



Biodiversity Assessment Report

Northern Coal Logistics Project

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Approval for Issue

Name	Signature	Date
Arne Bishop		23/06/2015

Summary

RPS has been engaged by Northern Coal Services Pty Ltd (the proponent) to undertake a Flora and Fauna Assessment of two proposed disturbance areas within the Northern Coal Logistics Project Area. This comprised Site 1 (undeveloped land to the north of the existing Newstan Colliery Surface Site) and Site 2 (the disused Hawkmount Quarry). The Project Area is located where additional infrastructure is required to be constructed to support the Project. The location and extent of the study area under investigation is shown in **Figure 1**.

These investigations will inform a component of an Environmental Impact Statement for this State Significant Development under Section 78A (8A) of the *Environmental Planning & Assessment Act 1979*. The Environmental Impact Statement responds to Director-General's Environmental Assessment Requirements generated for the proposal.

A core component of the biodiversity assessment process is the application of the BioBank Assessment Methodology to assess development impact, and to enable a suitable biodiversity offset arrangement to be determined. To that end, as the project is a State Significant Development (now termed 'Major Project'), and following discussions with both NSW Office of Environment and Heritage and NSW Planning and Environment, the assessment process herewith follows the recently introduced Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects. This involves a three stage investigation and reporting process; including:

Stage 1 – Biodiversity Assessment;

Stage 2 – Impact Assessment (Biodiversity Values); and

Stage 3 – Biodiversity Offset Strategy.

With regards to Stage 3 – Biodiversity Offset Strategy, currently, there is no specific offset site proposed.

The proposed development involves the removal of 4.03 ha of native vegetation at Site 1 and 4.72 ha at Site 2. The directly affected vegetation zones were determined to consist of:

Site 1

- 3.50 ha of HU803: Spotted Gum – Broad-leaved Mahogany – Grey Gum grass – shrub open forest on Coastal Lowlands of the Central Coast.
- 1.22 ha of HU 833 Smooth-barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands

Site 2

- 2.00 ha of disturbed HU 833 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands;
- 1.93 ha of HU 833 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.; and
- 0.10 ha of HU 798: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley.

The proposed development will result in the following direct impacts at Site 1:

- Loss of 4.72 ha of suitable habitat for the Little Bentwing-bat.

- Loss of 4.72 ha of suitable habitat for the Large-eared Pied Bat.
- Loss of 376 individual of *Tetratheca juncea*.

The proposed development will result in the following direct impacts at Site 2:

- Loss of 1 individual of *Grevillea parviflora* subsp. *parviflora*.

The table below provides a summary overview of the Credit Balance Ledger for the development sites. Overall the proposed development sites have generated the need for 453 Ecosystem credits and 5,925 Species credits. The below information was entered into the Credit Converter for Ecosystem credits and Species credits. This calculator is intended for use where there is a shortfall of credits for conservation measures in a biodiversity certification proposal. However, in this case it has been used as a rough guide to inform the proponent of how much land may be required for an offset site. This calculation has resulted in the requirement of approximately 22 hectares for Species credits and approximately 49 hectares for the Ecosystem credits.

Table 1 Summary of Ecosystem Credits Required

Plant Community Type	Area (ha)	Credits
Site 1		
HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	1.22	55
HU 803: Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	3.50	213
Site 2		
HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	3.93	181
HU 798: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	0.10	4
Total (Site 1 & Site 2)		453

Table 2 Summary of Species Credits Required

Common name	Scientific name	Extent of Impact (individuals or Ha)	Credits
Site 1			
Black-eyed Susan	<i>Tetratheca juncea</i>	376	5,640
Little Bentwing Bat	<i>Miniopterus australis</i>	4.72 ha	61
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	4.72 ha	61
Site 2			
Small flower Grevillea	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	1	14
Total (Site 1 & Site 2)			5,762

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Appendix 2	Site 1 – Biobanking Credit Report
Appendix 3	Site 2 – Biobanking Credit Report

