13. Ecology

This Chapter focuses on the ecology and predicted impacts that will result from subsidence in the mining area, as well as the direct impacts of land disturbance required for the establishment of the surface facilities and infrastructure.

13.1 Flora and Fauna Within the Impact Footprint

OzArk Environmental and Heritage Management Pty Ltd (OzArk) were commissioned to undertake an ecological assessment of the proposed W2CP. The study was comprehensive and covered both direct impact areas, and the area proposed to be developed as an Ecological Offset. This report is summarized below and contained in full as Appendix Q.

A separate ecological study was undertaken of the area where coal will be extracted, that is, the area where subsidence will occur. This is provided as a separate report in Appendix R and summarized in Section 13.2.

13.1.1 Methodology

The overall methodological approach for the final assessment of terrestrial ecology for the W2CP has seen the study area divided into three major groups according to the levels of proposed impact:

- Areas of direct impact: Surface facilities and associated infrastructure at the Buttonderry, Tooheys Road and Western shaft study areas (mine heads, rail loop, buildings, materials stockpiles; utilities and ventilation);
- Areas of indirect impact: Proposed mining area subsidence zones; and
- Areas of no impact: Habitat compensation areas or zones available to be set aside for intergenerational equity and ecological enhancements.

The assessment requirements for land within each division are deemed to be different due to the nature and extent of the proposed impacts. In areas of direct impact, detailed assessment was used to establish the absolute ecological values (according to State and Federal legislation) of these locations. Once the values were identified, mitigation measures have been devised including long-term management initiatives.

For areas of potential indirect impact such as subsidence, assessment was required to establish the likely ecological values, with a significant focus on the manner in which the potential impacts from subsidence may affect these values. Complete survey is not considered necessary to achieve this aim. Targeted survey and review of previous studies placed in their regional context is considered to be adequate to understand the potential impacts to the terrestrial values. The results of the assessment for these areas is provided in Section 13.2.

Locations that are being considered as habitat compensation or as areas of conservation for inter-generational equity required a more general assessment, primarily focused on predictive modeling accompanied by targeted survey. The aim was to establish the ecological values of these potential compensatory areas to

determine whether they are equitable to what is being impacted as a result of the direct and indirect impacts of the W2CP.

OzArk was briefed to assess proposed impacts of the W2CP upon flora and fauna species, particularly those species, populations and ecological communities with legislative protection listed under the *Threatened Species Conservation Act 1995* (TSC Act), the *Fisheries Management Act 1994* (FM Act) and the *Environmental Biodiversity Conservation Act 1999* (EPBC Act) in the direct impact areas.

The assessment also included describing the existing environment, highlighting areas or species of conservation concern within areas not proposed for direct impact associated with the Tooheys Road, Hue Hue Road ecological offset investigation area and on Buttonderry.

13.1.2 Classification

Vegetation classifications were assigned based on the nomenclature commonly used in recent studies of the region. This has allowed comparison with other ecological studies, therefore providing a more valuable data set for use in ecological assessment. However, with the potential to enter the DECCW Biobanking Scheme being investigated, the vegetation recorded on site has also been classified in accordance with the Biometrics system used for Biobanking. Table 13.1 provides a comparison of the vegetation classification for the two systems.

Table 13.1 Vegetation Classification Comparison

W2CP Ecology Report Classification	Biobanking Equivalent	Biobanking Code
Narrabeen Dooralong (Doyalson) Scribbly Gum Woodland	Scribbly Gum – Red Bloodwood Heathy Woodland on the coastal plains of the Central Coast, Sydney Basin.	HU 610
Alluvial Riparian Blackbutt Forest	Blackbutt – Pink Bloodwood shrubby open forest of the coastal lowlands of North Coast	HU 508
Alluvial Footslopes Redgum Forest	Forest Red Gum – Rough-barked Apple open forest on poorly drained lowlands of the Central Coast, Sydney Basin.	HU 546
Narrabeen Alluvial Drainage Line Complex	Swamp Mahogany Swamp Forest on coastal lowlands of the North Coast and Northern Sydney Basin	HU 633
Coastal Ranges Moist Layered Forest	Mountain Blue Gum – Turpentine Moist shrubby open forest of the Central Coast, Sydney Basin.	HU 571
Narrabeen Buttonderry Footslopes Forest	Smooth-barked Apple – Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin.	HU 621
Dooralong Spotted Gum Ironbark Forest	Spotted Gum – Broad leaved Ironbark grassy open forest of dry hills of lower Hunter Valley, Sydney Basin	HU 629

13.1.3 Literature Review

Flora and Fauna

A summary of available literature relevant to the current direct impact areas showed that:

- Vegetation mapping consistent with that used by LHCCREMS was required to contextualise existing data such that national, state, regional and local significance could be determined.

- Several threatened species of flora are known to occur in the proposed areas of direct impact, these include:

  • *Tetratheca juncea* – recorded in the Tooheys Road study area;
  • *Angophora inopina* – recorded Tooheys Road study area; and
  • *Grevillea parviflora* spp *parviflora* – recorded in the Hue Hue Road ecological offset investigation area;

- Three Endangered Ecological Communities (EEC's) have been previously identified within the Tooheys Road study area with one additional EEC being recorded on the Hue Hue Road ecological offset investigation area.

- Several threatened species of fauna are known to occur in the proposed direct impact areas, these include:

  • Greater Broad-nosed Bat (*Scoteanax rueppellii)* – recorded in Hue Hue Road ecological offset investigation area;
  • Eastern Falsistrelle (*Falsistrellus tasmaniensis*) – recorded as having the potential to occur, later recorded by OzArk at Tooheys Road study area;
  • Little Bentwing Bat (*Miniopterus australis)* - recorded at Tooheys Road study area;
  • Large Footed Mytosis (*Mytosis adversus*) recorded at Tooheys Road study area;
  • Yellow-bellied Sheathtailed Bat (*Saccolaimus flaviventris)* – recorded in the Tooheys Road and Hue Hue Road study areas.
  • Squirrel Glider (*Petaurus norfolcensis*) recorded in the Tooheys Road study area;
  • Yellow-bellied Glider (*Petaurus australis*) tentatively recorded in Hue Hue Road ecological offset investigation area;
  • Wallum Froglet (*Crinia tinnula*) recorded in the Tooheys Road and Hue Hue Road study areas; and
  • Green-thighed Frog (*Litoria brevipalmata*) – recorded at Buttonderry.

A review undertaken in 2000 of significant flora within the region revealed there to be a high diversity of rare, endemic and restricted plant species (Bell 2000). Since that time, a number of plant taxa and populations have been added to the Schedules of the TSC Act. There are currently ten endangered and eighteen vulnerable plant species listed for the Hunter-Central Rivers CMA (DECCW Database).

The Hunter Rare Plants Group, a sub-committee of the Hunter Region Botanic Gardens, is in the process of compiling a database of significant plant species, populations and communities in the region. This database currently shows there to be 1278 significant plant taxa, populations or communities within the Hunter Valley

and Central Coast, including 52 endemic entities. Those species not currently listed as endangered or vulnerable could potentially qualify for listing in the future.

A search of the DECCW threatened species website area using a combined geographic and habitat search showed that there are 118 items of conservation concern in the Hunter / Central Rivers - Wyong CMA. Of these, 76 are species of threatened or endangered animals (1 insect, 39 birds, 10 mammals {not including bats}, 12 bats, 6 reptiles and 8 species of frog). A search of the BioNet database focused on the LGA showed that nearly all these species listed by DECCW as having the potential to occur in the CMA region have been previously recorded in the LGA.

The Department of Industry and Investment - NSW Fisheries on line database lists 10 endangered species in NSW (9 fish and 1 dragonfly), 2 endangered populations, 3 EEC's, 1 presumed extinct species and 8 vulnerable species (1 dragonfly, 1 shrimp, 4 fish, 1 shark and 1 species of algae).

The DEWHA online database (protected matters report) shows that there are 46 threatened species and 31 migratory species in the Wyong LGA. Of the threatened species 33 are animals (13 birds, 5 frogs, 7 mammals, 2 fish, 3 reptiles and 3 sharks). A significant overlap of protected species occurs between the DEWHA and DECCW databases and where differences occur (i.e. DEWHA protected species not appearing on the DECCW database) it is with regard to marine species.

Wetlands

The Directory of Important Wetlands (DEWHA 2001 – a DEWHA online search tool) lists 43 wetlands totalling approximately 93,745 ha occurring in the Sydney Basin Bioregion. None of the wetland areas identified in the abovementioned searches occur in or close to the proposed W2CP direct impact areas.

The DEWHA online database (protected matters report) shows that there is one Ramsar[1] wetland in the Wyong LGA. The Hunter Estuary Wetlands comprises Kooragang Nature Reserve (designated to the Ramsar list in 1984) and Shortland Wetlands. Kooragang Nature Reserve is located in the estuary of the Hunter River, approximately 7 km north of Newcastle. Shortland Wetlands are located in the Ironbark Creek Catchment in the suburb of Shortland, 12 km northwest of Newcastle and 2.5 km from Kooragang Nature Reserve. Due to the distance of these wetlands from the area of proposed subsidence and surface facilities assocated with the W2CP, there will be no impact.

A search of the Wyong Shire Development Control Plan No 30 2003 (WSDCP No 30) was undertaken to identify SEPP 14 wetlands. One wetland area is identified as 7g, a development control plan area, within the WSDCP No 30. In relation to the W2CP, this area has been identified as vegetation, Narrabeen Alluvial Drainage Line Complex and Narrabeen Alluvial Drainage Line Complex (an EEC) occurring within the Tooheys Road study area, on DP 755245 Lots 102 and 103, immediately south and paralleling the TransGrid 300 kV easement.

Although not directly within the assessed areas, the Porters Creek Wetlands occurs within one kilometre of the Buttonderry and the Hue Hue Road potential offset

[1] Under the EPBC Act, a Ramsar wetland is either:

- an Australian wetland on the List of Wetlands of International Importance kept under the Ramsar Convention; or
- a wetland declared to be a Ramsar wetland by the Commonwealth Environment Minister.

Ramsar is the name of the place in Iran where the treaty was first signed in 1971.

properties (WSDCP No 30: 22). Porters Creek Wetland is listed as a specific example in the determination for the Sydney Freshwater Wetlands Endangered Ecological Community. This Wetland occurs within the catchment of the W2CP and supports a range of wetland and swamp forest vegetation communities. A management plan has been prepared for the wetland (Andrews-Neil 1995).

According to NSW Legislative Council Hansard (1996), Porters Creek Wetland acts as the natural flood storage area for Porters Creek and Wyong River and is the most significant coastal wetland in Wyong Shire, while the National Parks and Wildlife Service (NPWS) has referred to it as the most significant wetland between Newcastle and the Hawkesbury. The Warnervale Business Park study area forms part of a larger land holding which includes the majority of Porters Creek Wetland and Warnervale Airport. The wetland is largely undisturbed and contains endangered plant species, rare and endangered fauna and a high level of biodiversity. Nineteen endangered species - rare marsupials, wading birds, frogs and significant local plants were identified as known or likely to occur within the area. The wetland is also significant in the filtration and flood mitigation of Tuggerah Lakes. It provides a much-needed drought refuge for wildlife and is an important study area along the migratory route of birds and bats.

According to the Dooralong 9131-1S 1:25K topographical map sheet, Buttonderry Creek is not continuous, but ultimately flows into this wetland. However, the direct impacts associated with the surface facilities will not affect the wetland.

13.1.4 Flora

Based on all of the vegetation surveys completed, sixteen vegetation communities have been described, and a total of 275 vascular plant taxa recorded within the entire study area during the survey. Mapped vegetation units within the assessed areas are shown on Figure 13.1 to Figure 13.4. The mapping units shown on the figures are denoted on the vegetation descriptions.

MU15: Alluvial Footslopes Redgum Forest (Bell 2002a)

At the corner of Kiar Ridge and Hue Hue Roads, a small area of remnant Alluvial Footslopes Redgum Forest occurs. This vegetation has been partially cleared and grazed in the past, but still retains important elements of this community. The canopy is dominated by *Eucalyptus tereticornis, Eucalyptus resinifera* and *Angophora floribunda*, over a mid-storey of *Melaleuca decora, M. linariifolia* and *M. nodosa*. Ground layer vegetation consists of various grasses, sedges and herbs.

This vegetation type can perhaps be considered a drier form of the Alluvial Floodplain Shrub Swamp Forest, but in that community *Eucalyptus robusta* is prominent and the understorey supports a higher diversity of moisture loving sedges.

Within Wyong LGA, Alluvial Footslopes Redgum Forest is highly restricted and has suffered from fragmentation and clearing, with estimates of 86% loss having been made (Bell 2002a). Within the regional NPWS classification (2000), this community falls into the Wyong Paperbark Swamp Forest (Alluvial Riparian Blackbutt Forest). Alluvial Footslopes Redgum Forest can be considered part of the River Flat Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (RFFCF).

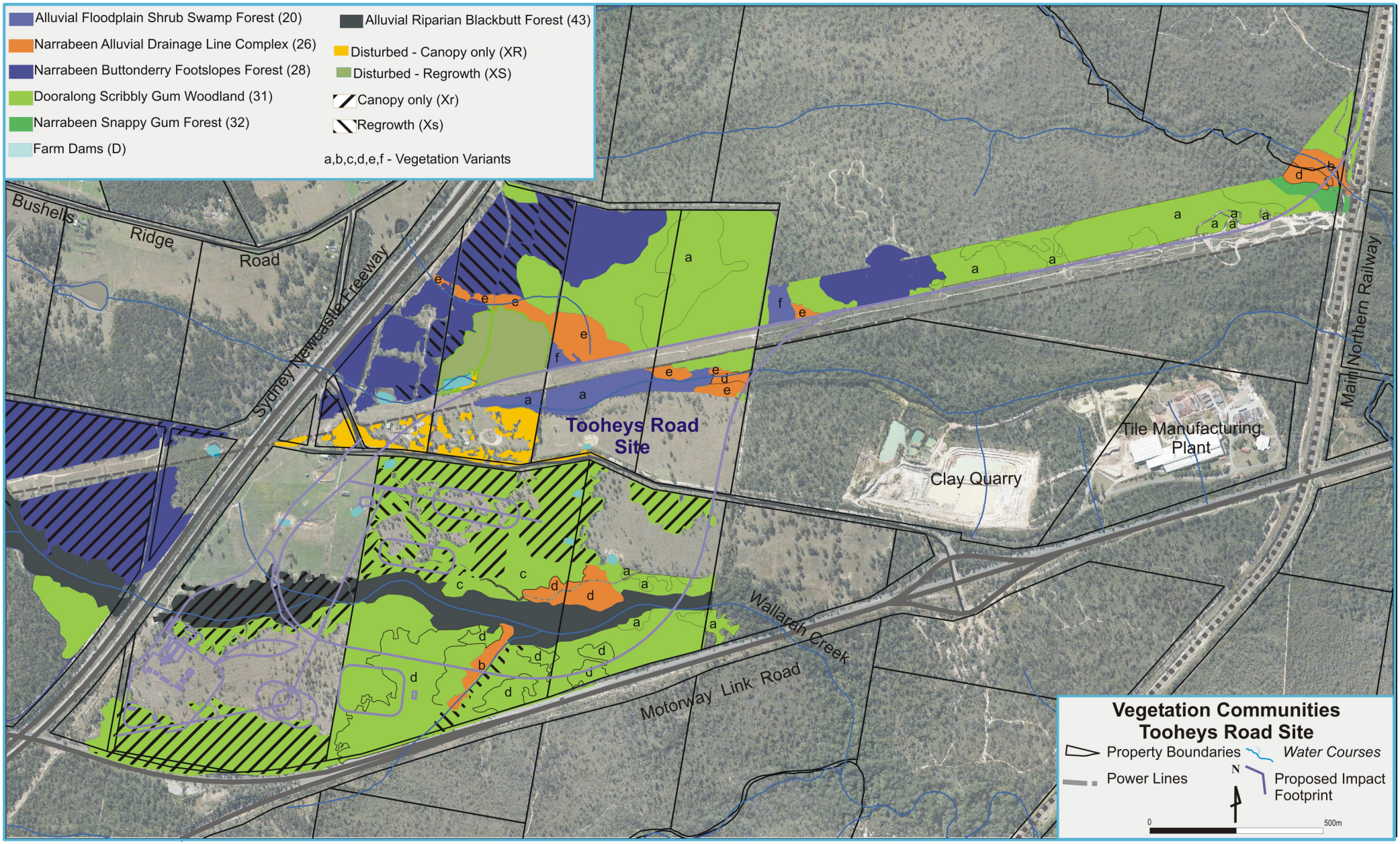

Figure 13.1 Vegetation Communities of the Tooheys Road Site

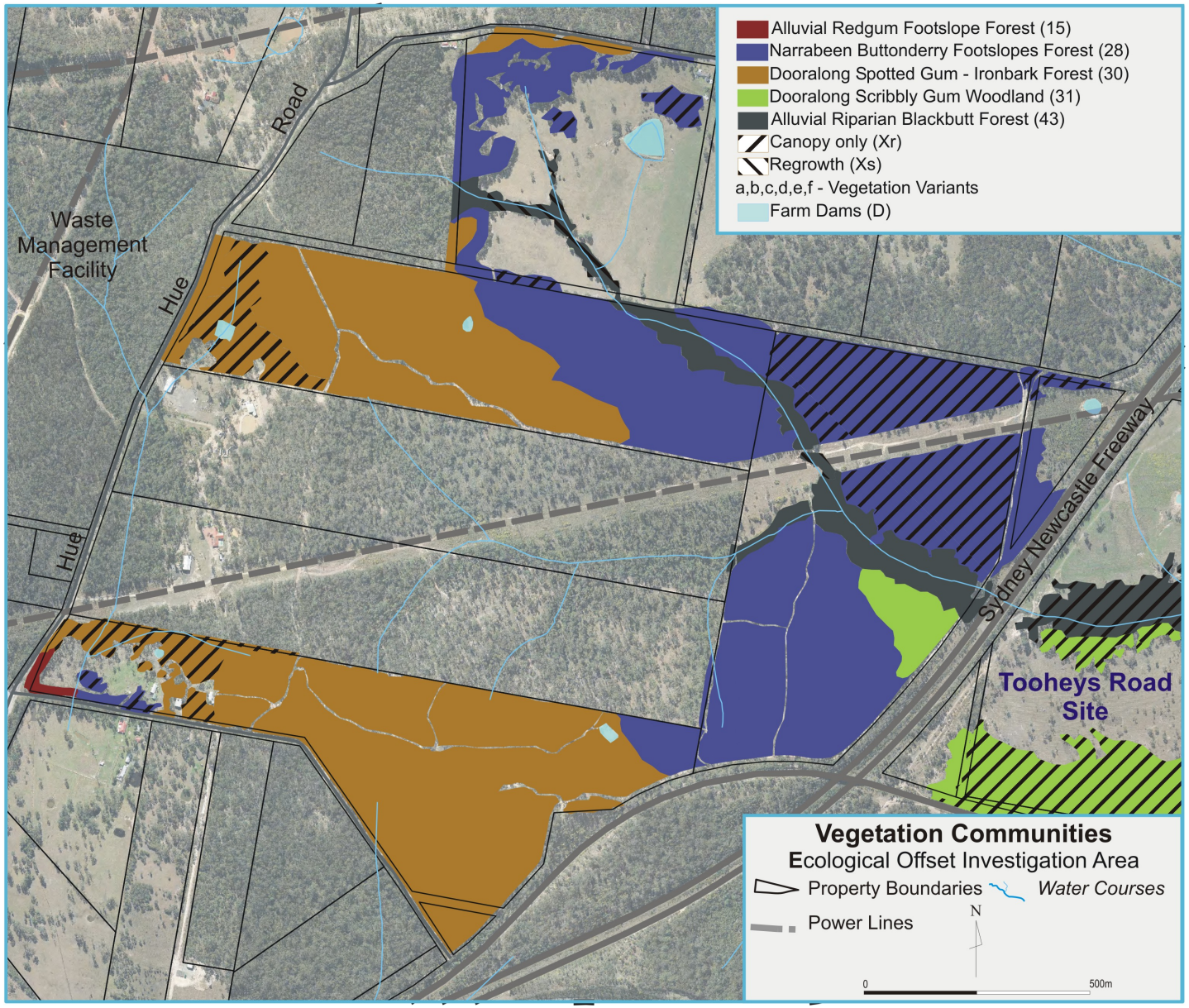

Figure 13.2 Vegetation Communcities of the Ecologcial Offset Area

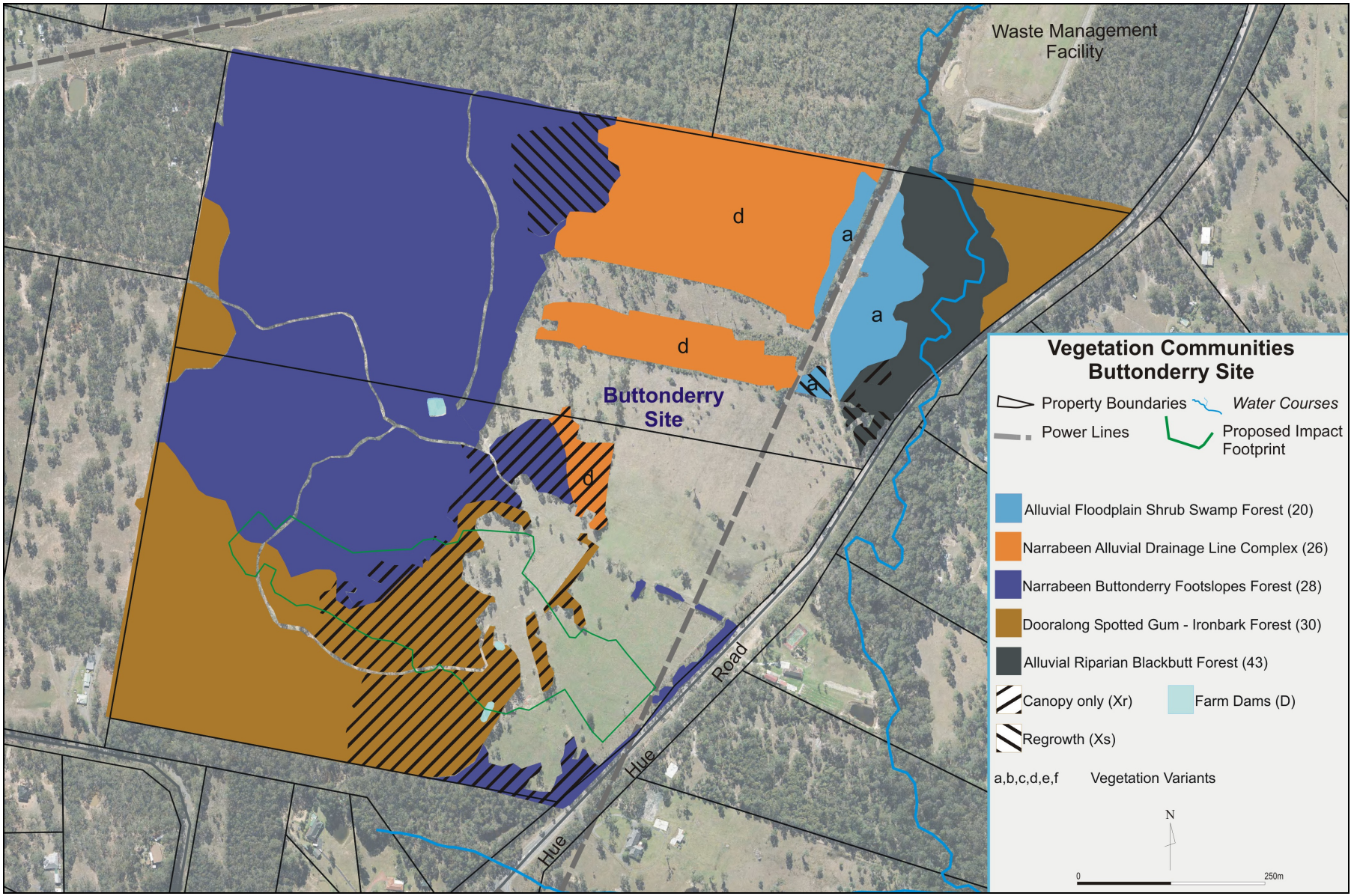

Figure 13.3 Vegetation Communities of the Buttonderry Site

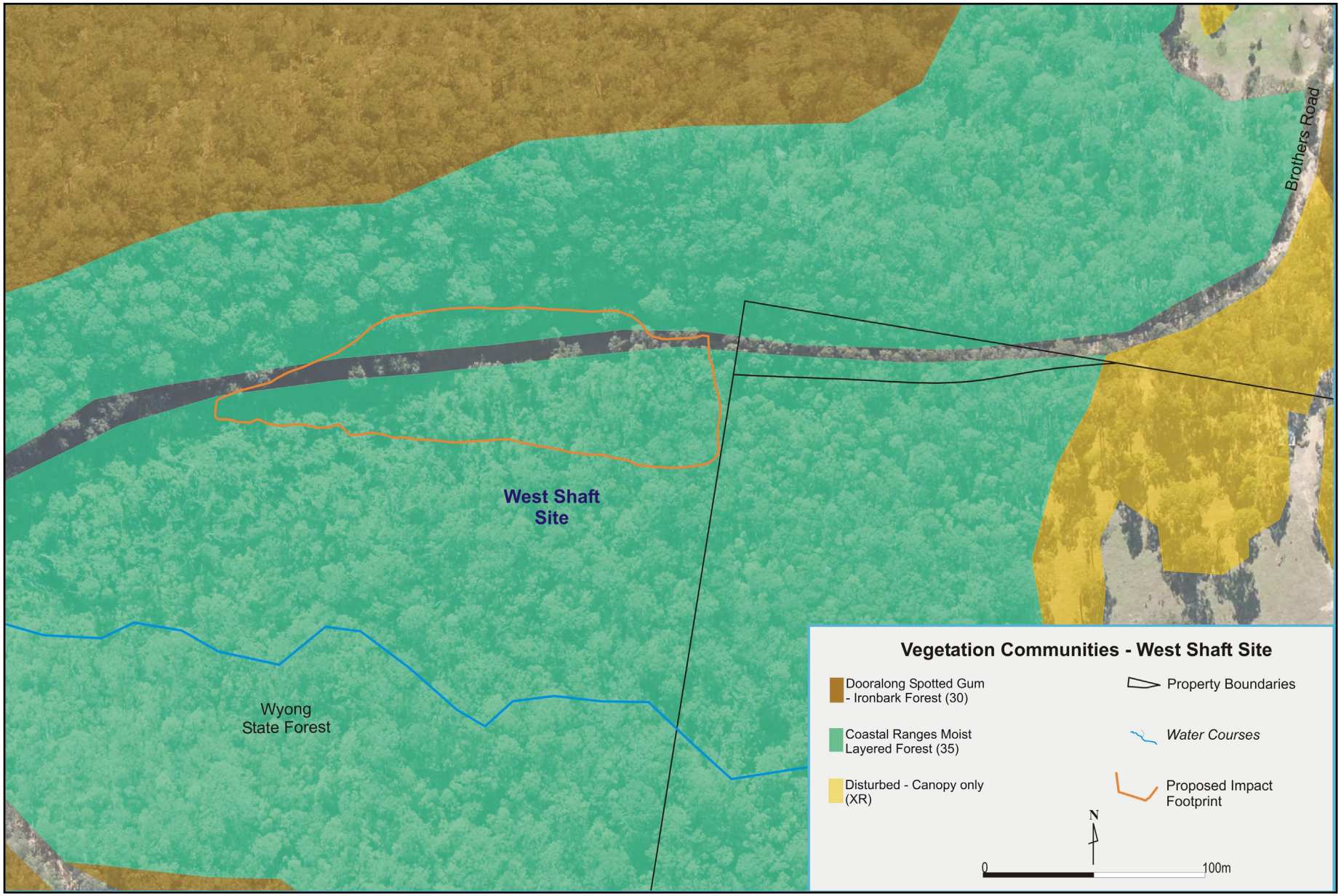

Figure 13.4 Vegetation Communities of the West Shaft Site

MU20a: Alluvial Floodplain Shrub Swamp Forest (Bell 2002a)

Alluvial Floodplain Shrub Swamp Forest occurs at two main locations in the study area. In the Tooheys Road site, the broad drainage line (outside of the impact zone) supports vegetation variously dominated by *Eucalyptus robusta*, *Angophora floribunda* and *Eucalyptus resinifera*, with a sub-canopy of *Melaleuca linariifolia* and *Melaleuca decora*. The understorey is characterised by a dense layer of sedges and grasses, a scattered shrub layer of *Leptospermum juniperinum, Gahnia clarkei* and juvenile *Melaleuca linariifolia* and *Eucalyptus* species. Further downstream, this area changes into "Narrabeen Alluvial Drainage Line Complex" as it continues into the adjacent Boral property.

The second location lies in the north-eastern corner of the Buttonderry property, again outside the immediate impact zone. *Eucalyptus robusta, Angophora floribunda* and *Eucalyptus tereticornis* dominate at this location, over a distinctive understorey of *Lomandra longifolia* and various grasses. It is evident that this area has been subject to light-to-moderate grazing pressure over the years. These forms of swamp forest are distinct from that supported in other drainage lines in the study area (eg: Narrabeen Alluvial Drainage Line Complex), and can be considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

The Alluvial Floodplain Shrub Swamp Forest, as described in Bell (2002a), is highly variable depending on depth to water table, soil type and other factors. Estimates of 67% loss have been made for this vegetation type (Bell 2002a). Within the regional classification of NPWS (2000), this community falls into either the Swamp Mahogany – Paperbark Swamp Forest or the Wyong Paperbark Swamp Forest. This community can be considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

MU 20f: Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant) (Bell 2002a)

Two small areas in the Tooheys Road section of the study area support a low, scrubby heath vegetation that fits best within Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant) of Bell (2002a). At this site, it is dominated by *Angophora inopina, Melaleuca sieberi,* and *Leptospermum trinervium* in the canopy, over a sedge-dominated understorey. This vegetation is only known regionally from within the Wallarah Creek and Porters Creek catchments. Portions of this community have been partially cleared in the past, however recovery has been good.

The Alluvial Floodplain Shrub Swamp Forest, as described in Bell (2002a), is highly variable depending on depth to water table, soil type and other factors. Estimates of 67% loss have been made for this vegetation type (Bell 2002a). Within the regional classification of NPWS (2000), this community falls into either the Swamp Mahogany – Paperbark Swamp Forest or the Wyong Paperbark Swamp Forest. This community is likely to form part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

MU26b: Narrabeen Alluvial Drainage Line Complex (Bell 2002a)

Two small areas support this vegetation type within the study area. At Tooheys Road, the vegetation occurring along Spring Creek near the Great Northern Railway best fits this unit. Scattered *Eucalyptus robusta* and *Eucalyptus resinifera* occur over a moderately dense understorey of *Acacia longifolia*, and various *Melaleuca* species. A range of sedges and grasses occurring the ground and along the banks of the creekline itself. A similar area occurs in a small tributary of Wallarah Creek in the south of the Tooheys Road parcel, although *Eucalyptus robusta* is not present. In both instances, the construction of the rail loop may impact on this community, at least initially.

Regionally, this type is equivalent to the Riparian Melaleuca Swamp Woodland of NPWS (2000). An estimated reduction of 17% since 1750 has been made for this vegetation type within Wyong LGA (MU26: Bell 2002a). This community is likely to form part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

MU26d: Narrabeen Alluvial Drainage Line Complex (Bell 2002a)

Broad, shallow drainage lines in the Buttonderry and Tooheys Road areas support an open sedge woodland where *Angophora costata, Eucalyptus resinifera, Melaleuca sieberi*, and *Melaleuca linariifolia* form the emergents. Occasional individuals of *Eucalyptus robusta* may also be present. Understorey vegetation is clearly dominated by sedge and grass species, with shrub species occurring often in dense patches. Ground layer vegetation includes *Banksia spinulosa* var. *collinear, Melaleuca thymifolia, Acacia longifolia, Leprosies scarious, Coriander cymbaria, Hemarthria uncinata* var*. uncinata, Schoenus brevifolius, Entolasia stricta, Gahnia clarkei, Leptospermum juniperinum, Pseudoraphis paradoxa, Empodisma minus, Deyeuxia quadriseta, Plinthanthesis paradoxa,* and *Baumea teretifolia.*

This community is typified by a very undulated ground surface which serves as water storage refuges during dry periods, and provide fauna habitat. Regionally, this type is equivalent to *Variant d* (Sedge Woodland) of the Narrabeen Alluvial Drainage Line Complex of Bell (2002a), and the Riparian Melaleuca Swamp Woodland of NPWS (2000). An estimated reduction of 17% since 1750 has been calculated for this vegetation type (MU26: Bell 2002a). Within the study site, there is some dieback of mature *Eucalyptus resinifera* individuals, possibly related to previous diversions of water flows upstream (Buttonderry Tip).

MU26e: Narrabeen Alluvial Drainage Line Complex (MU26e in Bell 2002a)

One drainage line in the Tooheys Road portion supports thickets of *Melaleuca linariifolia*, and other paperbarks that are closest to Narrabeen Alluvial Drainage Line Complex in Bell (2002a). Scattered emergents of *Angophora costata* and *Eucalyptus resinifera* are also present and it is likely that at least some of this community has developed in response to past clearing for agricultural purposes.

MU28: Narrabeen Buttonderry Footslopes Forest (Bell 2002a)

Narrabeen Buttonderry Footslopes Forest occurs extensively in the Buttonderry and Tooheys Road parcels, where it forms a mosaic pattern with Narrabeen Dooralong Spotted Gum – Ironbark Forest and Narrabeen Doyalson Scribbly Gum Woodland. It is characterised by a canopy of *Angophora costata, Eucalyptus capitellata, Corymbia gummifera, Melaleuca decora,* and *Eucalyptus fibrosa*. Understorey

vegetation includes such species as *Banksia spinulosa, Melaleuca nodosa, Bossiaea obcordata, Daviesia squarrosa, Epacris pulchella, Leptospermum trinervium, Goodenia heterophylla, Lomandra obliqua, Themeda australis,* and *Entolasia stricta*.

In some areas, soils are notably more sandstone-based than others, and this is reflected in the local understorey composition (eg: *Banksia spinulosa, Lomandra obliqua, Grevillea sericea, Comesperma ericinum* are present in the more sandy soils). In some locations, evidence of past clearing and regrowth is shown as dense thickets of *Allocasuarina littoralis*.

Within the context of regional vegetation studies, this vegetation community may be considered as part of the Coastal Plains Scribbly Gum Woodland (Narrabeen Doyalson Scribbly Gum Woodland: NPWS 2000). Within Wyong Shire, an estimated loss of 47% in distribution has been made since 1750 for this community (MU28: Bell 2002a).

