement.

The Modification disturbance area is limited to two relatively small areas (approximately 2.5 hectares (ha) in total) along the northern and western extent of the Clareval North West Open Pit, located within Mining Lease (ML) 1646.

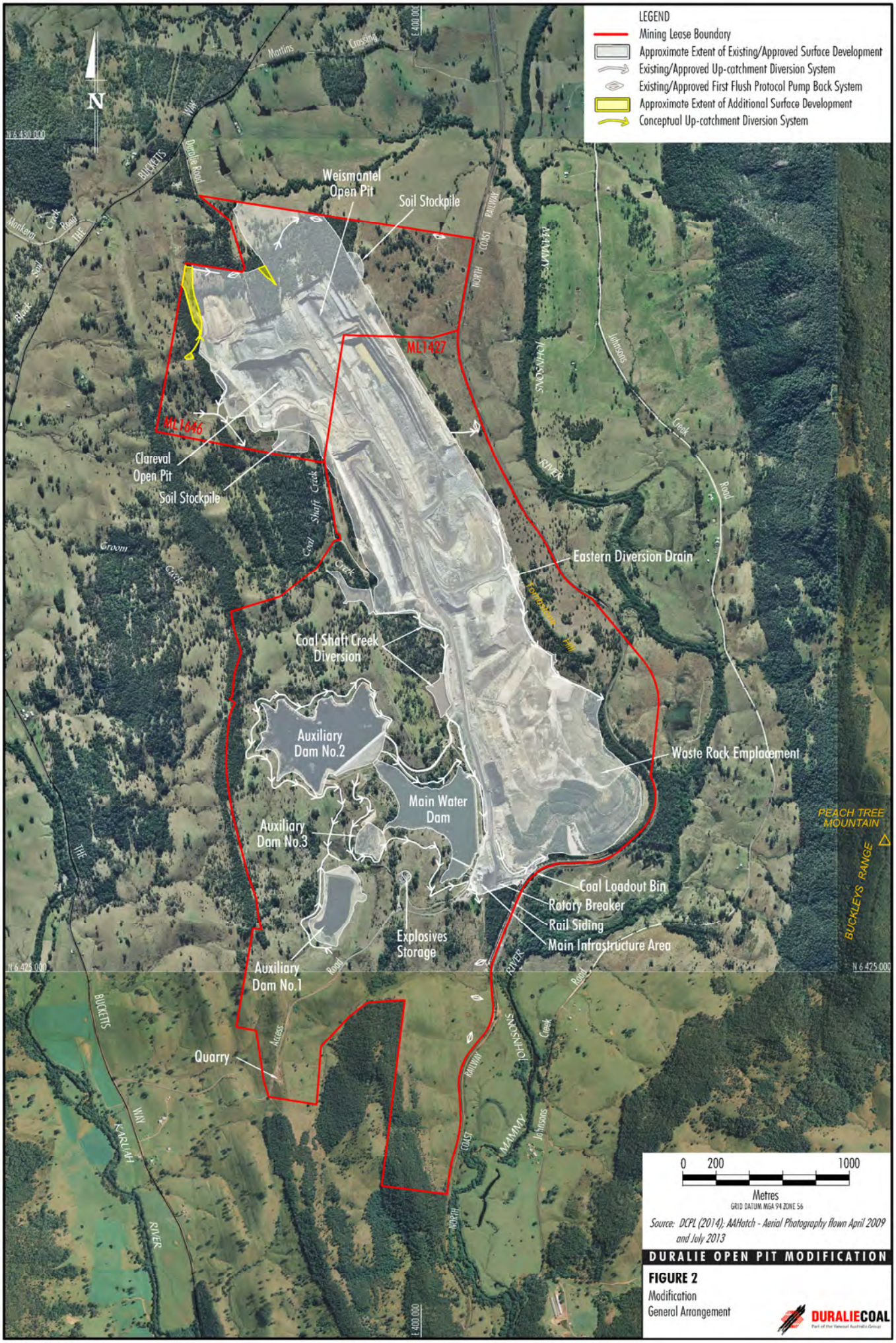
FloraSearch was commissioned by DCPL to conduct a flora assessment for the Modification.

1.1 ASSESSMENT OBJECTIVES

Potential impacts of the proposed Modification on flora are assessed in accordance with the *Guidelines for Threatened Species Assessment* (Department of Environment and Conservation and Department of Primary Industries [DEC and DPI], 2005) due to the Modification being assessed under Section 75W Part 3A of the *Environmental Planning and Assessment Act* (EP&A Act). The objectives of the survey and assessment are to:

- describe the natural vegetation within the Study area [which is the area for which the vegetation communities have been mapped on Figure 4];
- map the vegetation communities and vegetation types present within the Study area;
- compile comprehensive plant species lists for each vegetation community within the Study area;
- develop a list of threatened plant species, populations, communities or critical habitat, listed in the schedules of the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act*, *1999* (EPBC Act), that could potentially occur in the Study area;
- identify the magnitude, nature and significance of impacts from the Modification on flora species including threatened species, populations and ecological communities listed under the TSC Act and the EPBC Act; and
- describe impact avoidance, mitigation and offset measures to minimise impacts on flora.

GCL-14-23_Mod2_Fauna_103A



DURALIE OPEN PIT MODIFICATION

FIGURE 2
Modification
General Arrangement

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GCL-14-23_Mod2_Fauna_104B

1.2 REGIONAL SETTING

The Study area is within the Hunter-Central Rivers Local Land Services (LLS) Area and is just within the hinterland of the NSW lower North Coast region. Geologically, the Study area is in the narrow north-south oriented Stroud-Gloucester Syncline, formed in the early Permian by east-west compression of the underlying Carboniferous sedimentary rocks (Henderson, 2000) creating a depositional trough bounded by active faults. The resulting Stroud-Gloucester Basin accumulated sediments through the Permian, including the Gloucester Coal Measures, while also being subjected to episodes of faulting and compression. Volcanic flows in the early Permian along with a basal coal measure sequence comprise the earliest basin formation. Rhyolite flows from the early Permian now form prominent ridges around the Permian sediments in the centre of the basin (Henderson, 2000).

The Stroud-Gloucester Basin is bordered by rugged hills dominated by Carboniferous sediments and volcanics to the west (Monkerai Hills) and Carboniferous sediments alone to the east (Karuah Mountains). The rugged terrain in much of the surrounding region remains clothed in native forests, particularly east and west of the Stroud-Gloucester Basin. Most of this land is dedicated as National Parks, Nature Reserves, State Conservation Areas or State Forests. Flatter and gently undulating areas of the Stroud-Gloucester Basin have been cleared for agriculture and grazing. Nevertheless, in the Duralie area there is a series of parallel north-south oriented ridges and ranges that are naturally vegetated, including Linger and Die Ridge, Buckleys Range and many smaller ridge systems.

The Study area lies in the catchment of the Mammy Johnsons River which flows south into the Karuah River, before entering Port Stephens at Karuah.

1.3 BIOGEOGRAPHICAL AND BOTANICAL REGIONS

The Study area lies in the south of both the North Coast Botanical Division of NSW (Anderson, 1968) and the NSW North Coast Bioregion (Thackway and Cresswell, 1995). The North Coast Bioregion runs up the east coast of NSW from Port Stephens to just inside the Queensland border. The NSW portion is 5,692,351.6 ha or 96.1 percent (%) of the bioregion and 7.1% of the state (NSW Office of Environment and Heritage [OEH], 2014a). In NSW, the North Coast Botanical Division of NSW runs along the east coast from south of Newcastle to the Queensland border (Anderson, 1968).

1.4 DESCRIPTION OF THE STUDY AREA AND SURROUNDS

1.4.1 Topography

The terrain in the Study area is hilly with moderately steep slopes, and altitudes varying from approximately 80 to 170 metres (m) Australian Height Datum (AHD). The Modification area is semi-cleared with native vegetation remaining on rhyolite ridges to the west of Clareval Pit, in the area between the Clareval and Weismantel Pits and along a tributary of Mammy Johnsons River.

1.4.2 Soils

Three distinct Soil Landscapes occur on the Modification area, one of which also occurs on the proposed offset area (Henderson, 2000). In the north eastern section of the Modification area the soils are derived from the Permian sediments of the Gloucester Coal Measures, while those of the south western section are derived from early Permian Alum Mountain Volcanics, as are the soils in the proposed offset area (Henderson, 2000). The Soil Landscapes and their component soil types are summarised below.

Wards River Soil Landscape

The Wards River Soil Landscape is derived from the Gloucester Coal Measures and is restricted to the north-eastern section of the Modification area east of Duralie Road (Henderson, 2000). The dominant topsoils are brownish black earthy loams (A1 horizon) over brown hardsetting bleached loam (A2 horizon), brown prismatic clay (B horizon) and yellow prismatic clay (B horizon). The soils have relatively high erosion risks, may become seasonally waterlogged on the lower slopes, are highly acidic, have low fertility and high aluminium toxicity.

Stroud Road Soil Landscape

The Stroud Road Soil Landscape is derived from sediments and volcanics of the Permian Alum Mountain Volcanics and occurs on rolling low hills in the south-eastern block of the Modification area, and in the proposed offset area. The sediments contain conglomerate, sandstone, siltstone and coal, while the volcanics include basalt, rhyolite and rhyolitic ignimbrite. The soils vary according to the parent material and topographic position (Henderson, 2000). Topsoils are brown crumbly clay loams or brownish black polyhedral clay in the A horizon. The A1 horizon is brownish black weak crumb ped loam. Subsoils include gravelly brown earthy loam, brown plastic sticky clay, reddish brown polyhedral clay or gravelly mottled pale clay. Soils are locally prone to gully and sheet erosion, localised mass movement, localised high acidity and localised high fertility.

Gloucester Buckets Soil Landscape

The Gloucester Buckets Soil Landscape is also derived from sediments and volcanics of the Permian Alum Mountain Volcanics and occurs on rolling to very steep hills (Henderson, 2000) in the south-eastern block of the Modification area and in the proposed offset area. Topsoils include dark weakly structured loam or dark friable clay loam in the A1 horizon. The A2 horizon is bleached earthy loam while the subsoil comprises gravelly brown earthy loam. Soils are subject to localised sheet erosion, mass movement, rock outcrops and are often shallow, strongly acid, stony and of low fertility.

1.4.3 Land Use

The predominant historic land uses in the Study area have been logging and cattle grazing.

1.4.4 Surface Hydrology

The undulating to steep terrain in the Study area results in generally rapid drainage of the landscape via deep gullies and incised watercourses. More gently sloping upper catchment drainage lines and adjacent lower slopes may become waterlogged in wet weather conditions.

1.4.5 Climate

Pacific Environment Limited (2014) describes the long-term meteorological data for the region available from the Bureau of Meteorology (BoM) operated Automated Weather Station (AWS) at Paterson, located approximately 50 km south-west of the DCM. The annual average maximum and minimum temperatures recorded at the Paterson AWS are 24 degrees Celsius (°C) and 12°C, respectively. Rainfall data collected at the Paterson AWS shows that February is the wettest month, with an average rainfall of 121.5 millimetres (mm) over 11.4 rain days. The average annual rainfall is 932 mm with an average of 123.9 rain days.

1.5 LITERATURE REVIEW

1.5.1 Regional Flora Surveys

Broad scale classification and mapping of NSW Lower North Coast vegetation was conducted for the Comprehensive Regional Assessments (NSW National Parks and Wildlife Service [NPWS], 1999). This study identified 157 forest ecosystems between the Hunter Valley, the New England Highway and the Queensland border on the NSW North Coast and Northern Tablelands (NPWS, 1999). However, the mapping output from that study varies considerably in the accuracy and detail of its coverage (NPWS, 2001). Within the Study area, the coverage was based on predictions of vegetation types from Geographic Information System modelling and has relatively low reliability.

The Biometric Vegetation Types Database (OEH, 2012) compiles lists of Plant Community Types (PCT) according to the LLS area in which they occur. The Study area lies within the Hunter Central Rivers LLS area. Some 166 PCTs are listed by OEH (2012) within this area which includes a diverse range of landscapes and habitats. Only a small proportion of these PCTs are likely to occur within the Study area. The PCTs with most potential to occur on the Study area and surrounds are shown in Table 1. Some PCTs listed in Table 1 as potentially occurring on the Study area may differ somewhat floristically to the actual vegetation types present. This is because vegetation composition may change gradually with latitude, such that the vegetation types on the Study area have similarities with some of those in the adjoining Northern Rivers LLS area.

1.5.2 Flora and Vegetation Surveys Conducted for the Duralie Mine

ERM Mitchell McCotter Pty Ltd (1996) conducted flora surveys and vegetation mapping for the *Duralie Coal Project - Environmental Impact Statement*. These studies divided the vegetation on the Exploration Lease into six structural mapping units following Specht (1981). Within each structural unit ERM Mitchell McCotter identified a range of vegetation types. These are shown in Table 1 along with the closest equivalent PCTs for the Hunter Central Rivers LLS area (OEH, 2012). [Note: There is not always a good match between the community concepts of ERM Mitchell McCotter (1996) and the OEH (2012) PCTs, particularly in the dry sclerophyll and open forest communities.] ERM Mitchell McCotter (1996) provides brief accounts of the floristics for each of their vegetation types including the dominant tree species and associated shrub and ground layer species where present. Their flora list of 115 species included none that are listed as threatened under the TSC or EPBC Acts. In addition, AGC Woodward-Clyde Pty. Ltd. (1996) conducted extensive targeted searches for threatened flora species in the summer of 1995-96. No threatened flora species were found by the searches.