Stage I – Biodiversity Assessment

I.0 Introduction

RPS has been engaged by Northern Coal Services Pty Ltd (the proponent) to undertake a Flora and Fauna Assessment (FFA) of two proposed disturbance areas within the Northern Coal Logistics Project Area (the Project) development footprint. This comprised Site 1 (undeveloped land to the north of the existing Newstan Colliery Surface Site) and Site 2 (the disused Hawkmount Quarry). Hereafter, Site 1 and Site 2 are collectively referred to as the development sites. The development sites are located where additional infrastructure is required to be constructed to support the Project. The location and extent of the study area under investigation is shown in **Figure 1**.

These investigations will inform a component of an Environmental Impact Statement (EIS) for this State Significant Development (SSD) under Section 78A (8A) of the *Environmental Planning & Assessment Act 1979*. The EIS responds to Director-General's Environmental Assessment Requirements generated for the proposal.

A core component of the biodiversity assessment process is the application of the BioBank Assessment Methodology (BBAM) to assess development impact and to enable a suitable biodiversity offset arrangement to be determined. To that end, as the project is a SSD (now termed 'Major Project'), and following discussions with both NSW Office of Environment and Heritage (OEH) and NSW Planning and Environment, the assessment process herewith follows the recently introduced Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects (FBA). This involves a three stage investigation and reporting process; including:

Stage 1 – Biodiversity Assessment;

Stage 2 – Impact Assessment (Biodiversity Values); and

Stage 3 – Biodiversity Offset Strategy.

I.1 Description of Development

Locality The development sites are located between Fassifern and Dora Creek, on the western side of Lake Macquarie approximately 25 km south-west of Newcastle, NSW.

LGA Lake Macquarie

Area Two development sites are proposed by the Project being:

- Site 1 – Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-developed and upgrade of the coal handling and processing infrastructure within this surface site. The site is identified in **Figure 2** and
- Site 2 – an area of approximately 13.9 ha within the Hawkmount Quarry site (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement. The site is identified in **Figure 3**.

Current Land Use

The Newstan Colliery Surface Site is currently owned and operated by Centennial Newstan Pty Limited and comprises coal handling and processing infrastructure, reject emplacement areas, water management infrastructure, rail loading infrastructure and mine support infrastructure. The site is accessed from Miller Road, which traverses through the site, and the Main Northern Railway Line traverses immediately to the east.

Site 1 comprises undeveloped land that predominantly consists of native vegetation, with a power line easement dissecting the northwest corner.

The Cooranbong Entry Site is currently owned and operated by Centennial Mandalong Pty Limited and comprises coal handling and processing infrastructure, water management infrastructure and mine support infrastructure. The site is accessed from Gradwells Road (from Dora Creek) and is connected to Newstan Colliery Surface Site via private haul roads.

Hawkmount Quarry is located on Crown land under a permissive occupancy held by Lake Macquarie City Council (LMCC). It comprises a disused quarry located adjacent to the Cooranbong Private Haul Road. The quarry has not been used for extraction purposes for several years, and there is no evidence of any closure or rehabilitation activities.

Site 2 comprises mostly cleared/disturbed land, with some native vegetation.

The private haul roads that link the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Cooranbong Entry Site, Hawkmount Quarry and Eraring Power Station are:

- Newstan-Eraring Private Haul Road - owned by Eraring Energy and links the Newstan Colliery Surface Site to the Eraring Power Station.
- Cooranbong Private Haul Road – owned by Centennial Mandalong Pty Limited and links the Cooranbong Entry Site to the Newstan Colliery Surface Site via the Newstan-Eraring Private Haul Road.
- Awaba Private Haul Road – owned by Centennial Newstan Pty Limited and links the Awaba Colliery Surface Site to the Newstan-Eraring Private Haul Road.

Topography The Project Area is located in gently undulating terrain. Numerous drainage lines are present throughout the Project Area, which ultimately drain eastwards into Lake Macquarie.