MU30: Narrabeen Dooralong Spotted Gum – Ironbark Forest (Bell 2002a)

Areas mapped as supporting Narrabeen Dooralong Spotted Gum-Ironbark Forest are open forests dominated by Spotted Gum (*Corymbia maculata*) and Ironbarks (predominately *Eucalyptus fibrosa*), over a sparse understorey of shrubs such as *Daviesia ulicifolia* and *Podolobium ilicifolium*, and grasses such as *Themeda australis, Entolasia stricta, Imperata cylindrica* var. *major,* and *Microlaena stipoides* var. *stipoides.* In areas where previous clearing or under-scrubbing has occurred, dense thickets of *Melaleuca nodosa* predominate, greatly reducing the diversity of shrub and ground layer species. In some areas, sections of Narrabeen Dooralong Spotted Gum-Ironbark Forest have been partially cleared and underscrubbed for grazing purposes, and support a disturbed forest of variable density and canopy retention.

The main areas of occurrence of this community are in the Hue Hue Road proposed conservation area, and in parts of the Buttonderry portion.

Regionally, this vegetation type is equivalent to Coastal Foothills Spotted Gum – Ironbark Forest (Alluvial Footslopes Redgum Forest) in NPWS (2000). Bell (2002a) has estimated that the Narrabeen Dooralong Spotted Gum – Ironbark Forest within Wyong Shire has undergone a 53% loss in areal extent since 1750. Ongoing work in the classification of communities dominated by Spotted Gum in the region (Bell & Driscoll in prog.) has suggested that the Spotted Gum – Ironbark forests in the Warnervale area are distinct from all others regionally (from the Karuah River to the Hawkesbury River), and may qualify for listing as an Endangered Ecological Community. In the interim, these forests are considered regionally significant.

MU31: Narrabeen Doyalson Scribbly Gum Woodland (Bell 2002a)

Narrabeen Doyalson Scribbly Gum Woodland is a distinct healthy woodland occurring in the southern Lake Macquarie-Wyong region. It is characterised by a canopy of *Eucalyptus haemastoma, Corymbia gummifera, Eucalyptus capitellata* and *Angophora inopina,* with occasional occurrences of *Angophora costata* and *Banksia serrata.* A rich and diverse understorey includes *Lambertia formosa, Hakea laevipes* subsp*. laevipes, Persoonia linearis, Bossiaea heterophylla, Leptospermum trinervium, Epacris pulchella, Pimelia linifolia* subsp*. linifolia, Isopogon anemonifolius, Tetratheca juncea, Hibbertia vestita, Pultenaea palaceae, Ptilothrix*

deusta, Melichrus procumbens, Aristida warburgii, Entolasia stricta, and *Xanthorrhoea latifolia* subsp. *latifolia*.

This community is widespread in the local region, with over 3100 ha mapped for Wyong LGA (Bell 2002a), 4250 ha mapped for the region (NPWS 2000).

MU31a: Narrabeen Doyalson Scribbly Gum Woodland "A" (Bell 2002a)

Similar to Narrabeen Doyalson Scribbly Gum Woodland, this variant of the Narrabeen Doyalson Scribbly Gum Woodland differs in the higher proportion of grasses and graminoids in the ground layer vegetation, with woody shrubs such as *Banksia spinulosa* var. *collina, Hakea laevipes* subsp. *laevipes* and *Lambertia formosa* only sporadically occurring. This variant most likely originates through frequent fires which cause localised extinctions of sensitive species, and promote graminoid growth.

Within the current study area, this vegetation occurs almost exclusively in the DLALC lands on the site of the proposed rail loop.

MU31c: Narrabeen Doyalson Scribbly Gum Woodland "C" (Bell 2002a)

This variant of the Narrabeen Doyalson Scribbly Gum Woodland is characterised by dense thickets of *Allocasuarina littoralis* under a scattered canopy of *Eucalyptus haemastoma, Angophora costata* and *Eucalyptus capitellata*. It occurs in response to past clearing and underscrubbing for grazing activities, which has then been left to regenerate. The rapid growing *Allocasuarina* often forms monospecific stands in these situations, with little understorey vegetation present apart from grasses such as *Microlaena stipoides* var. *stipoides*, and the herbs *Pratia purpurascens, Goodenia hederaceae* and *Dichondra repens*.

Vegetation dominated by *Allocasuarina* and attributed to this variant occur only in the Tooheys Road portion, partially on the site of the proposed storage dam and coal stockpile.

MU31d: Narrabeen Doyalson Scribbly Gum Woodland (Bell 2002a)

This variant of the Narrabeen Doyalson Scribbly Gum Woodland represents a moist heath variant of the Woodland. It is known only from the Wallarah Creek area, and is similar to its parent community except that a greater proportion of sedges (*Lepyrodia scariosa, Leptocarpus tenax*) and other moisture loving shrubs (eg *Hakea teretifolia, Banksia oblongifolia, Melaleuca sieberi*) are present. In addition, this area supports often mallee-form and stunted *Angophora inopina*.

This variant has been mapped only for the southern area of the Tooheys Road portion, where the proposed rail loop and waste water dam occur.

MU 32: Narrabeen Snappy Gum Forest (MU32 in Bell 2002a)

Narrabeen Snappy Gum Forest occurs in close proximity to the Narrabeen Doyalson Coastal Woodland (Unit 31) in the northern parts of the Shire. Snappy Gum (*Eucalyptus racemosa*) is normally present as a characteristic component of the canopy, with other species such as *Angophora costata, Corymbia gummifera,* and *Eucalyptus capitellata* co-dominating. Understorey vegetation comprises a relatively dense shrub layer of *Acacia longifolia, Dodonaea triquetra, Acacia myrtifolia, Banksia spinulosa, Allocasuarina littoralis, Pultenaea paleacea, Pteridium*

esculentum, Pimelea linifolia, and *Persoonia levis*. Grasses such as *Themeda australis* and *Entolasia atricta* are important components of the ground layer, together with *Dianella caerulea, Lomandra obliqua,* and *Lindsaea linearis*.

A single occurrence of this vegetation type is present on Darkinjung land adjacent to the Main Northern Railway.

MU 35: Coastal Ranges Moist Layered Forest (MU35 in Bell 2002a)

Coastal Range Moist Layered Forest represents a vegetation type that is widespread in the western half of the Wyong LGA, much of which is contained in State Forests. These areas are generally tall forests with a moist mesic understorey, although long term disturbance may in some cases have resulted in a simple shrub component with a well developed herbaceous layer. Canopy species present can be highly variable, but those most consistently occurring include *Syncarpia glomulifera* subsp*. glomulifera, Allocasuarina torulosa,* and *Eucalyptus acmenoides*. Areas closer to drainage lines may support *Eucalyptus deanei* or *Eucalyptus saligna*, *Eucalyptus agglomerata* or *Angophora floribunda* may occur on moister slopes, while exposed slopes and ridges can be dominated locally by *Corymbia maculata, Eucalyptus pilularis, Eucalyptus propinqua,* or *Eucalyptus umbra*.

This vegetation type is present only within the western shaft study area.

MU34a: Alluvial Riparian Blackbutt Forest (Bell 2002a)

The bulk of Buttonderry Creek, including where it passes through the study area on the Buttonderry study area, supports Alluvial Riparian Blackbutt Forest. Dominant canopy species here include *Eucalyptus pilularis, Corymbia maculata* and in some places, *Eucalyptus saligna*, together with a well developed sub-canopy of *Melaleuca biconvexa* and *Melaleuca linariifolia*. A variety of sedges and herbs occur in the understorey, but *Gahnia clarkei* is prominent.

This vegetation type is closely associated with major creeklines on the Wyong sub-coastal plain, and generally occupies only a limited habitat niche. It appears that Buttonderry Creek is being impacted upon by the Buttonderry Waste Management Facility located adjacent and further upstream, as local residents have reported a reduction in water quality over recent years.

Alluvial Riparian Blackbutt Forest equates to the Alluvial Tall Moist Forest of NPWS (2000), of which approximately 4,565 ha remains in the region. However, narrow bands of Blackbutt and Spotted Gum are generally restricted to within Wyong LGA, with only 237 ha extant being mapped in Bell (2002a). This community is also included within the River Flat Eucalypt Forest on Coastal Floodplains EEC.

MUXr: Canopy-only vegetation

Several locations within the study area support vegetation where understorey structure has been completely or partially removed or modified, such that only emergent canopy trees remain. In such cases, these areas have been mapped with the mapping unit 'Xr' appended to the main vegetation map unit.

For example, Narrabeen Dooralong Spotted Gum – Ironbark Forest Xr refers to canopy-only vegetation of the Narrabeen Dooralong Spotted Gum – Ironbark Forest.

In areas where it has been difficult to assign remnant trees to a particular vegetation community, the tag "Xr" only has been applied, representing unspecified canopy-only vegetation.

MUX: Regrowth vegetation

A number of areas within the study area support regrowth vegetation that does not align well with any specific vegetation type. In such cases, these areas have been mapped with the map unit 'Xs' to indicate opportunist regrowth. In certain areas, the floristic composition present in regrowth areas allows alignment with established vegetation communities, and these are included within the general mapping for those communities, but with the suffix 'Xs'. For example, Narrabeen Dooralong Spotted Gum – Ironbark Forest Xs refers to regrowth vegetation of Narrabeen Dooralong Spotted Gum – Ironbark Forest.

MUW: Water bodies

Old farm dams scattered throughout the study area, and any other bodies of water, are marked as "D" in Figure 13.1.

Terrestrial Orchid Survey

Orchid surveys undertaken between late September and February 2008 recorded 15 species of terrestrial orchid and one epiphytic species. None of these orchid species are presently listed as endangered or rare, however two are listed as vulnerable. However, there is a previous DECCW Atlas record for the threatened orchid *Arachnorchis tessellatus* (syn. *Caladenia tessellata*) adjacent to the Pacific Highway on the southern portion of the Tooheys Road study area, but this record was not confirmed during the present survey. The recorded species were:

- *Arachnorchis tesselatus* (Vulnerable);
- *Caladenia alata;*
- *Caladenia catenata;*
- *Calochilus paludosus;*
- *Calochilus robertsonii;*
- *Cryptostylis hunteriana* (Vulnerable);
- *Cryptostylis subulate;*
- *Dipodium punctatum;*
- *Diuris alba;*
- *Diuris aurea;*
- *Genoplesium fimbriatum;*
- *Glossodia minor;*
- *Prasophyllum elatum;*
- *Thelymitra ixioides* var*. ixioides;*
- *Thelymitra pauciflora; and*
- *Cymbidium suave.*

13.1.5 Threatened Flora Species (non-orchid) Survey

Table 13.2 summarises the significant plant species present within the whole study area, and their locations are shown in Appendix Q.

Two of the seven targeted threatened flora species (*Angophora inopina, Tetratheca juncea*) were evident in large numbers across the Tooheys Road study area, while *Acacia bynoeana* was present in two locations along the proposed rail loop. *Grevillea parviflora* subsp*. parviflora* was present at two locations only (Hue Hue

Road ecological offset investigation area and Buttonderry), while *Melaleuca biconvexa* was present only along Buttonderry Creek. In addition, two nationally rare species (*Callistemon shiressii*, *Eucalyptus fergusonii* subsp. *dorsiventralis*) were recorded at the Western shaft study area, and one (*Macrozamia flexuosa*) on the Buttonderry study area in the non-impact area.

Table 13.2 Threatened Flora Recorded During the Current Assessment

Species	Status	Location
Acacia bynoeana	TSC, EPBC Vulnerable	Tooheys Road portion
Arachnorchis tessellatus	TSC Endangered	Tooheys Road (DECCW Atlas)
Angophora inopina	TSC, EPBC Vulnerable	Tooheys Road portion
Cryptostylis hunteriana	TSC,EPBC Vulnerable	Tooheys Road portion
Grevillea parviflora subsp. *parviflora*	TSC, EPBC Vulnerable	Hue Hue Road offsets
Tetratheca juncea	TSC, EPBC Vulnerable	Tooheys Road portion
Melaleuca biconvexa	TSC, EPBC Vulnerable	Buttonderry Ck, Buttonderry portion
Callistemon shiressii	Rare (3RC-)	Western shaft site
Eucalyptus fergusonii subsp. *dorsiventralis*	Rare (2RC-)	Western shaft site
Macrozamia flexuosa	Rare (2K)	Buttonderry portion

13.1.6 Fauna

The four study areas possess varying amounts of native vegetation and have varying levels of disturbance. Nonetheless, habitat for a large number of native species occurs and the suitability of habitat for locally occurring species is dependant on vegetation structure, floristics, connectivity, quality and the presence of key threatening processes (as defined by the NSW Scientific Committee) and domestic livestock and animals.

Five broad habitats were observed within the assessed areas:

- Dry sclerophyll habitat;
- Wet sclerophyll habitat;
- Swamp forest/ woodland;
- Open wetland; and
- Disturbed areas.

Dry Sclerophyll Habitat

Vegetation communities - Narrabeen Buttonderry Footslopes Forest, Narrabeen Dooralong Spotted Gum – Ironbark Forest, and Narrabeen Doyalson Scribbly Gum Woodland, Narrabeen Snappy Gum Forest, and their derivatives.

Habitat elements – Where the tree canopy is moderately dense it provides a range of breeding, feeding, sheltering and roosting locations for the regions' mammals and birds. The majority of resources available are fairly generic such as provision of pollen, nectar, fruit and hollow logs. Understorey species include winter flowering species (*Banksia spinulosa* and *Acacia sp*) that when combined with summer flowering species, provide important food resources for a wide variety of birds,

arboreal mammals and bats throughout the year. The Squirrel Glider is likely to use the foraging and breeding resources in denser areas of woodland within vegetation map codes that have not been modified (i.e. have an X or R following the vegetation code number).

The height and density of the shrubby understorey varies with the abundance of species present, giving a degree of habitat complexity in places. There is a moderate amount of leaf litter and fallen timber throughout. Ground cover vegetation provides habitat for many reptiles and smaller terrestrial mammals such as the Bush Rat and Brown Antechinus. Many species of shrub dwelling birds are present in suitable parts of the study area.

Fire has played an active part within dry sclerophyll forests in the study area with many trees of all ages showing evidence of frequent mosaic fire events between the last 5 to 20 years. Incidentally, fire swept through the DLALC portion of the study area in December 2006.

Wet sclerophyll habitat

Vegetation communities – Coastal Range Moist Layered Forest and Alluvial Riparian Blackbutt Forest.

It should be noted that cattle have impacted on this vegetation within Wallarah Creek at the Tooheys Rd site to reduce its technical grouping into this description however, it has been included for the purposes of this report.

Habitat elements – The majority of habitat elements present is the same for dry sclerophyll forest (see above). One difference is the presence of decorating bark on trees, which is suitable for microchiropteran bat and gecko habitat. Another difference is the nature of pools within Wallarah Creek. This is a low flow creek and as such many pools exist. These environments provide a multitude of complex microhabitats for frogs and species that are dependant on them.

As previously noted Wallarah Creek within the Tooheys Road study area does not have the degree of habitat complexity as seen within the Hue Hue Road ecological offset area and Buttonderry Creek however, high potential exists for this to rehabilitate through the restriction of access from domestic stock.

Swamp forest/ woodland

Vegetation communities – Alluvial Floodplain Shrub Forest and Narrabeen Alluvial Drainage Line Complex and their derivatives.

Habitat elements – The basic habitat elements are the same as for dry and wet sclerophyll forest, however the degree of habitat complexity is greater. This diverse habitat supports a very diverse range of native species. This environment is suitable for small insectivorous and nectar feeding birds, frogs and reptiles (especially snakes and goannas) and it possesses a higher abundance of dead and down timber. This habitat is where ground dwelling native mammals and small skinks are most likely to be recorded.

Open wetland

Vegetation communities – Water Bodies. These environments are characterised by farm dams with a varying degree of wetland vegetation such as sedges and rushes.

Habitat elements – All but one dam owned by WACJV in the direct impact areas have been desilted in the very recent past. Despite this high level of disturbance many frogs were seen and recorded at each location. It is expected that these areas are also an important feeding resource for snakes.

Disturbed areas

Vegetation communities - Clear areas.

Habitat elements – Often the only habitat elements present in these areas is grassland for large macropods and the odd, remnant hollow bearing tree.

Tree hollows within the direct impact study areas

Terminology used to describe the size of hollows includes:

- Small – suitable for species up to the size of a microbat;
- Medium - suitable for species larger than a microbat up to the size of a Squirrel Glider and a small parrot;
- Moderate - suitable for species larger than Squirrel Glider such as Brushtail Possum and or a large parrot such as a Galah; and
- Large – suitable as a nesting location for an owl or as habitat for greater glider.

Terminology used to describe the quality of hollows includes:

- Poor quality – can be the physical description of the hollow, for example it can be orientated such that rain will go directly into it, or the hollow limb is split to allow light or weather into it or it may be positioned in a bad location such as a large hollow suitable for a large owl being located within 30 m of the F3;
- Average quality – is a hollow suitable for use by the respective species without anything obviously wrong with it that is also located in a suitable environment;
- High quality – This may relate to the number of hollows present, for example where a tree has more than around 5 average quality microbat hollows it will be recorded as the one tree with a high quality hollow value. Alternately it simply may describe the structure and location of the hollow, for example a large hollow suitable for an owl located in undisturbed riparian vegetation with excellent connectivity or alternately in one case a tree in a disturbed location that had owl down and egg shell at the base of it (an actual nesting location).

The impact footprint for all three direct impact areas was pegged in the field. In total 142 trees within the impact footprints were identified as having hollows.

Rudimentary observations were taken to determine what species could potentially occupy those hollows and secondly document the quality of hollow present. Cumulatively, only 14.7% (n=21) of all trees recorded contained large hollows,

37.3% contained moderately sized hollows (n=53), 45.7% (n=65) contained medium sized hollows whilst only 2.1% (n=3) contained small hollows.

In terms of quality of the hollows observed, 78.2% (n=111) were of average quality, 11.3% (n=16) were of high quality, 5.6% (n=8) were of poor quality and an additional 7 possessed other traits such as being a recognised perching location.

Hollows were only recorded within approximately 100 m of the proposed rail loop however, all land likely to be cleared for the Tooheys Road infrastructure south of Tooheys Road was assessed. The banks of Wallarah Creek were only assessed within approximately 100 m of a rail loop crossing point. This assessment was effectively a worst case scenario as not all trees are likely to be removed in these areas as a result of the W2CP.

Tooheys Road study area

A total of 131 hollow bearing trees were recorded in the impact footprint. The rarest key habitat element within this property is trees possessing high quality large hollows that may be suitable as a breeding location for large forest owls such as the Powerful Owl. Only three trees (tree 7 north of Tooheys Road on WACJV land, tree 37 south of Tooheys Road also south of Wallarah Creek and tree 24 north of Tooheys Road in DLALC land near Spring Creek) with suitable owl nesting sites are located within the impact footprint. Tree 37 had evidence of eggshell, down and fledging feathers at the base of the tree and it is assumed to be a nesting location, most likely for a Tawney Frogmouth Owl.

Other high quality hollows identified were as follows:

- Tree numbers 9, 25 and Narrabeen Alluvial Drainage Line Complex in the Tooheys Road study area south of Wallarah Creek had moderate hollows that were of high quality;

- Tree numbers 18, 19 and 20 in the Tooheys Road study area south of Wallarah Creek had medium hollows that were of high quality; and

- Tree numbers 21 and 22 north of Tooheys Road on DLALC land have small hollows of high quality.

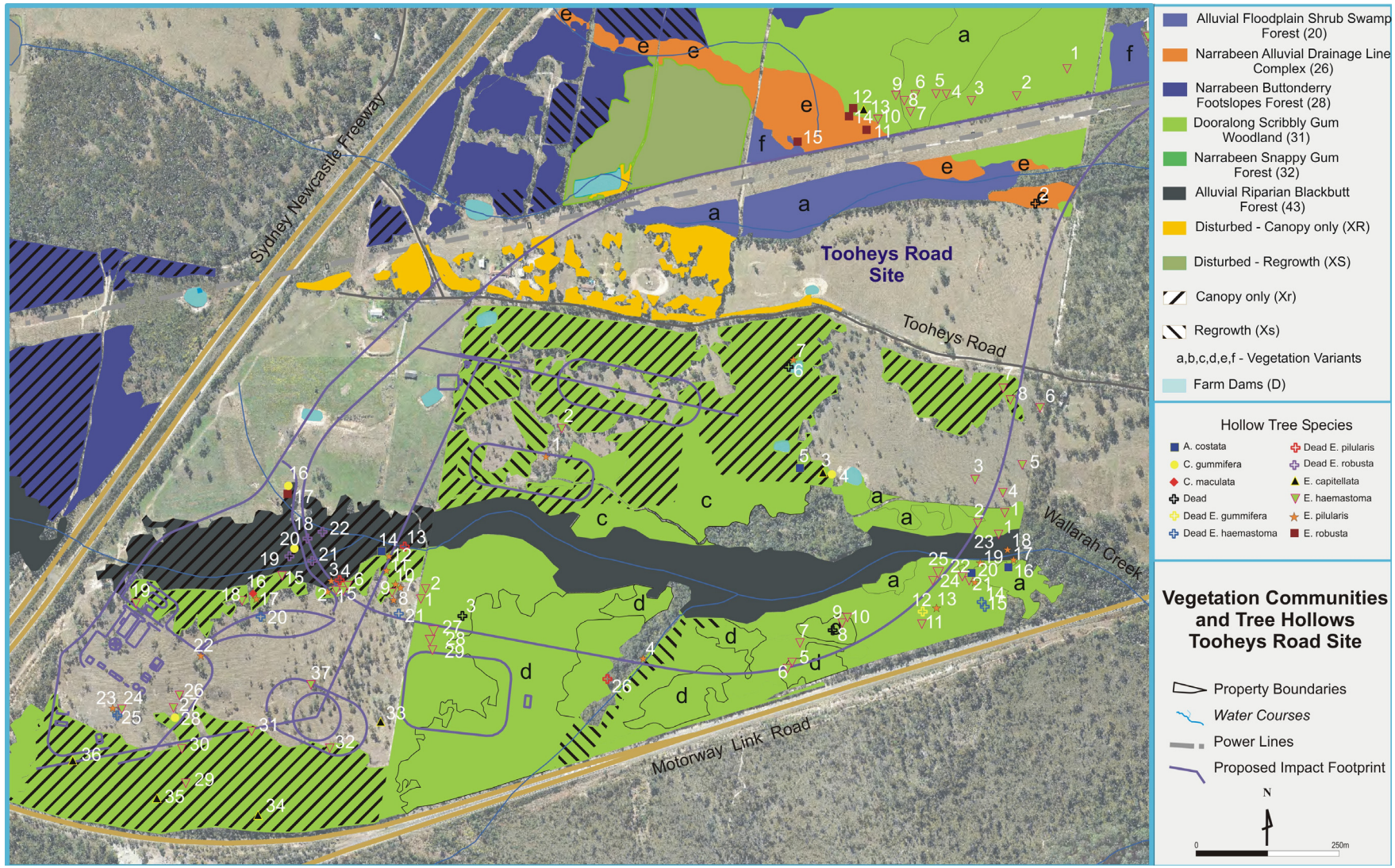

Figure 13.5 Location and Species of Trees Possessing Hollows within the Tooheys Road Impact Footprint.

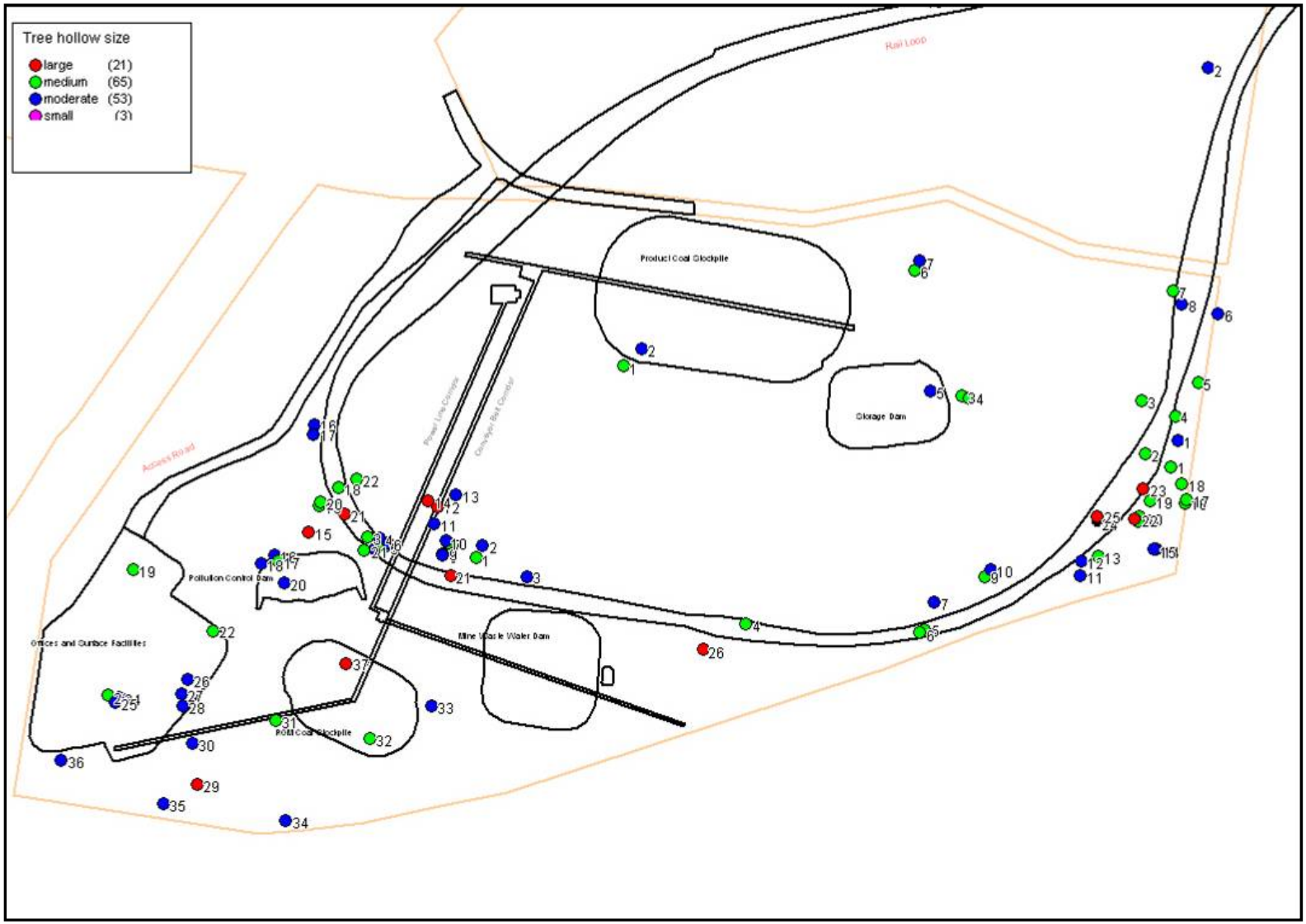

Figure 13.6 Location and Size of Tree Hollows within the Tooheys Road (Sth) Study Area

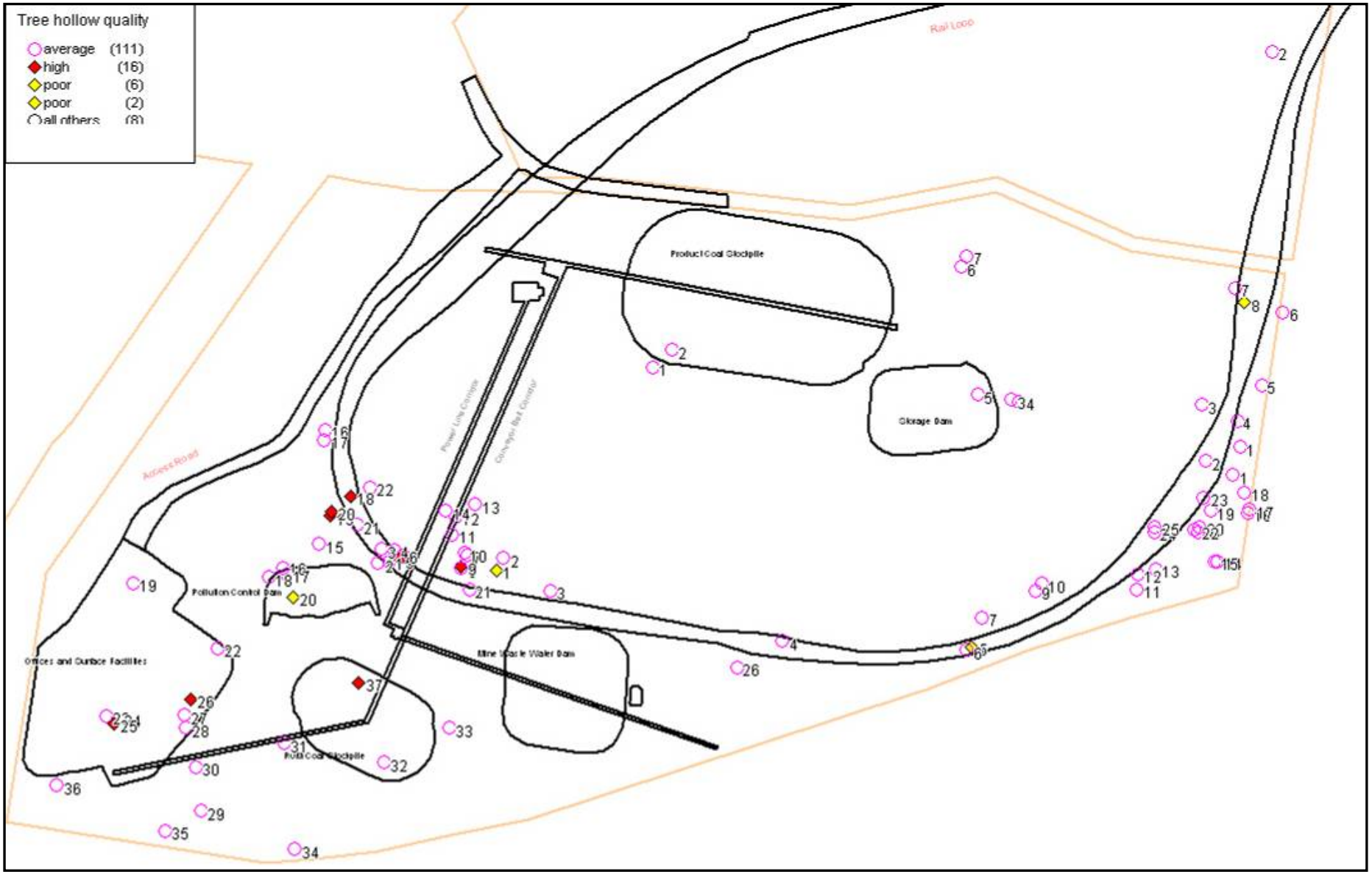

Figure 13.7 Location and Quality of Tree Hollows over the Tooheys Road (Sth) Study Area

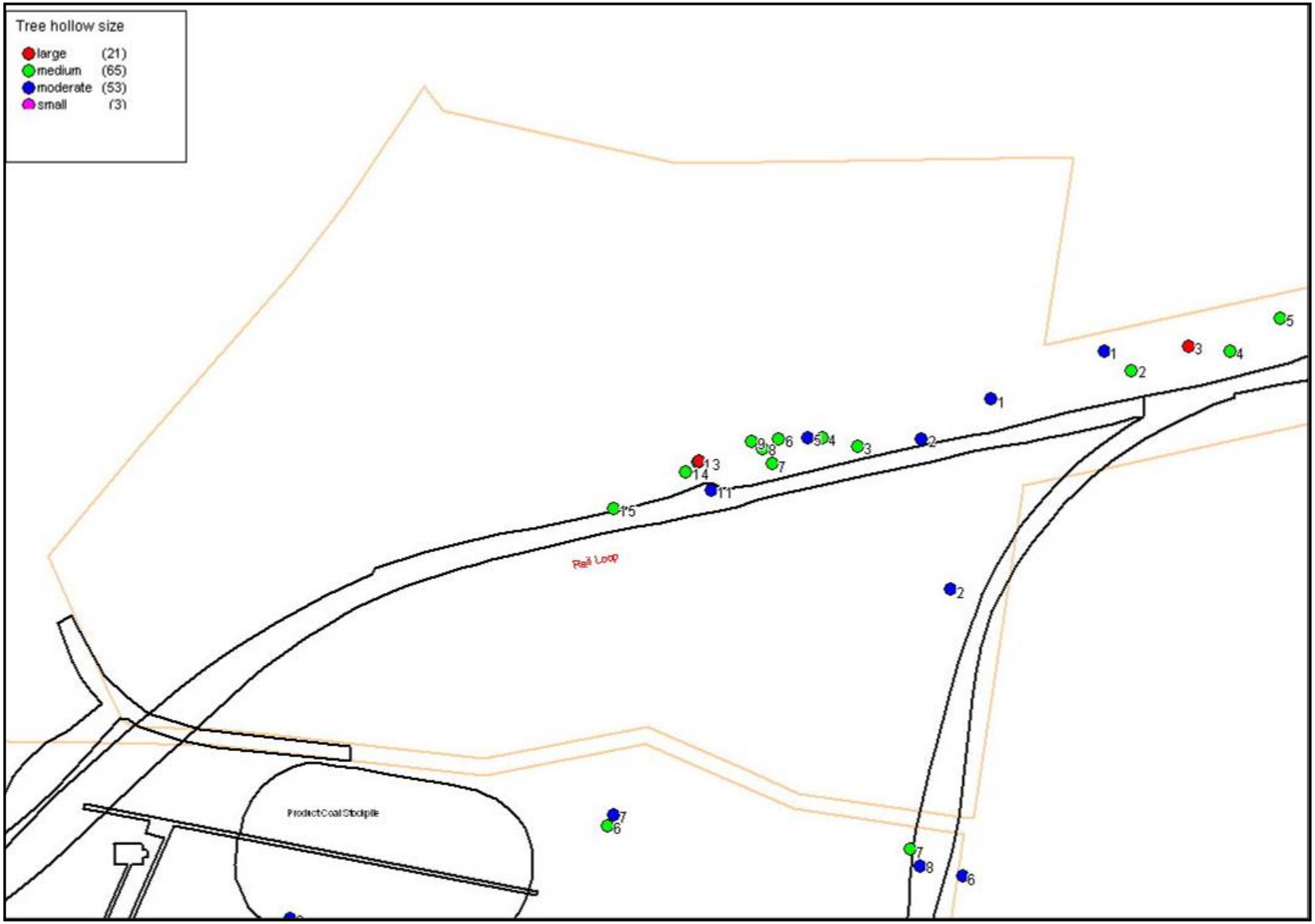

Figure 13.8 Location and Size of Tree Hollows over the Proposed Rail Loop North of Tooheys Road