Table 1
Vegetation Types Previously Identified within the Study area and Surrounds and Equivalent Biometric Plant Community Types

ERM Mitchell McCotter (1996)			Ecobiological (2009a,b)		Plant Community Types (OEH, 2012)		
Structural Formation	**Vegetation Type**	**Scientific Name**	**Vegetation Community**	**Scientific Name**	**Vegetation Formation/Class**	**Community Name**	**Scientific Name**
Closed Forest	Riparian Forest	*Tristaniopsis laurina, Casuarina cunninghamii, Eucalyptus saligna*	Riparian Closed Forest	*Waterhousia floribunda, T. laurina, Casuarina cunninghamii*	Rainforest/Dry Rainforest	Weeping Lilly Pilly - Water Gum Riparian Rainforest of the southern North Coast (HU651)	*Waterhousea floribunda, T. laurina, Neolitsea dealbata.*
Low Closed Forest	Riparian Forest	*Syzygium australe, Choricarpa leptopetala, T. laurina, Melaleuca linariifolia, M. styphelioides, Callistemon salignus*					
-	-	-	Dry Gully Rainforest	*Ficus rubiginosa, Rhysoetoechia bifoliolata, Dendrocnide excelsa*	Rainforest/ Subtropical Rainforest	Giant Stinging Tree – Fig dry subtropical rainforest of the North Coast and Brigalow Belt South (HU548)	*Dendrocnide excelsa, F. coronata, F. obliqua, F. macrophylla, Toona australis, Doryphora sassafras, Daphnandra micrantha, Dysoxylon fraserianum*
Forest	Ecotone Forest	*E. saligna, E. amplifolia, Angophora floribunda, E. acmenoides*	Blue Gum Moist Forest	*E. saligna, Lophostemon confertus*	Wet Sclerophyll Forests (Shrubby Subformation)/North Coast Wet Sclerophyll Forest	Tallowwood – Brush Box – Sydney Blue Gum moist shrubby forest on coastal foothills of the southern North Coast (HU642)	*E. microcorys,E. saligna, Lophostemon confertus*
	Swamp Sclerophyll Forest	*E. amplifolia, M. decora, M. linariifolia*	Cabbage Gum Floodplain Forest	*E. amplifolia*	Grassy Woodlands/ Coastal Valley Grassy Woodlands	Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands (HU526)	*E. amplifolia, E. moluccana, E. tereticornis*
	Dry Sclerophyll Forest	*E. carnea, E. acmenoides, E. fibrosa, E. siderophloia, E. globoidea, E. eugenioides, A. floribunda*	Spotted Gum – Red Ironbark – Thick-leaved Mahogany forest	*Corymbia maculata, E. carnea, E. microcorys, E. fibrosa*	Dry Sclerophyll Forests (Shrub/grass subformation)/Hunter Macleay Dry Sclerophyll Forests	Spotted Gum - Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast (HU630)	*C. maculata, E. siderophloia, E. umbra, E. punctata, A. costata*
Forest	Dry Sclerophyll Forest	-	Stringybark – Paperbark Forest	*E. acmenoides, E. carnea, M. nodosa*	Dry Sclerophyll Forests (Shrub/grass subformation)/ Hunter Macleay Dry Sclerophyll Forests	Spotted Gum - Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast (HU630)	*C. maculata, E. siderophloia, E. umbra, E. punctata, A. costata*

Table 1 (Continued)
Vegetation Types Previously Identified within the Study area and Surrounds and Equivalent Biometric Plant Community Types

ERM Mitchell McCotter (1996)			Ecobiological (2009a,b)		Plant Community Types (OEH, 2012)		
Structural Formation	**Vegetation Type**	**Scientific Name**	**Vegetation Community**	**Scientific Name**	**Vegetation Formation / Class**	**Community Name**	**Scientific Name**
Open Forest	Ridge Open Forest	*E. maculata, E. siderophloia, E. moluccana, E. tereticornis, E. punctata, E. canaliculata, E. acmenoides*	Spotted Gum – Grey Ironbark, Thick-leaved Mahogany Forest	*Corymbia. maculata, E. siderophloia, E. crebra, E. microcorys, E. canaliculata, E. carnea*			
			Red Gum Grassy Woodland	*E. tereticornis, E. moluccana, E. siderophloia*	Grassy Woodlands/ Coastal Valley Grassy Woodlands	Grey Box - Forest Red Gum - Grey Ironbark open forest of the hinterland ranges of the North Coast (HU549)	*E. moluccana, E. tereticornis, E. siderophloia, E. propinqua*
	Riparian Open Forest	*A. floribunda, E. punctata, E. canaliculata, E. moluccana, E. amplifolia, E. siderophloia*	Grey Gum – Red Gum – Apple Riparian Forest	*E. canaliculata, A. floribunda, E. acmenoides, E. tereticornis*			
Grassland	Grassland	Native and Introduced grasses	Secondary Native Grasslands	*Themeda australis, Imperata cylindrica, Microlaena stipoides, Entolasia stricta, Aristida vagans*	Grasslands/Coastal Valley Grassy Woodlands	Derived Grasslands in Coastal Valleys (HU670)	*Themeda australis, Aristida vagans, Cymbopogon refractus*
-	-	-	Perched Sedgeland	*Leptospermum trinervium, Hibbertia riparia, Rulingia dasyphylla, Bursaria spinosa, Dodonaea triquetra, Allocasuarina littoralis*	N/A	N/A	-
Wetland	Freshwater Wetland	*Triglochin procerum, Ottelia ovalifolia, Persicaria strigosa*	Freshwater Wetland Complex	[Not sampled]	Freshwater Wetlands	N/A	-

Cenwest Environmental Services and Resource Strategies (2010) produced the flora and fauna assessment for the Duralie Extension Project Environmental Assessment. The assessment was based on field surveys conducted by Ecobiological (2009a, b). Ecobiological recognised 11 native vegetation communities and a secondary native grassland vegetation type in the DCM area and surrounds. Table 1 shows the relationships of the communities recognised by Ecobiological with those of ERM Mitchell McCotter (1996) and the current Biometric PCTs (OEH, 2012). Most Ecobiological communities have a direct equivalent in the Biometric classification, except in two cases where two or three Ecobiological communities are part of a single Biometric community (Table 1).

1.6 DATABASE REVIEW

Lists of threatened species, populations, ecological communities and critical habitat that are known, or have potential, to occur in the Study area were derived by consulting the following sources in addition to the literature previously described. Database searches were conducted within a 20 × 20 km square centred on the Study area. The databases were searched in April 2014. Databases searched include the:

- BioNet [Atlas of NSW Wildlife] which includes the databases of the NPWS, Forestry Corporation of NSW and the Royal Botanic Gardens and Domain Trust Sydney (BioNet, 2014).
- Protected Matters Search Tool (Commonwealth Department of the Environment [DotE], 2014a).
- Schedules of the TSC Act and the EPBC Act.
- Preliminary and Final Determinations of the NSW Scientific Committee.

1.6.1 Threatened Flora Species

Table 2 compiles all threatened flora species listed under the TSC Act and the EPBC Act that were returned by the database searches for the wider region around the Study area. Table 2 documents the known distribution and habitats of these species and assesses the likelihood of their occurrence within the habitats present on the Study area. These considerations identified seven threatened species for assessment, four of which are considered to have a low probability and three a medium probability, of occurring on the Study area (Table 3). These species were specifically targeted during the surveys conducted for this study.

Of the threatened species considered to have some potential to occur on the Study area, two are trees, one is a climber, three are shrubs and one is a perennial herb (Table 3). The presence of the trees and shrubs can be detected at any time of the year and in any seasonal conditions, although identification is usually easier when flowering or fruiting material is present. It is considered that the survey effort, including quadrats, random meanders and other site inspections, has been adequate for detecting the presence of any occurrences of threatened flora species (if they were to occur).

Table 2
Threatened Flora Species that may Potentially Occur within the Study Area

Scientific Name	Common Name	Conservation Status[1]		Distribution	Habitat	Likelihood of Occurrence	Significance Assessment
		TSC Act	EPBC Act				
Allocasuarina defungens	Dwarf Heath Casuarina	E	E	The Dwarf Heath Casuarina was indicated as potentially occurring in the search area by the DotE Protected Matters Search Tool (DotE, 2014a). However, no records were returned for the search area by BioNet (2014).	Restricted to coastal sandplains and adjacent exposed hills and headlands (OEH, 2014b), which are absent from the Study area. Consequently, the Dwarf Heath Casuarina is not considered further here.	Nil	No
Asperula asthenes	Trailing Woodruff	V	V	From Bulahdelah to Kempsey (OEH, 2014b). However, no records were returned for the search area by BioNet (2014).	Grows in moist near coastal locations, particularly on river banks (OEH, 2014b). There is a small potential this species to occur on the tributary of Mammy Johnsons River on the Study area.	Low	Yes
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	The Leafless Tongue Orchid was indicated as potentially occurring in the search area by the DotE (2014a) Protected Matters Search Tool. However, no records were returned for the search area by BioNet (2014).	The Leafless Tongue Orchid is confined to low open woodlands with a heathy understorey on infertile, dry sandy loam soils on the NSW Central Coast (Bell, 2001). Such habitats are absent from the Study area. Consequently, the Leafless Tongue Orchid is not considered further here.	Nil	No
Cynanchum elegans	White-flowered Wax Plant	E	E	From the coast to the escarpment. Wollongong to Queensland border (OEH, 2014b).	Mainly in rainforest, but also occasionally in woodland (OEH, 2014b).	Low	Yes
Eucalyptus glaucina	Slaty Red Gum	V	V	From Broke to Taree and the Casino district (OEH, 2014b).	On deep, fertile soils in river valleys (OEH, 2014b).	Medium	Yes
Eucalyptus largeana	Craven Grey Box	E	-	Confined to Gloucester-Craven district and near Pokolbin (OEH, 2014b). Populations are known from Copeland Tops State Conservation Area and Berrico Nature Reserve, with unconfirmed records from Talawahl and Glen Nature Reserves and Willi Willi National Park. The majority of remaining populations occur on private lands and roadsides, often as single trees or small clumps interspersed with other tree species.	Found in wet forest on subcoastal ranges (OEH, 2014b).	Medium	Yes
Euphrasia arguta	An Eye-bright	CE	CE	From Bathurst to the Nundle area including the North Coast, Central and Northern Tablelands, and Central West and North West Slopes of NSW (Barker, 1992).	This species has recently been rediscovered in the Nundle area after being thought extinct (OEH, 2014b). Habitats include grassy areas beside rivers (Barker 1992) and grassy forests (DotE, 2014b).	Nil	No

Table 2 (Continued)
Threatened Flora Species that may Potentially Occur within the Study Area

Scientific Name	Common Name	Conservation Status[1]		Distribution	Habitat	Likelihood of Occurrence	Significance Assessment
		TSC Act	EPBC Act				
Grevillea guthrieana	Guthrie's Grevillea	E	E	Known from the north coast of NSW, at Booral near Bulahdelah and on the Carrai Plateau, south-west of Kempsey (OEH, 2014b). The Booral location is within the BioNet search area for this report.	Grows along creeks and cliff lines in eucalypt forest, on granitic or sedimentary soil (OEH, 2014b).	Low	Yes
Haloragis exalata subsp. *velutina*	Tall Velvet Sea-berry	V	V	This subspecies of Tall Sea-berry occurs on the north coast of NSW and southeastern Queensland. It is plentiful in inaccessible areas of the upper Macleay River. However, no records were returned for the search area by BioNet (2014).	Grows in damp places near watercourses. This subspecies also occurs in woodland on the steep rocky slopes of gorges (OEH, 2014b).	Nil	No
Melaleuca biconvexa	Biconvex Paperbark	V	V	Biconvex Paperbark is known from scattered and dispersed populations from the Jervis Bay area in the south and the Gosford-Wyong area in the north (OEH, 2014b). However, no records were returned for the search area by BioNet (2014).	Biconvex Paperbark generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects (OEH, 2014b).	Nil	No
Melaleuca groveana	Grove's Paperbark	V	-	Scattered in coastal districts north of Yengo National Park to southeast Queensland. Also found as a disjunct population near Torrington on the northern tablelands (OEH, 2014b). There are records in the Karuah Mountains to the north-east of the Study area (BioNet, 2014).	Grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcropping granite, rhyolite and sandstone on rocky outcrops and cliffs. It also occurs in dry, shrubby open forest and woodlands (OEH, 2014b). Suitable rocky, shrubby habitats are lacking on the Study area which is only lightly shrubby and lacks extensive rock outcrops.	Nil	No
Phaius australis	Lesser Swamp-orchid	E	E	Occurs in Queensland and north-east NSW as far south as Coffs Harbour. Historically, it extended farther south, to Port Macquarie (OEH, 2014b). However, no records were returned for the search area by BioNet (2014).	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas (OEH, 2014b). Suitable swampy habitats are lacking on the Study area.	Nil	No
Pomaderris queenslandica	Scant Pomaderris	E	-	North-east NSW and Queensland, including the New England Tablelands, North West Slopes and North Coast (OEH, 2014b). There is a record of this species in the Myall River State Forest within the BioNet search area to the south-east of the Study area (BioNet, 2014).	Moist eucalypt forest, sheltered shrubby woodlands, and occasionally along creeks (OEH, 2014b).	Low	Yes

Table 2 (Continued)
Threatened Flora Species that may Potentially Occur within the Study Area

Scientific Name	Common Name	Conservation Status[1]		Distribution	Habitat	Likelihood of Occurrence	Significance Assessment
		TSC Act	EPBC Act				
Senna acclinis	Rainforest Senna	E	-	Coast and tablelands from the Illawarra to Queensland (OEH, 2014b). There are records of this species within the BioNet (2014) search area in Chichester State Forest north-east of the Study area.	Edges of subtropical and dry rainforest (OEH, 2014b).	Low	Yes
Streblus pendulinus	Siah's Backbone	-	E	This species was returned by the DotE Protected Matters Search Tool (DotE, 2014a). The original listing considered it to be distributed on Norfolk Island and other Pacific Islands, and referred only to the Norfolk Island population (DotE, 2014c). Subsequently, this species has been synonymised with *S. brunonianus* which is common and widespread in eastern NSW.	The EPBC Act listing refers only to the Norfolk Island population of this species (DotE, 2014c). It is not considered further in this report.	Nil	No
Syzygium paniculatum	Magenta Lilly Pilly	E	V	The Magenta Lilly Pilly is found in a narrow coastal strip from Upper Lansdowne to Conjola State Forest (OEH, 2014b). The Magenta Lilly Pilly was returned by the BioNet (2014) search for two locations in the Karuah Mountains, one to the east of Wards River and the other to the east of Stroud.	On the south coast, the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral rainforest. On the central coast it occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (DotE, 2014c). Such habitats are absent from the Study area.	Nil	No
Tetratheca juncea	Black-eyed Susan	V	V	Confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock (OEH, 2014b). Black-eyed Susan was indicated as potentially occurring in the search area by the DotE Protected Matters Search Tool (DotE, 2014a). However, no records were returned for the search area by BioNet (2014).	The preferred substrates are sandy skeletal soil on sandstone, sandy-loam soils, low nutrients; and clayey soil from conglomerates, pH neutral. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape (OEH, 2014b). Suitable soils are lacking on the Study area.	Nil	No

[1] Threatened flora species conservation status under the TSC Act and EPBC Act.
V = Vulnerable E = Endangered CE = Critically Endangered