Vegetation Vegetation mapping has been conducted across the entire development sites by RPS. The following vegetation communities occur:

Site 1

- 3.50 ha of MU 15: Coastal Foothills Spotted Gum - Ironbark Forest;
- 1.22 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 2.78 ha of Cleared (roads, tracks and powerlines).

Site 2

- 2.00 ha of Regrowth Acacia decurrens;
- 1.93 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 0.10 ha of MU 6: Coastal Narrabeen Moist Forest; and
- 9.85 ha of Cleared (roads, tracks and waterbodies).

Proposed Development

The Project comprises both a continuation of existing operations and an upgrade to the surface coal handling and preparation infrastructure at the Newstan Colliery Surface Site and the Mandalong Mine - Cooranbong Entry Site (Cooranbong Entry Site), along with the existing private haul roads and rail loading infrastructure. These facilities are integral to the on-going handling, processing and transport of coal from the

underground workings of Newstan Colliery and Mandalong Mine (including the proposed Newstan Colliery Extension of Mining Project and Mandalong Southern Extension Project) for domestic and export markets.

The Project will allow for improved and flexible coal handling arrangements across both the Newstan Colliery and Mandalong Mine to deliver the range of coal products required to meet domestic and export market demands.

1.2 Background Information

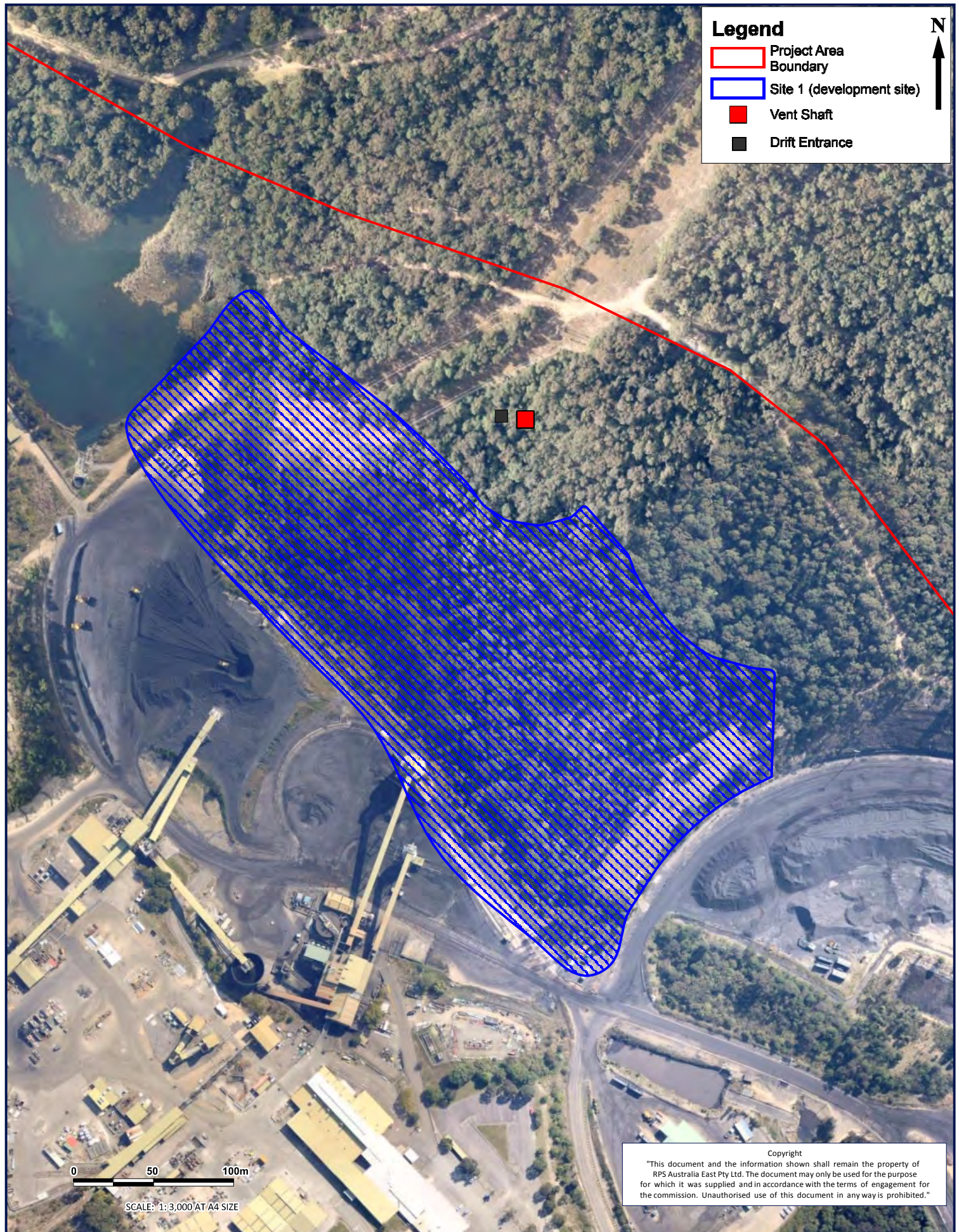
A review of relevant information was undertaken to provide an understanding of ecological values occurring or potentially occurring on the development sites and in the wider region. Such included previous ecological reports, vegetation maps, topographic maps, aerial photography and general scientific literature reviews. Of particular relevance were the following Information sources:

- Cumberland Ecology (2007). Newstan Colliery, modification to development consent, SEE, Ecological Impact Assessment;
- Cumberland Ecology (2008). Newstan Colliery, Longwall Panel 25, REF, Ecological Impact Assessment;
- Eco Biological (2005). Awaba Outbye SMP;
- Gunninah (1998). Proposed waste emplacements and coal handling facilities upgrade. Flora and fauna assessment. Newstan Colliery. October 1998;
- HLA (2006). Flora and Fauna Impact Assessment Upgrade to Existing Ash Dam Eraring Power Station. Flora and Fauna Report. Appendix E. February 2006;
- Hunter Eco (2008a). Awaba East Exploratory Drilling Program REF Stage 1 – Ecology. A Report for Centennial Coal;
- Hunter Eco (2008b). Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora investigation;
- Hunter Eco (2009). Awaba East Exploratory Drilling Program REF Stage 2 – Ecology. A Report for Centennial Coal;
- Umwelt / Gunninah (1998). Life Extension Project 1998 Flora and Fauna Assessment and SIS;
- Umwelt (2004). Centennial Newstan Longwall 22–23 Flora and Fauna Assessment; and
- Umwelt (2005). Summer targeted rare plants survey works for the Awaba open cut mine development environmental impact statement. Letter report to Centennial Coal. April 2005.

RPS has utilised the above information as a baseline, and undertaken a suite of ecological survey work across the development sites in order to update the dataset, and to assess significant habitat features of the development sites and their potential for supporting threatened species, populations and Endangered Ecological Communities (EECs) that are known to occur within the locality. Such works are included herewith as **Appendix 1 (RPS 2015)**.

Additional targeted fieldwork has also been undertaken utilising the FBA methodology to assess impacts and to inform biodiversity offsets considerations for the proposal.

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TITLE: FIGURE 2: SITE MAP - SITE 2