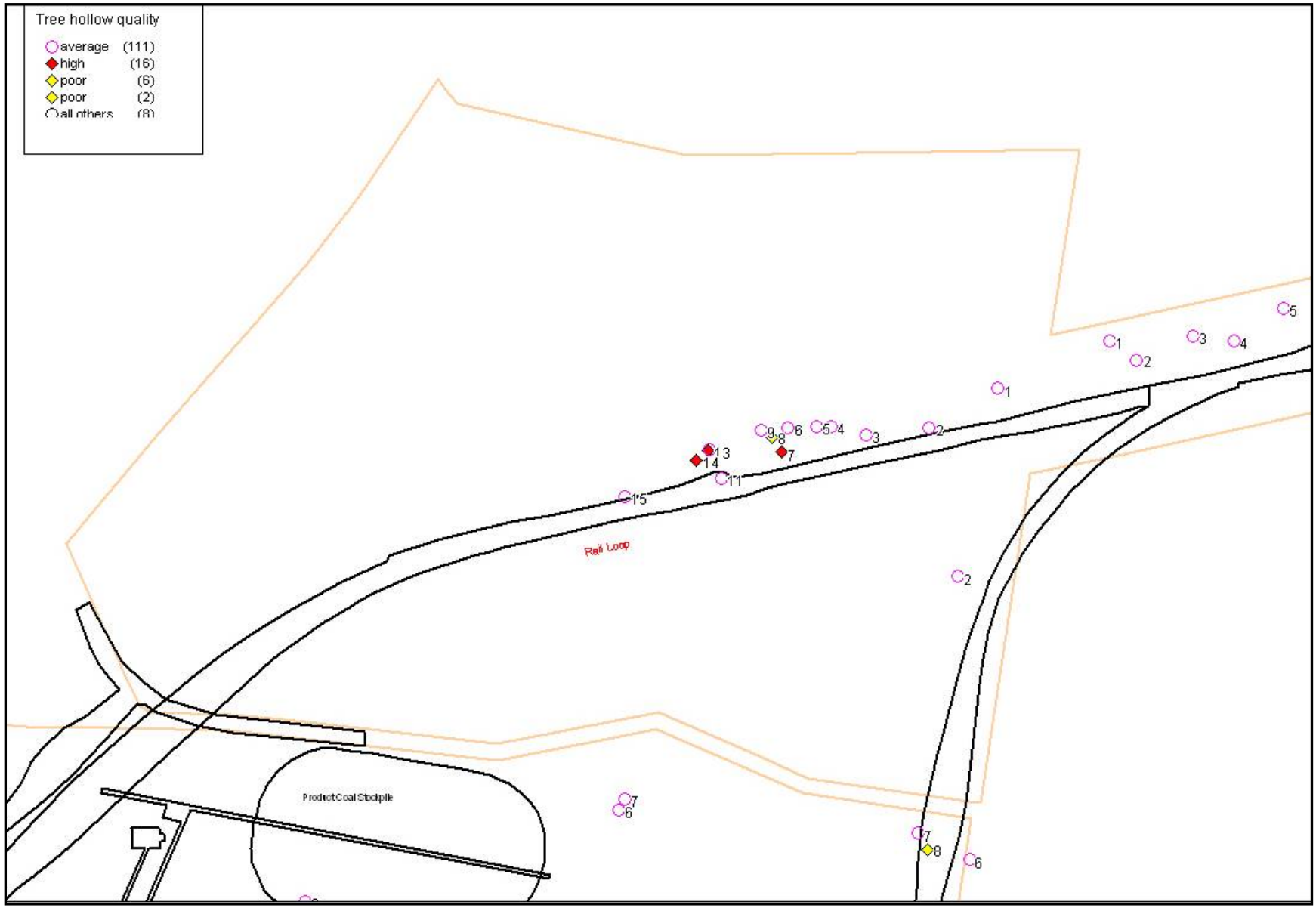

Figure 13.9 Location and Quality of Tree Hollows over the Proposed Rail Loop North of Tooheys Road

Figure 13.10 Location and Species of Trees Possessing Hollows within the Tooheys Road Rail Loop Impact Footprint on DLALC Land

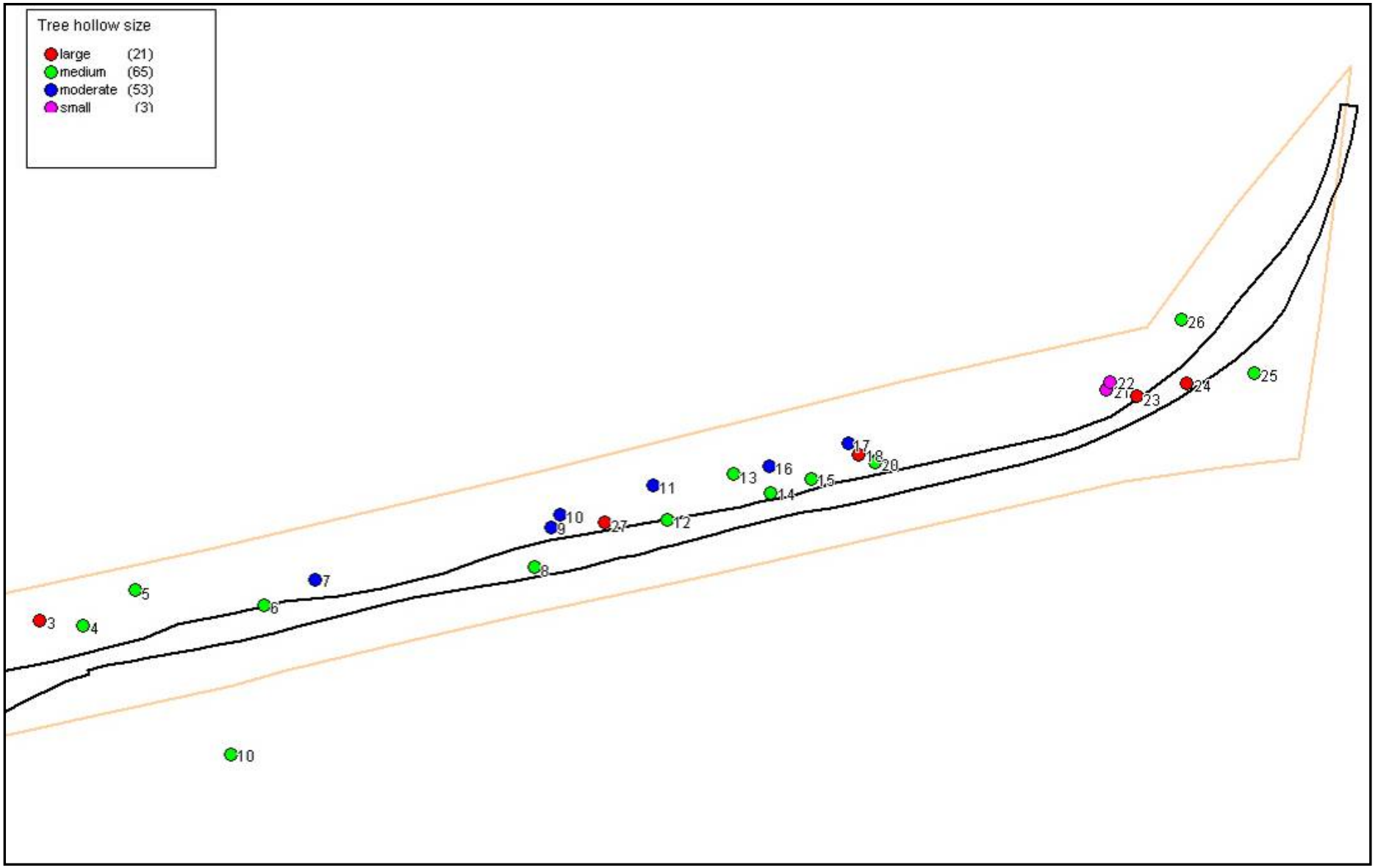

Figure 13.11 Location and Size of Tree Hollows over the Proposed Rail Loop North of Tooheys Road

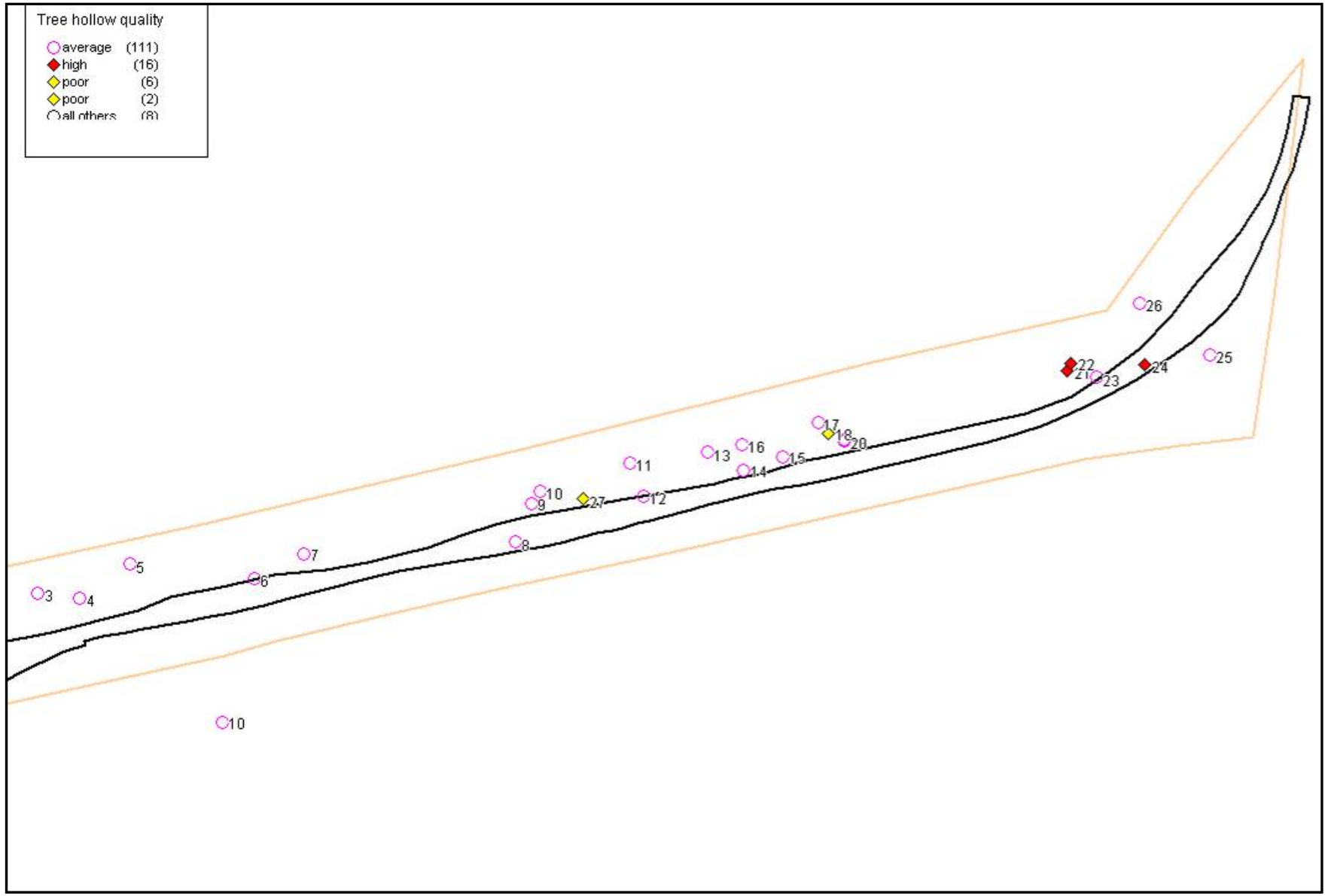

Figure 13.12 Location and Quality of Tree Hollows over the Proposed Rail Loop North of Tooheys Road

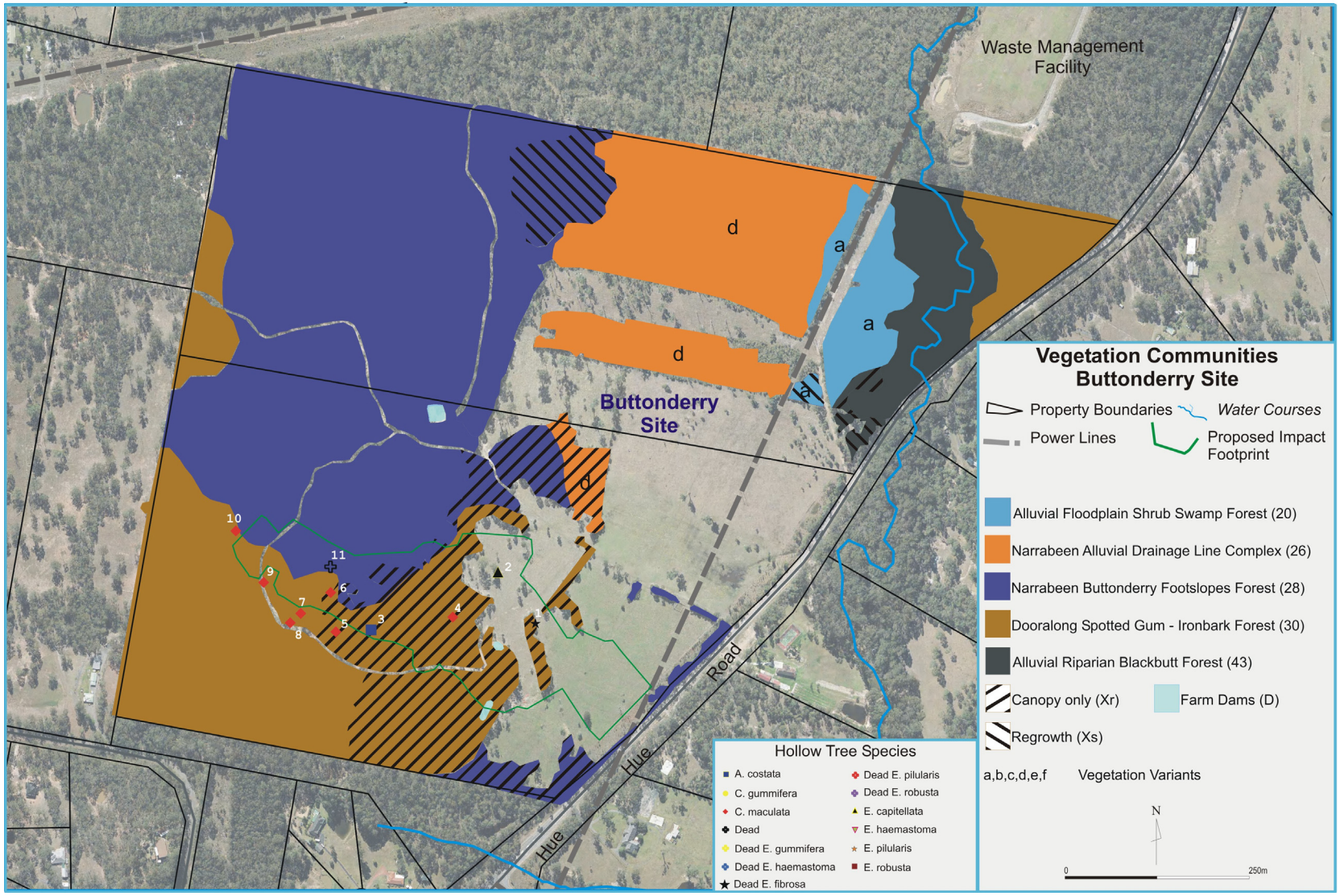

Figure 13.13 Location and Species of Trees Possessing Hollows within the Buttonderry Study Area

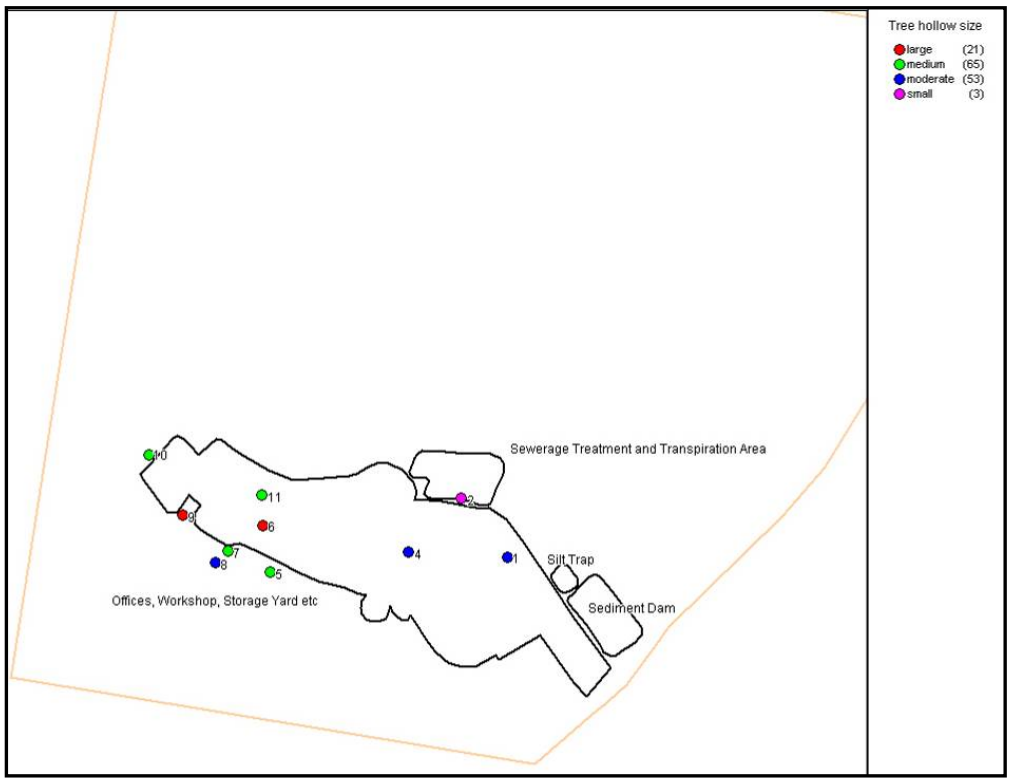

Figure 13.14 Location and Hollow Size within the Buttonderry Impact Footprint

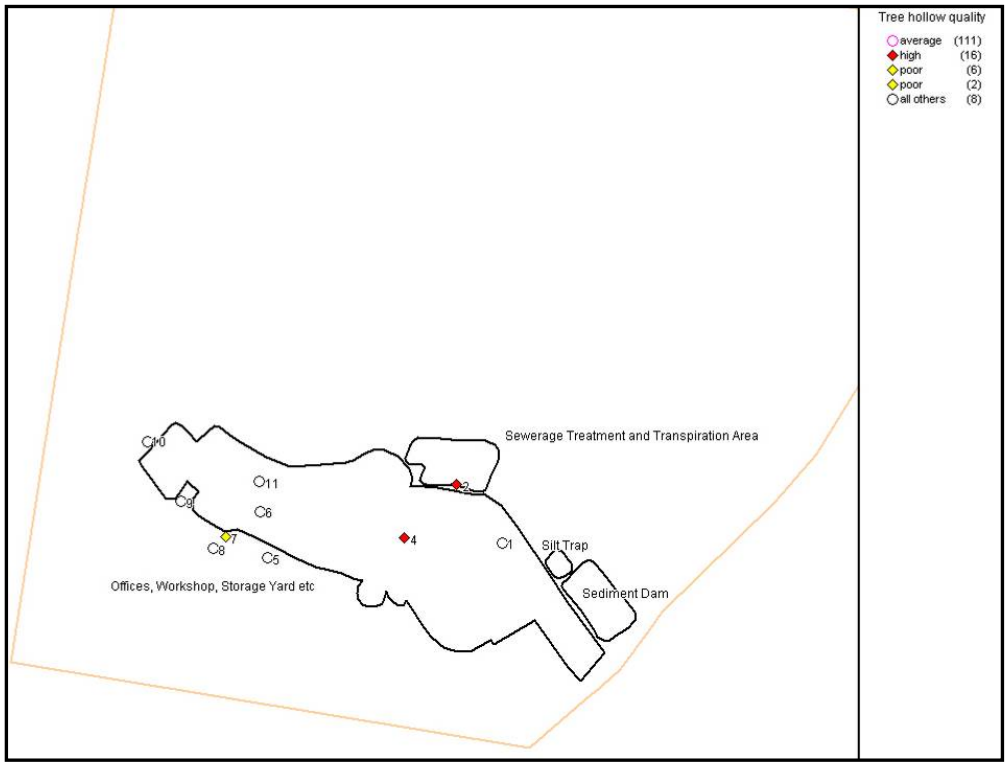

Figure 13.15 Location and Hollow Quality within the Buttonderry Impact Footprint.

Buttonderry direct impact study area
Only 11 hollow bearing trees will be impacted as a result of the proposal in the Buttonderry direct impact area. Although many old growth trees were observed down slope of this area, the hill comprising the impact footprint has undergone prior logging such that the majority of trees on site are not of hollow bearing age.

Western shaft study area
Trees within the Western shaft study area did not appear to be of an age to possess visible hollows.

Recorded Fauna Species

Birds comprise the most common species, 51 species recorded or assessed as having the potential to occur. Two of these, the Powerful Owl (*Ninox strenua*) and the Masked Owl (*Tyto novaehollandiae*) are threatened in NSW.

The Powerful Owl was sighted during call playback in the Tooheys Road study area, where ERM (1999b) had previously twice recorded Squirrel Glider. An individual Powerful Owl responded within seconds of call playback which took place after a series of Squirrel Glider calls were broadcast. Additionally, feather down, eggshell and small fledging feathers were noted at the base of tree No. 37 (main infrastructure impact footprint south of Wallarah Creek) in a high quality, large hollow of a *E. haemastoma* in the proposed location for the ROM stock pile. Although it is possible that these may be from Powerful Owl, it is more likely that they were from Tawney Frogmouth Owl given the extremely exposed location of the hollow (paddock tree).

The Masked Owl responded to call playback north of Tooheys Road. Although clear, the call was faint and appeared to originate several kilometres north of the Tooheys Road study area.

Three other species of birds recorded, White Bellied Sea Eagle, Chestnut-rumped Hylacola and Painted Button Quail were noted as regionally significant.

Mammals were next in frequency. Of the 38 species recorded, 11 were microchiropteran bats of which five are threatened (Little Bentwing-bat *{Miniopterus australis},* Large-footed Myotis *{Myotis adversus},* Yellow-bellied Sheathtail-bat {*Saccolaimus flaviventris},* Greater Broadnosed Bat {*Scoteanax rueppellii},* Eastern false pipistrelle {*Falsistrellus tasmaniensis}*). Five were arboreal mammals with one, the threatened Squirrel Glider (*Petarus norfolcensis*), positively identified within the Tooheys Road study area by ERM in 1999. This species is also highly likely to occur in the Hue Hue Road ecological offset investigation area where a potential recording of the threatened Yellow-bellied Glider was also taken. Despite a targeted search at the Tooheys Road study area where the previous Squirrel Glider record occurred, this species was not relocated.

Six mammals were introduced species. Three species of mammals were identified as regionally significant, Eastern Grey Kangaroo, Red-necked Wallaby and the Greater Glider. It is highly likely that the Sugar Glider remains within the assessed areas however, this regionally significant species was not recorded as a result of the assessments.

A large number of frogs have been identified within the study areas, however only 2 of the 16 species recorded are threatened. The Wallum Froglet (*Crinia tinnula*) was recorded on the Tooheys Road site by ERM in 1999 and according to Orbis citing

ERM (2003), in the proposed Hue Hue Road ecological offset investigation area. This species was not relocated during the OzArk assessment.

The second threatened frog recorded was a Green-thighed Frog (*Litoria brevipalmata*) on Buttonderry by ERM in 2003. Dwarf Green Tree Frogs occurring at the dam in Buttonderry look very similar to Green-thighed Frogs, a precautionary approach adopted by OzArk was to record frog calls in the study area, take detailed photographs of observed animals and send them to Mr Frank Lemckert for expert identification. Notwithstanding, frog habitat at Buttonderry will not be impacted however, due diligence has resulted in this species considered as present in the property. Two regionally significant species the Tusked Frog and Lesueur's Frog were recorded in agricultural dams in the Tooheys Road study area.

Only eight species of reptiles were recorded in the study areas.

13.1.7 SEPP 44 – Koala Habitat Protection

The Wyong Local Government Area is identified under Schedule 1 – Local Government Areas of *State Environmental Planning Policy No 44 (SEPP 44) – Koala Habitat Protection*. This policy seeks to protect the species by encouraging the proper conservation and management of areas that provide habitat for Koalas. All study areas except for the Western shaft area contains two preferred Koala feed tree species listed in Schedule 2 of the policy, *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus haemastoma* (Broad-leaved Scribbly Gum).

The study areas are also within the Central Coast Koala Management Unit area identified in the Draft Koala Recovery Plan, which includes *E. tereticornis* (Forest Red Gum) as a primary feed tree and *E. capitellata* (Brown Stringybark) as a supplementary feed tree species, but only Brown Stringybark occurs in the study areas (excluding Western shaft).

A colony of Koala was once known from the Wyong LGA (Parsons Brinkerhoff 2005 citing Payne 2002b), however records are scattered and the nearest record of a Koala is two kilometers to the south of the Tooheys Road study area (Parsons Brinkerhoff 2005 citing Department of Environment and Conservation 2005a).

Habitats connecting each study area to the location of the above mentioned record are fragmented by urban development. Scattered emergent eucalypts including *Eucalyptus robusta* and *Eucalyptus capitellata* occur within vegetation Narrabeen Alluvial Drainage Line Complex, Narrabeen Buttonderry Footslopes Forest and Narrabeen Doyalson Scribbly Gum Woodland. The density of feed trees in these areas does not meet the SEPP44 definition of potential Koala habitat.

13.1.8 Fish Communities and Aquatic Habitats

This section has been written following the guidelines in *Why do Fish Need to Cross the Road? Fish Passage requirements for Waterway Crossings* (Fairfull and Witheridge 2003).

Importance of the waterway and its associated fish and fish habitat:

Spring and Wallarah Creeks will be crossed by the proposed rail loop for the W2CP. Spring and Wallarah Creeks are named waterways with permanent to intermittent flows. Free standing water, pools and aquatic vegetation is present along these creeks in the current study areas. As the banks of the creeks are well defined and the creeks connect to other wetland areas, a Class 2 classification is relevant as

there may be potential for refuge, breeding or feeding areas for some aquatic fauna (e.g. fish & yabbies). Class 2 classification equates with Moderate Fish Habitat. Minimum crossing requirements recommended for Class 2 waterways are a bridge, arch structure, culvert (*2)* or ford.

Habitat Compensation

Under NSW Fisheries Policy and Guidelines for Aquatic Habitat Management and Fish Conservation 1999, a 2:1 habitat compensation policy for any fish habitat losses associated with development exists. Within the immediate environs of the creeks several mature trees, understory and ground layer vegetation exists which has been described as Narrabeen Alluvial Drainage Line Complex, Narrabeen Doyalson Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Alluvial Riparian Blackbutt Forest. Due to the linear nature of the proposed development, impacts will transect the creek bank vegetation thus keeping vegetation removal associated with the waterways to a minimum. The replacement of the removed trees with twice of that which was removed will be included in the site rehabilitation.

As Wallarah Creek is generally dry, fish habitat is usually absent however, Spring Creek may provide habitat for native species of fish.

Blockages to Fish Passage

A permit to temporarily or permanently block fish passage is required if either creek is to be blocked by silt fencing, construction of mounded access tracks or any other work that requires modifying the creek bed in a way that will prevent the natural flow of the creek. Given that this project is being assessed under Part 3A of the EP&A Act, the procurement of a Part 3A project approval has the effect that a permit will not be required. However, work will be undertaken with a duty of care to ensure both creeks will not be blocked as a result of the proposal. In this event best practice is to follow advice from DPI –Fisheries regarding maintaining fish passage during construction.

Significance of Impacts of the Development on Threatened Species Listed Under the Fisheries Management Act 1994

Items of conservation concern identified by the NSW DPI (Fisheries) include:

- Endangered species

- ❒ Eastern freshwater cod (*Maccullochella ikei*);
- ❒ Green sawfish (*Pristis zijsron*);
- ❒ Grey nurse shark (*Carcharias taurus*);
- ❒ Murray hardyhead (*Craterocephalus fluviatilis*);
- ❒ Oxleyan pygmy perch (*Nannoperca oxleyana*);
- ❒ River snail (*Notopala sublineata*);
- ❒ Southern Bluefin Tuna (*Thunnus maccoyii*);
- ❒ Trout cod (*Maccullochella macquariensis*); and
- ❒ Sydney Hawk dragonfly (*Austrocordulia leonardi*).

- Endangered populations

- ❒ Western population of purple spotted gudgeon (*Mogurnda adspersa*); and
- ❒ Western population of olive perchlet (*Ambassis agassizii*).

- Endangered ecological communities

- ❒ Aquatic ecological community in the natural drainage system of the lower Murray River catchment;
- ❒ Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River;
- ❒ Aquatic ecological community in the natural drainage system of the lowland catchment of the Lachlan River.

Species presumed extinct

- ❒ Bennetts seaweed (*Vanvoorstia bennettiana*).

Vulnerable species

- ❒ Adams emerald dragonfly (*Archaeophya adamsi*);
- ❒ Black cod (*Epinephelus daemelii*);
- ❒ Buchanans fairy shrimp (*Branchinella buchananensis*);
- ❒ Great white shark (*Carcharodon carcharias*);
- ❒ Macquarie perch (*Macquaria australasica*);
- ❒ Southern pygmy perch (*Nannoperca australis*);
- ❒ Silver perch (*Bidyanus bidyanus*); and
- ❒ Marine brown alga (*Nereia lophocladia*).

The DEWHA notes the following species as having potential to occur within the Wyong LGA:

- ❒ Australian Grayling (*Prototroctes maraena)* – listed as Vulnerable under the EPBC Act*;* and
- ❒ Macquarie Perch (*Macquaria australasica*) - listed as Endangered under the EPBC Act.

A review of the BioNet database shows that no species of threatened fish, crustaceans, mollusks or algae have been previously recorded within the Wyong LGA. Consultation with the DPI (NSW Fisheries) confirms that none of these fish species have been recorded in or near the study area locality and from local knowledge they are unlikely to occur.

A review of DPI sample point data in the Wyong area shows that Adams Dragonfly has been previously recorded in Tuggerah and given the species ecological niche requirements, it has potential to occur within Spring Creek and to a lesser degree the Tooheys Road study area.

Predictions Regarding the Type and Extent of Impact on Fish, Fish Habitat and Fish Passage

The impact on fish habitat will be minimal with the implementation of the environmental mitigation measures described throughout this EA document regarding soil and water management. Water quality monitoring will verify the anticipated level of impact. Fish passage will not be affected, however if any barrier permanent or temporary is to be erected during construction then consultation with DPI-Fisheries will be required.

Potential Impacts to Surface Water and Groundwater Flows as a Result of the W2CP

Potential impact to surface water could arise through sediment movement associated with removal of vegetation, dredging, excavation, and construction. Ground water quality will not be impacted if appropriate mitigative measures are undertaken. The direction of ground water flow will not change after the proposed works are completed.

13.1.9 Corridors and Connectivity

The Draft Wyong Conservation Strategy (2003) discusses in detail corridor pathways and environmental fragmentation in the Wyong Shire. According to the Strategy, the biggest wildlife corridor is located approximately 3 km north of the Tooheys Road study area, running loosely east – west. However, of more relevance to the current study area are four sub-regional pathways identified in the Shire:

- Hawkesbury dry forest pathways;
- Wet forest pathways;
- Riparian pathways; and
- Dry forest and woodland pathways.

Directly applicable to the W2CP are findings that state riparian corridors are the most heavily fragmented ecosystems in the Wyong Shire. These of course feature significantly in the assessed areas and retain the highest conservation value of all vegetation map units identified with approximately 60% of riparian corridors identified require further plantings or a degree of environmental restoration.

The Draft Wyong Conservation Strategy noted that, due to anthropomorphic impacts most species within this ecosystem that may serve as indicator species are now rare, restricted or too widespread and if pushed, the Wallum Froglet and Green-thighed Frog may be used (as indicator species for a functional riparian community). The Wallum Froglet was recorded by ERM (1999b) in the north of Tooheys Road proposed rail loop study area in the Narrabeen Alluvial Drainage Line Complex and also in the same vegetation unit just north of Wallarah Creek in small farm dam at the same location Squirrel Glider was recorded.

The bulk of wet forest pathways are on private land and are well represented within the Shire. Two indicator species were identified for this ecosystem, the Greater Glider and the Yellowbellied Glider, both requiring larger areas for conservation however, the Greater Glider has more sensitive corridor requirements. The Greater Glider was recorded by ERM (1999b) and although the actual location was not contained within the report, assessment of the available habitat would suggest that it was along Spring Creek (Narrabeen Alluvial Drainage Line Complex and its derivatives on DLALC property) on land that is no longer within the current study area. Notwithstanding, Spring Creek, by regional definition is an important wildlife corridor.

A tentative sighting of the Yellow-bellied Glider was made by ERM during late 1998. Again location details were not recorded, however site inspection results indicate that it was in association with Wallarah Creek (Alluvial Riparian Blackbutt Forest) where there is a high degree of environmental complexity surrounding the ecotones of the Hue Hue Road ecological offset investigation area. These environments are considered important as they are the link between remaining vegetation units across a wide variety of topographies.

Dry forest and woodland pathways are also associated with highly fragmented environments. It is within these that most urbanisation has occurred, and as such they are poorly represented in the regions' conservation reserves (Draft Wyong Conservation Strategy 2003: 102).

The Squirrel Glider is an indicator species for these environments and extensive studies have shown dispersal limits for the distribution of this species in the face of human impact. This species prefers Spotted Gum/ Ironbark (Narrabeen Dooralong Spotted Gum – Ironbark Forest) Angophora / Scribbly Gum Woodland, Dry Sclerophyll Forest and some types of swamp forests (Alluvial Footslopes Redgum Forest, Alluvial Floodplain Shrub Swamp Forest, Narrabeen Alluvial Drainage Line Complex, Narrabeen Buttonderry Footslopes Forest, Narrabeen Doyalson Scribbly Gum Woodland and their derivatives) all of which occur throughout the assessed areas.

The Squirrel Glider recorded within the Tooheys Road study area was within Narrabeen Doyalson Scribbly Gum Woodland and Narrabeen Alluvial Drainage Line Complex, and their derivatives however this was close to Alluvial Riparian Blackbutt Forest where more abundant and higher quality sheltering habitat occurred.

Targeted re-survey of this area did not result in identification of the species again, but it was noted that key habitat elements required for the species remain extant and will remain largely unchanged as a result of the W2CP proposal.