Table 3
Threatened Flora Species Targeted for Impact Assessment

Family Name	Scientific Name	Conservation Status[1]		Likelihood of Occurrence	Growth Form and Habitat
		TSC Act	EPBC Act		
Apocynaceae	*Cynanchum elegans*	E	E	Medium	Small slender climber, twining stems to 1 m, opposite broad acute leaves, milky sap, oval 6 to 10 centimetres (cm) long seed pod, seeds with silky hairs. Mainly rainforest, but also woodland (OEH, 2014b).
Fabaceae (Caesalpinioideae)	*Senna acclinis*	E	-	Low	Shrub to 3 m with compound leaves to 15 cm long, each with up to 6 pairs of oval-shaped leaflets. Groups of 2 to 5 golden yellow, cup-shaped flowers hang below branchlets. The flat seed pod is long and narrow, 12 to 15 cm long, 6 to 8 mm wide. Edges of subtropical and dry rainforest on the coast and tablelands (OEH, 2014b).
Myrtaceae	*Eucalyptus glaucina*	V	V	Medium	Tree to 30 m, red gum bark, juvenile leaves ovate, glaucous; adult leaves lanceolate to 18 × 3 cm, green or grey-green, concolorous; umbellasters 7-flowered, buds glaucous; fruit ovoid to globose, to 10 × 10 mm, disc raised, valves exserted. On deep, fertile soils (OEH, 2014b).
	Eucalyptus largeana	E	-	Medium	Tree to 40 m high; bark persistent on trunk and larger branches, grey with whitish patches, fibrous-flaky (`box'), smooth above, white to grey, shedding in short ribbons. Juvenile leaves disjunct, lanceolate to broad-lanceolate, dull dark green. Adult leaves disjunct, narrow-lanceolate, dark green, dull, concolorous. Conflorescence compound; umbellasters 7-flowered. Buds ovoid, calyptra hemispherical or conical, shorter than and as wide as hypanthium. Fruit pyriform or ovoid, 3–4 mm long, 2–3 mm diam.; disc depressed; valves enclosed (OEH, 2014b). Differs from the similar Coast Grey Box in the presence of a calyptra scar.
Proteaceae	*Grevillea guthrieana*	E	E	Low	A spreading shrub 2 to 4 m high. The branchlets are covered with long hairs when young and the leaf undersurface is also hairy. The leaves are 2 to 6 cm long and less than 1 cm wide. The flowers are green and maroon and form at the end of the branchlets. Grows along creeks and cliff lines in eucalypt forest, on granitic or sedimentary soil (OEH, 2014a).
Rhamnaceae	*Pomaderris queenslandica*	E	-	Low	Medium-sized shrub 2 to 3m tall with whitish stellate hairy stems; oval to narrow elliptical leaves, 2.5 to 7 cm long and 10 to 25 mm wide, shiny above and woolly below. Clusters of small creamy yellow flowers in spring-summer. Moist eucalypt forest, sheltered shrubby woodlands, and occasionally along creeks (OEH, 2014b).
Rubiaceae	*Asperula asthenes*	V	V	Low	Trailing perennial herb with leaves in whorls of four around the stem. It has tiny white star-shaped flowers and two-lobed fruit, only 1 mm long. Grows in moist near coastal locations, particularly on river banks (OEH, 2014b).

[1] Threatened flora species conservation status under the TSC Act and/or EPBC Act (current at 13 March 2012).
V = Vulnerable E = Endangered CE = Critically Endangered.

1.6.2 Threatened Populations

Twenty-six endangered populations are currently (May 2014) listed in Schedule 1 of the TSC Act. None of the populations potentially occur on the Study area.

1.6.3 Threatened Ecological Communities

Twenty-one TECs listed in the schedules of the TSC Act occur in the Hunter Central Rivers LLS area (OEH, 2012). Only two of these occur on the NSW North Coast, are not restricted to either near coastal habitats, or to altitudes below 50 m, and therefore have some potential to occur on the Study area:

- River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions Endangered Ecological Community (EEC) (the River-flat Eucalypt Forest on Coastal Floodplains EEC).
- Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions Vulnerable Ecological Community (VEC).

The River-flat Eucalypt Forest on Coastal Floodplains EEC is considered to have a low likelihood of occurring in the Study area for the following reasons:

- The River-flat Eucalypt Forest on Coastal Floodplains EEC generally occurs below 50 m AHD, but may occur on localised river flats up to 250 m AHD (Department of Environment and Conservation [DEC], 2004a).
- It occurs on coastal floodplains, which are defined as, *level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less* (DEC, 2004a). Such landforms do not occur on the Study area.

The potential for the Lower Hunter Valley Dry Rainforest VEC to occur on the Study area is discussed in detail in Section 3.6.

1.6.4 Critical Habitat

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

2 METHODS

Flora surveys were designed and undertaken in conformance with DEC (2004b) and OEH (2014d). The vegetation survey was carried out over 3 days in 2014; 15 and 16 April in the Modification area and 6 May in the offset area. The survey encompassed all remnants of native vegetation within both areas in order to sample and identify all vegetation communities present. All habitat types were surveyed to maximise the chances of finding populations of any threatened species that may occur. Complete coverage of the area was facilitated by recent aerial photography showing remnant vegetation. Both areas were traversed on foot.

2.1 VEGETATION SAMPLING

Two methods of documenting the vegetation were employed; quadrat sampling and random meanders. These methods are detailed in Sections 2.1.1 and 2.1.2, respectively. Figure 3 shows the locations of flora sample sites.

2.1.1 Quadrat Sampling

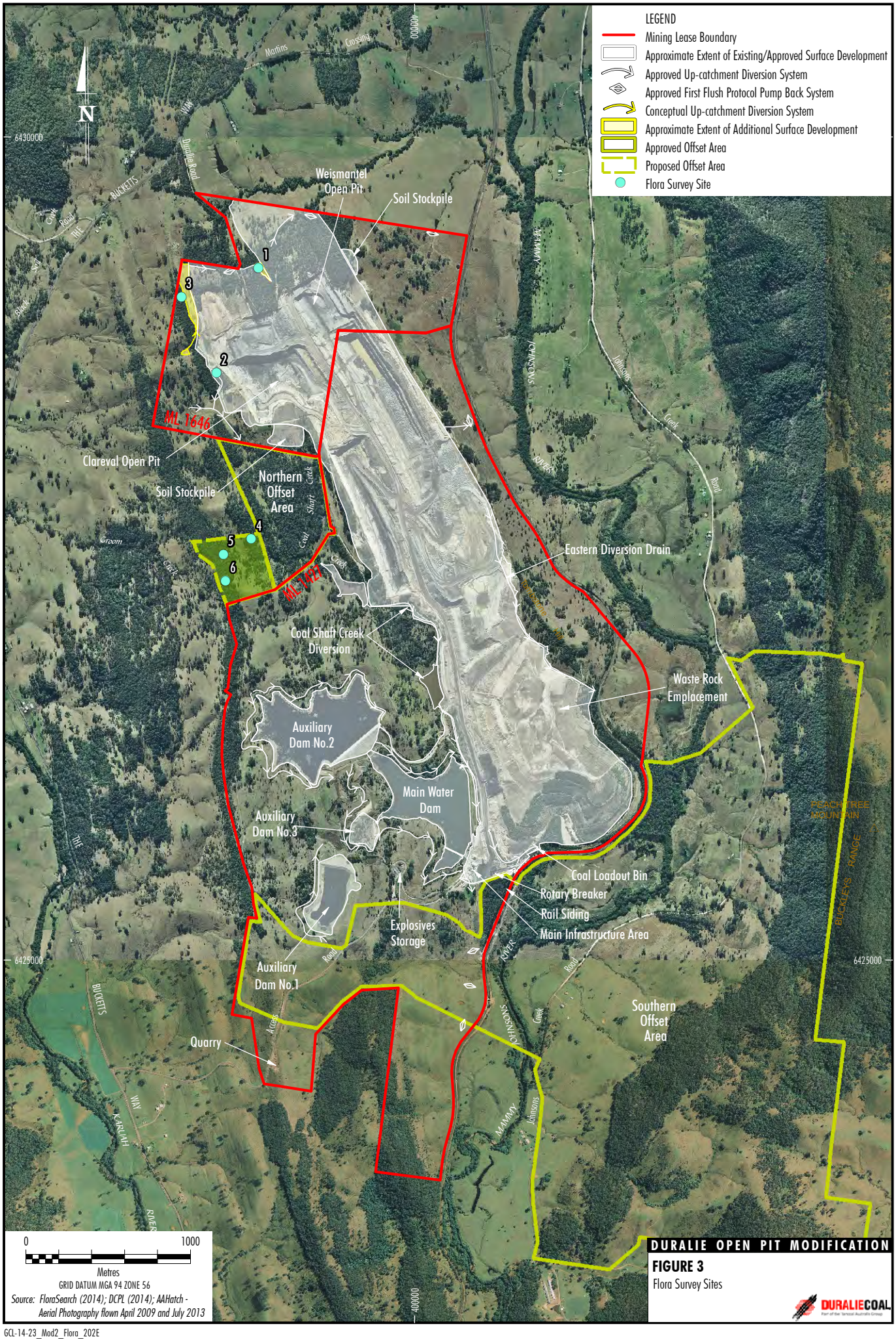
Six 20 × 20 m (0.04 ha) flora quadrat sites were sampled; three in the Modification area and three in the offset area (Figure 3). Within each plot the dominant species in each vegetation stratum were recorded, with an estimate of the percentage of the ground surface covered by their canopies. A list of all vascular plant species present within the quadrat was also made with each being assigned a cover abundance rating using a modified Braun-Blanquet scale (Table 4). Details recorded for each site included its Global Positioning System position, landform, physiography, topsoil characteristics, disturbance, vegetation structural formation and general comments. Plots were stratified across all vegetation communities in proportion to their representation on the Study area (Table 5).

Table 4
Modified Braun-Blanquet Cover Abundance Rating Scale

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

2.1.2 Random Meanders

Random meanders were used both to search for threatened flora species and populations (DEC, 2004b), and to record flora species additional to those found on the quadrats. 'Random meander' describes the nature of the search which is a randomly directed walk through habitat considered likely to support populations of the targeted species. The random meanders in this survey were targeted to the known habitats described in fact sheets and profiles of threatened species published on the websites of the OEH and the DotE, as well as on the website of the Royal Botanic Gardens and Domain Trust Sydney. The flora species targeted are given in Table 3. Six random meanders each of approximately 30 minutes duration were conducted by one person from each quadrat site. For each meander, lists of all flora species, additional to those recorded at the quadrat site, were compiled to provide further data on community composition and the flora diversity of the Modification and offset areas.



DURALIE OPEN PIT MODIFICATION

FIGURE 3

Flora Survey Sites

DURALIECOAL

GCL-14-23_Mod2_Flora_202E

Table 5
Sampling Effort Stratified by Vegetation Types

Community Number (this study)	PCT (OEH, 2012)	Plant Community Name	Quadrat Numbers	Random Meander Numbers
1	HU630	Spotted Gum – Grey Ironbark Forest	1, 2, 3, 5, 6	2, 4, 6
2	HU549	Grey Box – Forest Red Gum – Grey Ironbark Forest	4	5
3	HU613	Grey Myrtle – Flintwood Dry Rainforest	-	3
A	HU670	Derived Grassland	-	1
B	-	Acacia Regeneration	-	-

2.2 VEGETATION MAPPING

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

2.3 SPECIES LISTING

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

2.4 VEGETATION CONDITION ASSESSMENT

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

- *Disturbance*. Anthropogenic disturbance factors such as land clearing, vegetation thinning, fire roads and tracks, grazing, logging, quarrying, hazard reduction burning and recreation are considered. Natural disturbance factors considered include wildfires, storms and drought.
- *Native vegetation cover*. Broad comparisons are made between the current cover percentages of each vegetation layer and those expected in undisturbed examples of each community.
- *Juveniles*. The presence of juvenile plants of perennial species indicating that successful reproduction is occurring.
- *Exotic flora.* The presence of exotic flora species and their likely impacts on the viability of natural communities.
- *Fragmentation.* The degree to which the original natural vegetation has been broken into small patches isolated from other such patches and/or large undisturbed areas.

- *Overall degradation*. An overall level of degradation (nil, low, moderate, high, completely alienated) is assessed from the degree of disturbance and weed invasion.
- *Resilience*. An assessment is made of the likely ability of the area to naturally regenerate its native vegetation cover, either partially or fully, if degrading influences are removed.

Each of these factors is rated on a scale from 1 to 5: 1 = very low (0 - 10%), 2 = low (10 - 30%), 3 = moderate (30 to 70%), 4 = high (70 - 90%) and 5 = very high (90 - 100%).

3 RESULTS AND DISCUSSION

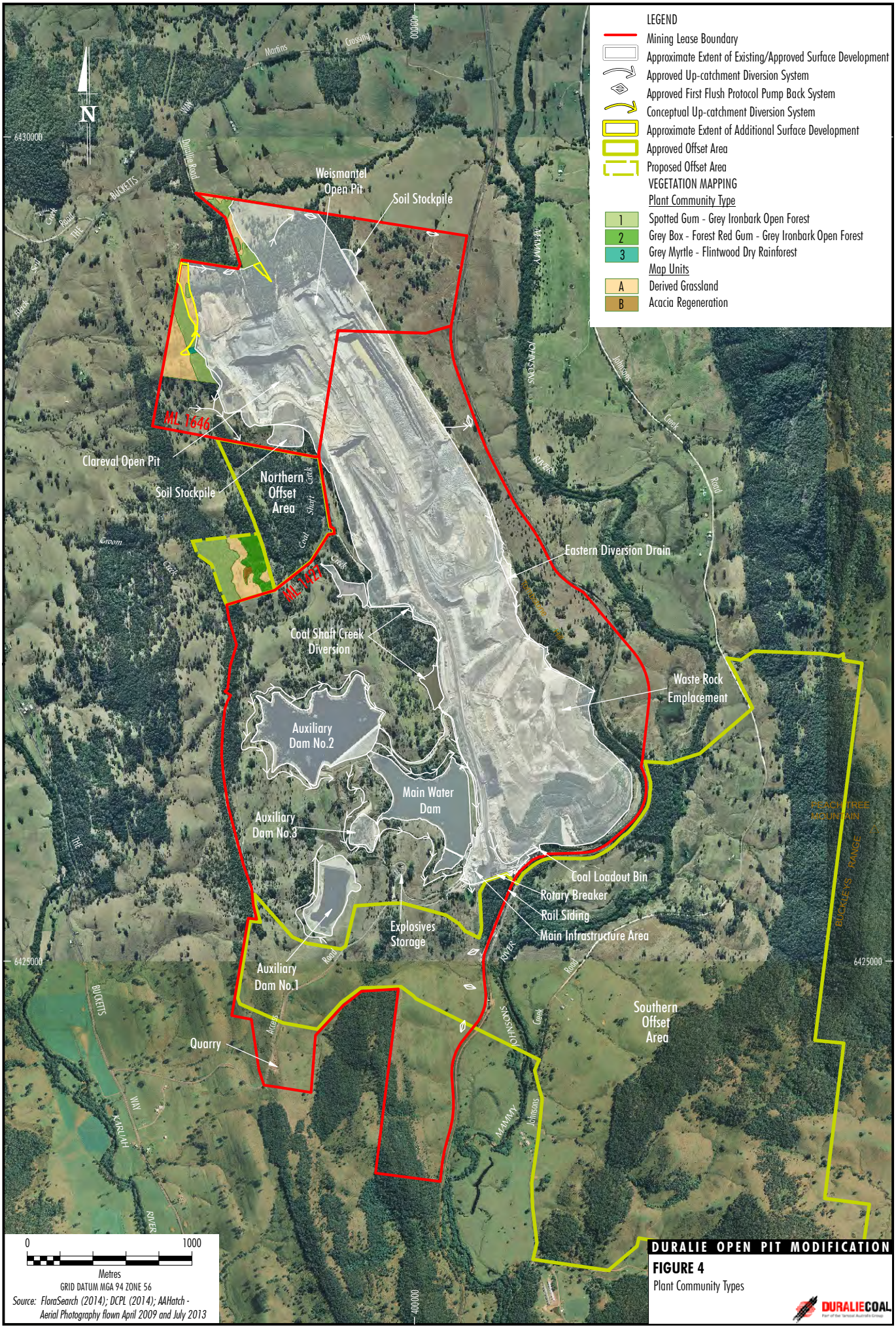
3.1 VEGETATION COMMUNITIES

Three natural climax PCTs were recorded on the Modification and offset areas, which each had two of the three communities (Table 6, Figure 4). In addition, two derived vegetation types were identified (Table 6, Figure 4). Descriptions of each PCT and vegetation type, except Map Unit B, which was not sampled, are given in Tables 7 to 10. PCT and vegetation types are mapped on Figure 4.