LOCATION: COAL LOGISTICS
NEWSTAN

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

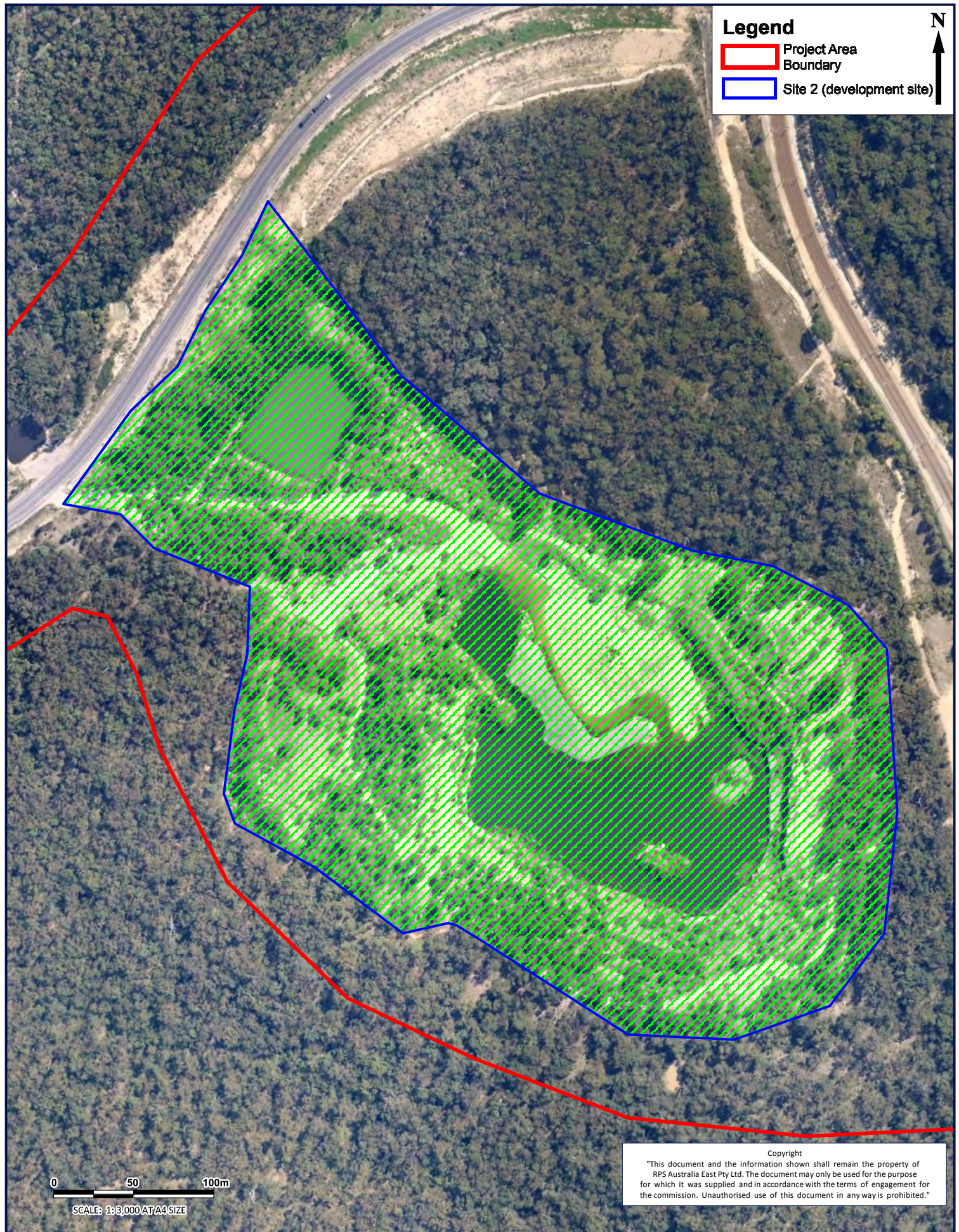
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PURPOSE: REPORT FIGURE

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TITLE: FIGURE 3: SITE MAP - SITE 2

LOCATION: COAL LOGISTICS -
HAWKMOUNT QUARRY

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 18/06/2015
PURPOSE: FIGURE REPORT

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2.0 Biodiversity Assessment – Development Sites

2.1 Identified Landscape Features

The development sites are situated within the:

- Sydney Basin IBRA Bioregion and the Wyong IBRA Subregion;
- Gosford – Cooranbong Coastal Slopes Mitchell Landscape; and
- the Hunter/Central Rivers Catchment Management Area (CMA).