Perhaps the greatest opportunity for keystone species conservation associated with the W2CP lies with the protection of wildlife corridors for the Squirrel Glider. The Hue Hue Road ecological offset investigation area provides a range of vegetation map units favoured by this species, as well as the best connectivity and patch size of all the current study areas. Despite the potential removal of habitat elements within the main impact footprint at Tooheys Road in Wallarah Creek will remain largely unaffected and resources associated with mining are more likely to result in habitat restoration and protection of this wildlife corridor than that associated with continued grazing agriculture.

The Western shaft site is part of a managed State Forest and by default has good connectivity.

Connectivity of the existing environment will be affected in the following ways:

<u>Tooheys Road and DLALC land</u>
The rail loop will only fragment one area of high quality vegetation (Alluvial Riparian Blackbutt Forest) south of Wallarah Creek for a proposed rail crossing. All other areas to be impacted are either already modified, or alternately habitat to be removed is an extension of an existing area of disturbance i.e. proposed rail loop north of Tooheys Road associated with the TransGrid easement.

The area to undergo the highest degree of fragmentation are Narrabeen Doyalson Scribbly Gum Woodland and Narrabeen Alluvial Drainage Line Complex and their derivatives south of Wallarah Creek, within the proposed rail loop impact footprint. On a broader perspective this patch of remnant vegetation is itself isolated from other remnants to the south by Doyalson Link Road and to the north, east and west of Wallarah Creek by previous clearing.

Buttonderry direct impact footprint area
Fragmentation of an existing corridor will not occur at this location.

Western shaft study area (Wyong State Forest)
The Western shaft study area is located within a managed state forest (DPI- Forests NSW). As such there are good levels of connectivity associated with the area. The W2CP will see an approximate 150 x 80 m area cleared for this proposed facility which is located on Brothers Road. The size and extent of the study area in association with existing levels of disturbance associated with the road does not affect the degree of connectivity in the immediate environs.

13.1.10 Species, Populations and Communities of Conservation Concern

Critically endangered, endangered and ecological communities of regional and local significance

A search of the DEWHA online database shows that there is one Critically Endangered Ecological Community occurring within the Wyong LGA listed under the EPBC Act. White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland are noted as having the potential to occur within the LGA.

A combined geographic and habitat search on the DECCW databases focused on the Hunter/Central Rivers > Wyong Catchment Management Area showed that there are 12 Endangered Ecological Communities (EEC's) listed under the TSC Act that have the potential to occur within the Catchment Management Area. Of these six are known to be recorded in the Wyong LGA:

- Swamp Sclerophyll Forest on Coastal Floodplains NSW North Coast, Sydney Basin and South-East Corner bioregions (SSFCF);
- Sydney Freshwater Wetlands (SFW);
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions (FWCF);
- River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions (RFEFCF);
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South-East Corner bioregions (SOFF); and
- Low Woodland with Heath on indurated sands at Norah Head (LWHISNH).

Two of the Endangered Ecological Communities listed in the TSC Act are present (Swamp Sclerophyll Forest on Coastal Floodplains, River Flat Forest on Coastal Floodplains), as are several of regional and local significance.

Endangered populations

A search of the DEWHA online database shows that there are no endangered populations within the Wyong LGA. A combined geographic and habitat search on the DECCW databases focused on the Hunter/Central Rivers > Wyong Catchment Management Area showed that there are two endangered populations occurring in the search area. Neither *Eucalyptus oblonga* (Narrow leaved Stringybark) population at Bateau Bay nor the *Eucalyptus parramattensis* subsp. population in the Wyong and Lake Macquarie LGA's was recorded within the assessed areas.

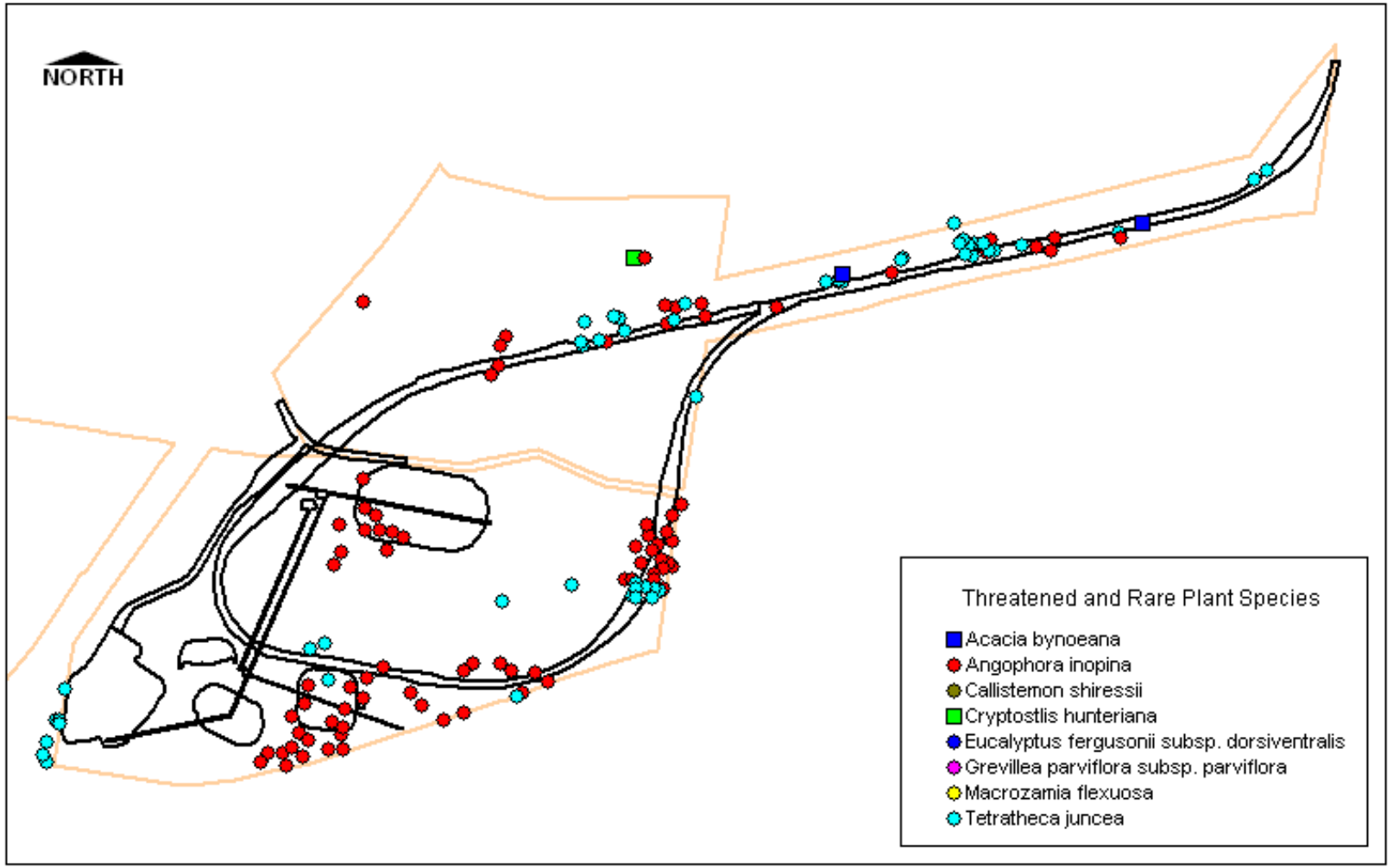

Figure 13.16 Location of Threatened Species of Plants on the Tooheys Road Main Infrastructure and Proposed Rail Loop Study Area

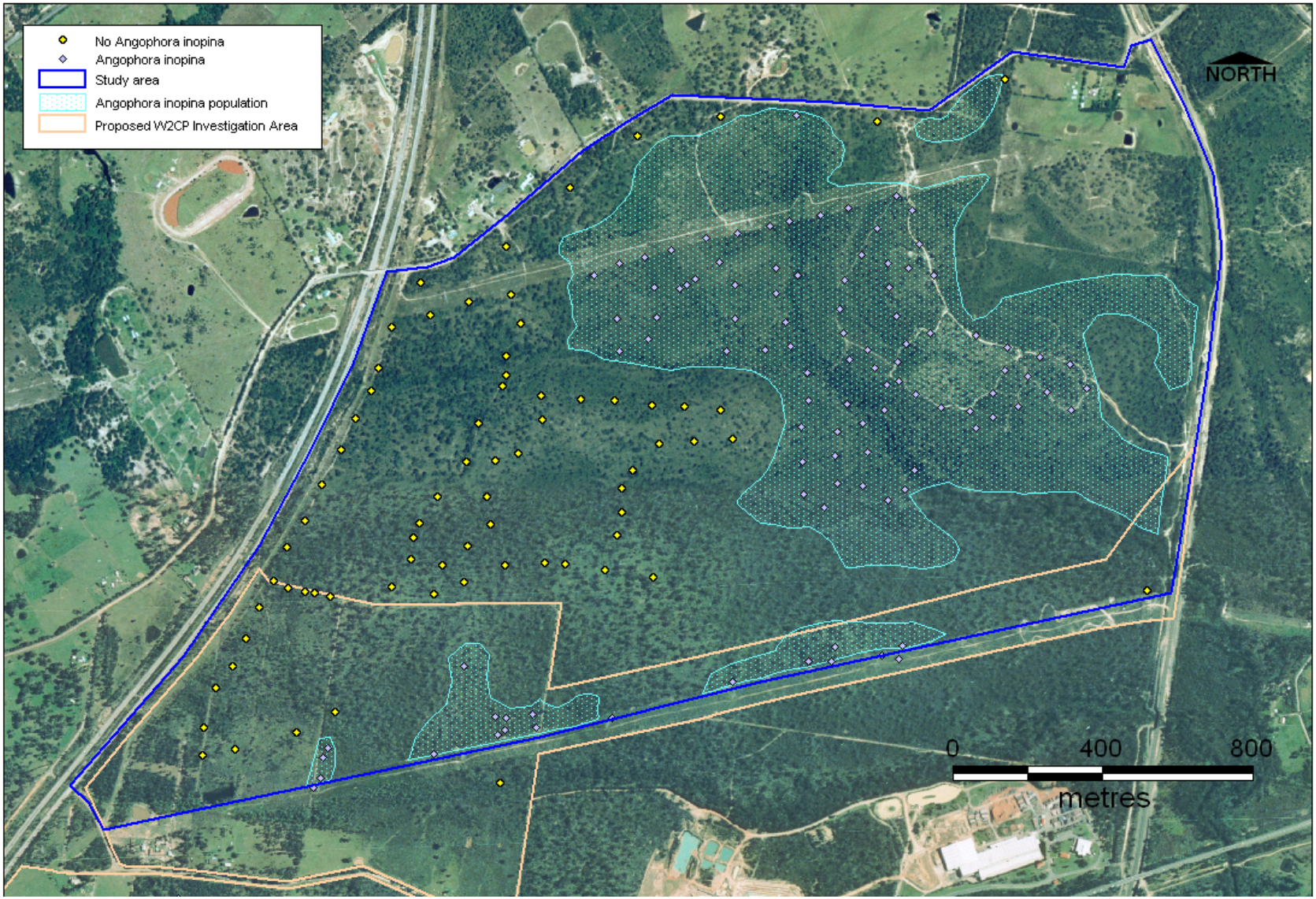

Figure 13.17 Distribution of *Angophora inopina* showing the Study Area

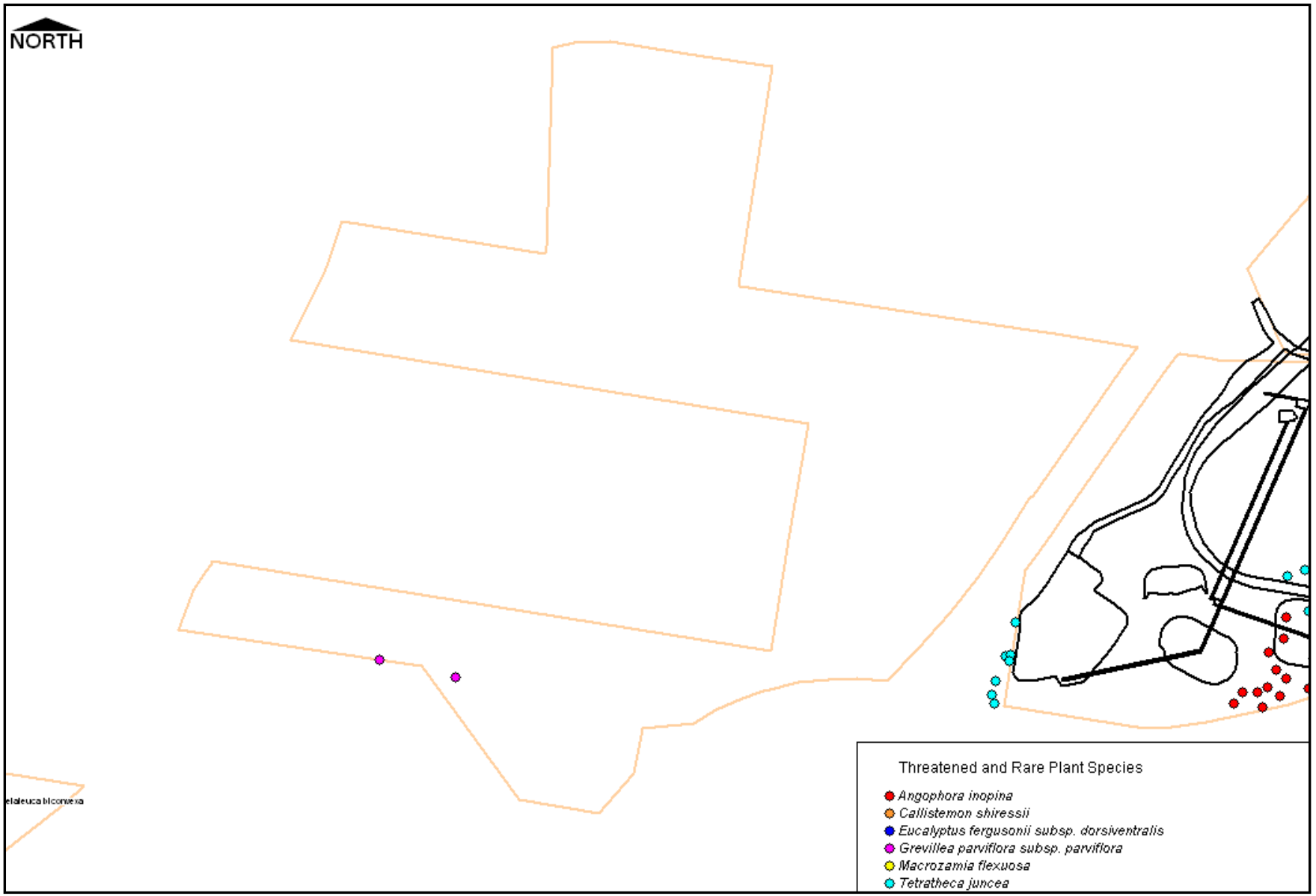

Figure 13.18 Location of Threatened Species of Plants on the Hue Hue Road Ecological Offset Investigation Area

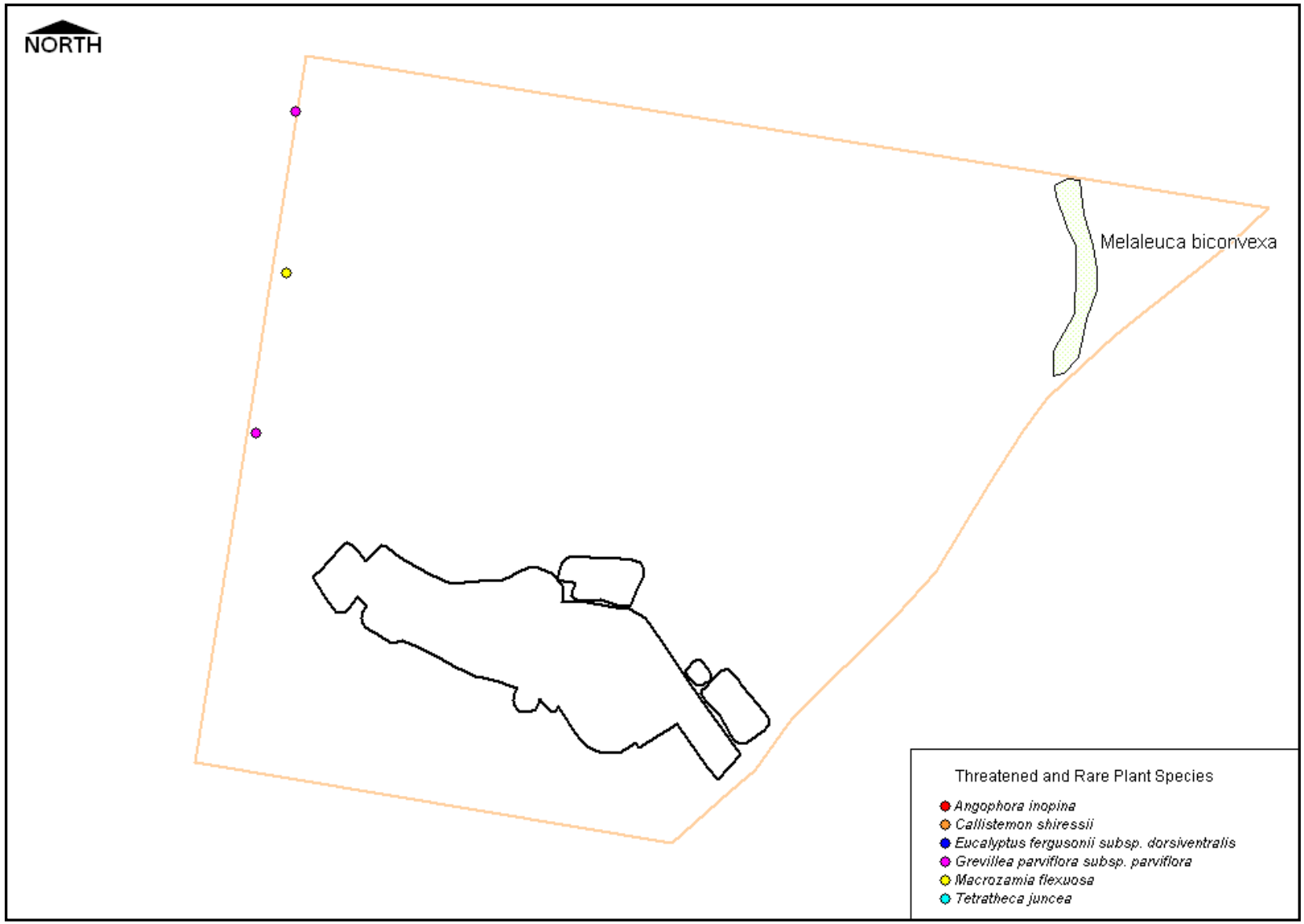

Figure 13.19 Location of Threatened Species of Plants on the Buttonderry Study Area (Impact footprint superimposed)

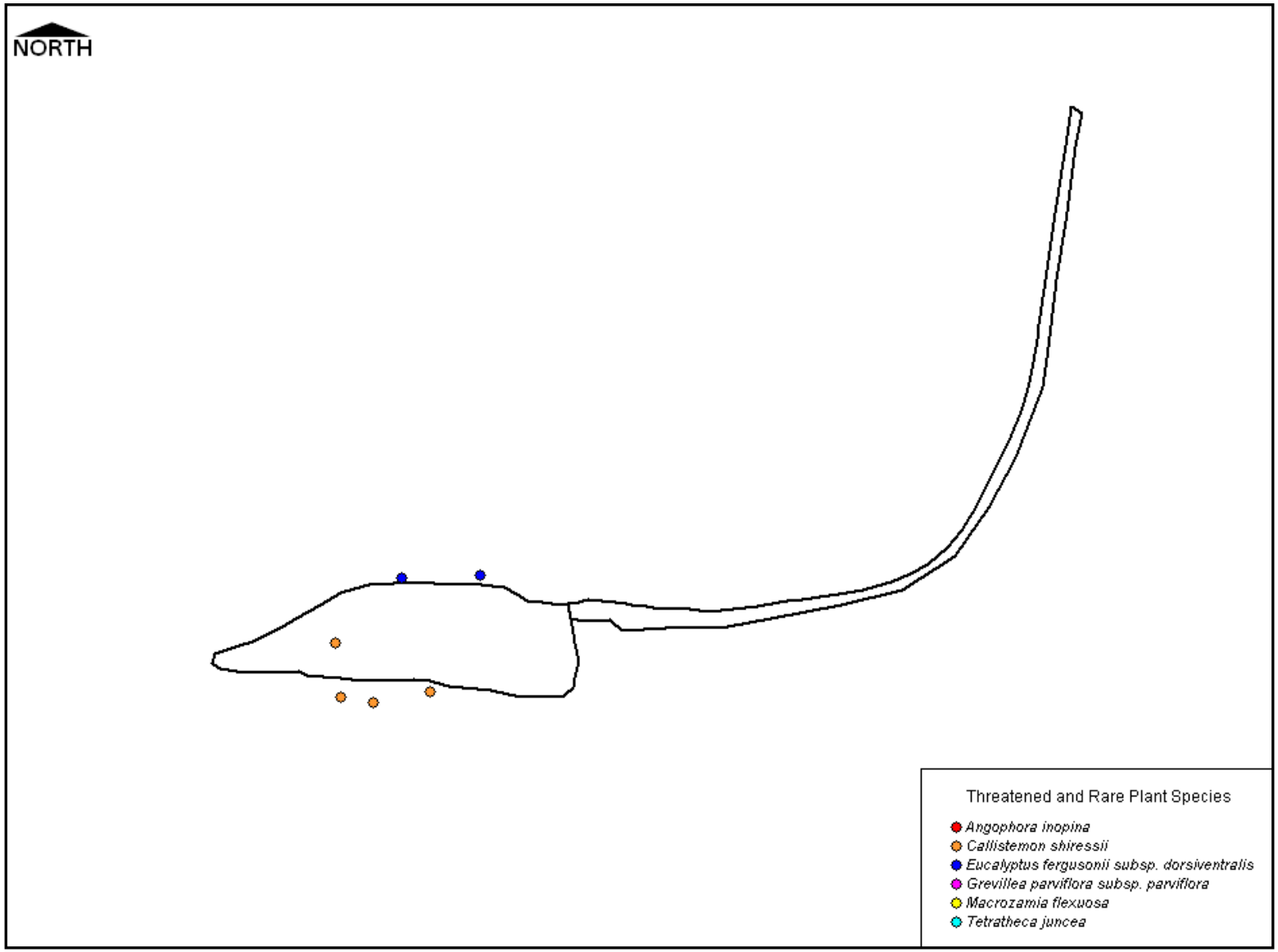

Figure 13.20 Location of Threatened Species of Plants at the West Shaft Site (Impact Footprint Superimposed)

Endangered, Threatened, Regionally and Locally Significant Flora and Fauna Species

A search of the DEWHA online database shows that there are a number of fauna species with legislative protection under the EPBC Act within the Wyong LGA, listed in Table 13.3.

No fauna species listed as endangered or threatened under the EBPC Act were recorded within the assessed areas, however the White Bellied Sea Eagle, a migratory terrestrial species, was recorded overflying the Tooheys Road study area.

Table 13.3 Summary of Items with Legislative Protection under the EPBC Act in the Wyong LGA

Species	No. of Threatened Species Recorded in the EPBC Database for Search Area
Animals	
Frogs (Threatened)	5
Birds	
Threatened Species	13
Migratory Terrestrial Species	7
Migratory Wetland Species	6
Migratory Marine Birds	9
Migratory Marine Species	6
Fish	
Threatened Ray-finned Fish	2
Sharks	
Threatened Sharks	3
Mammals	
Threatened Bats	2
Threatened Ocean Dwelling	2
Threatened Land Mammals	3
Reptiles	
Threatened Marine	2
Threatened Terrestrial	1
Other Matters Protected by the EPBC Act	
Birds	26
Ray-finned Fish	21
Reptiles (marine)	3
Whales and Cetaceans	12
Plants	13

A combined geographic and habitat search on the DECCW databases focused on the Hunter/Central Rivers > Wyong Catchment Management Area showed that there are 75 species of animals with legislative protection under the TSC Act within the Wyong area. These include:

- 39 bird species (5 endangered and 34 vulnerable);
- 6 reptile species (2 endangered and 4 vulnerable);
- 8 frog species (3 endangered and 5 vulnerable);
- 11 mammal species excluding bats (1 endangered and 10 vulnerable); and
- 11 species of bats (all vulnerable).

Of these animals, 10 threatened species of fauna were recorded as a combined result of previous and current environmental assessments of the W2CP study area, and are listed in Table 13.4.

Table 13.4 Threatened Species Recorded within the W2CP Study Areas

Scientific Name	Common Name	NSW Status	Location
Myotis adversus	Large-footed Myotis	V	Tooheys Road
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	Tooheys Road, Hue Hue Road potential offset
Scoteanax rueppellii	Greater Broad-nosed Bat	V	Hue Hue Road pot offset
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	Tooheys Road
Petaurus norfolcensis	Squirrel Glider	V	Tooheys Road
Petaurus australis	Yellow-bellied Glider	V	Hue Hue Road pot offset
Crinia tinnula	Wallum Froglet	V	Tooheys Road
Litoria brevipalmata	Green-thighed Frog	V	Buttonderry
Ninox strenua	Powerful Owl	V	Tooheys Road
Tyto novaehollandiae	Masked Owl	V	North of Tooheys Road

The most commonly recorded animal species were microchiropteran bats (total of 4) with two threatened species of arboreal mammals, two species of owl and two species of frog, known to occur within the boundaries of the current study areas. The locations of these species and the vegetative communities they were recorded in are provided in Appendix Q**.** The location for the Green-thighed Frog can not be given as it is only known to have been recorded at Buttonderry.

Other species noted by DECCW and DEWHA as having the potential to occur, but had not been recorded underwent further assessment based upon a desktop review of habitat requirements documented by DECCW and their potential to occur based upon previous DECCW records for the area. These were overlain with the potential impact from the proposal on key habitat elements essential for their survival. Of these, thirteen were considered likely to be affected by the proposed development and as such required assessments of significance (assessments contained within Specialist Flora and fauna Report, Appendix Q of this EA).

Review of the Draft Wyong Conservation Strategy revealed that there are nine species of animals that are considered regionally significant. These include:

- Great Barred Frog (*Mixophyes fasciolatus*) and the Brown Toadlet (*Pseudophyryne bibronii*) which are considered as declining in the region;
- Red-eyed Tree Frog (*Litoria chloris*) which is considered as an indicator species for wet riparian fauna habitat;
- Southern Angle-headed Dragon (*Hypsilurus spinipes*) which is considered as an indicator species for wet sclerophyll habitat and gully rainforests in the southern range limit;

- Southern Emu-wren (*Stipiturus malachurus*) is an indicator species for heath / scrub;

- Northern Brown and Long-nosed bandicoots (*Isoodon macrourus* and *Permeles nasuta*) are indicator species however are also considered to be at risk from predation by foxes and cats;

- Gould's Long-eared Bat (*Nyctophilus gouldi*) is an indicator species that are impacted by frequent burning in moist forest);

- Greater Glider (*Petauroides volans*) is considered to be an indicator species for forestry and wet sclerophyll forests; and

- Feather-tailed Glider (*Acrobates pygmaeus*) is considered an indicator species in relation to the affects of fragmentation.

Only the Greater Glider has been previously recorded within the Tooheys Road study area (ERM 1999b), however the ERM study area was much larger than the current. The only habitat suitable for this species is no longer within the W2CP impact footprint.

Migratory species

Only one migratory species, the White Bellied Sea Eagle *(Haliaeetus leucogaster),* was observed during former and current assessments. This species is listed under the EPBC Act as both a migratory terrestrial species and a listed marine species.

Critical habitat

A search of the DECCW and DEWHA online databases shows there are no critical habitats in the study areas.

13.1.11 Conservation Significance

Representativeness of Communities

The representativeness of vegetation communities identified within each study area is presented in **Table 13.4** and their local and regional size (in ha) is shown. The following vegetation map units are of state significance, protected under the TSC Act, and as such are recognised as being underrepresented within NSW:

- Alluvial Footslopes Redgum Forest;
- Alluvial Floodplain Shrub Swamp Forest;
- Narrabeen Alluvial Drainage Line Complex; and
- Alluvial Riparian Blackbutt Forest.

The following vegetation communities are considered to be well represented in NSW but not within the Wyong LGA and are consequently not afforded the same legislative protection under the TSC Act:

- Narrabeen Buttonderry Footslopes Forest;
- Narrabeen Dooralong Spottted Gum-Ironbark Forest;
- Narrabeen Doyalson Scribbly Gum Woodland; and
- Narrabeen Snappy Gum Forest.

Threatened species

Collectively, ten species of threatened fauna were recorded within the Tooheys Road, Hue Hue Road ecological offset investigation area, Buttonderry and Western shaft study areas. These species are protected under the TSC Act and have state significance.

Ten threatened species of flora were collectively recorded in the study areas. All study areas contain species of flora that have state significance and thus protection under the TSC Act. Tooheys Road, Hue Hue Road ecological offset investigation area and Buttonderry study areas also contain species that are nationally significant.

Degree of disturbance

All land owned by WACJV or proposed for impact as a result of the current assessment has been disturbed. The least disturbed property and perhaps that with the highest conservation significance is the Hue Hue Road ecological offset area. The most important ecological values have, for the most part, been conserved within the area i.e old growth riparian vegetation that has a continuous connection with surrounding undisturbed ecological communities. Only minor surface disturbance has occurred for fencing, roads and a light regime of logging for ironbark is evident in places. Other more heavily disturbed environments have been cleared of all understory vegetation and a portion of trees for grazing agriculture. These disturbed areas front Bushells Ridge and Tooheys Rds and thus are more suited for development than other, more difficult to access portions of land. Where clearing has occurred local levels of high soil disturbance are evident.

The Western shaft study area has only undergone prior logging and has been heavily impacted by Brothers Road. It is assessed as having a lower conservation than above as it is small, does not contain old growth with hollows nor the degree of habitat complexity.

Buttonderry has been heavily impacted for the purpose of farming. Large open spaces have been created through logging and tree clearing to encourage pasture growth. Fortunately the area of native vegetation to be impacted as a result of the current proposal has undergone logging and is largely regrowth with a few old growth trees remaining. Two small farm dams have been created as well as several tracks, trails and fence lines however, where unmodified native vegetation occurs there is a very low level of prior disturbance. Many old growth elements are present in these areas.

The Tooheys Road study area has undergone the highest level of disturbance of all the assessed areas. It is probable that all vegetation communities have been altered by human agricultural or infrastructure development. The least disturbed areas within the property are those which are difficult to build structures on or farm such as within drainage lines, creeks or dam areas and it is believed that much of the vegetation appearing to be undisturbed today is actually mature regrowth. The only exception to this generalisation would be old growth vegetation associated with Alluvial Riparian Blackbutt Forest within the eastern portion of Wallarah Creek.

One interesting observation is that Tooheys Road has presented a higher number of threatened species than any other portion of land assessed. It is assumed that this would be as a result of a higher degree of survey attention, the use of the area by many species as a feeding ground and the ability to see things in the field more clearly in areas that are partially cleared.

Special natural features

A 7(g) zoned wetland has been recorded on the Tooheys Road rail loop study area. Other natural features include the EEC's occurring within the Tooheys Road, Hue Hue Road potential conservation offset properties and Buttonderry study areas. These EEC's also encompass the area of land identified as 7(g) wetland.

The presence of a stand of *Melaleuca biconvexa* within the swamp forest community at Buttonderry was noted, this species is almost locally extinct.

13.1.12 Potential Impacts on the Natural Environment

Vegetation clearing

There are seven major vegetation map units in the assessed areas and three other non-specific vegetation types (Table 13.5). Cumulatively these map units represent 31,497 ha of remnant vegetation in the Wyong LGA and within the current study areas they occupy 323.10 ha of the 437.1 ha assessed. The greatest amount of native vegetation to be removed as a result of the proposed development will be within the Narrabeen Doyalson Scribbly Gum Woodland, of which only one of its derivative Narrabeen Doyalson Scribbly Gum Woodland has local significance.

Of those communities identified as having conservation significance, the most affected (in ha) will be the Alluvial Riparian Blackbutt Forest, where 1.05 ha will be cleared.

Table 13.5 Overview of the Extent of Vegetation Clearing for the W2CP

Vegetation Map Unit	Significance	Area of Vegetation Available in Study Areas (Ha)	Area of Vegetation to be Impacted (Ha)	Area of Vegetation to be Retained (Ha)
Alluvial Footslopes Redgum Forest	State	0.44	0	0.44
Alluvial Floodplain Shrub Swamp Forest	State	2.27	0.18	4.15
Narrabeen Alluvial Drainage Line Complex	State	18.62	0.62	17
Alluvial Riparian Blackbutt Forest	State	23.44	1.05	25.77
Narrabeen Buttonderry Footslopes Forest	Local	103.37	1.35	102.15
Narrabeen Dooralong Spotted Gum-Ironbark Forest	Local	74.52	3.2	71.32
Narrabeen Doyalson Coastal Woodland	Only derivative has local sig	85.91	14.29	71.63
Coastal Foothills Moist Layered Forest			0.92	0
Unspecified Regrowth		4.72	0.48	4.24
Unspecified Canopy		3.47	0.59	2.88
Dams		1.79	0.05	1.74

Table 13.6 Extent, Conservation Significance and Proposed Impacts of Vegetation Communities

Vegetation Community	Signif.	Extant LGA (ha)	Buttonderry (ha)			Tooheys Road / Hue Hue Road (Excluding DALC) (ha)			Wyong State Forest (ha)	
			Direct Impact	Offset	Total	Direct Impact	Offset	Total	Direct Impact	Total
Alluvial Footslopes Redgum Forest	State	145	-	-	-	-	0.44	0.44	-	-
Alluvial Floodplain Shrub Swamp Forest (variant a)	State	895	-	1.93	1.93	-	1.90	1.90	-	-
Alluvial Floodplain Shrub Swamp Forest (regrowth)	State		-	0.13	0.13	-	-	-	-	-
Alluvial Floodplain Shrub Swamp Forest (variant f)	State		-	-	-	0.18	0.19	0.37	-	-
Narrabeen Alluvial Drainage Line Complex (variant b)	State	254	-	-	-	0.13	0.87	1.00	-	-
Narrabeen Alluvial Drainage Line Complex (variant d)	State		-	8.64	8.64	0.09	3.99	4.07	-	-
Narrabeen Alluvial Drainage Line Complex (variant d canopy only)	State		-	0.65	0.65	-	-	-	-	-
Narrabeen Alluvial Drainage Line Complex (variant e)	State		-	-	-	0.40	2.79	3.19	-	-
Narrabeen Alluvial Drainage Line Complex (variant e regrowth)	State		-	-	-	-	0.06	0.06	-	-
Narrabeen Buttonderry Footslopes Forest	Local	1016	1.01	24.28	25.29	-	52.61	52.61	-	-
Narrabeen Buttonderry Footslopes Forest (canopy only)	Local		0.31	1.95	2.26	0.03	18.52	18.55	-	-
Narrabeen Buttonderry Footslopes Forest (regrowth)	Local		-	1.60	1.60	-	3.19	3.19	-	-
Dooralong Spotted Gum-Ironbark Forest	Local	2215	0.58	10.81	11.39	-	50.24	50.24	-	-
Dooralong Spotted Gum-Ironbark Forest (canopy only)	Local		2.62	3.16	5.78	-	7.11	7.11	-	-
Doyalson Scribbly Gum Woodland		3119	-	-	-	3.28	35.28	38.56	-	-
Doyalson Scribbly Gum Woodland (variant a)			-	-	-	0.05	1.02	1.06	-	-
Doyalson Scribbly Gum Woodland (variant c)			-	-	-	1.15	2.05	3.20	-	-
Doyalson Scribbly Gum Woodland (variant d)	Local		-	-	-	2.28	7.63	9.91	-	-
Doyalson Scribbly Gum Woodland (canopy only)			-	-	-	7.35	19.80	27.15	-	-
Doyalson Scribbly Gum Woodland (regrowth)			-	-	-	0.18	5.85	6.03	-	-
Narrabeen Snappy Gum Forest	Local	175	-	-	-	-	-	-	-	-
Coastal Foothills Moist Layered Forest		23440	-	-	-	-	-	-	0.92	0.92
Alluvial Riparian Blackbutt Forest	State	238	-	3.04	3.04	0.24	15.93	16.16	-	-
Alluvial Riparian Blackbutt Forest (canopy only)	State		-	0.16	0.16	0.81	4.94	5.75	-	-
Alluvial Riparian Blackbutt Forest (regrowth)	State		-	0.17	0.17	-	1.53	1.53	-	-
Dams	-	-	0.02	0.07	0.09	0.03	1.67	1.70	-	-
Unspecified Canopy Only	-	-	-	-	-	0.59	2.88	3.47	-	-
Unspecified Regrowth	-	-	-	-	-	0.48	4.24	4.72	-	-
Totals		31497	4.54	56.59	61.13	17.27	244.73	261.97	0.92	0.92

Fragmentation and edge effects

Habitat fragmentation may cause an eventual reduction of population sizes and the ability of species within it to disperse to others areas of remnant vegetation. Edge effects may result in new boundaries being created in a given habitat as a result of environmental modification (i.e. weed invasion may encroach new areas as a result of an easement cutting though a closed forest alternately the new access may favour the movement of predators within this previously inaccessible environment).