Table 6
Plant Community Types Recognised within the Study Area

Map Unit	Vegetation Class	Vegetation Type (this survey)		Plant Community Type (OEH, 2012)	
		Community Name	Dominant Tree Species on Study Area	Community Name	Dominant Tree Species
1	Hunter-Macleay Dry Sclerophyll Forests	Spotted Gum – Grey Ironbark – Thick-leaved Mahogany open forest	*Corymbia maculata, Eucalyptus carnea, E. siderophloia, E. canaliculata*	Spotted Gum - Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast (HU630)	*C. maculata, E. siderophloia, E. umbra, E. punctata, Angophora costata*
2	Coastal Valley Grassy Woodlands	Grey Box – Forest Red Gum – Grey Ironbark open forest	*E. moluccana, E. tereticornis, E. siderophloia, A. floribunda*	Grey Box - Forest Red Gum - Grey Ironbark open forest of the hinterland ranges of the North Coast (HU549)	*E. moluccana, E. tereticornis, E. siderophloia, E. propinqua*
3	Dry Rainforest	Grey Myrtle – Flintwood dry rainforest	*Backhousia myrtifolia, Scolopia braunii*	Shatterwood – Giant Stinging Tree – Yellow Tulipwood dry rainforest of the north coast and northern Sydney Basin (HU613)	*B. sciadophora, Dendrocnide excelsa, Drypetes deplanchei, D. australasica, B. myrtifolia, Lophostemon confertus, Choricarpia leptopetala, Tristaniopsis laurina, Acacia blakei*
A	Coastal Valley Grassy Woodlands	Derived Grassland	*Themeda australis, Imperata cylindrica, Cymbopogon refractus, Microlaena stipoides, Aristida vagans*	Derived Grasslands in Coastal Valleys (HU670)	*T. australis, Aristida vagans, Cymbopogon refractus*
B	-	Acacia Regeneration	*Acacia irrorata* subsp. *irrorata*	N/A	-

Native vegetation remnants on the Modification area are dominated by Map Unit 1, *Spotted Gum – Grey Ironbark – Thick-leaved Mahogany open forest* (Figure 4). A very small amount of Map Unit 3, *Grey Myrtle – Flintwood dry rainforest*, occurs in a rocky gully on the Modification area (Figure 4). Map Unit 1 is also the main native vegetation type in the offset area along with a smaller area of Map Unit 2, *Grey Box – Forest Red Gum – Grey Ironbark open forest* (Figure 4). Cleared areas that are dominated by native grasses with introduced grasses and forbs (Map Unit A) occur on both the Modification and offset areas. A small area of *Acacia irrorata* regeneration (Map Unit B) is present along a cleared drainage line in the offset area (Figure 4).



GCL-14-23_Mod2_Flora_201D

3.1.1 Hunter-Macleay Dry Sclerophyll Forests

Table 7
Community 1. Spotted Gum – Grey Ironbark – Thick-leaved Mahogany Open Forest

No. of Samples:	5 quadrats and 3 random meanders.
Landscape Position:	Drier exposed slopes and ridges (Figure 4).
Soil Landscapes:	Wards River Erosional Soil Landscape, Stroud Road Erosional Soil Landscape and Gloucester Buckets Colluvial Soil Landscape.
General Comments:	This community dominates the remnant native vegetation on both the Modification and offset areas (Figure 4).
Dominant and Characteristic Species	
Trees:	Thick-leaved Mahogany (*Eucalyptus carnea*) is the dominant canopy species on all areas, followed in abundance by Grey Ironbark (*E. siderophloia*), Spotted Gum (*Corymbia maculata*) and Large-fruited Grey Gum (*E. canaliculata*). Small amounts of Red Ironbark (*E. fibrosa*) and Rough-barked Apple (*Angophora floribunda*) occur in both the Modification and offset areas, while some Tallowwood was present in the south-western part of the Modification area.
Low Trees/Tall Shrubs:	Low trees were largely absent except for occasional Forest Oak (*Allocasuarina torulosa*). Willow Bottlebrush (*Callistemon salignus*) occurred along the watercourse in the north-eastern part of the Study area. Tall shrubs were generally sparsely distributed and included various *Acacia* species; Green Wattle (*Acacia irrorata* subsp. *irrorata*), Hickory Wattle (*A. implexa*), White Sally (*A. floribunda*) and Long-leaf Wattle (*A. longissima*). Other common tall shrubs were Large Mock Olive (*Notelaea longifolia*) and Red Ash (*Alphitonia excelsa*). Tantoon (*Leptospermum polygalifolium*) occurred beside the watercourse in the north-eastern Study area.
Low Shrubs:	Low shrubs were frequent, occupying up to 40% of the ground cover. The most prominent are Prickly Beard Heath (*Leucopogon juniperinus*), Gorse Bitter Pea (*Daviesia ulicifolia*), Prickly Shaggy Pea (*Podolobium ilicifolium*), Hairy Bush Pea (*Pultenaea villosa*), Prickly Moses (*A. ulicifolia*), Coffee Bush (*Breynia oblongifolia*) and Thyme Spurge (*Phyllanthus hirtellus*).
Vines:	Common Silkpod (*Parsonsia straminea*), Wonga Wonga Vine (*Pandorea pandorana*) and Stiff Jasmine (*Jasminum volubile*) are prominent in this community.
Creepers:	Creepers include Old Man's Beard (*Clematis aristata*), the Slender Tick-trefoils (*Desmodium varians* and *D. gunnii*), the Glycines (*Glycine clandestina* and *G. tabacina*), Hairy Apple Berry (*Billardiera scandens*) and Scrambling Lily (*Geitonoplesium cymosum*).
Ground Covers:	This community has a diverse, moderately dense cover of and grasses forbs, with grasses dominant. The main grasses included Three-awn Speargrass (*Aristida vagans*), Barbed Wire Grass (*Cymbopogon refractus*), Wiry Panic (*Entolasia stricta*), Blady Grass (*Imperata cylindrica*), Weeping Grass (*Microlaena stipoides*) and Kangaroo Grass (*Themeda australis*). The main forbs included Poison Rock Fern (*Cheilanthes sieberi* subsp. *sieberi*), Blue Trumpet (*Brunoniella australis*), Vernonia (*Vernonia cinerea*), Kidney Weed (*Dichondra repens*), Rough Guinea Flower (*Hibbertia aspera*), a Tick-trefoil (*Desmodium rhytidophyllum*), Whiteroot (*Pratia purpurascens*), Winter Apple (*Eremophila debilis*), *Opercularia diphylla*, Common Sword-sedge (*Lepidosperma laterale*), Wattle Matrush (*Lomandra filiformis* subsp. *filiformis*) and Spiny-headed Matrush (*Lomandra longifolia*).
Introduced Species:	Introduced species are uncommon in this community and may include some Lantana (*Lantana camara*) and Purpletop (*Verbena rigida*).
Equivalent Biometric Vegetation Type (OEH, 2012):	Spotted Gum - Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast (HU630).
Variants:	No variants were recorded.

3.1.2 Coastal Valley Grassy Woodlands

Table 8
Community 2. Grey Box – Forest Red Gum – Grey Ironbark Open Forest

No. of Samples:	One quadrat and one random meander.
Landscape Position:	Ridge, lower slopes and associated drainage line in the south-east of the offset area. (Figure 4).
Soil Landscape:	Stroud Road Erosional Soil Landscape.
General Comments:	Community 2 occurs on a limited area of suitable deep soils in the south- east of the offset area. The community has been cleared historically for grazing and much of the remnant area comprises young trees (20+ years old) with scattered mature trees.
Dominant and Characteristic Species	
Trees:	Dominated by Forest Red Gum (*Eucalyptus tereticornis*), Large-fruited Grey Gum (*E. canaliculata*) and Coast Grey Box (*E. moluccana*). Smaller representations of other tree species include Thick-leaved Mahogany (*E. carnea*), Grey Ironbark (*E. siderophloia*) and Rough-barked Apple (*Angophora floribunda*).
Tall Shrubs:	Patches of Green Wattle (*Acacia irrorata* subsp. *irrorata*).
Shrubs:	Few shrubs occur in this community, the main ones being Prickly Beard Heath (*Leucopogon juniperinus*) and Straggly Lantern-bush (*Abutilon oxycarpum*.
Vines:	The following two vines were recorded: Common Slikpod (*Parsonsia straminea*) and Wonga Vine (*Pandorea pandorana*).
Creepers:	The main creepers were the Glycines (*Glycine tabacina* and *G. clandestina*), Slender Tick-trefoil (*Desmodium varians*) and Native Wandering Jew (*Commelina cyanea*).
Ground Covers:	A wide range of native ground cover forbs and grasses were recorded with grasses predominating. The main native grasses included Barbed Wire Grass (*Cymbopogon refractus*), Bordered Panic (*Entolasia marginata*), Blady Grass (*Imperata cylindrica*), Paddock Lovegrass (*Eragrostis leptostachya*), Blady Grass (*Imperata cylindrica*), Weeping Grass (*Microlaena stipoides*), Basket Grass (*Oplismenus aemulus*) and Kangaroo Grass (*Themeda australis*). Prominent forbs include Slender Lagenophora (*Lagenophora gracilis*), Creeping Mint (*Mentha satureoides*), Kidney Weed (*Dichondra repens*), Whiteroot (*Pratia purpurascens*), Common Woodruff (*Asperula conferta*), An Oxalis (*Oxalis exilis*), Wattle Matrush (*Lomandra filiformis* subsp. *filiformis*) and *Carex longebrachiata*.
Introduced Species:	Introduced species are more common in this community than in Communities 1 and 3 due to previous disturbance and include; Fireweed (*Senecio madascariensis*), Lamb's Tongues (*Plantago lanceolata*), Purpletop (*Verbena bonariensis*), Narrow-leaved Carpet Grass (*Axonopus fissifolius*) and Paspalum (*Paspalum dilatatum*).
Equivalent Biometric Vegetation Type (OEH, 2012):	Grey Box - Forest Red Gum - Grey Ironbark open forest of the hinterland ranges of the North Coast (HU549).
Variants:	No known variants.

3.1.3 Dry Rainforests

Table 9
Community 3. Grey Myrtle - Flintwood dry rainforest

No. of Quadrats:	One random meander
Landscape Position:	Confined to a single rocky gully in the south-western part of the Modification area (Figure 4).
Soil Landscape:	Gloucester Buckets Colluvial Soil Landscape.
General Comments:	The low rainforest occurs along a small ephemeral watercourse and the adjoining lower slopes in an upper drainage line. Both sides of the gully comprise loose scree of rocks and small boulders. The canopy is dense; vines are numerous and the ground cover is dominated by mosses and ferns.
Dominant and Characteristic Species	
Trees:	The dominant low trees are Grey Myrtle (*Backhousia myrtifolia*) and Flintwood (*Scolopia braunii*).
Low trees/shrubs:	Shrubs include: Orange Thorn (*Pittosporum multiflorum*), Muttonwood (*Myrsine variabilis*), *Notelaea* species A and Scrubby Spurge (*Phyllanthus gunnii*).
Vines:	This community is characterised by numerous vines, including Gum Vine (*Aphanopetalum resinosum*), Common Silkpod (*Parsonsia straminea*), Wonga Vine (*Pandoreana pandorana*), Stiff Jasmine (*Jasminum volubile*), Pepper Vine (*Clematocissus opaca*) and Pearl Vine (*Sarcopetalum harveyanum*).
Creepers:	The only creeper recorded was Dusky Coral Pea (*Kennedia rubicunda*) on the edge of the rainforest patch.
Ground Covers:	Ferns are the dominant ground covers and included mainly Creeping Shield Fern (*Lastreopsis acuminata*), Rock Felt Fern (*Pyrrosia rupestris*), *Pellaea paradoxa*, Sickle Fern (*Pellaea falcata*), Bird's Nest Fern (*Asplenium australasicum*) and Staghorn Fern (*Platycerium superbum*).
Introduced Species:	One introduced species is present, Creeping Crofton Weed (*Ageratina riparia*).
Equivalent Biometric Vegetation Type (OEH, 2012):	Shatterwood – Giant Stinging Tree – Yellow Tulipwood dry rainforest of the north coast and northern Sydney Basin (HU613).
Variants:	No known variants.