Landscape features identified within the development sites and surrounding assessment buffers are depicted in **Figure 2** and **Figure 3**.

2.2 Determining Landscape Value

The development sites Landscape Values are scored based on several variables including:

- Percentage (%) Native Vegetation Cover;
- Connectivity Values; and
- Patch Size.

2.2.1 Percentage (%) Native Vegetation Cover

Two landscape assessment circles, being 100 and 1000 hectares in area, were initially centred over the proposed development sites using aerial imagery and Geographic Information System (GIS) software. Percentage native vegetation cover within each assessment circle was calculated in 5 % increments using GIS for 'Before' and 'After' development scenarios.

The 1000 hectare assessment circle was used to assess any loss (or negative impacts) of the proposed development on the percent native vegetation cover in the 'locality' and to identify threatened species that may occur within the development sites. The smaller 100 hectare circle was used to assess the loss of surrounding vegetation cover at an even more local scale as a result of the proposed development.

Site 1

The 100 hectare inner assessment circle was calculated as having a native vegetation cover class of 51-55% Before development, and 46-50% After development, resulting in a downward change or 'jump' of one native vegetation cover class.

The 1000 hectare outer assessment circle was calculated as having a native vegetation cover of 76-80% for Before and After development scenarios.

Site 2

The 100 hectare inner assessment circle was calculated as having a native vegetation cover class of 71-75% Before development, and 76-80% After development, resulting in a downward change or 'jump' of one native vegetation cover class.

The 1000 hectare outer assessment circle was calculated as having a native vegetation cover of 81-85% for Before and After development scenarios.

The assessment circles and associated native vegetation that were assessed via GIS are shown in **Figure 4** and **Figure 5**.

2.2.2 Connectivity Value

Step 1:

A desktop Connectivity Condition assessment was undertaken by assessing the average condition of native vegetation across the development sites 'Primary' linkages to adjoining vegetation. Primary linkages are defined as native vegetation that:

- Is in moderate to good condition;
- Has a patch size > 1 hectare in area;
- Is separated by a distance of <100 metres; and
- Is not separated by a dual carriageway or wider highway or similar hostile link.

These links exist at Site 1 and Site 2

Step 2:

- Site 1 and Site 2 do not contain a 'State Significant Biodiversity Link' and/or a 'Regionally Significant Biodiversity Link'.

Step 3:

- Site 1 has a current linkage width class of >500 m; and
- Site 2 has a current width of approximately 32 m which corresponds to the 30-100 m linkage width class.

Step 4:

- Site 1 will not be impeding on any connecting links with the development only incrementally increasing an already disturbed area (Newstan Colliery - Pit top). Therefore it is proposed that the linkage width class of >500 m will be retained after the development; and
- Site 2 will be incrementally reducing a connecting link to approximately 19 m which corresponds to the >5-30 linkage width class.

Step 5:

- Site 1 will not be crossing any linkage width classes; and
- Site 2 will cross on linkage width class.

Step 6:

- Site 1 outer assessment circle currently contains a woody Plant Community Type (PCT) with a linkage condition class of 3; and
- Site 2 outer assessment circle currently contains a woody PCT with a linkage condition class of 3.

Step 7:

- Site 1 outer assessment circle will contain a woody PCT with a linkage condition class of 3 following the development; and
- Site 2 outer assessment circle will contain a woody PCT with a linkage condition class of 3 following the development.



TITLE: FIGURE 4: ASSESSMENT
CIRCLE 1 - SITE 1

LOCATION: COAL LOGISTICS
NEWSTAN

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 19/06/2015
PURPOSE: REPORT FIGURE

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WARNING
No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from RPS Newcastle.