The area most affected by habitat fragmentation will be land south of Wallarah Creek in the Tooheys Road study area, within the impact footprint for the proposed rail loop. The overall effect however, is diminished on a broader perspective as this 'patch' of remnant vegetation is in itself an isolated fragment.

Failure to relocate Squirrel Glider recorded by ERM twice in 1999 in this area was concerning and if the population is present, further habitat fragmentation will pressure this species. There are several ways to ameliorate potential effects on this potentially extant species, such as habitat restoration within degraded areas of Wallarah Creek using favoured food species, the implementation of a long-term monitoring programme, provision of nesting boxes, feral animal control and investigation into developing effective materials / methods to re-instate dispersal of animals over the existing man made barriers surrounding the Tooheys Road property.

The degree of habitat fragmentation has been reduced by designing the rail loop so that it will run adjacent to the existing TransGrid 330 kV easement north of Tooheys Road. This will result in an edge effect occurring that will effectively push back existing habitat boundaries for native species approximately 50 m north of where it currently occurs.

There is a low abundance of weeds in the Tooheys Road study area and a high population of foxes and cats and this will not change the status of the existing environmental pressures, therefore the edge effect on most fauna species is largely inconsequential.

However, clearing of woodland habitat and construction of the rail line will increase the width of the TransGrid easement, which separates woodland habitats. This further fragments the northern part of the Tooheys Road study area and would increase barriers to movement and dispersal for some plant species with low dispersal ability and fauna species with low powers of dispersal such as frogs, reptiles, and small ground mammals. Other species are highly mobile and are able to tolerate or negotiate cleared areas such as arboreal mammals, birds, insectivorous bats and large ground mammals.

Within Buttonderry, the construction of the proposed development would further fragment the habitat within the study area. It would reduce the amount of habitat for flora and fauna.

13.1.13 Potential Impact on Threatened and Regionally Significant Species

Within the study area, threats to threatened flora include agriculture, mineral extraction, urban development, altered fire regimes, grazing and/or trampling, disease, pollution, weeds, forestry operations and changed hydrological regimes. Within the study areas the main potential impacts on flora from construction, operation and decommissioning of the proposed project include:

- ❒ Loss of habitat as a result of clearing and trampling. This results in a removal or reduction of vegetation;

- ❒ Creation of disturbed edge areas which may encourage introduction of competitive native and introduced species that out-compete other native species and dominate native vegetation;

- ❒ Changes in hydrology which could potentially lead to changes in vegetation assemblages; and

- ❒ Erosion and sedimentation which could potentially promote introduced species and alter conditions for native species.

Threats to threatened birds are essentially the same as noted above, however, a shortage of nesting hollows (due to a variety of causes) is the greatest potential impact to those species that rely on hollows for breeding.

The other important potential impacts on bird species abundance and distribution from construction, operation and decommissioning of the proposed project include:

- ❒ Loss of habitat through clearing, resulting in removal or reduction of foraging resources, nesting sites and materials, breeding opportunities, roosting sites, shelter and dispersal areas and corridors used by migratory or nomadic species;

- ❒ Creation of disturbed edge areas which favour the introduction of competitive native and introduced species displace native resident birds resulting in a reduction of overall bird biodiversity and abundance within an area;

- ❒ Changes in habitat resources can disrupt extant food-chain processes such as an increase in cleared areas encouraging an increase in aerial predation from raptors;

- ❒ Disruption to essential behavioural patterns as a result of noise generation, artificial lighting, dust and air quality, road traffic, human interference, invasion of introduced species and predation by feral animals; and

- ❒ Mortality due to drinking polluted waters, collision with artificial structures such as powerlines, road traffic and trains.

Threats to threatened mammals include past and on-going land uses, as listed for plants and birds (above), which have resulted in the removal and modification of habitats. Within the study areas and subject sites, the main potential impacts on mammal species and abundance from construction, operation and decommissioning of the proposed project include:

- ❒ Loss of habitat as a result of clearing that removes, reduces or modifies foraging resources, nesting sites or materials, breeding opportunities, roosting sites, shelter areas, dispersal areas and corridors;

- ❒ Creation of disturbed edge areas which can encourage introduction of competitive native and introduced fauna species that out-compete other native species and prey on native species;

- ❒ Invasion of native vegetation by introduced flora species, which results in a loss or modification for feeding, shelter and resources. This may result in changes

in relative abundance of mammal species because some mammals can persist or are advantaged by disturbed areas, in comparison to others that would not persist;

- Disruption to essential behavioural patterns as a result of noise generation, artificial lighting, dust and air quality, road traffic, human interference, invasion of introduced species and predation by feral animals; and

- Mortality due to drinking polluted waters and road-kills.

Existing threats to threatened amphibians and reptiles are the same for flora, birds and mammals as detailed above. Some amphibians in the region have also declined because of the Chytrid fungus. Frogs have almost certainly declined in the region due to this disease, however, major declines appear mostly in upland areas. The frog species recorded in the area are not amongst those known to be badly affected by the fungus and population densities remains in most coastal areas.

Within the study areas, the main potential impacts on amphibians and reptiles from construction and operation of the proposed project include:

- Loss of habitat as a result of clearing resulting in a removal, reduction or modification of foraging resources, nesting sites, breeding sites for amphibians and shelter areas;

- Predation by introduced species such as feral cats, dogs and foxes;

- Pollution or degradation (including sedimentation) of streams, ponds and swamps which prohibits breeding of some amphibians;

- Invasion of native vegetation (including swamps) by introduced flora species resulting in a loss or modification of feeding, shelter and resources. This may result in changes in relative abundance of reptiles and amphibians due to changes in food availability and shelter sites;

- Disruption to essential behavioural patterns as a result of changes in hydrology and water quality;

- Noise generation, artificial lighting, dust and air quality; and

- Road traffic, human interference.

Critically endangered and endangered ecological communities affected by the proposal

There are no critically endangered ecological communities that will be affected as a result of the proposal.

Endangered populations affected by the proposal

There are no endangered populations within the assessed study areas.

Endangered, threatened and regionally significant flora species affected by the proposal

There is one endangered, six vulnerable and three regionally significant species occurring within the study areas. All of these have the potential to be affected either directly or indirectly as a result of the proposal.

Angophora inopina
Although not counted in detail, the study area is likely to support several hundred plant clumps of *Angophora inopina*, principally in the Tooheys Road portion. Many of these will be destroyed through construction of the proposed rail loop and other surface facilities. Being a long-lived, resprouting species any *Angophora inopina* disturbed during construction activities will subsequently resprout: many specimens have been slashed under the power line easement and continue to grow but in a mallee habit. Given the existence of extensive populations to the immediate west and north, the local population of plants is unlikely to be placed at risk of extinction through the proposed development.

Arachnorchis tessellatus
The single record of this species recorded from the southern boundary of the Tooheys Road portion lies outside of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

Grevillea parviflora subsp. parviflora
The two populations of this species within the Hue Hue Road and Buttonderry portions lie outside of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

Melaleuca biconvexa
The single population of this species within the Buttonderry portion lies well outside and upstream of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

Tetratheca juncea
Although not counted in detail, the study area is likely to support several hundred plant clumps of *Tetratheca juncea*, principally in the Tooheys Road portion. Many of these will be destroyed through construction of the proposed rail loop and other surface facilities. *Tetratheca juncea* is pollinated by at least two sonicating bees (Driscoll 2003), and based on the amount of *Tetratheca juncea* in adjacent lands (S.Bell, pers obs.), it is likely that these bees are active in the area. Given the existence of extensive populations to the immediate west and north, the local population of plants is unlikely to be placed at risk of extinction through the proposed development.

Acacia bynoeana
Bell & Driscoll (2002) have detailed known populations of *Acacia bynoeana* from the Wyong LGA, and several populations are present within a 2-3 km radius of the site. Extensive populations occur in the Wyee area on Crown or DLALC land. Two plants were located on the edge of the existing transmission easement during the current survey. Consequently, it is unlikely that an adverse effect will occur on the local population of this species.

Cryptostylis hunteriana
The single plant located within the study area occurs in a proposed conservation offset, approximately 200 m upslope from any development. Consequently, no adverse effect is likely on the species.

Endangered, threatened and regionally significant fauna species affected by the proposal

There are ten species of threatened and three species of regionally significant mammals, one species of regionally significant reptile, two threatened and regionally significant frogs and two threatened and three regionally significant species of birds recorded within the study area. All of these have the potential to be directly and indirectly affected as a result of the proposal.

Desk top analysis shows that an additional eight species of mammals, three birds, two frogs and one insect have the potential to be impacted as a result of the proposal.

The Yellow-bellied Sheathtail Bat

(*Saccolaimus flaviventris*) occurs in rainforests, sclerophyll forests and woodlands. They roost alone or with up to ten others in large hollow trees, in buildings or abandoned nests of Sugar Gliders (Churchill 1998). This species has been previously recorded in the study area at the Tooheys Road and Hue Hue Road potential offset properties.

Common Bent-wing Bats

(*Miniopterus schreibersii*) occur in a range of habitats, from grasslands through to subtropical rainforest, but are typically found in well timbered valleys. The species is distributed throughout the coastal plains and highlands of NSW, VIC and SA. The species is reliant on caves for maternity and over wintering roosts. This species has been not previously recorded in the study area but has the potential to occur.

The Little Bentwing-bat

(*Miniopterus australis*) occupies caves and tunnels during the day and at night forages for small insects beneath the canopy of well-timbered habitats including rainforest, *Melaleuca* swamps and dry sclerophyll forests. Distribution in Australia becomes increasingly coastal towards the southern limit of its range which is in NSW. The Little Bentwing-bat relies on specific nursery sites to rear its young, with the most southern known site, being in the Macleay River water shed (Dwyer, 1995). This species has been previously recorded in the study area at the Tooheys Road study area.

Large-footed Myotis

(*Myotis adversus)* has disproportionately large feet; more than 8 mm long, with widely-spaced toes which are distinctly hairy and with long, curved claws. It has dark-grey to reddish brown fur above and is paler below. It weighs up to 15 grams and has a wingspan of about 28 cm. The species is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in

dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December (Churchill 1998). This species has been previously recorded in the study area at the Tooheys Road study area.

The Eastern False Pipistrelle

(*Falsistrellus tasmaniensis)* is relatively large with a head-body length of about 65 mm. It weighs up to 28 grams. It is dark to reddish-brown above and paler grey on its underside. It has long slender ears set well back on the head and some sparse hair on the nose. This species is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania where it prefers moist habitats, with trees taller than 20 m and roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. It hunts beetles, moths, weevils and other flying insects above or just below the tree canopy and hibernates in winter. Females are pregnant in late spring to early summer. This species has been previously recorded in the study area at the Tooheys Road study area.

The Greater Broad-nosed Bat

(*Scoteanax rueppellii)* has been included in this assessment as its call is very similar to those of the Eastern False Pipistrelle, as this is also a threatened species in NSW duty of care requires additional assessment of this species. This is large powerful bat, up to 95 mm long, with a broad head and a short square muzzle. It is dark reddish-brown to mid-brown above and slightly paler below. It is distinguished from other broad-nosed bats by its greater size. While similar to the Great Pipistrelle *Pipistrellus tasmaniensis*, it differs by having only two (not four) upper incisors. The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m. It utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. It forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young (Churchill 1998). This species has been previously recorded in the Hue Hue Road ecological offset investigation area.

Eastern Freetail-bat

(*Mormopterus norfolkensis)* has dark brown to reddish brown fur on the back and is slightly paler below. Like other freetail-bats it has a long (3 - 4 cm) bare tail protruding from the tail membrane. Freetail-bats are also known as mastiff-bats, having hairless faces with wrinkled lips and triangular ears. They weigh up to 10 grams. It is found along the east coast from south Queensland to southern NSW proffering dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made

structures and is solitary and probably insectivorous (Churchill 1998). This species has not been previously recorded however it has the potential to occur within the assessed areas.

The Squirrel Glider

The Squirrel Glider inhabits dry sclerophyll forest and woodland. In the south east Davey (1984, cited by ERM 1999b) recorded the species in *E. botryoides* and stands of Blackbutt (*E. pilularis)* and Spotted Gum (*Corymbia maculata*). Fifteen years later ERM (1999b) recorded the species twice in an area of map unit 26d: Narrabeen Alluvial Drainage Line Complex, map unit 31c: Narrabeen Doyalson Scribbly Gum Woodland map unit 43a: Alluvial Riparian Blackbutt Forest. Diet consists of arthropods, acacia gum, eucalypt sap, nectar and pollen. The species nests in a bowl-shaped leaf lined nest within a tree hollow. Home range is reported to be between 20-30 hectares.

The Yellow Bellied Glider

The Yellow Bellied Glider occupies coastal forests and adjacent sub-coastal forests of mid-high elevations. It prefers tall mature eucalypt forests in regions with high rainfall. It has a patchy distribution that is largely determined by the availability of suitable flowering eucalypts with overlapping blossoming periods (Strahan, 1995). Plant and insect exudates i.e. sap, nectar, honeydew, pollen and manna, make up the bulk of the diet. The species requires an abundance of large deep hollows which are only provided by mature and older trees (Strahan, 1995). Yellow-bellied Gliders live in small family groupings which occupy large and exclusive home ranges (30-65 ha), apparently because of the ephemeral nature of their food resources (Goldingay and Kavanagh 1991).

Brush-tailed Phascogale

(*Phascogale tapoatafa)* is tree-dwelling marsupial carnivore with a patchy distribution around the coast of Australia. In NSW it is more frequently found in forest on the Great Dividing Range in the north-east and south-east of the State. There are also a few records from central NSW. This species prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. It may also inhabit heath, swamps, rainforest and wet sclerophyll forest. They are agile climbers foraging preferentially in rough barked trees of 25 cm DBH or greater. They Feed mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Females have exclusive territories of approximately 20 - 60 ha, while males have overlapping territories of up to 100 ha. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span. Mating occurs May - July; males die soon after the mating season whereas females can live for up to three years but generally only produce one litter (DECCW threatened species web site 2006).

Wallum Froglet

Wallum Froglets are small frogs, usually no more than 15 mm long. They are extremely variable in colour and pattern, from light grey or brown to dark grey above and cream to dark grey below. The species is found only in acid paperbark swamps and sedge swamps of the coastal 'wallum' country. The species is a late winter breeder. Males call in choruses from within sedge tussocks or at the water edge. The Wallum Froglet is thought to be sensitive to reduction of water quality resulting from logging, roading, grazing and burning. They are highly sensitive to

environmental conditions, preferring a narrow pH range and specific depth and water retention properties in their wetland habitats. Wetland destruction and eutrophication associated with sandmining, coastal development and agriculture are also primary threats. Invasion by common generalist frogs following eutrophication also threatens the species (Parsons Brinkerhoff 2006b citing Ingram and Corben 1975b). The primary habitat components for this species are a dense herb layer, with an intermittent canopy cover for refuge. Ephemeral waterbodies such as larger puddles in heath or in watercourses and creeklines are required for breeding purposes. Little is known about the ecology of the Wallum Froglet but some evidence suggests that fidelity to breeding sites is maintained (Parsons Brinkerhoff 2006b citing White 1995). This species was recorded by ERM (1999b) at two locations in the Tooheys Road study area.

The Green-thighed Frog

The Green-thighed Frog is known from riparian rainforest, wet and dry sclerophyll forest and woodland communities east of the dividing ranges. Its range extends from Jimna Queensland to Gosford in the south. The species requires temporary water holes for breeding, often using ponds, waterholes in creeks, oxbows, depressions, artificial dams, scrapes and ditches. Water bodies often have shallows which are exposed to sunlight. Vegetation is characterised as submerged either totally (eg grasses) or partially emerging (shrubs, tussocks or sedges) rather than emergent (Ehmann 1997). This species was recorded by ERM (1999b) at the Buttonderry study area, unfortunately no further detail of the exact location was given however, it is not within the impact footprint as no suitable habitat for this species occurs in that location.

Turquoise Parrot (Neophema pulchella)

The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows, logs or posts, from Aug to Dec. It lays four or five white, rounded eggs on a nest of decayed wood dust (DECCW threatened species website 2006).

Once common even near Sydney, the population of this species crashed in the early 1900s and at one stage feared extinct. The population has since recovered and its range still appears to be increasing. Habitat clearance, overgrazing and a delay in adapting to the seeds of exotic weeds as an alternative food source were the reasons for the decline. Lack of high quality breeding hollows is still restricting population growth in some areas.

Powerful Owl (Ninox strenua)

This is the largest of Australia's owls, ranging from 600 to 660 mm in height. It can be readily detected by listening for its call, and identified by its large size and bold chevrons on the underparts, with males being somewhat larger than females (Schodde and Tidemann, 1996). The powerful owl occupies an extensive home range of up to 1000 hectares, generally within 200 kilometres of the coast in southeastern Australia and inhabits a range of vegetation communities especially

those with a dense canopy, such as rainforests. The Powerful Owl is a generalist predator feeding on smaller birds and arboreal mammals. The species roosts by day in dense foliage often within ridges covered by eucalypt forest. The species depends upon large mature hollow eucalypts for nesting in a hollow trunk or limb 8 metres to 20 metres or more high in a tree, generally in areas with a range of vegetation communities that sustain a high diversity of ground dwelling mammals and avifauna (Debus and Chafer, 1994). The species breeds between June and September.

The main threat to the Powerful Owl is the loss of old-growth forests, particularly those with tree hollows that are large enough to be used for breeding by the owls. Intensive forestry and clearing for pastoralism and other agricultural purposes can also reduce the prey densities of the Powerful Owl (Braithwaite *et al.* 1988).

Barking Owl (Ninox connivens)

The Barking Owl is distributed sparsely throughout temperate and semi-arid areas of mainland Australia, however is most abundant in the tropical north (Kavanagh 2002a). Most records for this species occur west of the Great Dividing Range (Kavanagh 2004). Habitat for this species includes dry forests and woodlands (Kavanagh 2002a), often in association with hydrological features such as rivers and swamps (Taylor *et al.* 2002). Its a medium-sized robust owl, smoky-brown above with large white spots on the wings, whitish below with dark grey to rusty streaks, feathered legs and powerful feet. Males grow larger than females. It typically roosts by day in pairs in leafy trees, sometimes in exposed conditions (Pizzey and Doyle, 1980). They are usually found in pairs which occupy 30 - 2000 hectare territories all year round (Schodde and Tidemann, 1993). This species is fairly widespread in NSW, except in the far north-west of the state, and it is rare east of the Great Dividing Range (Blakers *et al.* 1984). It is distributed in well-forested hills and flats, eucalypt savannah and riverine woodland in coastal and subcoastal eastern, northern and south-western mainland Australia. The species breeds from July to November and nests in an open hollow 10 - 250 centimetres deep in a trunk or spout of a tree at 3 - 30 m above ground. The chief prey items are mammals and birds, but it also feeds on insects and other invertebrates. Typical prey species include young hares, rats, mice, small bats and some marsupials, including possums.

The main threat to this species is the reduction in the number nest trees due to habitat clearance for forestry, agriculture and urban development (Lacey *et al.* 1990). Pesticides may also be a problem when territories are adjacent to agricultural land.

Masked Owl (Tyto novaehollandiae)

The masked owl occurs sparsely throughout the continent and nearby islands, including Tasmania and New Guinea (Kavanagh 2002a), except in the arid interior where it is absent (Blakers *et al*. 1984). This species is generally recorded from open forest habitat with sparse mid-storey but patches of dense, low ground cover. It is also recorded from ecotones between wet and dry eucalypt forest, along minor drainage lines and near boundaries between forest and cleared land (Kavanagh 2004). Masked owls nest (and roost) in large hollows of old trees and they also roost among dense foliage in variety of sub-canopy trees (Kavanagh 2004). It has a home range of between 400 and 500 hectares.

The main threat to this species is the reduction in the number nest trees due to habitat clearance for forestry, agriculture and urban development (ERM 1999b citing

Lacey *et al.* 1990). Pesticides may also be a problem when territories are adjacent to agricultural land.

Sooty Owl (Tyto tenebricosa)

A medium-sized owl to 45 cm long, with dark eyes set in a prominent flat, heart-shaped facial disc. Dark sooty-grey in colour, with large eyes in a grey face, fine white spotting above and below, and a pale belly. The plumage of the fledglings is similar to the adult, but has tufts of down on the head and underparts. The Sooty Owl has the largest eyes and roundest wings of all of the masked owls (Schodde and Tidemann, 1993). This species inhabits tall, wet forests of south-eastern Australia, particularly rainforest gullies that contain emergent eucalypt forests. It lives in pairs with permanent territories of 200 - 800 ha. It roosts in large hollows in tall eucalypt trees (Schodde and Mason 1980) the interlacing stems of a giant fig or a crevice under a bank or cliff (Hollands 1991). The species preys upon mammals including possums and gliders, rats and bandicoots and birds (Garnett, 1993; Schodde and Tidemann, 1993). It breeds opportunistically but produces only one brood a year, and nests in a spacious hollow that is 40 - 500 cm in depth, and located in a tall eucalypt in or on the edge of rainforest.

Historically, the main threat has been habitat clearance for agriculture with large areas of rainforest being completely eliminated. This activity has largely ceased and the species is most threatened by disturbance of creekside rainforest, particularly of nest trees, and by clearfelling for forestry (Garnett 1993). Suitable habitat is also vulnerable to fire, either wildfires or prescribed burns that are allowed to move into the rainforest fringes.

Adam's Emerald Dragonfly

(*Archaeophyta adamsi*) is a moderately large, robust dragonfly. Larvae grow to about 23 mm in length and have a large two-lobed frontal plate on the head, which distinguishes them from any other species found in NSW. The adults have a brown-black body with yellow markings, and a slight green or bluish metallic reflection on some parts. The abdomen length is around 46 mm and wingspan around 37 mm. It is one of Australia's rarest dragonflies. Only five adults have ever been collected, and the species is only known from a few sites in the greater Sydney region.

Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation. All dragonflies are predatory. The larvae stalk or ambush their aquatic prey while the adults capture their prey on the wing. Adam's emerald dragonfly larvae live for 7 years or so and undergo various moults before metamorphosing into adults. Adults probably live for a few months at most. Adult dragonflies generally fly away from the water to mature before returning to breed. Males congregate at breeding sites and often guard a territory. Females probably lay their eggs into the water. Adam's emerald dragonflies seem to have a low natural rate of recruitment and limited dispersal abilities (DECCW threatened species webpage 2006).

Migratory species affected by the proposal

The White Bellied Sea Eagle (*Haliaeetus leucogaster)* is a Migratory Wetland Species and Listed Marine Species under the EPBC Act 1999. This species frequents large rivers, fresh and saline lakes, reservoirs, costal areas and seas. They are opportunistic carnivores, feeding on birds, mammals, fish, reptiles and carrion (Green 1959, Quinn 1969, Smith 1985 cited by the Victorian Dept of Environment & Sustainability web page {2005}).

Birds often have favoured roosts on prominent trees and soar in large circles with wings upswept during flight. While hunting they may hover low and dive close to the water to catch prey. Pairs may hunt together and they are known to harass other bird species (such as terns) and either steal prey or have them regurgitate it. White Bellied Sea Eagles have been recorded in the northern hemisphere from India to China and south through Asia, New Guinea and Australia. They occur along the coastline of Australia and also range inland over large rivers and wetlands.

Core habitat elements for this species will not be affected by the proposed action and therefore there is no requirement to refer the matter to the D-G of the DEWHA.

It is further noted that W2CP is the subject of a controlled action decision under the EPBC Act, made on 21 December 2007.

NSW Legislation – 7 part tests for Direct Impact Areas

In assessing whether development is likely to significantly affect threatened species, populations or ecological communities or their habitats listed under the TSC Act or or the FM Act, seven factors can be taken into account (in accordance with section 5A of the EP&A Act) as follows:

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

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

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

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

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

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

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

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

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

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

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

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

The 7 part tests for assessing the significance of impacts on EEC's and flora and fauna species is included in full in the specialist report contained in Appendix Q. The conclusion of the assessments is provided below.

Swamp Sclerophyll Forest on Coastal Floodplains

Swamp Sclerophyll Forest on Coastal Floodplains (SSFCF) essentially represents those vegetation communities where Swamp Mahogany (*Eucalyptus robusta*) forms a prominent component in the canopy, principally on the coastal floodplains draining east from the Great Dividing Range. It is based on the work of Keith and Scott (2004). One small area of SSFCF occurs at Tooheys Road, and a further small area at Buttonderry.

The Section 5A assessment concluded that the local occurrence of Swamp Sclerophyll Forest on Coastal Floodplains is **unlikely** to be significantly impacted upon by the proposed development.

River Flat Eucalypt Forest on Coastal Floodplains

River Flat Eucalypt Forest on Coastal Floodplains (RFEFCF) essentially represents those vegetation communities on coastal floodplains supporting vegetation outside of areas of SSFCF, populated by a range of eucalypt species. It is based on the work of Keith and Scott (2004). Within the current study area, Wallarah Creek and an un-named creek at Tooheys Road/ Hue Hue, and Buttonderry Creek at Buttonderry support RFEFCF.

The Section 5A assessment concluded that the local occurrence of River Flat Eucalypt Forest on Coastal Floodplains is **unlikely** to be significantly impacted upon by the proposed development.

Lower Hunter Spotted Gum – Ironbark Forest

Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF) is based on the NPWS (2000) classification of vegetation in the Lower Hunter Valley and Central Coast. Formerly not thought to occur in the Wyong LGA, recent research on LHSGIF has confirmed its presence there. LHSGIF occurs predominantly at Hue Hue Road, with a further small area at Buttonderry.

The Section 5A assessment concluded that the local occurrence of Lower Hunter Spotted Gum – Ironbark Forest is unlikely to be significantly impacted upon by the proposed development.

Angophora inopina

Angophora inopina is widespread in the southern Lake Macquarie-Wyong area, but its full distribution currently extends from Warnervale to Bulahdelah. It occupies a range of habitats within this region, but principally occurs in open healthy woodland. Large numbers of plants occur within the Tooheys Road portion of the current study

area. Further assessment mapped the population to show that it predominately occurs on land adjoining the study area.

The Section 5A assessment concluded that the local population of *Angophora inopina* is **unlikely** to be significantly impacted upon by the proposed development.

Arachnorchis tessellatus

Very few recent records of *Arachnorchis tessellatus* exist in the region, which extend south from the Swansea area in southern Lake Macquarie. It occupies a range of habitats within this region, from coastal headlands to open forests and alluvial soils. Although no specimens were observed during the current surveys, a record does exist for the southern edge of the Tooheys Road portion.

The Section 5A assessment concluded that the local population of *Arachnorchis tessellatus* is **unlikely** to be significantly impacted upon by the proposed development.

Grevillea parviflora subsp. parviflora

Grevillea parviflora subsp*. parviflora* occurs from the Karuah area north of Newcastle to the outskirts of Sydney. It occupies a range of habitats within this region, with the Cessnock area in particular supporting large numbers of species across a variety of habitat. Recent investigations into the taxonomy of this species has revealed considerable morphological variations not currently recognised in the group, and hence taxonomic revisions are required. Two small populations of this species occur in the Buttonderry area, one on the edge of Kiar Ridge Road and the other at the rear of the Buttonderry portion.

The Section 5A assessment concluded that the local population of *Grevillea parviflora* subsp*. parviflora* is **unlikely** to be significantly impacted upon by the proposed development.

Melaleuca biconvexa

Melaleuca biconvexa occurs principally south from southern Lake Macquarie, although there are records from Port Macquarie on the North Coast. It occupies a range of swamp or moist forest habitats within this region, although in the Wyong area riparian or swamp communities of Blackbutt, Bluegum or Swamp Mahogany are the most common. One population of this species occurs along Buttonderry Creek in the north-eastern corner of the Buttonderry portion.

The Section 5A assessment concluded that the local population of *Melaleuca biconvexa* is **unlikely** to be significantly impacted upon by the proposed development.

Tetratheca juncea

Tetratheca juncea is widespread in the southern Lake Macquarie area, but its full distribution currently extends from Wyong to Bulahdelah. It occupies a range of habitats within this region, from coastal headlands to open forests, on conglomerates, sandstones and coastal sands. Large numbers of plants occur within the Tooheys Road portion of the current study area.

The Section 5A assessment concluded that the local population of *Tetratheca juncea* is **unlikely** to be significantly impacted upon by the proposed development.

Acacia bynoeana

Acacia bynoeana occurs from south of Sydney to the lower Blue Mountains, and north to the Cessnock district. On the Central Coast, it typically occurs in healthy woodlands or open forests. A few small populations were recorded in proximity to the proposed rail corridor on DLALC land.

The Section 5A assessment concluded that the local population of *Acacia bynoeana* is **unlikely** to be significantly impacted upon by the proposed development.

Cryptostylis hunteriana

Cryptostylis hunteriana occurs along the east coast of Australia from Victoria and southern NSW, into southern Queensland. On the Central Coast, it typically occurs in healthy woodlands or open forests (Bell 2001), while further south wetter habitats are preferred (Clark et al. 2004). A single flower spike was recorded on the Tooheys Road property.

The Section 5A assessment concluded that the local population of *Cryptostylis hunteriana* is **unlikely** to be significantly impacted upon by the proposed development.

Swamp Sclerophyll Forest on Coastal Floodplains

Swamp Sclerophyll Forest on Coastal Floodplains (SSFCF) essentially represents those vegetation communities where Swamp Mahogany (*Eucalyptus robusta*) forms a prominent component in the canopy, principally on the coastal floodplains draining east from the Great Dividing Range. It is based on the work of Keith and Scott (2004). One small area of SSFCF occurs at Tooheys Road, and a further small area at Buttonderry.

This Section 5A assessment concludes that the local occurrence of Swamp Sclerophyll Forest on Coastal Floodplains is unlikely to be significantly impacted upon by the proposed development.

Microchiroptean Bats

There are seven threatened species of microchiroptean bats (as described previously) known to occur, or have potential to occur in the direct impact study areas, and are assessed together.

The Section 5A assessment concluded that the local populations of Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*), Common Bent-wing Bat (*Miniopterus schreibersii*), Little Bent-wing Bat (*Miniopterus australis*), Large-footed Myotis (*Myotis adversus),* Eastern False Pipistrelle (*Falsistrellus tasmaniensis),* Greater Broad-nosed Bat (*Scoteanax rueppellii)* and Eastern Freetail-bat (*Mormopterus norfolkensis)* are **unlikely** to be significantly impacted upon by the proposed development.

Arboreal Mammals

There are three threatened species of arboreal mammals (as described previously) known to occur, or have potential to occur in the direct impact study areas, and are assessed together.

The Section 5A assessment concluded:

- The potential population of Yellow-belied Glider and Brush-tailed Phascogale in the Hue Hue Road ecological offset investigation area **will not** be impacted upon by the proposed development;
- Should a local population of Squirrel Glider remain extant in the Tooheys Road study area at Wallarah Creek it is **likely** to be significantly impacted upon by the proposed development; and
- Local populations of Squirrel Glider occurring in the Buttonderry, Hue Hue Road ecological offset investigation area and the western shaft site are **unlikely** to be significantly impacted upon by the proposed development.

Frogs

There are two threatened species of frogs (as described previously) known to occur, or have potential to occur in the direct impact study areas, and are assessed together.

The Section 5A assessment concluded:

- The potential population of Green-thighed Frog in the Buttonderry study area will not be impacted upon by the proposed development;
- Should a local population of Wallum Froglet remain extant in the Tooheys Road study area it has the potential to be significantly impacted upon by the proposed development. This assessment may change with further research; and
- Local populations of Green-thighed Frogs or Wallum Froglet occurring in the Buttonderry, Hue Hue Road potential conservation offsets and the western shaft site that were not observed but have the potential to occur are unlikely to be significantly impacted upon by the proposed development.

Tree Hollow Dependant Birds

There are five threatened species of frogs (as described previously) known to occur, or have potential to occur in the direct impact study areas, and are assessed together.

The Section 5A assessment concluded:

- It is unlikely that Masked Owl, Barking Owl, Sooty Owl and the Turquoise Parrot will be affected by the proposal given that the majority of habitat available for these species will not be impacted; and

- It is unlikely that a local population of Powerful Owl will become extinct as a result of the proposed work however, care should be undertaken for the management of a potential nesting tree (tree 37) in the Tooheys Road study area south of Wallarah Creek. A specific management plan should be documented detaining appropriate actions to take and to identify replacement of those habitat values lost as a result of the project.