3.1.4 Coastal Valley Grassy Woodlands

Table 10
Map Unit A. Derived Grassland

No. of Quadrats:	One random meander
Landscape Position:	Cleared parts of the Modification and offset areas.
Soil Landscapes:	Wards River Erosional Soil Landscape and Stroud Road Erosional Soil Landscape.
General Comments:	Derived grasslands occupy areas of the landscape that have been cleared historically for agricultural purposes, mainly livestock grazing. Clearing has generally taken place on areas with deeper soils on flat or undulating terrain. Most cleared areas are dominated by native grasses. However, introduced grasses and weeds may be locally abundant and areas of native shrub regeneration are also present.
Dominant and Characteristic Species	
Trees:	Trees are generally absent, although occasional remnant native eucalypts may be present.
Low trees/shrubs:	Shrubs may include regeneration of Prickly-leaved Paperbark (*Melaleuca nodosa*), Green Wattle (*Acacia irrorata* subsp. *irrorata*) and Prickly Moses (*Acacia ulicifolia*).
Vines/Creepers:	Vines and creepers are generally rare in this community.
Ground Covers:	Native and introduced grasses dominate this vegetation type. The main native grasses are the same as for nearby uncleared areas, viz., Three-awn Speargrass (*Aristida vagans*), Barbed Wire Grass (*Cymbopogon refractus*), Common Lovegrass (*Eragrostis brownii*), Blady Grass (*Imperata cylindrica*), Weeping Grass (*Microlaena stipoides*), *Paspalidium distans* and Kangaroo Grass (*Themeda australis*). The main introduced grasses include Narrow-leaved Carpet Grass (*Axonopus fissifolius*) and Paspalum (*Paspalum dilatatum*). The main native forbs were Indian Pennywort (*Centella asiatica*), White Root (*Pratia purpurascens*), Berry Saltbush (*Einadia hastata*) and Small St. Johns Wort (*Hypericum gramineum*). The most prominent introduced forbs were Catsear (*Hypochaeris radicata*), Blackberry Nightshade (*Solanum nigrum*), Fireweed (*Senecio madagascariensis*), the Purpletops (*Verbena rigida* and *V. caracasana*) and the sedge *Cyperus sesquiflorus*.
Equivalent Biometric Vegetation Type (OEH, 2012):	Derived Grasslands in Coastal Valleys (HU670).
Variants:	This vegetation type varies according to the degree of habitat disturbance, with more disturbed areas having higher proportions of introduced species.

3.2 FLORA SPECIES

Attachment A summarises the plant species recorded on the Study area according to the vegetation communities in which they occur. A total of 231 plant species was identified on the quadrat plots and random meanders by the current survey (Table 11). Of these, 191 (82.7%) are native to the natural communities of the Study area and surrounds and 40 (17.3%) are introduced (Table 11). The numbers of species found in each community varied according to the sampling intensity (Table 11). The largest numbers of species were found in Communities 1 and 2 with 156, and 117 species, respectively (Table 11). Because of their area and distribution these communities attracted the largest sampling efforts. Conversely, relatively few species were recorded in community 3 and Map Unit A that had only one sample each.

Table 11
Number of Native and Introduced Flora Species and the Total Number of Species Recorded in each Vegetation Community

Community	Number of Samples	Total Plant Species	Number of Native Species	% Native Species	Number of Introduced Species	% Introduced Species
1	8	156	136	87.2	20	12.8
2	2	117	94	80.3	23	19.7
3	1	27	25	92.6	2	7.4
A	1	61	37	60.7	24	39.3
B[1]	-	-	-	-	-	-
Total	**12**	**231**	**191**	**82.7**	**40**	**17.3**

[1] Map Unit B was not sampled.

The plant families with the highest numbers of native species (Attachment A) were the Grasses, family Poaceae (26 species); the Pea Flowers, subfamily Faboideae (15 species); the Daisies, Asteraceae (11 species); the Eucalypts and related genera in the family Myrtaceae (13 species); the Rushes and Sedges, Cyperaceae (12 species) and the Wattles, subfamily Mimosoideae (7 species). In all, some 67 families of native plants were represented (Attachment A).

3.3 INTRODUCED FLORA SPECIES

Table 11 shows the incidence of introduced (exotic) species on the Study area. Overall, the number (40) and percentage (17.3%) of introduced species is relatively low, especially since parts of the Study area and surrounds are cleared or semi-cleared farmland used for grazing livestock. The numbers and proportions of introduced species vary considerably among the 4 sampled vegetation types, from 7.4% in Community 3 to 39.3% in Map Unit A (Table 11).

The proportion of introduced species in each community is generally correlated with the degree of disturbance. The lowest proportions of introduced species (7.4%) occurred in Community 3, Dry Rainforest, where the heavily shaded ground layer is not conducive to introduced species. Moderate levels of introduced species (12.8% and 19.7%) occur in the larger remnant woodland patches of Communities 1 and 2, respectively, that have been grazed in the past.

Introduced flora species on the Study area belong to 17 plant families (Attachment A); the main ones being the Grasses, Poaceae (11 species), Daisies, Asteraceae (10 species), the Verbenaceae (3 species) and the Nightshades, Solanaceae (2 species).

3.4 CONDITION OF THE VEGETATION

In this section an assessment is made of the condition of the existing vegetation relative to pristine habitat of the original native communities. Table 12 presents condition ratings for seven disturbance factors (Section 2.4) for each of the vegetation communities recognised on Study area. An overall rating for the condition or range of conditions, of each community is also given. As would be expected, the condition of different patches of the same community varies considerably depending on size and disturbance.

Table 12
Vegetation Condition

Community/Map Unit	1	2	3	A	B
Disturbance level	2-4	3-4	3	5	5
Native vegetation cover	5	4	5	3	3
Presence of canopy juveniles	2-3	3	4	1	2
Incidence of exotic species	2	3	1	3-4	3
Degree of fragmentation	3	4	4	-	-
Resilience	5	4	4	2	2
Overall condition rating	4-5	3	3	2	2

[1] Overall condition rating: 1 = very poor, 2 = poor, 3 = moderate, 4 = good, 5 = very good.

[2] Rating system: 1 = very low (0 - 10%), 2 = low (10 - 30%), 3 = moderate (30 to 70%), 4 = high (70 - 90%), 5 = very high (90 - 100%).

North-eastern Section of Modification Area

This area is north of the existing DCM operations and east of Duralie Road. The native vegetation in this area is confined to three disjunct patches of Community 1, which are disturbed to varying degrees by past clearing. The most intact patch in the south has a continuous tree canopy and largely undisturbed shrub and ground cover layers.

The trees have been cleared or heavily thinned in the distant past and there is evidence of more recent logging. Most trees are less than 50 years old and represent regeneration from a past clearing event.

The northern edge of the southern patch is semi-cleared as is the small western patch and the northern patch. The northern patch is centred on the small valley of a tributary of Mammy Johnsons River and supports a somewhat different assemblage of species to the southern patches, including semi-aquatic and riparian species. The cleared areas support Derived Native Grassland (Map Unit A) with a strong representation of introduced grasses and forbs, and areas of native shrub regeneration.

Overall, the southern patch of Community 1 is considered to be in very good condition, including the proposed disturbance area. The fragmented parts of the southern patch and the northern patch are considered to be in good condition, while the derived grassland is rated as poor.

South-western Section of Modification Area

The south-western part of the Modification area is dominated by a linear, continuous north-south oriented band of Community 1 interrupted by a small patch of Community 3 (Dry Rainforest) where the vegetated band crosses a small gully (Figure 4). The band of vegetation occurs on a narrow rocky ridge line and associated steep east facing slopes. Similar to the north-eastern section of the Modification area, the band of Community 1 in the south-east is mostly 40 to 50 year old regrowth with a continuous tree canopy, and intact shrub and ground layers. The small patch of Community 3 also has a complete upper canopy and intact ground layer. Areas of cleared land support Derived Grasslands in Coastal Valleys (Map Unit A) with regenerating trees and shrubs characteristic of Community 1.

Overall, the areas of Communities 1 and 3 in the band of remnant native vegetation are considered to be in very good condition and Map Unit A is rated as being in poor condition (relative to the original vegetation).

Offset Area

The proposed offset area comprises two north-south oriented bands of remnant native vegetation on parallel ridges separated by a small cleared valley (Figure 4). The eastern band is dominated by Community 2 and the larger western one by Community 1. The northern half of the Community 1 band has largely continuous native tree, shrub and ground cover, while the southern part is semi-cleared and has areas of young regeneration comprising eucalypts and acacias. An impressive stand of old growth Forest Red Gum (*Eucalyptus tereticornis*) occupies the ridge top in the extreme south of this band. The western band has a relatively uniform tree canopy and natural sparse shrub and dense ground cover layers. Both the eastern and western bands have patches or individuals of large old growth eucalypts surrounded by 40 to 50 year old regeneration. The bands of Community 1 and 2 are separated by a deep, narrow, cleared valley comprising Derived Native Grassland (Map Unit A). A small patch of Acacia Regeneration (Map Unit B) adjoins Community 2 within the area of Map Unit A.

Overall, the area of Community 1 is considered to be in very good condition and that of Community 2 varies from moderate to very good condition. Map Units A and B are rated as being in poor condition (relative to the original vegetation).

3.5 THREATENED FLORA SPECIES

No species listed under the TSC Act or the EPBC Act was found on the Study area by this survey.

3.6 THREATENED ECOLOGICAL COMMUNITIES

One threatened ecological community, the Lower Hunter Valley Dry Rainforest VEC, which is listed under the TSC Act, potentially occurs on the Modification area.

Community 3 in this study, Grey Myrtle – Flintwood Dry Rainforest, has floristic similarities to the Lower Hunter Valley Dry Rainforest VEC (DECCW, 2008). The remnant on the Modification area is very small and floristically depauperate. Accordingly, it is difficult to assign it to the rainforest Suballiances defined by Floyd (1990) or to PCTs recognised in the Biometric Vegetation Types Database (OEH, 2012) on the basis of floristics alone.

The Final Determination of the NSW Scientific Committee for the Lower Hunter Valley Dry Rainforest VEC (DECCW, 2008) defines the diagnostic characteristics of the VEC and its relationships to rainforest types described in other publications and studies. In particular, it is clear that the VEC is based largely on community MU2 of Peake (2006), viz., Barrington Footslopes Complex Dry Rainforest. This community *typically occurs on Carboniferous sediments of the Barrington footslopes along the northern rim of the Hunter Valley floor, where it occupies gullies and steep hillslopes with south facing aspects*. The Final Determination also indicates the VEC falls broadly within *Sub-alliance 23 Ficus-Streblus-Dendrocnide-Cassine in the rainforest classification of Floyd (1990)*. The VEC *has been recorded from the local government areas of Cessnock, Maitland and Port Stephens, and is likely to occur or have occurred in Muswellbrook, Singleton, Upper Hunter and Dungog (within the Sydney Basin Bioregion and NSW North Coast Bioregion)*. *It may occur elsewhere in the Bioregions*. The Study area is within Dungog Shire. However, it is not on Carboniferous sediments.

Three aspects of the VEC description in the Final Determination (DECCW, 2008) make it highly unlikely that it includes the Modification area occurrence, *viz*:

- The Study area is not on Carboniferous sediments.
- The Study area is not on the *northern rim of the Hunter Valley floor*.
- The Study area occurrence is not on a south facing slope, rather the slope faces east.

It is considered most likely that the Modification area dry rainforest remnant represents the following dry rainforest PCT recognised for the Hunter Central Rivers LLS area and which is not listed as threatened.

> *Shatterwood – Giant Stinging Tree – Yellow Tulipwood dry rainforest of the North Coast and Northern Sydney Basin (HU613)*. This community is equivalent to Floyd's (1990) Sub-alliance 28 which is also not part of the VEC. Community HU613 was identified in the Karuah Mountains within the Study area for the Stratford Extension Project EIS (FloraSearch, 2012). It characteristically occurs on steep rocky slopes and gullies similar to the location of the dry rainforest on the current Study area.

3.7 NOXIOUS WEEDS

Four introduced species recorded in the surveys are regarded as noxious weeds in the Dungog Shire Council area; Blackberry (*Rubus fruticosus*) aggregate species (class 4[1]), Mistflower (*Ageratina riparia*) (class 4), Fireweed (*Senecio madagascariensis*) (class 4) and Giant Parramatta Grass (*Sporobolus fertilis*) (class 3[2]) (NSW Department of Primary Industries [DPI], 2014). However, none were abundant anywhere within the Study area.

Blackberry and Fireweed are also listed as Weeds of National Significance (Weeds Australia, 2014).

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

[2] The plant must be fully and continuously suppressed and destroyed.

4 EVALUATION OF POTENTIAL IMPACTS ON FLORA

4.1 NATIVE VEGETATION/HABITAT CLEARANCE

Clearing of native vegetation is listed as a key threatening process under both the TSC Act and the EPBC Act. The total disturbance area for the Modification is 2.5 ha and predominantly comprises existing cleared areas (Derived Grasslands in Coastal Valleys) (Table 13).

Table 13
Clearance of each Plant Community Type within the Modification area

Plant Community Type		Approximate Area to be Cleared (ha)
No.	**Name**	
HU630	Spotted Gum – Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast	0.7
HU670	Derived Grasslands in Coastal Valleys	1.8
	Total	**2.5**

Consistent with the approved DCM, final voids would remain in the Clareval and Weismantel open pits at the cessation of mining. The portion of the Modification disturbance area associated with changes to the open pit limits would form part of the DCM final void, and therefore, would not be rehabilitated.

The surface catchment of the final voids would be reduced to a practicable minimum by maximising backfilling of the natural surface and through the use of upslope diversion and contour drains around their perimeter. As such, the relocated water diversion infrastructure within the Modification disturbance area would be retained as part of the final landform.

The Modification would increase the elevation of the central portion of the waste emplacement, however, there would be no change to the approved rehabilitation strategy and goals due the Modification. The waste rock emplacement would continue to be progressively rehabilitated and revegetated with native grass, shrub and tree species characteristic of the vegetation communities cleared during the progression of mining activities.

4.1.1 Regional Context

The Modification area is situated on the western edge of a very large area of native vegetation, including The Glen Nature Reserve (2,750 ha) and surrounding forested private land, the Myall River State Forest (approximately 15,000 ha) and Ghin-Doo-Ee National Park (4,819 ha) to the south and south-east. These forests are in turn connected to Myall Lakes National Park (47,593 ha) on the coast through Nerong State Forest (2,200 ha). Bulahdelah and Wauk Wauk State Forests are also connected to the Myall Lakes National Park, making a very large connected network of Parks, Reserves, State Forests and forested private land comprising well over 100,000 ha in all. Much larger areas of natural vegetation exist in the Barrington Tops complex of State Forests and National Parks extending west from the western side of the Karuah River valley. In this context, the loss of 2.5 ha of native vegetation in the Modification area is a very small proportion of the forested land in the local area and wider region.

The main impact of the Modification on native flora is considered to be a further depletion of the vegetation communities that occur on the Permian sediments of the Gloucester Coal Measures. Table 14 shows the estimated percentage of pre-European extent of the relevant vegetation types remaining in NSW (OEH, 2012).