- Legend**
- Project Area Boundary
 - Site 2 (Development site)
 - Linkage width
 - Assessment Circles

N
↑



TITLE: FIGURE 5: ASSESSMENT
CIRCLE 2 - SITE 2

LOCATION: COAL LOGISTICS
HAWKMOUNT QUARRY

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 19/06/2015
PURPOSE: REPORT FIGURE

LAYOUT REF: FIGURE 5: ASSESSMENT CIRCLE 2 - SITE 2
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Step 8:

- Site 1 will not be crossing any linkage condition classes; and
- Site 2 will not be crossing any linkage condition classes.

Step 9:

- Site 1 will contain a final connectivity value score of 0; and
- Site 1 will contain a final connectivity value score of 2.

2.2.3 Patch Size

To assess the Patch Size, the assessment must:

- Determine the percent native vegetation cleared in the Mitchell Landscape in which most of the development occurs. In this case the Mitchell Landscape is 'Gosford – Cooranbong Coastal Slopes' and this landscape is 38% cleared; and
- Determine the Patch size class, which in this instance is 'extra large'.

Based on the above, the derived Patch Size Score is 12.

2.3 Derived Landscape Value

Data for Percentage Native Vegetation Cover, Connectivity and Patch Size is combined to give the proposed development sites Landscape Score of 18.4 at Site 1 and 13.8 at Site 2.

2.4 Assessing Native Vegetation**2.4.1 Vegetation Zones**

These vegetation types were classified based on the 'best fit' vegetation type listed in the Plant Communities Types Database (OEH 2009). Parameters used to choose the 'best fit' Vegetation Type included overstorey and understorey floristics, soil landscape, location and topographic position. On this basis the following Lower Hunter and Central Coast Regional Environment Management Strategy (LHCCREMS (NPWS 2000)) vegetation units which were mapped by RPS within the Sites are deemed to be best fits with the corresponding Plant Community Types listed below:

- LHCCREMS Map Unit (MU) 6: Coastal Narrabeen Moist Forest has been assessed as corresponding to HU 798: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley.
- LHCCREMS MU 15: Coastal Foothills Spotted Gum - Ironbark Forest has been assessed as corresponding to HU803: Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast.
- LHCCREMS MU 30: Coastal Plains Smooth-barked Apple Woodland has been assessed as corresponding to HU 833 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands. In addition, the Floristic structure and composition of the regrowth *Acacia decurrens* area has been deemed to correspond with a Moderate/GoodPoor (disturbed) condition area of HU 833.

The proposed development involves the removal of 4.03 ha of native vegetation at Site 1 and 4.72 ha at Site 2. The directly affected vegetation zones were determined to consist of:

Site 1

- 3.50 ha of HU803: Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast; and
- 1.22 ha of HU 833 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.

Site 2

- 2.00 ha of disturbed HU 833 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands;
- 1.93 ha of HU 833 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.; and
- 0.10 ha of HU 798: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley.

Full descriptions of these communities are presented within **Appendix 1**.