Adam's Emerald Dragonfly

(*Archaeophyta adamsi*) is a moderately large, robust dragonfly. Larvae grow to about 23 mm in length and have a large two-lobed frontal plate on the head, which distinguishes them from any other species found in NSW. The adults have a brown-black body with yellow markings, and a slight green or bluish metallic reflection on some parts. The abdomen length is around 46 mm and wingspan around 37 mm. It is one of Australia's rarest dragonflies. Only five adults have ever been collected, and the species is only known from a few sites in the greater Sydney region.

Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation. All dragonflies are predatory. The larvae stalk or ambush their aquatic prey while the adults capture their prey on the wing. Adam's emerald dragonfly larvae live for 7 years or so and undergo various moults before metamorphosing into adults. Adults probably live for a few months at most. Adult dragonflies generally fly away from the water to mature before returning to breed. Males congregate at breeding sites and often guard a territory. Females probably lay their eggs into the water. Adam's emerald dragonflies seem to have a low natural rate of recruitment and limited dispersal abilities (DECCW threatened species webpage 2006).

The Section 5A assessment concluded that if the Adams Dragonfly were to occur within the study areas the extent of habitat suited for this species to be removed compared to what will remain intact is small and as such the proposal is **unlikely** to cause a significant impact to the species.

EPBC Act – Assessments of Significance

The assessment of impacts on EEC's and flora and fauna species in accordance with the EPBC Act is included in full in the specialist report contained in Appendix Q. The conclusion of the assessments is provided below.

Angophora inopina

The action (development in the study area) is considered likely to impact on *Angophora inopina*, as the local population represents an "important population" at the limit of its distribution. Impacts may be felt due to increased fragmentation, loss of occupancy area and potential for invasion by exotic weed species. Impacts to *Angophora inopina* have been referred to the Minister of the Department of Environment, Water, Heritage and the Arts (DEWHA) and have been subsequently determined as a Controlled Action.

Arachnorchis tessellatus

The action (development in the study area) is considered unlikely to impact on local populations of *Arachnorchis tessellatus.*

Grevillea parviflora subsp. parviflora

The action (development in the study area) is unlikely to impact on local populations of *Grevillea parviflora* subsp*. parviflora*. The proposed development of the subject site is not considered to impact upon an 'important population' of *Grevillea parviflora* subsp*. parviflora*.

Melaleuca biconvexa

The action (development of the study area) is unlikely to impact (either directly or indirectly) on local populations of *Melaleuca biconvexa*, as no specimens are planned for removal. The local population of *Melaleuca biconvexa* is not considered an 'important population' under the Act.

Tetratheca juncea

The action (development of the study area) will impact on a number of local sub-populations of *Tetratheca juncea* within the study area. Several tens of plants will be removed through the construction of the proposed rail loop and other surface facilities, resulting in loss of occupied habitat. Other plants will be excluded from development, and while not surveyed in detail, it is likely that several other unrecorded sub-populations occur in adjacent areas, both in WACJV ownership and the contiguous DLALC/ Crown lands.

Acacia bynoeana

The action (development in the study area) is considered unlikely to impact on *Acacia bynoeana*, as much larger populations and contiguous habitat occur in the wider area. Invasion by exotic weed species may impact on the species long-term survival, however there is minimal risk of this occurring in this habitat.

Cryptostylis hunteriana

The action (development in the study area) is considered unlikely to impact on *Cryptostylis hunteriana*, as the proposed development will occur approximately 200 m downslope of the only known record of this species in the study area.

13.1.14 Key Threatening Processes – Surface Facilities

The *Threatened Species Conservation Act 1995* lists in Schedule 3 a number of activities that are regarded as potentially damaging to native flora and fauna. The relevant items listed in Schedule 3 and how they apply to the W2CP is summarised in Table 13.7. It should be noted that this table sets out a simple yes or no answer as a checklist to establish the issues that that are addressed in the EA. A similar table is provided in Section 13.2.11 which covers Key Threatening Processes for the mining area. Key Threatening Processes that are of a National concern are listed under the EPBC Act. Table 13.8 summarises the relevance of National KTPs and the W2CP.

Table 13.7 State Key Threatening Process Summary for the W2CP Surface Facilities

Key Threatening Process (KTP)	KTP active prior to this proposal	Will the proposal exacerbate KTP	Will the proposed offsets mitigate the Impact
Alteration of habitat following subsidence due to longwall mining	No	No	No
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	**Yes**	**Yes**	**Yes**
Anthropogenic climate change	**Yes**	**Yes**	Unable to determine
Bushrock removal	No	No	No
Clearing of native vegetation	**Yes**	**Yes**	**Yes**
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	**Yes**	No	**Yes**
Competition and habitat degradation by feral goats (*Capra hircus*)	**Yes**	No	**Yes**
Competition from feral honey bees (*Apis mellifera*)	**Yes**	No	No
Death or injury to marine species following capture in shark control programs on ocean beaches	No	No	No
Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments	No	No	No
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	No	No	No
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	**Yes**	No	**Yes**
Herbivory and environmental degradation caused by feral deer	No	No	No
Importation of red imported fire ants (*Solenopsis invicta*)	No	No	No
Infection by psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations	No	No	No
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	No	No	**Yes**
Infection of native plants by *Phytophthora cinnamomi*	No	No	No
Introduction of the large earth bumblebee (*Bombus terrestris*)	No	No	No
Invasion and establishment of exotic vines and scramblers	**Yes**	No	**Yes**
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	No	No	No

Table 13.7 State Key Threatening Process Summary for the W2CP Surface Facilities

Key Threatening Process (KTP)	KTP active prior to this proposal	Will the proposal exacerbate KTP	Will the proposed offsets mitigate the Impact
Invasion and establishment of the cane toad (*Bufo marinus*)	No	No	No
Invasion, establishment and spread of *Lantana camara*	No	No	No
Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed)	No	No	No
Invasion of native plant communities by exotic perennial grasses	**Yes**	No	**Yes**
Invasion of the yellow crazy ant (*Anoplolepis gracilipes* (Fr. Smith)) into NSW	No	No	No
Loss of hollow-bearing trees	**Yes**	**Yes**	**Yes**
Loss or degradation (or both) of sites used for hill-topping by butterflies	No	No	No
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	No	No	No
Predation by the European red fox (*Vulpes vulpes*)	**Yes**	No	**Yes**
Predation by the feral cat (*Felis catus*)	**Yes**	No	**Yes**
Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish)	**Yes**	No	No
Predation by the ship rat (*Rattus rattus*) on Lord Howe Island	No	No	No
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	No	No	No
Removal of dead wood and dead trees	**Yes**	**Yes**	**Yes**

Table 13.8 National Key Treatening Process Summary for the W2CP Surface Facilities

Key Threatening Process	Is this already occurring on site?	Will there be a direct effect?	Will there be an operational effect?
Competition and land degradation by rabbits	Yes – this species was recorded on site during the 2006 field assessments.	Managed mine site – rabbits will be excluded through feral animal controls.	There will be a positive effect. Existing populations will be controlled by the development.
Land clearance	Yes - Historically the area has been cleared for grazing and subsequently used for pasture improvement and possibly cropping.	Yes land clearing would be required.	Yes the proposal would aim to revegetate the Project Site and improve internal connectivity.

Table 13.8 National Key Treatening Process Summary for the W2CP Surface Facilities

Key Threatening Process	Is this already occurring on site?	Will there be a direct effect?	Will there be an operational effect?
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	Yes	Any additional anthropomorphic activity would increase this KTP	Yes – Refer to Section 12.7.
Predation by European red fox	Yes – this species was recorded on site during the 2006 field assessments.	Direct impacts would not directly increase the potential effects of this KTP.	There will be a positive effect. Existing populations will be controlled by the development.
Predation by feral cats	Yes – this species was recorded on site during the 2006 field assessments.	Direct impacts would not directly increase the potential effects of this KTP.	There will be a positive effect. Existing populations will be controlled by the development.

Table 13.9 Ecological Assessment Report Considered the KTPs

Name of NSW KTP	Name of Nationally listed KTP	Details of threat	Has mitigation been offered?
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	No Nationally listed equivalent	Creeks and drainage lines have the potential to be impacted if there is a change or alteration in site hydrology and species dependant on these habitats would decline.	Yes – see direct impact area ecology report (Appendix Q): • Section 6.1.8 (general measures) • 5.2.9 (fisheries issues); and • 5.3.4 and 9.2 (Special natural features - A 7 (g) zoned wetland).
Anthropogenic climate change	Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	It is understood that any human activity will produce green house gasses.	No – the effects of these has not been a component of the ecological assessment (Appendix Q), however detailed greenhouse gas assessment is included in the main document as Section 12.7.

Table 13.9 Ecological Assessment Report Considered the KTPs

Name of NSW KTP	Name of Nationally listed KTP	Details of threat	Has mitigation been offered?
Clearing of native vegetation	Land clearance	The primary impact of the proposed W2CP surface facilities is the removal of 4.54 of 56.59 ha of native vegetation at the Buttonderry study area, 17.27 ha (of 261.97 ha) of native vegetation at the Tooheys Rd study area and 0.92 ha of native vegetation within the Wyong State Forest. Cumulatively, W2CP direct impacts will removal 22.73 ha of native vegetation. Up to 10 ha of native vegetation will also be removed within DLALC land adjoining the TransGrid easement for the purpose of the proposed rail spur.	Yes – see direct impact area ecology report (Appendix Q): • Section 6.1.1 (vegetation clearing, general recommendations) • 5.3.4 and 9.2 (Special natural features - A 7 (g) zoned wetland) . • 9.3 (vegetation); and • 9.8 (impacts to threatened species).
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	Competition and land degradation by rabbits	Feral animals are already common within the assessed areas; however local populations of rabbits would be significantly reduced by feral animal control on site.	Yes – see direct impact area ecology report (Appendix Q): • Section 6.1.7 (general recommendations – development of a feral animal management plan) • 9.5 (specific recommendations).
Competition and habitat degradation by feral goats (*Capra hircus*)	No Nationally listed equivalent	The property has in the past been used for goat farming.	Yes – already implemented. Goats were removed from the property under the current land ownership.
Competition from feral honey bees (*Apis mellifera*)	No Nationally listed equivalent	Competition for tree hollows and with native bee habitat (direct threat to hollow dependant species and to the Tetratheca population).	Yes – see direct impact area ecology report (Appendix Q): • Section 6.1.7 (general recommendations – development of a feral animal management plan) • 9.5 (specific recommendations, does not target this species but this will be rectified in the feral animal management plan).

Table 13.9 Ecological Assessment Report Considered the KTPs

Name of NSW KTP	Name of Nationally listed KTP	Details of threat	Has mitigation been offered?
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	No Nationally listed equivalent	High frequency fires are a threat to all biota in the Project Site. Fire has been noted as a specific threat to the population of *Angophora inopina* occurring both within and on adjacent land to the Project Site.	Yes – see direct impact area ecology report (Appendix Q): • Section 6.1.9 (general recommendations); and Section 9.6 (specific recommendations for a fire management plan).
Invasion and establishment of exotic vines and scramblers	No Nationally listed equivalent	Competition with native biota.	Yes – see direct impact area ecology report (Appendix Q): • Section 6.1.9 (general recommendations for a vegetation management plan); and • Section 9.6 (specific recommendations).
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	No Nationally listed equivalent	Introduction of disease potentially wiping out a naive population.	Yes – see direct impact area ecology report (Appendix Q): • Section 9.7 discusses actions required to maintain population health in the event of management of a frog population.
Predation by the feral cat (*Felis catus*)	Predation by feral cats	Predation of, and competition with, native biota.	Yes – see direct impact area ecology report (Appendix Q): • Section 6.1.7 (general recommendations – development of a feral animal management plan) • Section 9.5 (specific recommendations, does not target this species but will be included in the feral animal management plan).

Table 13.9 Ecological Assessment Report Considered the KTPs

Name of NSW KTP	Name of Nationally listed KTP	Details of threat	Has mitigation been offered?
Predation by the European red fox (*Vulpes vulpes*)	Predation by European red fox	Predation of, and competition with, native biota.	Yes – see direct impact area ecology report (Appendix Q): • Section 6.1.7 (general recommendations – development of a feral animal management plan) • Section 9.5 (specific recommendations, does not target this species but will be included in the feral animal management plan).

13.1.15 Mitigation Strategies - General

Vegetation

In order to limit the impact of vegetation clearing on the environment, the following strategies will be employed:

- Human movement will be restricted to dedicated tracks and specific areas to be impacted such that the development will have no impacts occurring beyond those boundaries. This will be achieved by marking out the limits of the site with an easily identified boundary marker;

- Installation of orange road work curtilage delimiting the extent of the impact footprint in areas where EEC's have been identified to ensure there are no inadvertent impacts on the EEC outside of the impact footprint.

- All contractors and staff undertaking work within the locality of the presence of the EEC will undergo an induction which will inform staff of the legal requirements WACJV has undergone to impact the EEC and enforce a due diligence ethic for minimising all unnecessary impacts. Part of the induction will focus on an environmental risk assessment;

- Minimise clearing of vegetation as much as practicable, only removing what has to be removed and have no impact on vegetation outside of the impact footprint.

- Identify hollow bearing trees from painted numbers on their trunks or by the red and white flagging tape tied around it and clearly mark it again with a distinctive identifier;

- Tree clearing in spring will be avoided due to bird nesting;

- Remove non habitat trees (hollow bearing) first to ensure that the associated disturbance will flush out any animals from within the habitat trees;

- Before felling a tree, it will be checked for the presence of birds or nestlings and arboreal mammals;

- As part of the clearing process, the tree will be gradually nudged at intermittent intervals so that any animal occupying a habitat tree can have the chance of vacating the area after the initial disturbance period;

- An ecologist will be engaged when hollow bearing trees are to be removed to check all hollow bearing trees for the presence of birds or nestlings and arboreal mammals before felling or pushing;

- An appropriate plan will be prepared and in place and equipment on site to cater for injured animals. Advice will be sought from a qualified wildlife veterinarian prior to preparing this plan; and

- No vegetation will be burnt on site. Available options such as removal for use as firewood or mulching for rehabilitation works will be considered at the time.

Birds

Specific mitigation measures for birds include:

- ❒ use native species that provide resources for birds in rehabilitation areas, such as trees that will bear hollows in the future;
- ❒ raise awareness of employees and contractors in relation to road kills and train strikes through environmental training and signs; and
- ❒ identify opportunities to create effective wildlife corridor at the planning stage and enhance those identified corridors within the sites so that the vegetation provides enough cover for bird dispersal.

Specific mitigation recommended for the Powerful Owl recorded in the Tooheys Road study area include:

- ❒ Develop a specific management plan to remove tree 37 south of Wallarah Creek that contains a bird of prey nest (possibly powerful owl);
- ❒ This plan should detail the timing and method of tree removal and should be supervised by a qualified ecologist; and
- ❒ Appropriate habitat compensation should occur for the values removed such as replacement of the tree with up to four nesting boxes for this species that should be placed in adjoining woodland.

Mammals

Mitigation measures for threatened mammals are essentially the same as for threatened birds, with the following additions:

- ❒ Using native species that provide resources for mammals in rehabilitation areas, such trees that will bear hollows in the future and native grasses and sedges that form thick ground layers;
- ❒ Salvage hollows logs from areas to be cleared and place these in areas to be rehabilitated; and
- ❒ Erect nest boxes in adjacent vegetation or rehabilitation areas for arboreal fauna including insectivorous bats, and monitoring their use.

Frogs

Mitigation measures to ameliorate impacts for threatened amphibians and reptiles are the same for threatened flora and fauna (above), however additional measures include:

- ❒ Using native species that provide resources for reptiles in rehabilitation areas, such as trees with peeling bark, hollows or crevices for geckos, lizards and snakes;
- ❒ Ensuring the acidity of the water in adjacent swamps and streams remains the same to preserve amphibian habitat;

- ❒ Salvage hollows logs and debris from areas to be cleared and place in rehabilitation areas or identified corridors to provide habitat for reptiles;

- ❒ Create artificial ponds and wetlands on the site to compensate for swamps, and dams that may be impacted by the proposed project. Design these so that they can be drained to control populations of Mosquito Fish should they encroach on the area – parallel drainable ponds would best suit management of frogs and Mosquito Fish;

- ❒ Raise awareness of employees and contractors in relation to sensitivity of water bodies for amphibian habitat; and

- ❒ Enhance identified corridors within the sites so that the vegetation is appropriate for reptile and amphibian dispersal.

Specific measures for the Wallum Froglet include:

- ❒ Installing culverts beneath the proposed rail loop;

- ❒ Connecting areas of known habitat; and

- ❒ Erecting and maintaining frog-exclusion fencing along both sides of the proposed rail loop in riparian areas.

At minimum design of these structures ensure that they:

- ❒ Connect known habitats to the east and west of the proposal area;

- ❒ Be a minimum of 1 m high and 3 m wide;

- ❒ Have a channel through the centre of the culverts to hold water, even in dry times to better encourage frogs to use the structures; and

- ❒ Be otherwise lined with a natural substrate comprising earth or humus have a fence (either made from fine mesh or 50 cm vertical metal), constructed at the entrance of the culverts to prevent larger predators from entering to limit their predation on the smaller frogs within the culverts.

Frog-exclusion fencing could be constructed along the eastern and western sides of the proposed rail loop or access tracks in the general vicinity of known populations, or anywhere mapped vegetation units of Narrabeen Alluvial Drainage Line Complex, or Alluvial Riparian Blackbutt Forest occur. Fencing would minimise mortality and would act to guide frogs into culverts. The exact form of the frog exclusion fencing would need to be researched and trialled.

The translocation of individuals from the impact footprint may be implemented just prior to destruction. It must be noted that this is not a mitigation measure, but is a duty of care so that the unnecessary death of individuals can be minimised where possible.

13.1.16 Mitigation Strategies – Threatened Species

Specific measures for threatened plants include:

- A Vegetation Management Plan (VMP) will be developed to document the locations of threatened flora and audit their status annually. The VMP will aim to 'improve or maintain' the status of these species in the study area.

- Establishing a specific 12 ha Vegetation Enhancement Area along Wallarah Creek within the Tooheys Road site as shown on Figure 16.1 in Chapter 16. The outcome of the VMP will be to determine the existing status of this community and its habitat value, establish the necessary management works required to improve the community as well as ongoing management principles.

- Establishing a sepecific *Angophora inopina* Revegetation Area at the Tooheys Road site. The outcomes of the VMP will be to establish the methodology for enhancing *Angophora inopina* population within the nominated 6 ha area as shown on Figure 16.1. The principles of Landscape Function Analysis (LFA) will be implemented to provide a predictive understanding of how well the rehabilitation and habitat enhancement activities are working.

- Establishing a 50 ha Ecological Offset Area as shown on Figure 16.1. The VMP will provide principles for the ongoing management of this property as well as a mechanism for its permanent protection.

Specific measures for *Acacia bynoeana* (V TSC Act, V EPBC Act) include:

- attempts will be made to translocate plants (either through extraction of the entire plant, or via propagation from cuttings) from the impact zones, and relocate them into suitable habitat within the Ecological Offset areas. This will only be undertaken with the consent of the relevant authorities, and ideally in concert with researchers at the University of Newcastle (Mike Cole & Colin Driscoll).

Specific measures for *Angophora inopina* (V TSC Act, V EPBC Act) include:

- physically marking and tagging trees present within the impact areas prior to construction; and

- propagating the species from locally collected seed, and enhancing existing populations in adjacent, undisturbed lands – such as within the *Angophora inopina* Vegetation Enhancement Area. However, given the large numbers of plants already present in the area (Bell 2004), this may not be necessary.

- A Fire Management Plan (FMP) will be developed in conjuction with the DLALC (the majority of the population occurs on DLALC land). As this species is fire sensitive the aim of the FMP will be to reduce the risk of high intensity fire where the population occurs.

Specific measures for *Tetratheca juncea* (V TSC Act, V EPBC Act) include:

- instigating a translocation and monitoring program. A similar translocation program has been running in the northern Wyong area for 3 years (Driscoll & Bell 2004), with some degree of success. Any translocation program will

follow the guidelines published by the Australian Network for Plant Conservation (Brown et al. 2003). However, such a program would require the agreement of relevant government agencies. Given the large number of *Tetratheca juncea* in the lands that will not be directly impacted upon, together with the adjacent lands, such a translocation may not be required.

Specific mitigation measures for threatened birds include:

- Rehabilitaiton activities will use native species that provide resources for birds, such as trees that will bear hollows in the future;
- Raise awareness of employees and contractors in relation to road kills and train strikes through environmental training and signs; and
- Identify opportunities to create effective wildlife corridor at the planning stage and enhance those identified corridors within the sites so that the vegetation provides enough cover for bird dispersal.

Mitigation measures for threatened mammals are essentially the same as for threatened birds, with the following additions:

- Rehabilitaiton activities will use native species that provide resources for mammals, such as trees that will bear hollows in the future and native grasses and sedges that form thick ground layers;
- Salvage hollows logs from areas to be cleared and place these in areas to be rehabilitated; and
- Erect nest boxes in adjacent vegetation or rehabilitation areas for arboreal fauna including insectivorous bats, and monitor their use.

Specific mitigation recommended for the Powerful Owl (V TSC Act) recorded in the Tooheys Rd study area includes:

- Develop a specific management plan to remove tree 37 south of Wallarah Creek that contains a bird of prey nest (possibly powerful owl). This plan will detail the timing and method of tree removal and be supervised by a qualified ecologist; and
- Appropriate habitat compensation will occur for the values removed such as replacement of the tree with up to four nesting boxes for this species that will be placed in adjoining woodland.

Mitigation measures to ameliorate impacts for threatened amphibians and reptiles are the same for threatened flora and fauna (above), however additional measures include:

- Rehabilitaiton activities will use native species that provide resources for reptiles, such as trees with peeling bark, hollows or crevices for geckos, lizards and snakes;
- An appropriately qualified and experienced ecologist will be engaged to provide advice and assist with pre-clearing surveys and be present during the removal of habitat trees;

- ❒ Ensuring the acidity of the water in adjacent swamps and streams remains the same to preserve amphibian habitat;

- ❒ Salvage hollows logs and debris from areas to be cleared and place in rehabilitation areas or identified corridors to provide habitat for reptiles;

- ❒ Create artificial ponds and wetlands on the site to compensate for swamps, and dams that may be impacted by the proposed project. These ponds will be designed so that they can be drained to control populations of Mosquito Fish should they encroach on the area – parallel drainable ponds would best suit management of frogs and Mosquito Fish;

- ❒ Raise awareness of employees and contractors in relation to sensitivity of water bodies for amphibian habitat;

- ❒ Enhance identified corridors within the sites so that the vegetation is appropriate for reptile and amphibian dispersal;

- ❒ It is not anticipated that translocation of wildlife into new areas of occupation would be required. However, should an appropriately qualified species of interest 'expert' recommend this is requisite during the project, DECCW would be approached and translocation would be undertaken in accordance with DECCW Policy – *Policy for the Translocation of Threatened Fauna in NSW.* If fauna is translocated they will be monitored (under a specific DII ethics approval) using appropriate methods to gather data relating to the success of the activity.

Specific measures for the Wallum Froglet (V TSC Act) include:

- ❒ Installing culverts beneath the proposed rail loop;

- ❒ Connecting areas of known habitat;

- ❒ Erecting and maintaining frog-exclusion fencing along both sides of the proposed rail loop in riparian areas;

- ❒ Further research would be required to determine the appropriate culvert length, height and width for the Wallum Froglet, at minimum it should:
    - o be a minimum of 1 m high and 3 m wide;
    - o have a channel through the centre of the culverts to hold water, even in dry times to better encourage frogs to use the structures; and
    - o be otherwise lined with a natural substrate comprising earth or humus have a fence (either made from fine mesh or 50 cm vertical metal), constructed at the entrance of the culverts to prevent adult Cane Toads from entering to limit their predation on the smaller frogs within the culverts.

- ❒ The translocation of individuals from the impact footprint may be implemented just prior destruction. Further research with relevant government agencies would be required to determine the need for a translocation permit;

- ❒ Any systematic handling of frogs will require the development of a hygiene protocol to minimise the spread of the Chytrid fungus; and

- ❒ Further research into obtaining the appropriate approvals to undertake this would also need to occur.

13.1.17 Biodiversity and Land Management Strategy

WACJV owns approximately 115 ha of forested land that will not require disturbance as part of the development proposal. These lands lie generally between the Buttonderry and Tooheys Road sites. There are also approximately 318 ha of forested land within the development areas that would also not be disturbed.

Developing an ecological offset strategy for the estimated loss of a maximum of 33 ha of existing native vegetation is straightforward. Although it is proposed to offset an area of 50 ha of existing native vegetation on lands currently owned by the WACJV it is also proposed to develop a more comprehensive biodiversity land management strategy that takes into account other aspects of the project in order to provide real benefits to the wider environment, consistent with the philosophies of the DECCW Biobanking and Offsets Policy (refer to Section 4.13). The main elements of the strategy are discussed below.

Securing 50 ha of existing native vegetation on WACJV land holdings between the Buttonderry and Tooheys Road surface facilities areas as shown on Figure 16.1. Subject to negotiation, this area will be protected by a permanent land covenant registered on the Land Title. This provides greater protection than alternative means such as land zoning, voluntary conservation agreements or even dedication as part of the National Parks Estate.

Remaining vegetated areas within the project facilities sites will be actively managed for ongoing conservation purposes. The area will also serve as a buffer around the facilities to minimise visual impacts. The nominated conservation lands include 12 ha along Wallarah Creek within the Tooheys Road site which will be subject to active management to increase its habitat value and a further 6 ha area nominated for specific revegetation works for *Angophora inopina.*

The main purpose of the 50 ha land dedication is to link in with other vegetated land to the south and south west of the Tooheys Road site as well as to the north of the Buttonderry site. This vegetated corridor will be enhanced by active management of dedicated land and will provide a long term fauna corridor in the region.

There are large areas within the infrastructure sites which represent good quality grazing land. The remaining grazing land around the Buttonderry Site is currently zoned for agricultural purposes and will remain as such. However, riparian vegetation of Wallarah Creek which flows through the Tooheys Road site will be actively managed for conservation purposes. Specifically, this zone will be enhanced by the removal of existing weed infestation and replanting with native vegetation.

WACJV will also develop, in consultation with landowners, a riparian zone enhancement program along Jilliby Jilliby Creek. This program will be designed to improve water quality and riverbank stability by a combination of weed removal and new plantings. The program will fall under the Wallarah 2 Coal Community Trust which will be funded by the project owners.

The ecological offset strategy will result in no net loss of flora and fauna values in the area in the medium to long term, as a result of the W2CP. It will provide opportunities to improve the regional biodiversity by permantely protecting and

conserving habitat areas, and with the active management techniques proposed will improve the value of existing vegetation.

13.2 Flora and Fauna of Predicted Subsidence Areas

OzArk Environmental and Heritage Management Pty Ltd (OzArk) were commissioned by Wyong Areas Coal Joint Venture (WACJV) to undertake ecological assessment within the W2CP Proposed mining area. This area includes land with potential to be affected by subsidence. The area potentially affected by subsidence is shown on Figure 13.21 and Figure 13.22 which is approximately 41.7 Km^2. Although there is technically an island within the subsidence footprint (0.88 km^2) which will not be subsided, for completeness, this internal area has been included in the study area and assessed.

These areas are regarded as being potentially subject to indirect impact**,** as underground mining activities will result in some surface impacts. Assessment has been undertaken to establish the likely ecological values, with a significant focus on the manner in which the proposed impacts (subsidence, tilt, altered hydrology etc.) may affect these values. Complete survey is not considered necessary to achieve this aim. Targeted survey and review of previous studies placed in their regional context is considered adequate to understand the potential impacts to the terrestrial ecological values.

Database searches and literature reviews were undertaken and the result were used to compliment / supplement previous survey and desktop assessments of the existing natural terrestrial environment. Baseline information gathered was subsequently analysed to determine significance of impact upon items of conservation value known, or having the potential to occur, within the assessed indirect impact areas.

The report is contained in full as Appendix R, and summarised in the following sections. A separate assessment was undertaken of the impact of the W2CP on the ecological values as a result of the construction and operation of the surface facilities, as discussed above.

13.2.1 Database Reviews

Records of threatened species of plants and animals were obtained from the Department of Environment and Climate Change and Water (DECCW) for the project locality using the Dooralong 9131-1S and Wyong 9131-2N 1:25 k map sheets.

Species, populations, communities and migratory species noted by the Department of Environment, Water, Heritage and the Arts (DEWHA) as having the potential to occur within the Local Government Area (LGA) was accessed through the DEWHA online protected matters report database and then mapped using the DECCW wildlife atlas.

The BioNet and NSW Fisheries Fish files online database was also searched so that any gaps in DECCW data from other agencies (Royal Botanic Gardens, DPI-Fisheries and Forest NSW and the Australian Museum) could be identified.

Determining the location and extent of EEC's in the Wyong LGA was problematic due to different methods employed to describe vegetation over the years. To

properly address the presence of EEC's in the study area vegetation mapping within the proposed subsidence area was undertaken.

Several threatened species of flora are known to occur in the area of proposed subsidence; these include:

- *Tetratheca juncea*;
- *Melaleuca biconvexa*; and
- *Grevillea parviflora* spp *parviflora*.

The locations of threatened plants in the Wyong LGA can be seen in Figure 13.21 with those occurring within the potential subsidence area seen as Figure 13.22.

Several threatened species of fauna are known to occur in the proposed subsidence area (**Figure 3.24**) these include:

- Giant Barred Frog *(Mixophyes iteratus);*
- Stuttering Frog *(Mixophyes balbus);*
- Grey-headed Flying-Fox *(Pteropus poliocephalus);*
- Spotted-tailed Quoll *(Dasyurus maculatus);*
- Masked Owl *(Tyto novaehollandiae); and*
- Black-necked Stork *(Ephippiorhynchus asiaticus).*

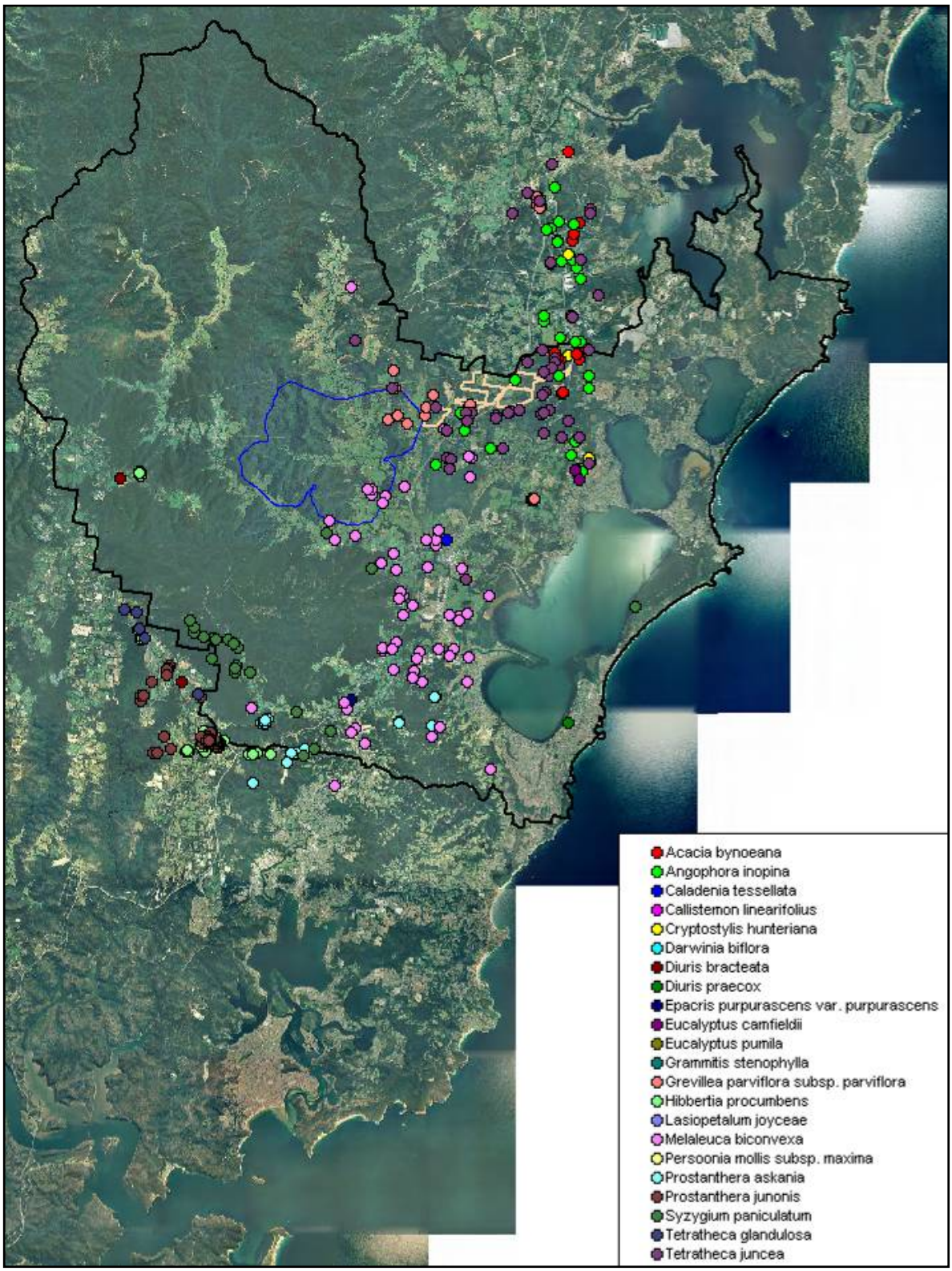

Figure 13.21 Threatened Flora within the Wyong LGA (black) and the Area of Proposed Subsidence (blue) (Source: Eastcoast Flora Surveys).