Table 14
Estimated Percentage of Pre-European Extent of Plant Community Types Remaining in NSW

Plant Community Type		Cleared Estimate (rounded to nearest 5%)
No.	Name	
HU630	Spotted Gum – Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast	35%
HU670	Derived Grasslands in Coastal Valleys	N/A

Source: OEH (2012).

The Modification layout has been designed to minimise harm to native vegetation in the mining lease by avoiding, as far as possible, disturbance to any occurrences that do not overlie the open cut areas.

4.2 POTENTIAL IMPACTS FROM IRRIGATION

The existing DCM is approved to undertake irrigation on rehabilitation areas within a contained catchment. This irrigation method would be continued with the proposed irrigation areas draining directly to mine water storages. No impacts on existing native vegetation would occur.

4.3 LOSS OF HABITAT CONNECTIVITY

The Modification would not result in an increase in the fragmentation and isolation of native vegetation above that which has previously been approved for the existing operations. The two small patches of native vegetation that would be cleared are not part of landscape corridors, but are small additions to areas previously approved for clearance.

4.4 GROUNDWATER DEPENDENT ECOSYSTEMS

No groundwater dependent ecosystems have been identified on or near the Study area (after National Water Commission, 2006). In addition, the flora surveys have not detected any vegetation that appears to be associated with groundwater. All vegetation on the Study area appears to be dependent on rainfall and surface flows.

4.5 INTRODUCED FLORA

Similar to the approved DCM, soil disturbance related to vegetation clearance is likely to create opportunities for weed establishment around the margins of the open pits, on soil stockpiles and waste rock emplacements. This would increase the potential for weed incursion into the native habitats of the wooded ranges to the north and west of the Study area. Some 40 introduced flora species occur on the Study area (Table 11), four of which are listed as Noxious in the Dungog Shire Council area (Section 3.7). Most of the weeds are associated with previously disturbed areas, especially cleared farmland and derived native grasslands.

It is unlikely the Modification would result in the establishment of any new weeds given the long history of clearing and livestock grazing on the site and the range of weeds already present. In addition, DCPL undertakes weed control programmes to reduce the occurrence of noxious weeds. With the continued implementation of these measures, it is considered that the Modification is unlikely to significantly increase weed incidence in the local area generally.

4.6 DUST AND VEGETATION

There is no increase in air quality impacts for the Modification to those currently approved under the Duralie Extension Project (Pacific Environment Limited 2014).

4.7 BUSHFIRE RISK

Modification activities, including construction and environmental management and monitoring, may pose a risk of fire ignition (e.g. via increased vehicle traffic through dry vegetation). High frequency fire is listed as a key threatening process in the TSC Act (OEH, 2014e). DCPL would continue to implement strategies to minimise fire risk including prohibition of smoking in fire prone areas and rapid response to any outbreak of fire. The overall risk of increased bushfire frequency due to the Modification is likely to be very low.

4.8 THREATENED FLORA

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

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

1. Whether or not the proposal, including actions to avoid or mitigate impacts or compensate or prevent unavoidable impacts will maintain or improve biodiversity values.
2. Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.
3. Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.
4. Whether or not the proposal will adversely affect critical habitat.

4.8.1 Threatened Flora Species listed under the TSC Act

The baseline flora survey targeted seven threatened flora species for field searches. The targeted species included all threatened flora known to occur, or potentially occur, within a 20 × 20 km square centred on the Study area, and that have potential habitat there. Although listed as potentially occurring on the Study area in Table 3, Slaty Red Gum (*Eucalyptus glaucina*) and Craven Grey Box (*Eucalyptus largeana*) are large conspicuous species that would have been detected by the surveys if they were present. Similarly, the shrubs Guthrie's Grevillea (*Grevillea guthrieana*), Rainforest Senna (*Senna acclinis*) and Scant Pomaderris (*Pomaderris queenslandica*) would have been detected if they were present, given the small size of the Study area and the completeness of the search coverage. As these five conspicuous species were not recorded on the Study area they are not considered further.

The assessment in this section is confined to the two remaining less conspicuous species (Table 15), which are treated together.

Table 15
Threatened Flora Species Considered in this Assessment

Scientific Name	Common Name	Broad Landscape Position
Asperula asthenes	Trailing Woodruff	Riparian zones
Cynanchum elegans	White-flowered Wax Plant	Forested areas

Trailing Woodruff and White-flowered Wax Plant

Trailing Woodruff occurs in riparian zones. Although there is riparian habitat in the Study area, it is absent from the disturbance areas. The White-flowered Wax Plant most commonly occurs in dry, littoral and subtropical rainforests, but may sometimes be found in woodlands (NPWS, 2000). Both species have only a low potential to occur in the habitats on the Study area. This is supported by the lack of records for these species in the Stratford-Duralie area despite numerous surveys since 1994.

Threats relevant to the Trailing Woodruff include disturbance from grazing animals, invasion by introduced weeds near watercourses and the use of herbicides (NPWS, 2000). Threats to the White-flowered Wax Plant include habitat loss and fragmentation, habitat degradation through weed invasion, grazing, rubbish dumping, landfill, urban run-off, track widening and inappropriate fire regimes, as well as the loss of small populations through natural catastrophes and environmental change (NPWS, 2000).

4.8.2 Key Thresholds

1. Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.

The proposal has been designed to maintain and improve biodiversity values in the immediate vicinity of the Modification. The dominant vegetation type on the Modification area, Community 1 (*Spotted Gum – Grey Ironbark – Thick-leaved Mahogany Open Forest*), is replicated on the offset area at a ratio of 1 to 7.4 with vegetation of the same quality. In addition the offset area includes remnants of Community 2 (*Grey Box – Forest Red Gum – Grey Ironbark Open Forest*) which is absent from the Modification area.

The proposed management of the offset area is designed to maintain the existing remnant native vegetation in perpetuity, but also to improve its condition, encourage regeneration, increase its area and to link remnant patches to each other. A number of actions would be taken to ensure the offset achieves these objectives, including;

- fencing of the area and removal of livestock;
- weed and feral animal control;
- appropriate fire management regimes;
- establishment of the offset adjoining an existing larger offset area, thereby improving the long term viability of both;
- strategic plantings of appropriate native tree and shrub species to create corridors between remnants; and
- monitoring and reporting of biodiversity.

2. Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.

With respect to the two threatened flora species, Trailing Woodruff and White-flowered Wax Plant, whose presence on the Study area could not be discounted by the flora survey, there is potential for loss of part or all of local populations through the clearance of habitat, if they were to occur. However, no populations of these species have been detected on the Study area or surrounds in extensive surveys of the Duralie mine site since 1995. Accordingly, it is considered highly unlikely that populations of these species exist on the Modification area, or that the Modification could result in the extinction of local populations of these species.

3. Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.

No populations of Trailing Woodruff and White-flowered Wax Plant are known to occur on the disturbance areas for the Modification.

While potential habitat for the Trailing Woodruff occurs in the riparian zone of the tributary of Mammy Johnsons River within the Modification area, habitat is absent from the disturbance areas. Accordingly, it is highly unlikely that the Trailing Woodruff would be affected by the Modification or that the Modification would place it at risk of extinction.

There is a very small chance that the Modification may remove individuals of the White-flowered Wax Plant. However, although rare, this species is very widespread (Table 2). Consequently, the possible loss of individuals in the disturbance area would not place the species as a whole at risk of extinction. In any event, there are large areas of similar habitat within the surrounding region with a nearby record of White-flowered Wax Plant in the Karuah Mountains.

4. Whether or not the proposal will adversely affect critical habitat.

No Critical Habitat for Trailing Woodruff or White-flowered Wax Plant has been declared under either the TSC Act (OEH, 2014c) or the EPBC Act (DotE, 2014d).

Conclusion

It is concluded from the above assessment of key thresholds that the Modification is unlikely to have an adverse impact on Trailing Woodruff or White-flowered Wax Plant.

4.8.3 Threatened Populations Listed under the TSC Act

Database searches indicated that no listed threatened flora populations occur on or near the Study area (Section 1.6.2).

4.8.4 Threatened Ecological Communities Listed under the TSC Act

No threatened ecological communities were identified on the Study area by this survey or any other surveys conducted since 1995.

4.8.5 Threatened Flora and Communities Listed under the EPBC Act

FloraSearch has considered the potential for impacts from the Modification on threatened flora and ecological communities listed under the EPBC Act. The conclusion of the self assessment is that the proposed Modification is not likely to have a significant impact on any threatened flora or ecological communities listed under the EPBC Act.

4.9 CUMULATIVE IMPACTS

4.9.1 Loss of Native Vegetation

The clearance of native flora for the Modification would continue an historical, albeit fluctuating, trend towards reduction in the area of native vegetation in the region. The most fertile arable land in the lower lying, flat to undulating parts of the region is productive agricultural land that has been farmed intensively for a century and a half. The surrounding steeper slopes, hills and ranges, while retaining their natural vegetation cover, have been subject to episodes of logging on public and private land throughout this period. Much of the public land was originally dedicated as State Forests for timber extraction, however, more recently much of this land has been transferred to conservation reserves.

A consequence of the history of land clearing in the Gloucester Valley is that native vegetation types characteristic of the more fertile soils of the valley floor and footslopes have been considerably reduced in the region with only small fragmented remnants remaining, usually on privately-owned land. In contrast, most vegetation types on steeper slopes and skeletal soils are well represented in the conservation reserve system.

The Modification would result in the loss of 2.5 ha of native vegetation, or less than 1% above that approved for the DCM. In addition to native vegetation losses associated with the DCM, vegetation clearance has occurred or is approved for the nearby Stratford Coal Mine, also on the Permian sediments of the Gloucester Coal Measures. However, the total loss is a very small proportion of both the area that has been cleared historically and of the amount of native vegetation remaining in the immediate surrounds of the Study area.

4.9.2 Offset Strategy

The offset strategy for the Modification is described in Section 6.

4.9.3 Threatened Flora

The Study area has no threatened flora species, populations, ecological communities or critical habitat listed under the TSC Act or EPBC Act and no cumulative impact is expected to occur on such entities.

5 IMPACT AVOIDANCE AND MITIGATION MEASURES

Impact avoidance and mitigation measures for the Modification are provided below.

Impact Avoidance

The changes to the limit of the open pit are required to improve geotechnical stability and, therefore, additional disturbance associated with these changes to the open pit limit cannot be avoided without potentially impacting the long-term stability of the open pit low walls.

The relocation of existing water diversion infrastructure adjacent to the Clareval pit has been designed to occur within derived grassland wherever possible to avoid additional disturbance of native forest. In addition, the relocated water diversion infrastructure has been designed to avoid disturbance of PCT 3 (Grey Myrtle – Flintwood Dry Rainforest).

Impact Mitigation

Potential impacts to flora and fauna are currently managed through implementation of measures included in the *Duralie Coal Mine Biodiversity Management Plan* (Greening Australia, 2013). These include:

- vegetation clearance procedures;
- weed control and prevention;
- bushfire prevention; and
- dust suppression.

These measures would continue to be implemented and management plans would be updated where relevant. For example, the plan would be revised to incorporate the proposed offset area.

6 OFFSET MEASURES

Measures that are proposed to avoid and mitigate impacts from the Modification on flora are described in Section 5. This section describes an offset proposal aimed at addressing the residual impacts.

6.1 EXISTING BIODIVERSITY OFFSET STRATEGY

DCPL has established offset areas on company owned land to the east and west of the DCM (Northern and Southern Offset Areas) (Figure 2). The broad completion criteria are outlined in Table 16.

Table 16
Offset Strategy Completion Criteria

Domain	Completion Criteria
Enhancement areas (i.e. existing remnant vegetation)	Areas of remnant vegetation within the offset area (290ha) have been conserved and enhanced.
Revegetation areas	354 ha of revegetated woodland/open woodland habitat areas and 36 ha of revegetated forest habitat areas as a self sustaining ecosystem.
Direct links between the offset area and rehabilitation area	Native vegetation has been established which directly links vegetation areas of the offset area with the rehabilitation area.

The approved *Duralie Coal Mine Biodiversity Management Plan* (BMP) (Greening Australia 2013) includes detailed management measures for the existing offset areas (Figure 4), including:

- encouraging native regeneration by providing appropriate fencing to exclude grazing from existing treed areas;
- selective revegetation in derived grasslands by appropriate plantings or seeding using local seed sources;
- managing weeds and pests;
- managing fire including mosaic burnings likely needed to optimise species diversity;
- creating signage of the proposed offset area;
- restricting vehicular and people access; and
- monitoring ongoing management performance, habitat quality and diversity, species diversity, landscape resilience and landscape function within the offset, by suitably qualified person(s).

In accordance with the BMP (Greening Australia 2013), the existing offset areas will be independently audited every three years unless the Director-General directs otherwise.

The characteristics of the proposed offset areas are described in Section 6.3, a reconciliation of the proposed offset strategy against the OEH Offset Principles is provided in Section 6.4, and the ecological gains of the proposed offset areas are provided in Section 6.5.

6.2 PROPOSED BIODIVERSITY OFFSET STRATEGY

The proposed offset area for this Modification is located adjacent to the western side of the existing Northern Offset Area (Figure 4). The offset proposal for the Modification involves conserving an area of land with existing conservation values and providing active management to maintain and enhance the values. The proposal has been prepared considering government guidelines (i.e. the OEH's principles for the use of biodiversity offsets in NSW) (OEH, 2014e).

The existing and proposed offset strategies are quantified in Table 17.

Table 17
Existing and Proposed Offset Strategies

Domain	Existing Biodiversity Offset Strategy	Proposed Biodiversity Offset Strategy	Outcome
Enhancement areas (i.e. existing remnant vegetation)	290	9	299
Revegetation areas	354	3.5	357.5
Total	**644**	**12.5**	**656.5**

6.2.1 Offset Proposal - Management, Security, Monitoring and Auditing

The proposed offset area is located close to the Modification area (Figure 4). The sub-sections below outline the proposed method of conserving the offset area, proposed management, monitoring and independent audit.

Conservation in Perpetuity

Enduring conservation of the proposed offset area would be secured to the satisfaction of the NSW Secretary of the Department of Planning & Environment.

Proposed Management Plan and Management Measures

The *Duralie Coal Mine Biodiversity Management Plan* would be revised to incorporate the proposed offset area. A number of management measures are listed and described below based on flora and fauna surveys of the proposed offset area and an assessment of the measures required to enhance the flora and fauna values of the area, including:

- revegetation of cleared land to substantially increase the amount of vegetation in the area;
- management of livestock grazing;
- control of weeds to enable natural regeneration of native vegetation;
- exotic animal management to benefit native wildlife;
- bushfire management; and
- controlling vehicular access.

Revegetation

The proposed offset area provides for a combination of protection and enhancement of existing remnant vegetation as well as active revegetation to increase the overall biodiversity of the area by restoring the internal connectivity of woodland/forest habitats within it.

Part of the proposed offset area is cleared land (3.5 ha) comprising predominantly native and introduced grasses. The cleared land separates two patches of remnant native dry sclerophyll forest vegetation. The aim of revegetation would be to establish a range of habitat niches including canopy, understorey and ground cover.

Natural regeneration of woodland/forest is likely to occur in the cleared lands owing to the proximity of adjoining native forests. However, to speed up the process, the cleared lands would be actively managed as follows:

1. Increase potential for natural regeneration through management of threatening processes that inhibit natural regeneration (e.g. removal of weeds).
2. Revegetate, if required, with appropriate plantings or seeding of species represented in the surrounding native vegetation communities. Local seed sources would be used.

Management of Livestock Grazing

Livestock grazing would be excluded from the offset area through the provision of appropriate stock fencing.

Control of Weeds

Four flora species listed as Noxious in the Dungog Shire under the *Noxious Weeds Act, 1993* were recorded in the proposed offset area. Three of these species are listed as Class 4 weeds (Mistflower [*Ageratina riparia*], Fireweed [*Senecio madagascariensis*], Lantana [*Lantana camara*]), and one is listed as a Class 3 weed, Giant Parramatta Grass (*Sporobolus fertilis*). These and other weeds would be controlled and monitored by an appropriately qualified contractor using standard methods.

Animal Pest Management

Animal pests would be controlled and monitored by an appropriately qualified contractor using standard methods.

Fire Management

Access tracks throughout the proposed offset area would be maintained for fire management. The *Duralie Coal Mine Biodiversity Management Plan* would describe fire management procedures applicable to the proposed offset area.

Controlling Vehicular Access

Vehicular access would be controlled by fencing and signing the offset area. Vehicle movements would be predominately on designated vehicle tracks.

Monitoring

A programme would be undertaken to monitor and report on the effectiveness of the measures and the performance of the offset, with summary reporting to be carried out annually and comprehensive reporting following the independent environmental audit. The monitoring would be undertaken by a suitably qualified person(s).

6.3 FLORA CHARACTERISTICS OF THE PROPOSED OFFSET AREA

The proposed offset area (its size, location and proposed management regime) were selected using a methodology that takes into consideration a range of factors:

- the location of the proposed offset area relative to the proposed disturbance area;
- the location of existing offset areas;
- the land tenure available on which to locate a proposed offset area (i.e. company-owned land);
- the location of potential mineral resources;
- the occurrence of the same vegetation and habitat types as the proposed disturbance area;
- the shape of the proposed offset area in relation to the spatial arrangement of existing vegetation and offset areas;
- the vegetation (and its condition) of the proposed disturbance area relative to the proposed offset area;
- the size of the proposed offset area relative to the proposed disturbance area;
- the ecosystem resilience and condition of the proposed offset area; and
- existing infrastructure – e.g. roads, rail, powerlines, houses and the proposed Gloucester Gas pipeline corridor (all outside of the proposed offset area).

A number of these factors are further discussed below in relation to the proposed offset area.

6.3.1 Regional Location

The proposed offset area is located in close proximity to the Modification area and therefore has the capacity to benefit biodiversity values in the same region as the Modification. Vegetation communities can change in plant composition over distance due to differences in a range of environmental factors. The proposed offset area is ideally located because it is local to the area proposed to be disturbed, occurs on the same geological formation and in the same climatic zone.

6.3.2 Existing Reserve System

The proposed offset area compliments the existing reserve system in NSW. The existing and proposed offset areas have particular value as they conserve native vegetation on the Gloucester Coal Measure geological formation, which is not represented in any National Parks or Nature Reserves in the surrounding region, although some other Voluntary Conservation Agreement Areas occur on the Gloucester Coal Measures.

6.3.3 Regional Conservation Priorities

Valley Floor Vegetation

As indicated above, the offset area preserves examples of vegetation on the Permian sediments of the Gloucester Valley floor, an area that has been heavily cleared historically for farming and livestock grazing. Accordingly, the offset makes a significant contribution to the aim of conserving remnant vegetation in heavily cleared agricultural landscapes.

6.3.4 Tenure of the Proposed Offset Area

The proposed offset area is located on the following tenure (lot and DP): Lot 2, DP 595876. As previously stated, the land tenure underlying the proposed offset area would be secured in perpetuity for wildlife conservation.

6.3.5 Vegetation

The offset area contains grassy woodlands, dry sclerophyll forests, derived grassland and acacia regeneration. Table 18 compares the vegetation types/map units within the disturbance area with those in the proposed offset area.

Table 18
Quantification of Vegetation Types in the Modification Area and Offset Area

Plant Community Type		Approximate Area to be Cleared (ha)	Approximate Area in Offset (ha)
No.	**Name**		
HU630	Spotted Gum – Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast	0.7	5.2
HU549	Grey Box – Forest Red Gum – Grey Ironbark open forest of the hinterland ranges of the North Coast.	0	3.5
HU670	Derived Grasslands in Coastal Valleys	1.8	3.5
N/A	Acacia Regeneration	0	0.3
	Total	**2.5**	**12.5**

The proposed offset area contains all the vegetation types present in the disturbance areas (Table 17) and also includes one additional PCT, Grey Box – Forest Red Gum open forest (HU549) and the acacia regeneration vegetation type. The presence of HU 549 in the offset area represents a biodiversity gain from the offset.

6.3.6 Shape

The shape of the proposed offset area takes into consideration the spatial arrangement of existing vegetation in the area, including the existing offset area, and aims to link and expand on the size of the existing patches (Figure 4). The offset area has a low area:perimeter ratio to minimise edge effects and abuts the existing offset area, thereby enlarging it and maximising the biodiversity dividend of both areas.

6.3.7 Ecosystem Resilience and Condition

The remnant native vegetation in the offset area is in similar moderate to very good condition as that on the Modification area (Section 3.4), while the cleared lands are currently rated as being in poor condition on both, owing to the lack of native tree and shrub cover. Given the relatively small area of cleared land within the offset and its close proximity to the surrounding native vegetation, it would be readily colonised by native flora. An important feature of the offset area is the presence of scattered old growth eucalypts, some of which are very large and potentially provide high quality wildlife habitat.

6.4 RECONCILIATION OF THE PROPOSED OFFSET STRATEGY AGAINST OEH OFFSET PRINCIPLES

Table 19 provides a reconciliation of the proposed offset strategies against the OEH Offset Principles (OEH, 2014e). The reconciliation in Table 19 demonstrates that the proposal meets OEH Offset Principles.

Table 19
Reconciliation of the Proposed Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2014f)	Description of How the Proposed Offset Addresses the OEH Offset Principles
1. Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.	Measures to avoid and mitigate Modification impacts on flora are described in Section 5. The proposed offset strategy is designed to address residual impacts.
2. Offset requirements should be based on a reliable and transparent assessment of gains and losses.	The flora in both the proposed disturbance area and offset area has been comprehensively surveyed by FloraSearch. This report provides an assessment of both including: • area of the offset and area of impact; • communities/species present and their conservation status; • connectivity and condition of habitat; • management actions and security for the offset site; • the offset area (totalling 12.5 ha) would be conserved in perpetuity; and • measures to monitor and independently audit the biodiversity offset are provided. Ecological gains of the proposed offset area are discussed in Section 6.5.
3. Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.	Biodiversity values to be lost are fully replicated on the proposed offset area: • the dominant PCT to be impacted is well represented in the offset area; and • additional vegetation types would be conserved to those that would be impacted.
4. Offsets must be additional to other legal requirements.	The implementation of the offset strategy is supplementary, in that the biodiversity offset area is not subject to an existing conservation agreement or other legally imposed environmental management actions.
5. Offsets must be enduring, enforceable and auditable.	Enduring conservation of the proposed offset area would be secured to the satisfaction of the NSW Secretary of the Department of Planning & Environment. However, DCM is committed to: • Managing the proposed offset area principally for biodiversity conservation. • Managing the area in accordance with the DCM Biodiversity Management Plan. • The offset area is on land owned by DCM ensuring the offset area can be appropriately managed. • The proposed offset area would be monitored and audited in accord with the existing requirements for the neighbouring Northern Offset Area.
6. Supplementary measures can be used in lieu of offsets.	Supplementary measures are not required.
7. Offsets can be discounted where significant social and economic benefits accrue to NSW as a consequence of the proposal.	No discounting of the offset is sought for this proposal.

6.5 ECOLOGICAL GAINS OF THE PROPOSED OFFSET

It is considered the Modification meets the standard in the requirements that flora biodiversity values in the region would be maintained and improved in the long-term. The offset area contains the same dominant PCT as on the Modification area, which is also similar in condition.

The offset area has a number of features that ensure it meets the 'maintain or improve' test. These include:

- The dominant vegetation type proposed to be cleared by the Modification is well represented in the offset area.
- The vegetation on the cleared parts of the offset area comprises mainly derived native grassland and acacia regeneration and is in close proximity to native forest remnants in good condition, so that when it is removed from livestock grazing, it can be expected to begin natural regeneration.
- Cleared paddock areas would be planted strategically to appropriate tree and shrub species to augment natural regeneration and provide habitat for recolonisation by other flora and wildlife.
- The plantings would also be designed to link isolated woodland remnants via corridors to facilitate movement of plants between remnants.
- The offset supports samples of all native vegetation communities within the Modification disturbance areas and has a greater diversity of vegetation communities than occur on the Modification area.
- The proposed offset area adjoins an existing offset area thereby enlarging it and increasing its long term viability. Accordingly, the addition of the offset as a new protected area enhances nature conservation over the whole region.

7 CONCLUSIONS OF THE ASSESSMENT

- The proposal would result in the loss of 0.7 ha of open forest and 1.8 ha of derived grasslands.
- The area of native vegetation to be cleared represents a very small proportion of the extant native vegetation in the local area and wider region.
- The Modification has been designed to avoid or minimise impacts on the larger remnant woodland patches that do not overlie proposed open cut pits, including vegetation communities that have been heavily impacted by past land use in the Gloucester Valley.
- Mitigation strategies are considered adequate to control risks to native flora arising from weed invasion, pests and fires.
- The impact assessment demonstrated the Modification is highly unlikely to adversely affect any threatened flora species, or their habitats that may potentially occur on the Modification Area.
- The Modification would have no impact on threatened populations, threatened ecological communities or critical habitat, as none occur on the Modification Area.
- The main cumulative impact on native flora is a further very small depletion of vegetation communities that have been heavily cleared historically for agriculture in the region.
- The 2.5 ha of native vegetation that would be removed for the Modification is offset with 12.5 ha of similar native vegetation and derived grasslands in the immediate surrounds.
- The offset has a greater diversity of vegetation types than the Modification Area.
- It is concluded that the offset area meets the OEH offset principles and results in a net improvement in regional biodiversity values.

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ATTACHMENT A

FLORA SPECIES LIST

LEGEND:

Q = Quadrat

RM = Random Meander

Numbers in Quadrat columns are Braun Blanquet cover abundance ratings (Table 3)

Letter codes in Random Meander columns are:

a – abundant

c – common

o – occasional

u – uncommon

r – rare

Presence of a species is recorded with a dot in samples not rated for abundance (●).

Introduced species are preceded by an asterisk (*).

	Community/Map Unit	1								2		3	A
	Sample	Q1	Q2	Q3	Q5	Q6	RM2	RM4	RM6	Q4	RM5	RM3	RM1
Scientific Name	**Common Name**												
CLASS FILICOPSIDA													
Aspleniaceae													
Asplenium australasicum	Bird's Nest Fern											●	
Blechnaceae													
Blechnum cartilagineum	Gristle Fern							●					
Dennstaedtiaceae													
Pteridium esculentum	Common Bracken							●					
Dryopteridaceae													
Lastreopsis acuminata	Creeping Shield Fern											●	
Lastreopsis microsora subsp. *microsora*	Creeping Shield Fern							●					
Polypodiaceae													
Platycerium superbum	Staghorn											●	
Pyrrosia rupestris	Rock Felt Fern											●	
Pteridaceae													
Adiantum aethiopicum	Common Maidenhair							●	●				
Cheilanthes distans	Bristly Cloak Fern										c		
Cheilanthes sieberi	Poison Rock Fern	3	2	2	2	2				2	u		u
Pellaea falcata	Sickle Fern		2	2							o	●	
Pellaea paradoxa												●	
Pteris tremula	Tender Brakefern										u		
CLASS MAGNOLIOPSIDA													
SUBCLASS MAGNOLIIDAE													
Acanthaceae													
Brunoniella australis	Blue Trumpet	2	3	3	3	2				3	o		
Amaranthaceae													
Alternanthera denticulata	Lesser Joy Weed							●			u		
**Amaranthus viridis*	Green Amaranth												u
Aphanopetalaceae													
Aphanopetalum resinosum	Gum Vine											●	
Apiaceae													
Centella asiatica	Indian Pennywort		3								u		c
Hydrocotyle sp.								●					
Hydrocotyle tripartita	Pennywort										c		
Apocynaceae													
**Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush										r		r
Parsonsia straminea	Common Silkpod		3	1				●		2	o	●	r
Asteraceae													
**Ageratina riparia*	Creeping Crofton Weed										r	●	
**Bidens pilosa*	Cobblers Pegs		1					●					
Brachyscome procumbens			3			1							
**Cirsium vulgare*	Spear Thistle			1						1	o		u
**Conyza canadensis* var. *canadensis*	Canadian Fleabane							●			u		u
**Conyza sumatrensis*	Tall Fleabane							●					u
Cotula australis	Carrot Weed										o		
Craspedia variabilis										2	u		
Epaltes australis	Spreading Nut-heads												u
Euchiton sphaericus	Star Cudweed				1						r		
**Hypochaeris radicata*	Catsear	1			2	1				1	o		c
Lagenophora gracilis	Slender Lagenophora				4					3			