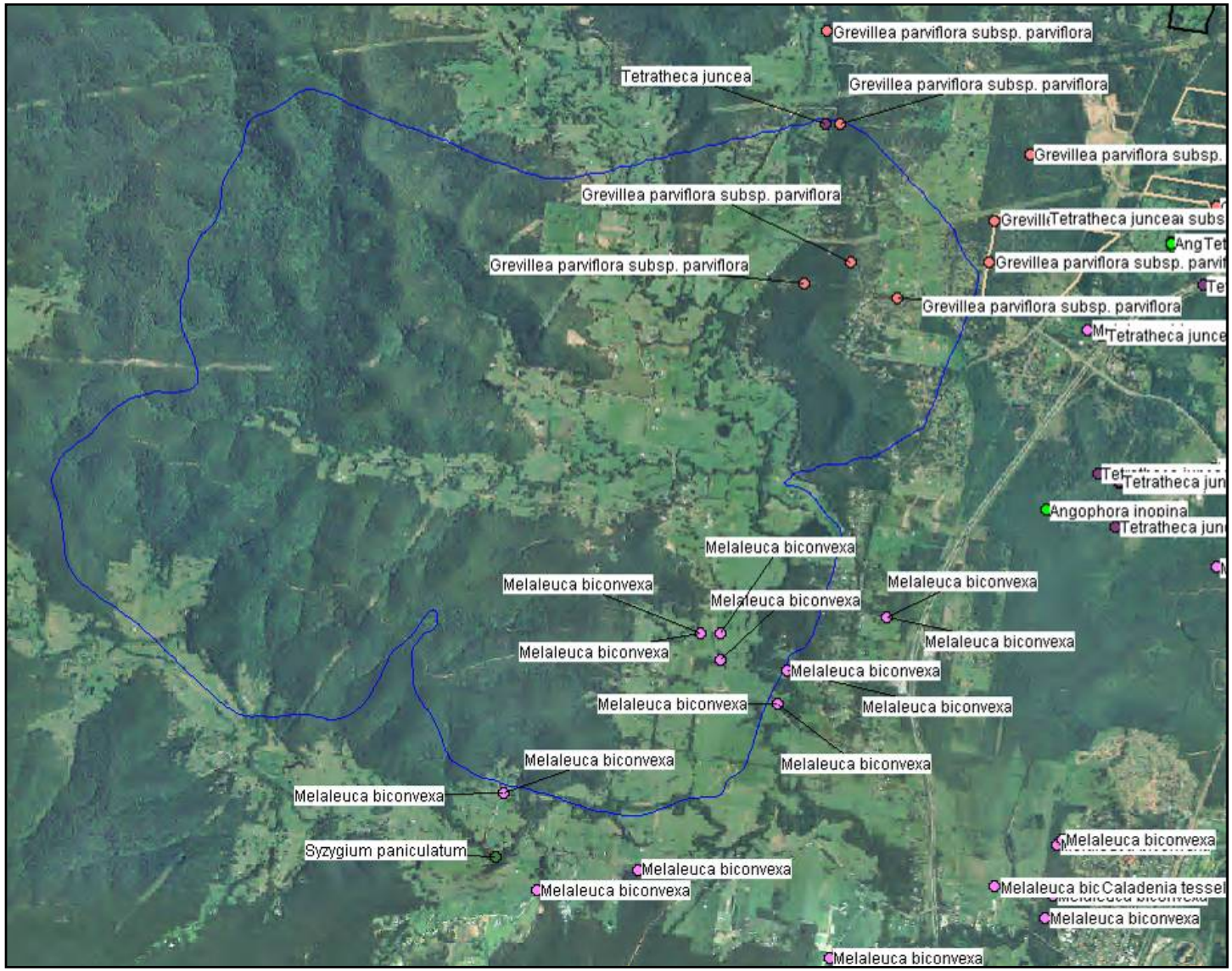

Figure 13.22 Threatened flora within the predicted subsidence area (blue)

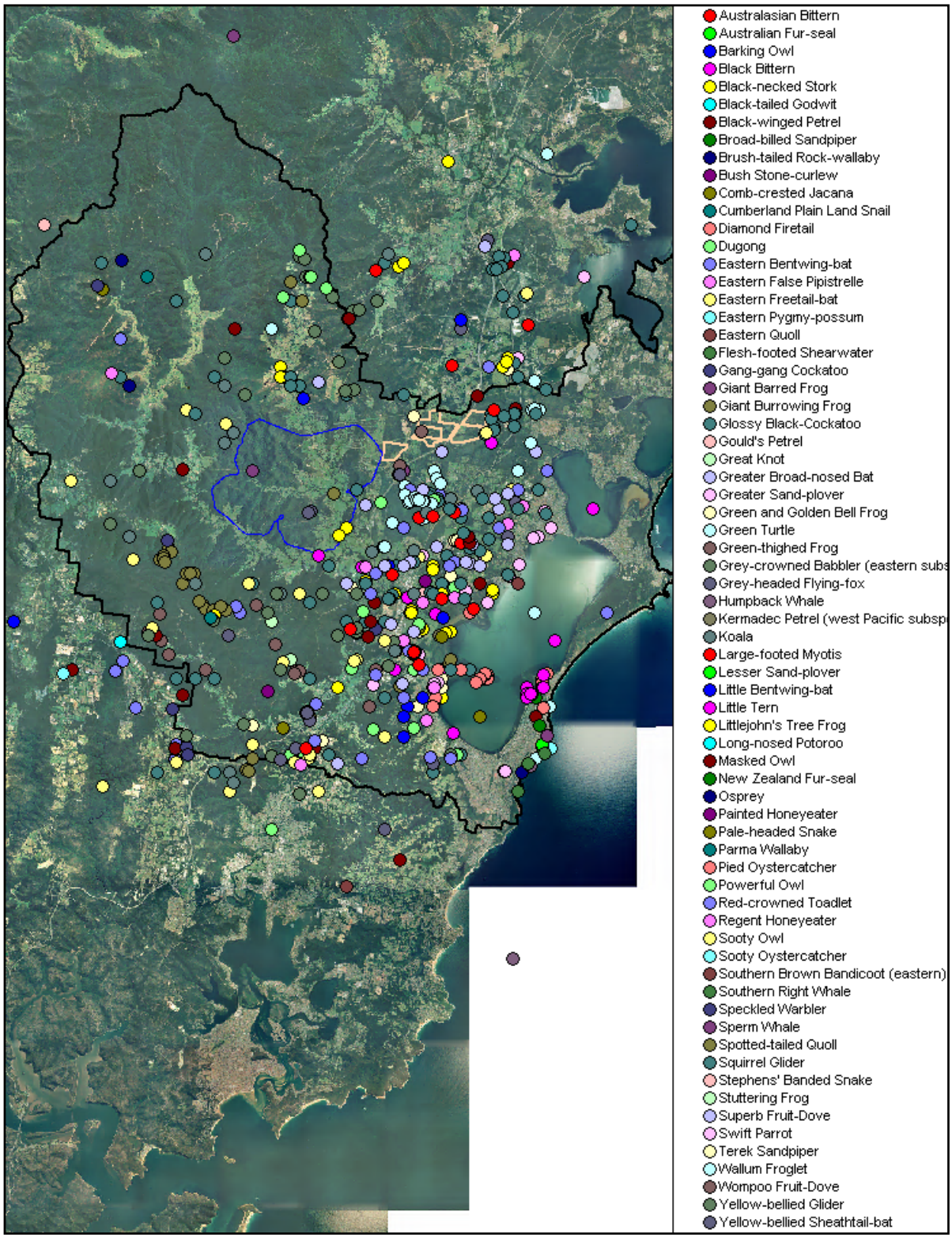

Figure 13.23 Threatened fauna within the Wyong LGA (black). The predicted subsidence area is shown in blue and proposed surface facilities and ecological offset investigation area in pink

Figure 13.24 Threatened Fauna within the Proposed Subsidence Area (blue) (Source: Eastcoast Flora Surveys).

Those species recorded outside the predicted subsidence area but within the same landform units (i.e. treed hills and cleared valleys) include (Figure 13.23):

- Sooty Owl *(Tyto tenebricosa);*
- Powerful Owl *(Tyto strenua);*
- Barking Owl *(Ninox connivens);*
- Koala *(Phascolarctos cinereus);*
- Black Bittern *(Ixobrychus flavicollis);*
- Australasian Bittern *(Botaurus poiciloptilus);*
- Giant Burrowing Frog *(Heleioporus australiacus);*
- Glossy Black Cockatoo *(Calyptorhynchus lathami);*
- Gang Gang Cockatoo *(Callocephalon fimbriatum);*
- Regent Honeyeater *(Xanthomyza phrygia);*
- Greater Broad-nosed Bat *(Scoteanax rueppellii);*
- Eastern Falsistrelle *(Falsistrellus tasmaniensis);*
- Little Bentwing Bat *(Miniopterus australis);*
- Large Footed Mytosis *(Mytosis adversus);*
- Yellow-bellied Sheathtailed Bat *(Saccolaimus flaviventris)* tentative sighting only;
- Squirrel Glider *(Petaurus norfolcensis);*
- Yellow-bellied Glider *(Petaurus australis);*
- Wallum Froglet *(Crinia tinnula);* and
- Green-thighed Frog *(Litoria brevipalmata).*

With specific regard to Migratory Wetland Species listed by DEWHA in the Wyong LGA, the following species have been previously listed in the area of proposed subsidence:

- Fork-tailed Swift;
- Latham's Snipe;
- Cattle Egret;
- Rufous Fantail; and
- Black-faced Monarch.

13.2.2 Vegetation within the Predicted Subsidence Area

Definition of vegetation communities within the proposed subsidence zone was based on previous survey and analysis for the Wyong LGA (Bell 2002a). Limited access to most stands of remnant vegetation present due to private ownership meant that new floristic data could not be collected, and a re-analysis of such data was not undertaken. Key indicator species, as defined in Bell (2002a), were used to attribute each stand of vegetation to a particular vegetation unit. Mapped vegetation units within the proposed subsidence zone can be seen on Figure 13.25 and the extent in the study area seen on Table 13.10**.** The following descriptions are based on observations made from publicly accessible roads, together with vegetation unit descriptions contained in Bell (2002a).

MU15: Alluvial Footslopes Redgum Forest (Bell 2002a)

Small remnants of Alluvial Footslopes Redgum Forest are present principally in the southern sections of the study area, although prior to clearing it would have been quite extensive along the floodplains. In nearly all cases, these remnants are characterised by small groups of *Eucalyptus amplifolia* and/or *Angophora floribunda* over a highly cleared or modified understorey, such as with the establishment of turf farms. In some areas, sub-canopies of *Melaleuca linarifolia, Melaleuca biconvexa* or *Melaleuca decora* may also be present, and ground layer vegetation consists of

various grasses, sedges and herbs. This vegetation type can perhaps be considered a drier form of the Alluvial Floodplain Shrub Swamp Forest (MU20), but in that community *Eucalyptus robusta* is prominent and the understorey supports a higher diversity of moisture loving sedges.

Within Wyong LGA, Alluvial Footslopes Redgum Forest is highly restricted and has suffered from fragmentation and clearing, with estimates of 86% loss having been made (Bell 2002a). Within the regional NPWS classification (2000), this community falls into the Wyong Paperbark Swamp Forest. Alluvial Footslopes Redgum Forest can be considered part of the River Flat Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (RFFCF).

MU19: Alluvial Woollybutt-Melaleuca Sedge Forest (Bell 2002a)

A few small pockets of Alluvial Woollybutt-Melaleuca Sedge Forest occur in the eastern sections of the study area, and originally would have formed a continuum of similar vegetation extending to the south towards Porters Creek Wetland. It is dominated by *Eucalyptus longifolia* (regionally uncommon), together with paperbarks such as *Melaleuca linarifolia, Melaleuca nodosa, Melaleuca sieberi* and *Melaleuca decora*. In intact examples, sedges such as *Schoenus brevifolius, Lepidosperma quadrangulatum* and *Chorizandra cymbaria* are prominent, along with scattered shrubs such as *Melaleuca thymifolia* and *Leptospermum juniperinum*. In areas where partial clearing has occurred, such as along Dickson Road, *Melaleuca nodosa* responds in the form of dense thickets.

Within Wyong LGA, Alluvial Woollybutt-Melaleuca Sedge Forest is highly restricted to the Porters Creek catchment, and estimates of 70% loss have been made (Bell 2002a). Within the regional NPWS classification (2000), this community falls into the Wyong Paperbark Swamp Forest. Alluvial Woollybutt-Melaleuca Sedge Forest can be considered part of the River Flat Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (RFFCF).

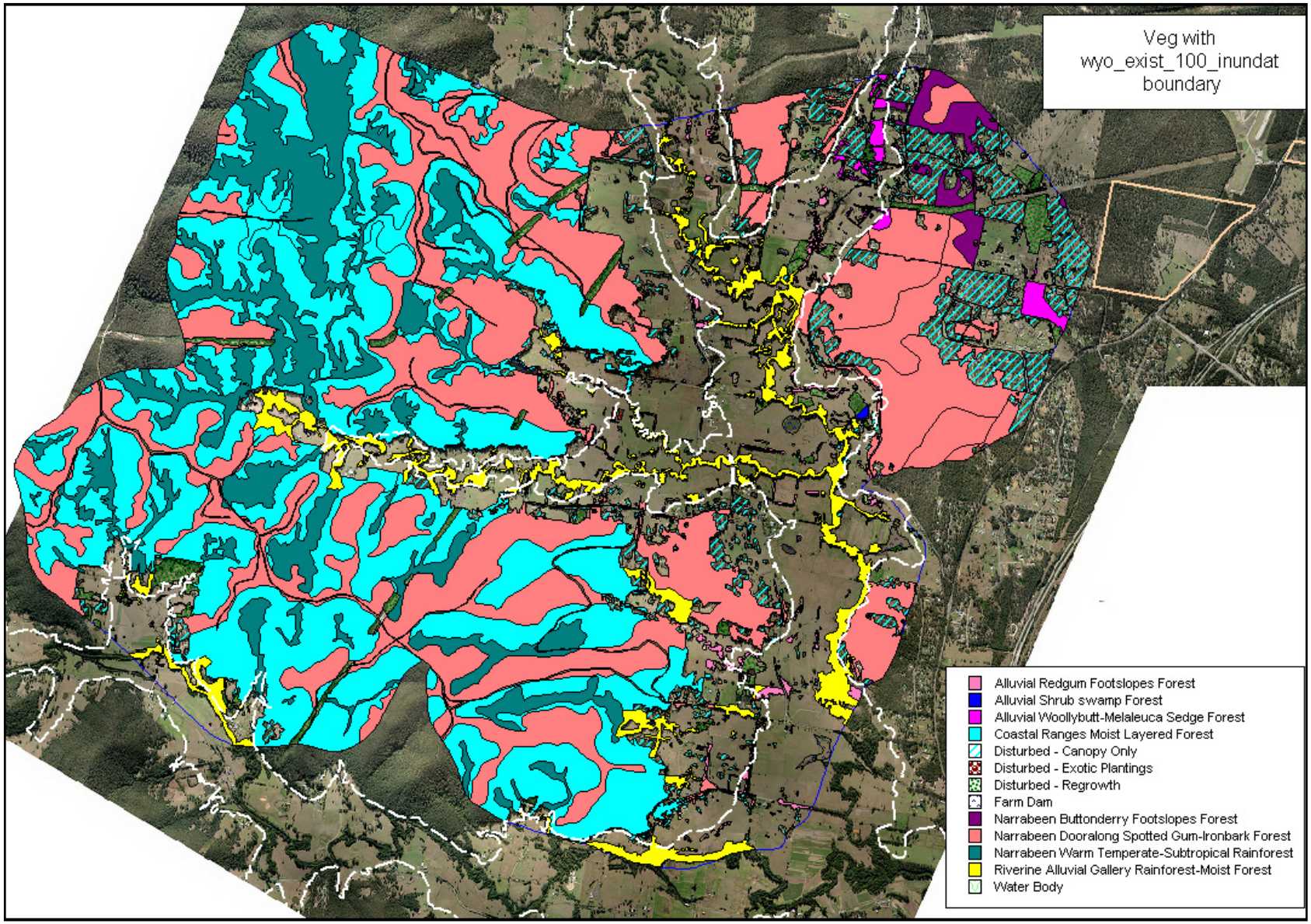

Figure 13.25 Vegetation within the Predicted Subsidence Area

Table 13.10 Vegetation within the Predicted Subsidence Area

Vegetation Community		Signif	Extant LGA	Extant zero subsidence	1% flood extent		5% flood extent		20% flood extent	
MU	**Name**		**ha**	**ha**	**ha**	**% of extant**	**ha**	**% of extant**	**ha**	**% of extant**
15	Alluvial Footslopes Redgum Forest	State	145	19.11	14.02	73.4	11.71	61.3	9.87	51.6
19	Alluvial Woollybutt-Melaleuca Sedge Forest	State	308	17.72	14.71	83.0	8.44	47.6	8.36	47.2
20a	Alluvial Floodplain Shrub Swamp Forest (variant a)	State	895	0.72	0.72	100.0	0.72	100.0	0.72	100.0
28	Narrabeen Buttonderry Footslopes Forest	Local	1016	34.30	0.07	0.2	0.03	0.1	0.02	0.1
30	Dooralong Spotted Gum-Ironbark Forest	Local	2215	1019.00	3.13	0.3	1.92	0.2	1.07	0.1
35	Coastal Foothills Moist Layered Forest	-	23440	998.75	3.21	0.3	2.30	0.2	1.76	0.2
40	Riverine Alluvial Gallery Rainforest-Moist Forest	State	565	163.01	116.12	71.2	112.48	69.0	108.22	66.4
42	Narrabeen Warm Temperate-Subtropical Rainforest	-	4386	398.05	2.65	0.7	1.86	0.5	1.19	0.3
D	Farm Dams	-	-	25.56	14.70	57.5	13.53	52.9	12.80	50.1
W	Water Bodies	-	-	3.85	3.80	98.7	3.80	98.7	3.80	98.7
Xr	Unspecified Canopy only	-	-	238.82	21.44	9.0	18.28	7.7	16.91	7.1
Xs	Unspecified regrowth	-	-	74.37	28.36	38.1	15.11	20.3	13.77	18.5
Totals	-	-	-	***2994.64***	***222.93***	***7.45***	***190.18***	***6.35***	***178.49***	***5.96***

MU20a: Alluvial Floodplain Shrub Swamp Forest (Bell 2002a)

Alluvial Floodplain Shrub Swamp Forest occurs at a single location in the study area, in a small patch of vegetation near Dickson Road. Although occurring on private property and not inspected, it is evident that the canopy is dominated by *Eucalyptus robusta*, with a sub-canopy of *Melaleuca linariifolia* and *Melaleuca decora* also apparent. The understorey is characterised by a dense layer of sedges and grasses, a scattered shrub layer of (probably) *Leptospermum juniperinum, Gahnia clarkei* and juvenile *Melaleuca linariifolia* and *Eucalyptus* species. The Alluvial Floodplain Shrub Swamp Forest, as described in Bell (2002a), is highly variable depending on depth to water table, soil type and other factors. Estimates of 67% loss have been made for this vegetation type (Bell 2002a).

Within the regional classification of NPWS (2000), this community falls into either the Swamp Mahogany – Paperbark Swamp Forest (MU37) or the Wyong Paperbark Swamp Forest. This community can be considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

MU28: Narrabeen Buttonderry Footslopes Forest (Bell 2002a)

Narrabeen Buttonderry Footslopes Forest occurs in the north-eastern section of the study area, where it forms a mosaic pattern with Narrabeen Dooralong Spotted Gum - Ironbark Forest. It is characterised by a canopy of *Angophora costata, Eucalyptus capitellata, Corymbia gummifera, Melaleuca decora,* and *Eucalyptus fibrosa*. Understorey vegetation includes such species as *Banksia spinulosa, Melaleuca nodosa, Bossiaea obcordata, Daviesia squarrosa, Epacris pulchella, Leptospermum trinervium, Goodenia heterophylla, Lomandra obliqua, Themeda australis,* and *Entolasia stricta*. In some areas, soils are notably more sandstone-based than others, and this is reflected in the local understorey composition (eg: *Banksia spinulosa, Lomandra obliqua, Grevillea sericea, Comesperma ericinum* are present in the more sandy soils).

Within the context of regional vegetation studies, this vegetation community may be considered as part of the Coastal Plains Scribbly Gum Woodland (Narrabeen Doyalson Scribbly Gum Woodland: NPWS 2000). Within Wyong Shire, an estimated loss of 47% in distribution has been made since 1750 for this community (Narrabeen Buttonderry Footslopes Forest: Bell 2002a).

MU30: Narrabeen Dooralong Spotted Gum – Ironbark Forest (Bell 2002a)

Narrabeen Dooralong Spotted Gum-Ironbark Forest occurs extensively across the study area. This community is dominated by Spotted Gum (*Corymbia maculata*) and Ironbarks (predominately *Eucalyptus fibrosa* at lower elevations, or *Eucalyptus fergusonii* and *Eucalyptus placita* at higher elevations), over a sparse understorey of shrubs such as *Daviesia ulicifolia* and *Podolobium ilicifolium*, and grasses such as *Themeda australis, Entolasia stricta, Imperata cylindrica* var. *major,* and *Microlaena stipoides* var. *stipoides.* In areas where previous clearing or under-scrubbing has occurred, dense thickets of *Melaleuca nodosa* predominate, greatly reducing the diversity of shrub and ground layer species. In some areas, sections of MU30 have been partially cleared and underscrubbed for grazing purposes, and support a disturbed forest of variable density and canopy retention.

Regionally, this vegetation type is equivalent to Coastal Foothills Spotted Gum – Ironbark Forest (MU15) in NPWS (2000). Bell (2002a) has estimated that the

Narrabeen Dooralong Spotted Gum – Ironbark Forest within Wyong Shire has undergone a 53% loss in areal extent since 1750.

MU 35: Coastal Ranges Moist Layered Forest (Bell 2002a)

Coastal Range Moist Layered Forest represents a vegetation type that is widespread in the western half of the Wyong LGA, and quite extensive within the current study area. These areas are generally tall forests with a moist mesic understorey, although long term disturbance may in some cases have resulted in a simple shrub component with a well developed herbaceous layer. Canopy species present can be highly variable, but those most consistently occurring include *Syncarpia glomulifera* subsp*. glomulifera, Allocasuarina torulosa,* and *Eucalyptus acmenoides*. Areas closer to drainage lines may support *Eucalyptus deanei* or *Eucalyptus saligna*. *Eucalyptus agglomerata* or *Angophora floribunda* may occur on moister slopes, while exposed slopes and ridges can be dominated locally by *Corymbia maculata, Eucalyptus pilularis, Eucalyptus propinqua,* or *Eucalyptus umbra*.

NPWS (2000) describe Coastal Ranges Open Forest, which equates to this community elsewhere in the region. Bell (2002a) has estimated a 21% loss of this vegetation type within the Wyong LGA.

MU 40: Riverine Alluvial Gallery Rainforest-Moist Forest (Bell 2002a)

Riverine Alluvial Gallery Rainforest-Moist Forest occurs only on the deeper alluvium associated with the larger streams, and it merges into MU42 higher up in the catchment where Narrabeen Sediments are found. It often forms narrow zones restricted to the immediate creekline environment. This vegetation type is prone to weed invasion, particularly Camphor Laurel (*Cinnamomum camphora*) and Privet (*Ligustrum* spp.). Native species characterising this vegetation type include emergent *Eucalyptus saligna, Syncarpia glomulifera* subsp. *glomulifera* or *Eucalyptus deanei*, over a canopy of *Acmena smithii, Alphitonia excelsa, Cryptocarya glaucescens, Cryptocarya microneura, Guioa semiglauca, Alectryon subcinereus, Symplocos stawellii, Melicope micrococca, Wilkea heugeliana,* and *Daphnandra* sp. A. Understorey vegetation is usually sparse, but the climbers *Morinda jasminoides, Dioscorea transversa, Cissus antarctica* and *Geitonoplesium cymosum* are common. NPWS (2000) have identified this vegetation type as a specific form of their Coastal Wet Gully Forest (MU1).

Within Wyong LGA, Bell (2002a) has estimated a 16% loss of this community since 1750. Riverine Alluvial Gallery Rainforest-Moist Forest forms part of the Lowland Rainforest in the NSW North Coast and Sydney Basin EEC.

MU 42: Narrabeen Warm Temperate-Subtropical Rainforest (Bell 2002a)

Narrabeen Warm Temperate-Subtropical Rainforest occurs in the ranges to the west of the Jilliby Valley, and occurs extensively outside of the study area elsewhere. It is restricted to the protected south-to-easterly facing gullies and lower slopes along the escarpment. A variety of tree species co-dominate these rainforests, although the more typical ones include *Acmena smithii, Doryphora sassafras, Cryptocarya glaucescens, Ceratopetalum apetalum, Eucalyptus saligna, Alphitonia excelsa*, *Syncarpia glomulifera* subsp. *glomulifera, Guioa semiglauca, Neolitsea dealbata, Synoum glandulosum, Sloanea australis, Syzygium oleosum, Wilkea huegeliana, Caldcluvia paniculosa, Polyosma cunninghamii, Dysoxylon rufum*, and *Syzygium australe*. Understorey vegetation is typically sparse although ferns and climbers are normally prominent. Subtropical influences include epiphytic species (eg: *Arthropteris tenella, Microsorum pustulatum, Hymenophyllum australe, Asplenium*

australasicum forma *australasicum, Microsorum scandens, Platycerium bifurcatum* var. *bifurcatum, Pyrrosia rupestris*), tree ferns (*Cyathea leichhardtiana, Cyathea australis*, *Cyathea cooperi*) and palms (*Archontophoenix cunninghamiana, Livistona australis*). This vegetation type equates to the Coastal Warm Temperate-Subtropical Rainforest of NPWS (2000).

Within Wyong LGA, a 16% loss since 1750 has been reported (Bell 2002a).

MUXr: Canopy-only vegetation

Several locations within the study area support vegetation where understorey structure has been completely or partially removed or modified, such that only emergent canopy trees remain. In such cases, these areas have been mapped with the MU 'Xr'.

MUXs: Regrowth vegetation

A number of areas within the study area support regrowth vegetation that does not align well with any specific vegetation type. In such cases, these areas have been mapped with the MU 'Xs' to indicate opportunist regrowth.

MUW: Water body

Bodies of water that do not appear to be directly attributable to farm dams are marked as "W" in the accompanying mapping. Examples of these include billabongs and other bodies of water associated with the major creeks, and are likely to be natural.

13.2.3 Groundwater Dependant Ecosystems

MU 40, Riverine Alluvial Gallery Rainforest-Moist Forest is reliant on deep alluvium in close proximity to a permanent water source, and in this context may be considered a Groundwater Dependent Ecosystem.

13.2.4 Vegetation Within Jilliby State Conservation Area and Wyong State Forest

Approximately 1158 ha of native vegetation within the proposed subsidence area occurs within the Jilliby State Conservation Area, and 640 ha occur within the Wyong State Forest. Breakdown of vegetation types and number of hectares is provided in Table 13.11 below.

Table 13.11 Vegetation of Conservation Areas within Proposed Subsidence Area

	Jilliby Conservation Area ha	Wyong State Forest ha
Total Area within Proposed Subsidence Area:	*1158 ha*	*640 ha*
Disturbed Regrowth (XS)	14	7
Narrabeen WTSR (MU42)	292	91
Riverine AGRMF (MU 40)	-	1
Coastal Ranges MLF (MU35)	470	310
Dooralong SGIF (MU30)	349	219
Total Mapped Vegetation Units	1124	628

Note: The difference between number of ha in subsidence area versus number of ha in Mapped Vegetation Units (MU's) is due to the volume of un-identified areas along roads and tracks.

13.2.5 Subsidence Induced Flood Regime Alteration Impacts to Vegetation Communities

Detailed flood modelling has been undertaken for the Project, and is discussed previously in Chapter 9. From this modelling, it was estimated that only 7.45% of the existing natural vegetation in the study area is *currently* subject to flooding in the 1:100 year (1% AEP) flood, and the vast majority of this vegetation is also subject to flooding in smaller floods. Modelling for the 1:100 year, 5:100 year (5% AEP) and 20:100 year (20% AEP) flooding regimes showed that the range of existing flooding events primarily affect the Riverine Alluvial Gallery Rainforest-Moist Forest, with minor effect on Alluvial Floodplain Shrub Swamp Forest, Alluvial Woollybutt-Melaleuca Sedge Forest and Alluvial Footslopes Redgum Forest. All four of these communities occur on floodplain alluvium and equate to existing EEC's. Other communities occupy little or none of the land surface within the three current or future flood zones.

The potential impact of subsidence induced changes to existing flood regimes on the four vegetation communities within the flood affected areas is described below.

Riverine Alluvial Gallery Rainforest-Moist Forest – this community is reliant on deep alluvium in close proximity to a permanent water source, and in this context may be considered a Groundwater Dependent Ecosystem. Currently within the proposed mining area, this community is flooded by the 1%, 5% and 20% AEP flood events. Anticipated mine related subsidence will not alter this flood frequency for this vegetation community.

While the frequency of flood events will not be altered by the W2CP, a slight increase in the depth of inundation of this already highly flood-prone community may occur, having the potential to affect between 66 and 72% of the extant distribution of this community within the study area. However, such an effect is unlikely to be significantly detrimental to this community, and is unlikely to provide any significant risk for loss of rainforest species.

Alluvial Floodplain Shrub Swamp Forest – this community occurs in regularly inundated locations with a high water table. The single stand present within the proposed mining area will continue to be potentially affected by all three flooding scenarios. Increased occasional flooding is not expected to significantly alter the composition of this community, although there is a low risk that some species replacement may occur in the lower strata.

Alluvial Woollybutt-Melaleuca Sedge Forest – this community occurs in areas irregularly subjected to flooding events with a high water table. Changes due to subsidence for the 1:100 yr flood event will continue to affect 83% of the extant distribution of this community within the study area. The more frequent flood scenarios will continue to affect around 47% of mapped stands. No significant changes to the extent of this community that is flood-prone is anticipated.

Alluvial Footslopes Redgum Forest – this community typically occurs on alluvial floodplains and associated footslopes, and can withstand some flooding events. Between 51 and 74% of the extant distribution of this community within the proposed mining area will continue to be affected by flooding events. Flood study results (ERM 2009) demonstrate that there will be no significant change to flood frequencies for the areas hosting this community as a result of mining, and there is only a low potential for any likelihood of species replacement in the lower stratum and canopy composition should not change.

13.2.6 Impacts to Groundwater Dependant Ecosystems

There is potential that between 66 and 72% of the extant distribution of Riverine Alluvial Gallery Rainforest-Moist Forest will be affected within the proposed mining area. As groundwater and flooding studies outlined (refer to Chapters 8 and 9 respectively), the potential for hydrological changes to impact significantly on the general stream and alluvial systems is low. The main effect will not be in changing the inundation frequency of this community during the range of flooding regimes, but rather as a result of slightly increased depth of flooding during the major flood events.

Accordingly there are unlikely to be detrimental impacts to this community and no significant potential for any loss of rainforest species.

Existing groundwater levels within the valleys range from 2 m to 30 m below the surface but generally within 8 to 10 m from the surface. As the longwall panels move through the alluvial floodplain the groundwater level is expected to drop by approximately 0.5 m. Ultimately the water table within subsided valley areas would rise and equilibrate across all extracted panels to a new and shallower steady state elevation. As described by Mackie Environmental Research 2009 (Appendix B), the rebound will average 1.3 m higher than at present. This has the potential to impact on vegetation systems in the valley alluvials. Although the majority of vegetation is cleared grazing land, which will be unaffected, riparian vegetation systems will need to be monitored for up to 2 years following extraction. These communities rely on shallow aquifers and it is not anticipated that the anticipated rise in groundwater level will impact on these communities.

13.2.7 Aquatic and Semi-Aquatic Habitats

The Directory of Important Wetlands (DEH 2001 – a DEWHA online search tool) lists 43 wetlands, totalling approximately 93,745 ha, occurring in the Sydney Basin Bioregion. None of the wetland areas identified in the abovementioned search occur in or close to the proposed mining area.

The DEWHA online database (protected matters report) shows that there is one RAMSAR wetland in the region, however this is not within the Wyong LGA.

A search of the Wyong Shire Development Control Plan No 30 2003 (WSDCP No 30) was undertaken to identify SEPP 14 wetlands in the local area. There are no areas identified as 7g (wetland area) or associated development control plan area west of the F3 freeway.

Although not directly within the assessed areas, the Porters Creek Wetland occurs within one kilometre east of the Buttonderry and Tooheys Rd surface infrastructure properties (WSDCP No 30: 22). Porters Creek Wetland is listed as a specific example in the determination for the Sydney Freshwater Wetlands Endangered Ecological Community. This Wetland occurs downstream within the catchment of part of the W2CP (Buttonderry surface site) as well as the Wyong Employment Zone (WEZ) and supports a range of wetland and swamp forest vegetation communities. A management plan has been prepared for the wetland (Andrews-Neil 1995).

According to NSW Legislative Council Hansard (1996), Porters Creek Wetland acts as the natural flood storage area for Porters Creek and Wyong River and is the most significant coastal wetland in Wyong Shire, while the National Parks and Wildlife

Service (NPWS) has referred to it as the most significant wetland between Newcastle and the Hawkesbury.

The Warner Business Park and WEZ study area forms part of a larger land holding which includes the majority of Porters Creek Wetland and Warnervale Airport for which an EIS was prepared. The wetland is largely undisturbed and contains endangered plant species, rare and endangered fauna and a high level of biodiversity. Nineteen endangered species - rare marsupials, wading birds, frogs and significant local plants were identified in the EIS as known or likely to occur within the area. The wetland is also significant in the filtration and flood mitigation of Tuggerah Lakes Estuary. It provides a much-needed drought refuge for wildlife and is an important study area along the migratory route of birds and bats.

According to the Dooralong 9131-1S 1:25K topographical map sheet, approximately 1 km of Hue Hue Creek occurs within the proposed subsidence area. This creek flows into Porters Creek Wetland.

Tuggerah Lakes Estuary is comprised of three shallow lagoons (Tuggerah, Budgewoi and Munmorah Lakes) and occupies an area of 70 km^2 (Bio-Analysis 2006). A Tuggerah Lakes Estuary Management Plan exists, although the 'Tuggerah Lakes Estuary Process Study', a GAP analysis conducted in 2001, provides a better understanding and some base line ecological values of the environment.

The Tuggerah Lakes Estuary also possesses several EEC's and habitat for a wide variety of state and nationally listed threatened terrestrial and aquatic flora and fauna.

The Wyong River, Jilliby Jilliby and Little Jilliby Jilliby Creeks (which occur within the proposed subsidence area) flow into Wyong River which in turn drains into the Tuggerah Lakes Estuary.

13.2.8 Overview of Waterways, Farm Dams / Wetlands

Within the proposed subsidence area, there are a number of waterways including Wyong River, Jilliby Jilliby Creek, Little Jilliby Jilliby Creek, Hue Hue Creek, as well as many dams and temporary ponds. A calculation of the areas shows that farm dams equate to 25.56 ha, and other water bodies roughly 3.85 ha.

Unfortunately, access to private land prevented detailed investigation of habitat potential for threatened species within the proposed subsidence area. Further, several forest tracks were impassable at the time of the assessment preventing an inspection (for terrestrial ecology) of the Narrabeen Warm Temperate-Subtropical Rainforests occurring in the elevated floors of the Wyong State Forest that form the headwaters of Little Jilliby Jilliby Creek.

Collectively, all waterways observed had been modified, the exception being the creek headwaters in the surrounding forested hills (headwaters of Little Jilliby Jilliby Creek provide the best example of these). Land clearing has played a major role in reshaping the environment and remnant native vegetation associated with water bodies is highly fragmented. Grazing livestock has further impacted waterways outside the forested areas, particularly horses and to lesser degree cattle, goats and novelty livestock that have removed or impacted edge vegetation.

Vegetation in all dams was noted as generally very sparse, mostly consisting of isolated clumps of *Scenoplectus* sp, *Juncus* sp and *Carex* sp, that was generally

cropped by animals that has access to it. Occasionally north of Jilliby in the Dooralong Valley, areas of *Isolepsus* were observed along former waterways (cowls and or extinct meanders of creeklines). In all areas domestic dogs were evident.

Altered surface hydrology is evident on the cleared valley floors with many once shallow depressions either dug out and bunded to make farm dams or filled and levelled to facilitate cultivation. There is undoubted altered water/soil chemistry in the area, although absolute data is not available. A review of the Tuggerah Lakes Estuary report (Bio-Analysis 2006: 2) noted that nutrient concentrations in the water column were (at that point in time) above the water quality guidelines.

The Dooralong valley catchment drains into the Wyong River then into the Tuggerah Lakes Estuary and stocking rates and rural activities such as turf farming are known to contribute to elevated nutrient loads. Eutrophication of Jilliby Jilliby Creek was evident in February 2006, however, later heavy rains had flushed the system.

The surface hydrology associated with ephemeral headwaters in the forested hills has undergone minor impact from erosion as a result of logging, access track construction and easement clearing by state government authorities (DPI, State Forests and TransGrid).

13.2.9 Impacts to Wetlands / Waterbodies from Longwall Mining

Much of the impact of subsidence on landscapes is related to the change in relationship of pre-mining and post-subsidence surface topography. Landscapes with erosive soils on long slopes may be subject to potential erosion due to slope increase or displacement of erosion control structures thus polluting water with sediment. In low areas with very high water tables temporary ponding could occur if disrupted surface drainage patterns causes runoff to collect in any newly created low portions if these areas do not freely drain. According to Darmody (n.d: 154), in agricultural areas ponding may be viewed in a positive way because it creates wetlands beneficial to wildlife.

Other detrimental impacts that could be associated with longwall mining in certain circumstances (geology, mine design, etc) include cracking of particular geology types resulting in reduced flow or draining of water bodies (particularly in association with swamps on sandstone geologies), release of dissolved natural salts and hydrogen sulphide that is toxic to aquatic life in shale geologies of the metropolitan catchment and low oxygen and elevated soluble iron levels. These issues have been raised by Total Environment Centre and other groups in the Southern Coalfields longwall mining inquiry.

Another potential impact is the change in the natural relationship of faults within geological strata which has the potential to result in similar impacts as with cracking described above. More specific data on these potential impacts in relation to WC2P project can be sourced from the subsidence, flooding and groundwater specialists assessments.

Interpretation of these studies suggests there are no potential impacts to water quality associated with the proposed subsidence from the W2CP because:

- The mine design has been based on avoiding the risk of introducing any continuous cracking from the surface down to the coal seam, thus avoiding the risk of downwards or upwards discernible mixing of the two different water types. At the near-surface are the mostly fresh surface alluvial aquifer groundwaters. These aquifers in most locations are fresher after rain but do not degrade as evidently as the surface waters in the streams and billabongs when they go to low flow and then stagnate. The deep more saline groundwater at the coal seam level is not capable of migrating to surface and the depressurization of the deep aquifer system will mean that the groundwater flow path will report to the mine void itself (which will be collected and pumped to the mine water management system).
- Any implications for the surface alluvial groundwaters would be very localised and temporary (days and weeks) but would not involve wholesale loss of water that supports surface ecosystems. The localised re-equilibration of the alluvial aquifer groundwaters would only involve the locally occurring water and not exogenous groundwaters of different quality.
- There are no known no high risk acid sulphate soils mapped as occurring within the proposed subsidence zone.

The escape of gases is very unlikely as the W2CP project has an associated economically viable natural gas deposit that will be collected by gas drainage systems prior to mining. There will be no seam to surface connecting pathways for gas to escape to the surface. The air quality will be unimpacted and thus there will be no toxic effect to native species.

With regard to water energy dispensation, the waterways in the proposed subsidence area reflect a general typical post-European impact pattern where the environment once consisted of thick moisture loving vegetation where many shallow creeks and semi active drainage lines would flood and inundate a wide area. The path of the waterways were active in the deep alluvium and as such meandering corners of the creek were occasionally cut or filled with sediment, and 'new' slightly adjusted paths of flow followed. Due to historic changes in surface water hydrology, mostly related to land clearing, the existing waterways are now incised as a result of increased water speed, Jilliby Jilliby Creek is now 1 m wide and approximately 1.5 m deep.

Predicted subsidence will have an effect on stream power values in subsided areas and as a result has the potential to cause minor erosion. The potential effect will not however, be associated with large flooding events as backed up water dissipates energy. The most likely impact from a change in energy ration would occur in-stream (progressive scouring) and be associated with minor flooding intervals i.e. 1:3 flooding events that do not overtop banks (reduce energy / water velocity). The most likely time for minor erosion to occur would be during a 1:3 year flood event in the 5 to 6 months during which mining is underneath the creeks when the upstream and downstream edges of subsidence are be constantly changing. Many variables would influence the probability for this to occur, however, there is low risk and low associated consequence of this event causing environmental damage, as mitigation will quickly occur under an approved Subsidence Management Plan (SMP), which by nature incorporates surface monitoring. (pers comm. ERM 2007[2]).

[2] Geoff Herman author of the ERM W2CP Flood Impact Assessment (ERM 2007) 16.7.07.

Subsidence effects in the forested areas in the Wyong State Forest / Jilliby State Conservation Area also has potential to alter existing soil erosion and affect water quality downstream. From inspection, the soils are stable within vegetation however, where land has been cleared (i.e. TransGrid easements with access tracks) the clay based soils on the slopes have moderate erodibility. Most, if not all, drainage lines inspected in the hills have a deep layer of mulch and leaf litter but are also choked with *Lantana sp.* Whilst this is a noxious weed, the species serves to hold the soil together very efficiently. It is very unlikely that *Lantana* will be controlled in these areas, however, if such a project were to occur, it is a procedural normality (given the land tenure) of habitat restoration projects to mitigate the erodibility of the soils. Similar to above, the SMP will require regular inspection so that upstream scour protection can be implemented in subsided areas as soon as it becomes evident.

Although the hills of the Wyong State Forest includes mainly underlying sandstone geology of the Terrigal formation, the valley floor comprising the headwaters of Little Jilliby Jilliby Creek are mapped as Patonga Claystone. The predicted tilt and tensile strains due to the predicted subsidence in the area are described in the specialist subsidence report[3]. With the Narrabeen Warm Temperate-Subtropical Rainforest community being found wholly on Patonga Claystone, there will be minimal impact to surface hydrology because of subsidence. If any portions of the community are underlain by Terrigal Formation sandstone, potential exists for localised changes to surface hydrology if surficial rock fracturing were to occur. Whilst this potential has been noted, the water quality would still remain unaffected because there will be no capability for mixing with saline waters from the seam.

The flood behaviour in the Yarramalong Valley is not anticipated to significantly change as a result of subsidence. The modelling undertaken for the W2CP indicates flood levels generally reduce by 0.01 to 0.08 m in the vicinity of proposed subsidence areas. Flood depths in the Wyong River are expected to reduce by a similar amount with the exception of a 1.2 km section of the River where depths may increase by up to 0.13 m. With the exception of a small backwater between area flood extents vary by less than 5 m. Flow velocities will be unaffected.

13.2.10 Impacts to Adjoining Wetlands

In relation to Porters Creek Wetland, it is not within the proposed subsidence area and is at least 2 km away and as such a detrimental change will not affect the wetland. Further, impacts from mining on groundwater and surface water environments are judged to be low and unlikely to measurably deplete resources of the alluvial lands situated in the Dooralong and Yarramalong Valleys (Mackie (2008). ERM (2008) state that Hue Hue Creek will experience subsidence of up to 0.95 m under the floodplain that will cause reductions in flood levels within or near the subsided areas (within the zero subsidence line) of 0 to 0.5 m with changes of flood depths of -0.1 to +0.7 m. Based upon the flood study (ERM 2008) it would be theoretically impossible for flows to the wetland to change unless culverts under the F3 freeway were altered. The total volume of water flowing into Porters Creek Wetland will remain the same as it is currently governed by the size of existing culverts.

Similarly, impacts to the Tuggerah Lakes Estuary groundwater and surface water are judged to be low and unlikely to measurably deplete resources of the alluvial lands situated in the Dooralong and Yarramalong Valleys (Mackie 2008) and as

[3] Refer to primary information contained in the subsidence specialist's report

such the inference is that no change will occur within the catchment and hence to the Tuggerah Lakes Estuary. Further, ERM (2008) state that no significant changes to flood extents and depths in the Yarramalong Valley (Wyong River) will occur due to predicted mine subsidence. The maximum predicted subsidence under the main channel of the Wyong River will be in the order of 0.15 m. The Dooralong Valley (Jilliby Jilliby Creek and its tributaries) will experience predicted subsidence of up to 1.2 m in parts of the channel and mainly less than 1.6 m within a limited section (5.2 km) of the floodplain (greater subsidence of up to 2.4 m is predicted in the forested areas away from floodplain lands).

Reductions in flood levels within or near the proposed subsided areas of 0 to 1.85 m and changes of flood depth of -1.1 to +1.1 m may occur. Similarly, the volume of water flowing into the Tuggerah Lakes Estuary will not change, the only effects will be that peak of a flooding event will be reduced due to increased water storage capacity within the subsidence area. The peak flow has been modelled to drop by less than 0.5% and will be delayed between 30 minutes to an hour. The predicted effects of subsidence therefore are unlikely to result in changes in flooding / hydrological activity outside the catchment area that will affect this estuary.

13.2.11 Key Threatening Processes – Subsidence Area

Key Threatening Processes have been discussed previously in Section 13.1.14. However, the Key Threatening Processes associated with the surface disturbance required for the constrution of the surface facilities are different to those that occur within the mining area where subsidence will be experienced. Table 13.12 summarises the State KTPs in relation to underground extraction. Other KTPs that may be active within the mining area as a result of surface activities on land above the mining area are beyond the control of the project and outside the scope of this assessment. It should be noted that this table sets out a simple yes or no answer as a checklist to establish the issues that are addressed in the EA.

Table 13.12 State Key Threatening Process (KTP): Subsidence Area

Key Threatening Process	KTP active prior to this proposal	Will the proposal exacerbate KTP	Will the proposed offsets mitigate the Impact
Alteration of habitat following subsidence due to longwall mining	No	**Yes**	**Yes**
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	**Yes**	**Yes**	**Yes**
Anthropogenic climate change	**Yes**	**Yes**	Refer to Section 12.7
Bushrock removal	No	No	No
Clearing of native vegetation	No	No	No
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	**Yes**	No	No
Competition and habitat degradation by feral goats (*Capra hircus*)	**Yes**	No	No
Competition from feral honey bees (*Apis mellifera*)	**Yes**	No	No
Death or injury to marine species following capture in shark control programs on ocean beaches	No	No	No
Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments	No	No	No
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	No	No	No
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	**Yes**	No	No
Herbivory and environmental degradation caused by feral deer	No	No	No
Importation of red imported fire ants (*Solenopsis invicta*)	No	No	No
Infection by psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations	**Yes**	No	No
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	No	No	**Yes**
Infection of native plants by *Phytophthora cinnamomi*	No	No	No

Table 13.12 State Key Threatening Process (KTP): Subsidence Area

Key Threatening Process	KTP active prior to this proposal	Will the proposal exacerbate KTP	Will the proposed offsets mitigate the Impact
Introduction of the large earth bumblebee (*Bombus terrestris*)	No	No	No
Invasion and establishment of exotic vines and scramblers	**Yes**	No	No
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	No	No	No
Invasion and establishment of the cane toad (*Bufo marinus*)	No	No	No
Invasion, establishment and spread of *Lantana camara*	**Yes**	No	No
Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed)	No	No	No
Invasion of native plant communities by exotic perennial grasses	**Yes**	No	No
Invasion of the yellow crazy ant (*Anoplolepis gracilipes* (Fr. Smith)) into NSW	No	No	No
Loss of hollow-bearing trees	No	No	No
Loss or degradation (or both) of sites used for hill-topping by butterflies	No	No	No
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	No	No	No
Predation by the European red fox (*Vulpes vulpes*)	**Yes**	No	No
Predation by the feral cat (*Felis catus*)	**Yes**	No	No
Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish)	**Yes**	No	No
Predation by the ship rat (*Rattus rattus*) on Lord Howe Island	No	No	No
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	No	No	No
Removal of dead wood and dead trees	No	No	No

Further comment on those KTPs highlighted in bold have been provided below:

Alteration of habitat following subsidence due to longwall mining - key threatening process in NSW

Description (as per DECCW website)
Alteration of habitat following subsidence due to longwall mining was listed as a KEY THREATENING PROCESS on Schedule 3 of the Threatened Species Conservation Act 1995 [15 July 2005]. Longwall mining is an underground coal mining technique that involves removing a panel of coal. Longwall mining can cause the land above the mined-out coal to destabilise and collapse, this is known as subsidence.

Subsidence due to longwall mining has been recognised as causing habitat alteration, such as causing cracks beneath a stream or other water body. This may lead to a temporary or permanent loss of water flows and could cause permanent changes to riparian community structure and composition.

Species and ecological communities that depend on aquatic and semi-aquatic habitats are particularly susceptible to the impacts of subsidence. Subsidence can cause a decrease in water quality such as reduced oxygen availability, encouraging bacterial growth, smothering native plants and animals. Subsidence can also increase the amount of iron oxides in the water which directly affects native plants and animals.

Threatened species and ecological communities are known to occur in areas affected by subsidence due to longwall mining and include the following: Blue Mountains water skink, giant dragonfly, broad-headed snake, Epacris hamiltonii, eastern pygmy possum, giant burrowing frog, stuttering frog, and large-footed myotis, Genowlan Point Allocasuarina nana heathland, O'Hares Creek shale forest, shale/sandstone transition forest, and the Newnes Plateau shrub swamp in the Sydney Basin Bioregion.

Longwall mining occurs in the Northern, Southern and Western Coalfields of NSW. The Northern Coalfields are centred on the Newcastle-Hunter region. The Southern Coalfield lies principally beneath the Woronora, Nepean and Georges River catchments approximately 80-120 km SSW of Sydney. Coalmines in the Western Coalfield occur along the western margin of the Sydney Basin.

Threat abatement - priority actions
A number of priority actions have been identified for this key threatening process. Priority actions are the specific, practical things that must be done to tackle a key threatening process. They have been grouped into 5 overarching threat abatement strategies.

General comment
The effects of subsidence on native fauna and flora are unlikely to be significant. The determinations of impact to the natural environment are based upon results from the subsidence (WACJV 2009), flooding (ERM 2009) and groundwater specialist (Mackie Environmental Research 2009) studies appended to this EA.

The ecological assessment has considered each of these Key Threatening Processes (both State and National KTPs) with respect to the subsidence area, and ensured that mitigation measures have been developed for each. Details are provided in the report contained in Appendix R, and summarized in Table 13.15.

Table 13.13 State Treat Abatement Priority Actions

Description of priority action	DECCW Priority	Comment
Threat abatement strategy: Develop and implement protocols and guidelines		
Prepare guidelines outlining key factors that should be considered when assessing impacts of new longwall mines on biodiversity.	High	This project is being assessed by the DOP, if DECCW have prepared guidelines they would be taken into consideration during the approval process.
Threat abatement strategy: Monitoring		
Develop recommendations for monitoring impacts of new longwall mines on biodiversity and mitigation methods.	High	Long term monitoring of subsidence is a component of the Proposal.
Threat abatement strategy: Prepare Statement of Intent		
Prepare Statement of Intent by 2008.	High	N/A
Threat abatement strategy: Review and amend or adopt existing legislation and policies		
Ensure rigorous assessment of new mines continues through existing approval processes including the preparation of subsidence management plans.	High	This project is being assessed by the DOP, if DECCW have prepared guidelines they would be taken into consideration during the approvals. Subsidence Management Plan will be required if planning approval is granted.
Threat abatement strategy: Review evidence of impacts		
Examine the effects of subsidence from longwall mining on priority ecosystems including streams, wetlands and threatened species, populations and ecological communities.	High	Long term monitoring of subsidence is a component of the Proposal.

Table 13.14 Nationally Listed Key Threatening Process (KTP): Subsidence Impact Area

Key Threatening Process	Is this already occurring on site?	Will there be a direct effect	Will there be an operational effect
Competition and land degradation by rabbits	Yes	No.	No.
Land clearance	Yes - Historically the area has been cleared for grazing and subsequently used for pasture improvement and cropping on the valley floor and forestry on the hills.	No.	No clearing required in the subsidence area.
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	Unknown	Any additional anthropomorphic activity would increase this KTP	Section 12.7 of the EA provides details on this issue.
Predation by European red fox	Yes.	Subsidence would not directly increase the potential effects of this KTP.	Operation of the Project Site does not have potential to increase population densities of vertebrate species.
Predation by feral cats	Yes.	Subsidence would not directly increase the potential effects of this KTP.	Operation of the Project Site does not have potential to increase population densities of vertebrate species.

Table 13.15 Ecological Assessment Report Considered the KTPs

Name of NSW KTP	Name of Nationally listed KTP	Details of threat	Has mitigation been offered?
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	No Nationally listed equivalent	Creeks and drainage lines have the potential to be impacted if there is a change or alteration in site hydrology and species dependant on these habitats would potentially decline.	Yes – mine design has been undertaken to reduce or eliminate risk / severity of subsidence and its associated flow on effects. Long term monitoring has been detailed in the EA. Monitoring is consistent with the DECCW threat abatement plan.
Anthropogenic climate change	Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	It is understood that any human activity will produce green house gasses.	Section 12.7 of the EA provides details on this issue.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	No Nationally listed equivalent	Introduction of disease potentially wiping out a naive population.	Yes – monitoring of frog population had been noted within the recommendations of the ecology report. To undertake any frog work it must be consistent with the DECCW *Threatened Species Survey and Assessment: Guidelines for Developers and Activities – Working Draft* (2004) or the *Threatened species survey and assessment guidelines: field survey methods for fauna: Amphibians* (2009).

13.2.12 Fauna with Potential to be Affected by Subsidence

Significant fauna of the Wyong region

Although the Sydney Basin Bioregion has the highest human population of any NSW bioregion, significant areas of native vegetation remain unchanged since European occupation. Despite this, serious rates of decline of grassland, woodland and forest bird species, as well as ground-nesting birds and ground-feeding insectivorous birds, have occurred. Sightings of rainforest birds, which increased significantly across Australia, did not follow this trend in the Sydney Basin despite the presence of areas of relatively intact rainforest (Australian Terrestrial Biodiversity Assessment 2002).

Forest and woodland birds of the bioregion are thought to be somewhat protected in Hawkesbury sandstone communities contained within conservation reserves (Australian Terrestrial Biodiversity Assessment 2002). General threats to species in the bioregion include broad-scale vegetation clearing and loss of remnants as well as grazing by stock. Urbanisation is also a major threat to many species in built-up areas.

A search of the DECCW threatened species website area using a combined geographic and habitat search showed that there are 118 items of conservation concern in the Hunter / Central Rivers CMA. Of these, 76 are species of threatened or endangered animals (1 insect, 39 birds, 10 mammals {not including bats}, 12 bats, 6 reptiles and 8 species of frog). A search of the BioNet database focussed on the LGA showed that nearly all these species listed by DECCW as having the potential to occur in the CMA region have been previously recorded in the LGA.

The Department of Primary Industries - NSW Fisheries online database lists 10 endangered species in NSW (9 fish and 1 dragonfly), 2 endangered populations, 3 EEC's, 1 presumed extinct species and 8 vulnerable species (1 dragonfly, 1 shrimp, 4 fish, 1 shark and 1 species of algae).

The DEWHA online database (protected matters report) shows that there are 46 threatened species and 31 migratory species in the Wyong LGA. Of the threatened species 33 are animals (13 birds, 5 frogs, 7 mammals, 2 fish, 3 reptiles and 3 sharks). A significant overlap of protected species occurs between the DEW and DECCW databases and where differences occur (i.e. DEWHA protected species not appearing on the DECCW database) it is with regard to marine species.

The Lake Macquarie City Council has produced guidelines for flora and fauna survey within the LGA. Appendix 3 of that document lists regionally significant species. Any species identified as 'regionally significant' in this document, that were recorded within current the study areas, have been appropriately identified.

Sensitivity of local fauna to subsidence

Threatened species that occur within vegetation communities most likely to be impacted by subsidence are by default at greatest risk. Aquatic and semiaquatic environments have received the most attention due to the nature of habitat alteration that can occur sometimes as a result of subsidence, especially in sandstone geologies. Hanging swamps or high altitude swamps on sandstone are often provided as examples of ecological communities placed at most risk from subsidence, however the W2CP proposed mining area contains no examples of these type of communities.

Within the proposed subsidence area there are four basic types of habitats:

- Aquatic habitats (creeks, dams and the rivers) with permanent water;
- Semi-aquatic habitats (areas which become temporarily inundated) that may provide feeding or breeding resources for particular species or populations. These may be regular (seasonal) or irregular (1:20 years) in nature and experience a wide difference in duration of inundation;
- Valley floor terrestrial habitats; and
- Hilly landform habitats.

The above habitat types are listed in order of sensitivity for a worst case scenario subsidence related impact as changes in hydrology have a rapid effect on ecological communities and hence the species supported by them.

No significant impacts to water quality or quantity as a result of subsidence are anticipated, and therefore any aquatic species currently dependant on a permanent water body ecosystem are likely to remain unaffected as a result of the W2CP project.

Semi-aquatic habitats are the most sensitive to habitat alteration given the local conditions. Although one of the constraints of this study has been the inability to directly access the fauna dependent on these ecosystems, the DECCW database suggests that several species of threatened frogs able to tolerate high nutrient levels, stocking rates, and trampling and indeed thrive in extensively cleared agricultural land have the potential to occur within the W2CP study area. An abundance of calling frogs within the area was noted during the recent reconnoitre, and although none were immediately noted as threatened species, there nonetheless remains potential for them to occur. Secondly, several of the DEWHA and DECCW wetland and migratory wetland species have potential to utilise feeding resources provided by these environments.

Survey Results

The existing semi-aquatic environments, which were inundated at the time of assessment, provided habitat for a number of wetland bird species including:

- White-faced Heron (*Egretta novaehollandiae*) – commonly recorded through the valley floor in a variety of habitats. This species feeds on a variety of animals that include insects, fish and amphibians;
- White-necked Heron (*Adrea pacifica*) – only one pair seen in recently inundated grassland in the locality of Jilliby. This species has a similar diet to the White-faced heron;
- Purple Swamphen (*Porphyrio porphyrio*) – one pair sighted at large permanent dam, perched on a small (1 x 6 m) island, near the intersection of Dickson / Dooralong Roads. Appeared to be utilising grassy vegetation on the island for shelter which was inaccessible to livestock. This species eats the soft shoots of reeds and rushes but will also opportunistically eat ducklings;
- Australian White Ibis (*Threskionis molucca*) – the most abundant wetland species noted occurring in flocks of more than 200 in several locations through the Dooralong Valley. The diet of this species includes a broad range of items, hence their success in the environment, including terrestrial and aquatic

invertebrates and any anthropomorphic scraps. The long beak has been known to be used to dig for muscles and crayfish;

- Glossy Ibis (*Plegadis falcinellus*) – found in association with Straw-necked and Australian White Ibis, together being collectively the second most common species of bird encountered at all sites, occurring in large flocks of between 100 to 200 birds at each location. Diet is similar to that listed above;
- Straw-necked Ibis (*Threskiornis spinicollis*) as above;
- Pied Cormorant (*Phalacrocorax varius*) – only observed in one location, same area as the purple swamp hen. Sitting on a fence post. This species also feeds on a wide variety of aquatic animals ranging from insects (including yabbies) to fish;
- Grey Teal (*Anas gracilis*) – only observed once on deep water at the same location (a modified billabong, large dam) as the purple swamp hen. Feed on dry land plants, aquatic plants, seeds, crustaceans, and insects and their larvae;
- Pacific Black Duck (*Anas superciliosa*) – common on all waterways, permanent to temporary. This species is mainly vegetarian but will also eat small crustaceans, molluscs and aquatic insects.
- Maned Duck (*Chenonetta jubata*) – occasionally seen in areas with more ground cover (less intensively grazed) in association with permanent water. This species feed on seeds and green shoots of various grasses;
- Cattle Egret (*Ardea ibis*) - associated with cattle and shallow or recently inundated pastures throughout the valley. Frequently observed, approximately 15 to 20 individuals noted. Feeds on insects such as grasshoppers, frogs, cane toads, lizards and some small mammals;
- Intermediate Egret (*Ardea intermedia*) – commonly seen throughout the study area on recently inundated pastures up to 50 individuals noted. Similar diet to that listed above; and
- Masked Lapwing (*Vanellus miles*) - two pairs seen within the study area, both surrounding recently inundated grasslands. Diet consists of insects and their larvae, and earthworms.

13.2.13 Discussion

Terrestrial habitats on the valley floor have been heavily impacted by agriculture and settlement. What remains is associated with small pockets of remnant vegetation that will remain largely unaffected by subsidence. Water chemistry will also remain the same. Similarly, the majority of species within hilly landform habitats in the Wyong State Forest and Jilliby State Conservation Area are not very susceptible to subsidence and the habitat values of the vegetation it supports will remain the same.

With respect to changes to the abundance of potential habitat for threatened species, 55.8 ha that is not currently inundated during a 1:100 flood event (prior to mining) will be inundated to a shallow degree, while approximately 10 ha that is currently inundated (prior to mining), will not be flooded during the same event after subsidence has occurred (ERM 2008). As these changes will occur in like for like habitat (predominantly cleared, grazed or farmed agricultural land) there will be no net loss of potential habitat that would place any threatened species at risk of local extinction.

The presence of wetland birds within the Dooralong Valley led to the assumption that a healthy macroinvertebrate population existed in the area but interestingly, no small waders such as snipes, crakes, sandpipers etc were observed. Understandably, some species would not be expected, i.e. Latham's Snipe (*Gallinago hardwickii*) which are not likely to be observed until the summer months. Other influencing factors include the level of inundation and flooding of suitable mudflats on dam banks, however, an overarching factor appeared to be the effect of domestic livestock on edge vegetation at water bodies.

As previously stated ponding or surface swale effects will not be an issue given the topography and drainage patterns of the land. The following information has been provided as a worst case scenario.

All semi-aquatic habitats for terrestrial species on the valley floors were recorded as 'fragmented' or 'isolated' in their current state. Given that the average depth of subsidence anticipated to occur in the valley floor is in the order of 1 m over each panel width (150 m to 175 m) and each panel is separated by 50 m it would not be unreasonable to assume that if small, cryptic species were located in the middle of an unsubsided area it would be able to make it 25 m to find the edge of the lower ground areas that had been subsided if temporary changes to local soil moisture conditions occurred.

Given the nature of semi-aquatic environments on the valley floor, it is not unreasonable to assume that the subsided areas would, at an ecological level, function the same as semi-aquatic areas prior to subsidence, as the microflora and fauna would remain unaffected by the process. The only difference may be that the duration of water logging may be slightly longer in a worst case local situation.

The only species sensitive to change could be the Giant Barred Frog (*Mixophyes iterates)* and the Stuttering Frog (*Mixophyes balbus)* that are both known to occur in the proposed subsidence area at the headwaters to Little Jilliby Jilliby Creek in Narrabeen Warm Temperate-Subtropical Rainforest predominantly on Patonga Claystones in the lower gully sections of the hilly landform.

The Littlejohn's Tree Frog (*Litoria littlejohni)* is also considered as likely to occur. These species breed around shallow, flowing rocky streams. The females lay eggs onto moist creek banks or rocks above water level or in a foam on that water where the tadpoles latter grow into larger frogs. The frog species would be susceptible to changes in pools or creeks if altered hydrology affected surface water in the area.

Impacts to other species of legislative interest listed by DECCW and DEWHA have been assessed as low, or unknown. Details of the assessments are provided in Table 5 of the specialist report contained in Appendix R.

13.2.14 Recommendations and Mitigation

When a SMP is developed for the W2CP project, it will include the establishment of several monitoring points within Riverine Alluvial Gallery Rainforest-Moist Forest to measure and document the health and status of the EEC as it has potential, albeit low, to be adversely impacted by the proposal.

The data generated will establish if potential impacts to the EEC are related to subsidence or other external processes. The data will also be a resource from which to develop mitigative measures with improvement of future mining technologies for those areas that are not undermined.

It is unlikely that the potential for migratory birds to utilise available habitat will be affected by subsidence. When the SMP is developed it will, at regular intervals, review the Schedules of the TSC and EPBC Acts, NPWS Wildlife Atlas or BioNet database and consider impacts to ecological niches of those species known to occur within the proposed subsidence impact area.

It is unknown if several species of threatened frogs occur within the area therefore, targeted opportunistic surveys for Giant Barred Frog, Green Thighed Frog, Green and Golden Bell Frog, Wallum Froglet and Little Johns Tree Frog should be undertaken as part of the SMP if access to privately owned land is allowed in the future. Although a net increase in inundated areas will occur after subsidence it would be pertinent to try and study any changes to these potentially occurring populations prior to and as a result of subsidence.

Two species of threatened frogs (Giant Barred Frog and Stuttering Frog) are known to occur within the Wyong State Forest under a TransGrid easement in a moist layered / warm temperate subtropical rainforest environment. Although this area will not be undermined for 30 years, these populations will be included as an item of concern in the SMP. Further study on the population for species will occur in this and similar locations such that the ecological niches in the area and security of the locals populations are transparent. This process will assist future mine managers to mitigate impacts with improvements to mining technologies.

13.2.15 Conclusion

The effects of subsidence to native fauna and flora are unlikely to be significant. Current impacts of agriculture and land management practices in the Yarramalong and Dooralong valleys are considered to represent ongoing risks to biodiversity. There are no species of concern at risk from local extinction with respect to the W2CP. This overarching statement is made with the body of knowledge currently at hand.

Effective management of potential impacts to species of concern, if planning approval is granted, would be through a Fauna and Flora Management Plan implemented through overarching Subsidence Management Plan.

The majority of effects associated with the predicted W2CP subsidence will occur in currently cleared and disturbed land in the Dooralong valley floor where changes to flood inundation are likely to occur, or where it is unlikely to be significant from an ecological point of view.

In specific relation to migratory wetland birds, there will be no net loss of potential habitat, those species adapted to agricultural areas will remain secure and those species adapted to more natural settings i.e. Porters Creek Wetland and the Tuggerah Lakes Estuary will continue to have the same potential to be recorded in those locations.

13.3 Weed Management

The flora survey carried out by OzArk (contained in Appendix Q and R) also identified and recorded exotic species present in the study areas.

The greatest potential impact of the W2CP with regard to weeds is through the construction of Tooheys Road, Buttonderry and the Shaft site. By removing the existing ground cover, the soil surface is exposed and more susceptible to invasion by exotic or weed species.

The following management strategy has been designed specifically for this project and with two main objectives, namely:

- To reduce existing weed infestation on W2CP property; and
- Avoid the spread of weeds to other areas during construction.

The Noxious Weeds Act 1993 provides a framework for the state wide control of noxious weeds. The weed control program is to be implemented at every location which is disturbed by the activities associated with the W2CP.

Three separate weed management strategies have been developed to cater for different circumstances under which weeds may be encountered. These include existing weed infestations, areas to be cleared and hence vulnerable to infestation, and currently un-infested agricultural land which may have the potential to be impacted by weed seed as a consequence of the construction process.

Existing Weed Infestations

There are a number of patches of existing weed infestation on W2CP properties. It is important that the construction program assists in alleviating this problem as far as practicable while at the same time, avoid the spread of these weeds to other areas. For weed infested sites, the following protocol will be followed:

- At least 28 days prior to construction activities commencing, each weed infested site, access track and work area will be sprayed with a general none specific herbicide such as “Grazon” or “Roundup Bioactive” in accordance with manufacturers specifications. This will kill all vegetative material including any pasture grass or natives which may be present.
- At least 14 days prior to construction activities commencing, areas where soil disturbance will be necessary, such as the tower sites will be again sprayed with an approved soil residual herbicide to kill dormant seeds. The application rate will be determined in accordance with manufacturers specifications to ensure residual effect of no longer than 3 months.
- Immediately prior to construction vehicles entering the site, treated areas where there has been a weed infestation will be inspected to ensure that all visible weeds have been killed. The need for any additional treatment such as ripping and mulching the site will be determined at this point in time.
- Construction vehicles working in weed infested areas should remain dedicated to these areas until each work phase is complete. Vehicles which must travel between an identified weed infested area to another site must be clean prior to entering the new area.
- Once construction activities have ceased, all areas previously sprayed will be sown with a sterile cover crop of oats or rye depending on the season. The purpose of this will be to cleanse the paddock prior to sowing the final seed mix.

- ❒ No later than 12 months after construction has been completed, the final seed mix will be sown to ensure a stable and sustainable ground cover is obtained.

Ongoing maintenance of the treated areas will be required for two years following completion of construction. Maintenance in the form of additional sowing, fertiliser application and spot spraying may be required. Once the work site has been assessed as being weed free and the affects of the construction works have been concluded, no further weed suppression will be necessary.

Woodland Areas

Whether currently impacted by weeds or not, areas which require clearing will necessitate a change in vegetation structure from woodland to grassland. The clearing process will involve soil disturbance and provide an ideal environment for weed invasion. For these areas, the following protocol has been developed:

- ❒ At least 14 days prior to clearing, the works area should be inspected for weeds, in particular woody weeds and aggressive weeds such as lantana and blackberry. These should be spot sprayed with “Grazon” or equivalent in accordance with manufacturers specifications.

- ❒ Equipment involved in clearing will remain at each site until completed. The equipment will then be washed prior to moving to the next work area.

- ❒ Following the completion of the construction works, the cleared area should be sown with a grass seed mix comparable with the surrounding vegetation systems. Seasonal requirements may affect the actual time for seeding of areas to maximise success of stabilising grasses.

- ❒ Within 12 months of construction completion, the site will be inspected and spot spraying of weeds may be undertaken.

Un-infested Construction Sites

The primary objective for these areas is not to introduce weeds to the construction site. This will be achieved by employing two simple methods:

- ❒ Only recently cleaned vehicles may enter the area; and

- ❒ Immediately following completion of the construction program, the disturbed area will be sown with a seed mix comparable to the surrounding land.

As with weed infested sites, weed free areas will be inspected 12 months following completion of construction to determine their weed status. This will include inspections of the paddocks surrounding the construction sites to determine if there has been an increase in weed infestation as a result of the project.