	Community/Map Unit	1								2		3	A
	Sample	Q1	Q2	Q3	Q5	Q6	RM2	RM4	RM6	Q4	RM5	RM3	RM1
Scientific Name	**Common Name**												
Lagenophora stipitata	Blue-bottle Daisy	4	3										
Ozothamnus diosmifolius	Rice Flower										●		
Ozothamnus obcordatus	Grey Everlasting		1										
**Senecio madagascariensis*	Fireweed							●		1	c		o
Sigesbeckia orientalis subsp. *orientalis*	Indian Weed						●			2			
**Tagetes minuta*	Stinking Roger										o		u
**Taraxacum officinale*	Dandelion									1			
Vernonia cinerea	Vernonia	3	3	3	1	3							
**Xanthium cavanillesii*	South American Burr							●					
Bignoniaceae													
Pandorea pandorana	Wonga Wonga Vine		4	4		3				2	r	●	
Brassicaceae													
Rorippa laciniata	A Watercress										c		
Campanulaceae													
Wahlenbergia communis	Tufted Bluebell										r		
Wahlenbergia gracilis	Australian Bluebell		1										
Caryophyllaceae													
**Stellaria media*	Common Chickweed										o		
Casuarinaceae													
Allocasuarina torulosa	Forest Oak			1					●				
Celastraceae													
Maytenus silvestris	Orange Bark			2			●						
Chenopodiaceae													
Einadia hastata	Berry Saltbush										o		o
Clusiaceae													
Hypericum gramineum	Small St John's Wort				3	2				3	r		o
Convolvulaceae													
Dichondra repens	Kidney Weed		3	4	3	5				5	c		
Dilleniaceae													
Hibbertia aspera	Rough Guinea Flower	2	2		5	3							
Hibbertia obtusifolia	Hoary Guinea Flower				2	2				3	c	●	
Ericaceae - Styphelioideae													
Leucopogon juniperinus	Prickly Beard-heath	5	2	3	5	2		●		5	c		
Fabaceae: Faboideae													
Daviesia ulicifolia	Gorse Bitter Pea	3	2		3	1					r		
Desmodium brachypodum	Large Tick-trefoil			2									
Desmodium gunnii	Slender Tick-trefoil		3	3	3	2				2			
Desmodium rhytidophyllum	Rusty Tick-trefoil	3	4	4	4	5							u
Desmodium varians	Slender Tick-trefoil	2	3	2	3	3				3	o		
Dillwynia retorta	Eggs and Bacon												u
Glycine clandestina	Twining Glycine	3		3	3	3				4	c		
Glycine tabacina	Variable Glycine		3		3	3				3	c		
Hardenbergia violacea	Purple Coral Pea			2		1	●		●				
Indigofera australis	Australian Indigo											●	
Kennedia rubicunda	Dusky Coral Pea					2						●	
Lespedeza juncea subsp. *sericea*							●			2	u		
Podolobium ilicifolium	Prickly Shaggy Pea			2		5	●		●				
Podolobium scandens	Netted Shaggy Pea	3											
Pultenaea villosa	Hairy Bush-pea	1			3								

	Community/Map Unit	1								2		3	A
	Sample	Q1	Q2	Q3	Q5	Q6	RM2	RM4	RM6	Q4	RM5	RM3	RM1
Scientific Name	**Common Name**												
Fabaceae: Mimosoideae													
Acacia falcata	Sickle Wattle				2		●						
Acacia floribunda	White Sally		3										u
Acacia implexa	Hickory Wattle	2	3								r		
Acacia irrorata subsp. *irrorata*	Green Wattle	2				4		●		5	c		
Acacia leiocalyx subsp. *leiocalyx*	Curracabah												r
Acacia longissima	Long-leaf Wattle			3		2							
Acacia ulicifolia	Prickly Moses	3		3	4			●					o
Flacourtiaceae													
Scolopia braunii	Flintwood											●	
Geraniaceae													
Geranium homeanum	A Native Geranium										r		
Geranium solanderi	Native Geranium		1										
Goodeniaceae													
Goodenia heterophylla	Variable Leaf Goodenia								●				u
Haloragaceae													
Gonocarpus teucrioides	Raspwort				3								
Lamiaceae													
Mentha satureioides	Creeping Mint									3	c		
Plectranthus parviflorus	Cockspur Flower		3										
**Prunella vulgaris*	Self-heal										u		
Lobeliaceae													
Pratia purpurascens	Whiteroot	4	3	4	3	4		●		5	c		c
Malvaceae													
Abutilon oxycarpum	Straggly Lantern-bush										c		
Brachychiton populneus	Kurrajong				1								
**Modiola caroliniana*	Red-flowered Mallow										u		
**Sida rhombifolia*	Paddy's Lucerne		2								u		r
Menispermaceae													
Sarcopetalum harveyanum	Pearl Vine											●	
Stephania japonica	Snake Vine											●	
Moraceae													
Ficus rubiginosa	Port Jackson Fig	1											
Maclura cochinchinensis	Cockspur Thorn										r		
Myrsinaceae													
**Anagallis arvensis*	Scarlet Pimpernel										u		u
Myrsine variabilis	Muttonwood						●					●	
Myrtaceae													
Angophora floribunda	Rough-barked Apple							●	●		u		
Backhousia myrtifolia	Grey Myrtle											●	
Callistemon salignus	Willow Bottlebrush							●					
Corymbia maculata	Spotted Gum		5	6	5		●	●	●			●	o
Eucalyptus canaliculata	Large-fruited Grey Gum		5	5		4	●	●	●	5		●	
Eucalyptus carnea	Thick-leaved Mahogany	6	4	4	5	7	●	●	●		c		o
Eucalyptus fibrosa	Red Ironbark	5			6								o
Eucalyptus microcorys	Tallow Wood						●		●				
Eucalyptus molucanna	Grey Box								●	5	u		
Eucalyptus siderophloia	Grey Ironbark	4	6	5		4	●	●	●		o	●	o
Eucalyptus tereticornis	Forest Red Gum									6	a		
Leptospermum polygalifolium	Tantoon							●					

	Community/Map Unit	1								2		3	A
	Sample	Q1	Q2	Q3	Q5	Q6	RM2	RM4	RM6	Q4	RM5	RM3	RM1
Scientific Name	**Common Name**												
Melaleuca nodosa	Prickly-leaved Paperbark												o
Oleaceae													
**Ligustrum sinense*	Small Leaved Privet							●					
Jasminum volubile	Stiff Jasmine		1	1	2	2	●					●	
Notelaea longifolia	Large Mock-olive				2	2	●			3	u		
Notelaea ovata	Ovate-leaf Mock Olive			2			●						
*Notelaea*sp. *A sensu Harden (1992)*				1								●	
Oxalidaceae													
Oxalis exilis	A Native Oxalis		2	2				●		3	o		
Passifloraceae													
**Passiflora subpeltata*	White Passionflower											●	
Phyllanthaceae													
Breynia oblongifolia	Coffee Bush	1	3	1	1			●		2	u		
Glochidion ferdinandi	Cheese Tree			1									
Phyllanthus gunnii	Scrubby Spurge											●	
Phyllanthus hirtellus	Thyme Spurge	3		2		1							
Pittosporaceae													
Billardiera scandens	Hairy Apple Berry	1		1	2	2		●		1			
Pittosporum multiflorum	Orange Thorn						●			1	r		
Plantaginaceae													
Plantago cladarophylla				2									
Plantago gaudichaudii	Narrow plantain									1			
**Plantago lanceolata*	Lamb's Tongues		1	2		1				5	o		u
Veronica plebeia	Trailing Speedwell										●		
Polygalaceae													
Polygala japonica	Dwarf Milkwort						●						
Polygonaceae													
Persicaria decipiens	Slender Knot-weed							●			c		
Persicaria hydropiper	Waterpiper							●					
Rumex brownii	Swamp Dock										u		
**Rumex crispus*	Curled Dock										o		
Proteaceae													
Persoonia linearis	Narrow-leaved Geebung	1											
Ranunculaceae													
Clematis aristata	Old Man's Beard		3	1		2							
Clematis glycinoides	Headache Vine									1			
Ranunculus lappaceus	Common Buttercup									2			
Ranunculus sessiliflorus	Small-flowered Buttercup										o		
Rhamnaceae													
Alphitonia excelsa	Red Ash		1		2	1		●			r		
Rosaceae													
**Rubus fruticosus* agg. sp.	Blackberry							●					
Rubus parvifolius	Native Raspberry							●			c		
Rubiaceae													
Asperula conferta	Common Woodruff		2							3			
Galium leiocarpum						1							
Opercularia diphylla					4	2							
Pomax umbellata	Pomax	1		1		3							u
**Richardia stellaris*											u		
Rutaceae													

	Community/Map Unit	**1**								**2**		**3**	**A**
	Sample	**Q1**	**Q2**	**Q3**	**Q5**	**Q6**	**RM2**	**RM4**	**RM6**	**Q4**	**RM5**	**RM3**	**RM1**
Scientific Name	**Common Name**												
Boronia polygalifolia	Dwarf Boronia	2				1							
Citrus x taitensis	Bush Lemon		1										
Santalaceae													
Exocarpos strictus	Dwarf Cherry			3					●				●
Scrophulariaceae													
Eremophila debilis	Winter Apple		1	3	2	2				1			
Solanaceae													
**Solanum mauritianum*	Wild Tobacco Bush							●	●				r
**Solanum nigrum*	Black-berry Nightshade							●					c
Solanum prinophyllum	Forest Nightshade		1	3		1				1	u		u
Solanum stelligerum	Devil's Needles											●	
Stackhousiaceae													
Stackhousia viminea	Slender Stackhousia									1			
Stylidiaceae													
Stylidium graminifolium	Grass Trigger-plant								●				
Thymelaeaceae													
Pimelea linifolia subsp.*linifolia*	Slender Rice Flower	3							●				u
Ulmaceae													
Trema tomentosa var. *aspera*	Native Peach			1				●					
Verbenaceae													
**Lantana camara*	Lantana		1	1		2	●	●			o		u
**Verbena caracasana*											u		a
**Verbena rigida*	Purpletop		3		3	2				4	u		o
Violaceae													
Viola betonicifolia	Native Violet								●				
Vitaceae													
Cayratia clematidea	Native Grape						●						
Clematicissus opaca	Pepper Vine					2						●	
SUBCLASS LILIIDAE													
Anthericaceae													
Arthropodium sp.			2	3	3	3							
Tricoryne elatior	Yellow Autumn-lily				1								r
Commelinaceae													
Commelina cyanea	Native Wandering Jew									3	c		
Cyperaceae													
Carex appressa	Tall Sedge							●					
Carex inversa	Knob Sedge		1	2							o		
Carex longebrachiata	Drooping Sedge									2	a		
Cyperus gracilis	Slender Flat Sedge		2	2							o		
Cyperus haspan	A Sedge		1	3									
**Cyperus sesquiflorus*	A Sedge												o
Cyperus sphaeroideus	A Sedge										o		
Cyperus trinervis	A Sedge										r		
Fimbristylis dichotoma	Common Fringe-sedge			2	2					2	r		u
Gahnia aspera	Rough Saw-sedge		1	3		1		●			u		
Lepidosperma elatius	Tall Sword-sedge			2				●					u
Lepidosperma laterale	Common Sword-sedge	2	2	2	2	3							
Schoenoplectus mucronatus	A Club-rush							●					
Hypoxidaceae													
Hypoxis hygrometrica var. *villosisepala*	Golden Weather-grass	3	2	2	2	1				2	o		u

	Community/Map Unit	1								2		3	A
	Sample	Q1	Q2	Q3	Q5	Q6	RM2	RM4	RM6	Q4	RM5	RM3	RM1
Scientific Name	**Common Name**												
Juncaceae													
Juncus subsecundus													r
Juncus usitatus	Common Rush										u		
Lomandraceae													
Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush	2	3	2	2			●		3	o		
Lomandra longifolia	Spiny-headed Mat-rush			3	3	2		●			o		
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush			2									
Luzuriagaceae													
Eustrephus latifolius	Wombat Berry			1				●	●				
Geitonoplesium cymosum	Scrambling Lily		3		2	2		●		2	u		
Orchidaceae													
Acianthus sp.	Pixie Caps								●				
Pterostylis sp.	A Greenhood Orchid								●				
Spiranthes australis	Ladies' Tresses										r		
Phormiaceae													
Dianella caerulea var. *assera*	Blue Flax-lily	2											
Dianella caerulea var. *cinerascens*	Blue Flax-lily		3	3		2				2			u
Dianella longifolia var. *longifolia*	Smooth Flax-lily		1	2	3								
Dianella longifolia var. *stenophylla*	Smooth Flax-lily												r
Poaceae													
**Andropogon virginicus*	Whisky Grass												u
Aristida personata	Purple Wire-grass					3					o		
Aristida vagans	Three-awned Speargrass	4	3	3	5	4				2			o
Austrostipa rudis	A Speargrass					2			●				
**Axonopus fissifolius*	Narrow-leafed Carpet Grass		2	1						4	c		a
Bothriochloa sp.	Red Grass		2							1	c		
Capillipedium spicigerum	Scented-top Grass				1			●		1	o		
Cymbopogon refractus	Barbed Wire Grass	5	6	3	2	4		●		6	a		o
Cynodon dactylon	Couch										c		
Dichelachne micrantha	Shorthair Plumegrass				2	2							
Digitaria diffusa	Open Summer-grass		2	2						1			
Digitaria parviflora	Small Flowered Finger Grass				2	1							
Echinopogon caespitosus	Bushy Hedgehog Grass	3	2	3	1								u
**Ehrharta erecta*	Panic Veldtgrass							●					
Entolasia marginata	Bordered panic					2		●		3			
Entolasia stricta	Wiry Panic	5	2	3	5	2							
Eragrostis brownii	Common Lovegrass	2			4	2							o
Eragrostis leptostachya	Paddock Lovegrass			2						3	c		
**Eragrostis pilosa*	Soft Lovegrass		3										
Imperata cylindrica	Blady Grass	6	3	5	2	5		●		4	o		a
Microlaena stipoides	Weeping Grass		4	3	2	4		●		5	c		o
Oplismenus aemulus	Basket Grass		3	4				●		4	o		
Panicum effusum	Hairy Panic					2				1			
Panicum simile	Two-coloured Panic	4		3	2	3				2	u		
Paspalidium distans	Spreading Panic-grass		1	3		1				2			o
**Paspalum dilatatum*	Paspalum		2	2						3	u		c

	Community/Map Unit	1								2		3	A
	Sample	Q1	Q2	Q3	Q5	Q6	RM2	RM4	RM6	Q4	RM5	RM3	RM1
Scientific Name	**Common Name**												
Paspalum distchum	Water Couch										c		
**Paspalum notatum*	Bahia Grass												o
**Paspalum urvillei*	Vasey Grass				1			●		2			
Pennisetum alopecuroides	Swamp Foxtail										o		
**Pennisetum clandestinum*	Kikuyu Grass												u
Poa sieberiana	Fine-leaved Tussock Grass			1									
**Setaria pumila*	Pale Pigeon Grass										o		
**Setaria sphacelata*	South African Pigeon Grass												r
Sporobolus creber	Western Rat-tail Grass				2					1	u		
**Sporobolus fertilis*	Giant Parramatta Grass		2										r
Themeda australis	Kangaroo Grass	2	5	5	6	5		●		5	a		o
No. Native Species	**191**												
No. Introduced Species	**40**												
Total Species	**231**												