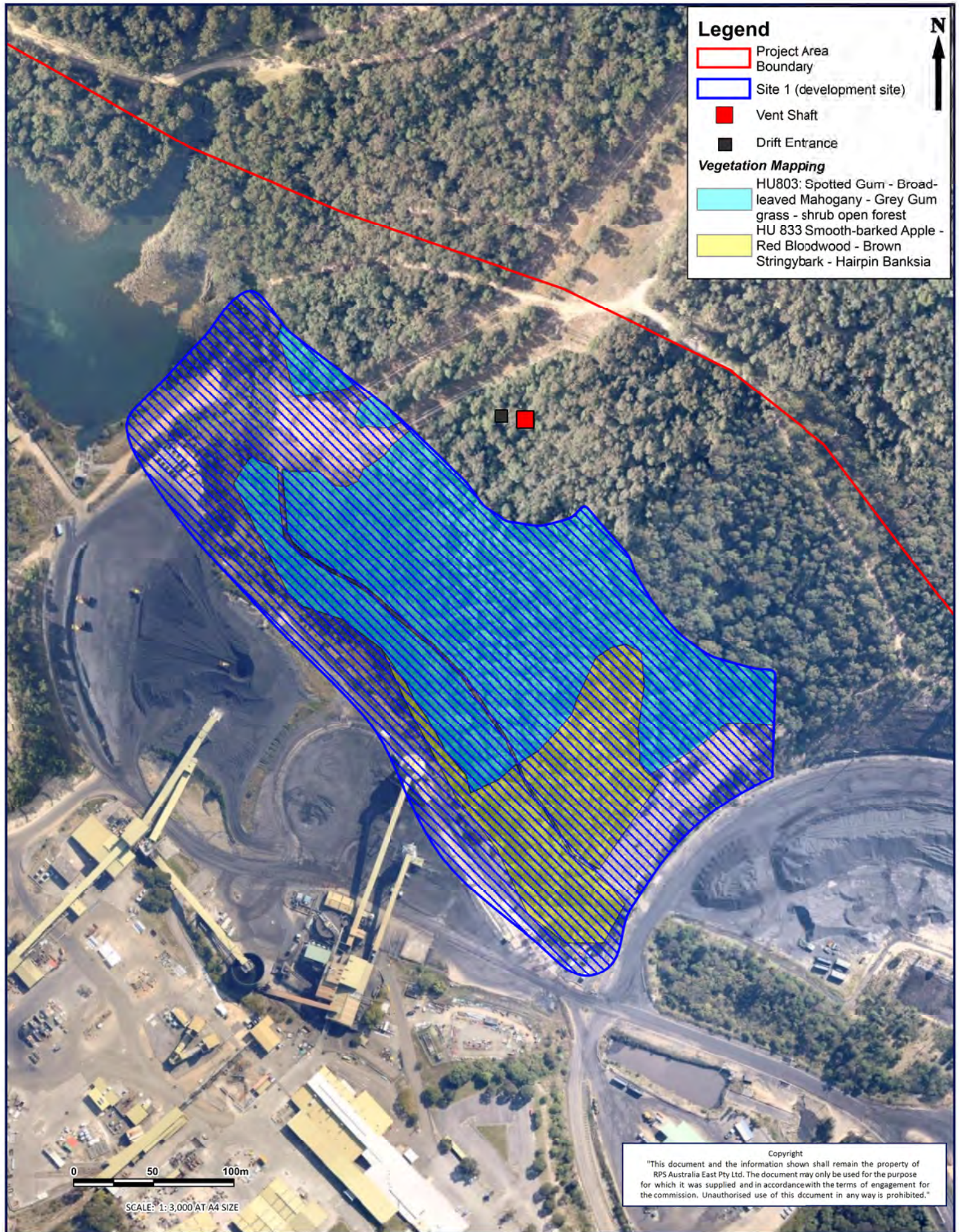
Final Scientific Committee Determinations under the TSC Act were reviewed to assess whether any of the Vegetation Zones were classified as Endangered or Critically Endangered EECs. This assessment did not find any of the above listed communities to be commensurate with any currently listed EECs under the TSC Act and/or the EPBC Act.

The vegetation communities listed above correspond to three BioBank Vegetation Zones recorded for the development sites and entered into the Credit Calculator, listed below in **Table 3** and shown in **Figure 6** and **Figure 7**.

Table 3 Vegetation Zones – Development sites

Veg Zone #	Vegetation Formation	Biobank Vegetation Type	Area (ha)	Identification Method	Condition Class	EEC	Estimate percent cleared value	Site Value Score
Site 1								
1	Dry Sclerophyll Forest (Shrubby)	HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	1.22	Detailed floristics for the site were ground-truthed by RPS (2015).	Moderate / Good	Not commensurate with an EEC	45%	53.65
2	Dry Sclerophyll Forest (Shrubby)	HU 803: Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of	3.50	Detailed floristics for the site were ground-truthed by RPS (2015).	Moderate / Good	Not commensurate with an EEC	71%	75.00

Veg Zone #	Vegetation Formation	Biobank Vegetation Type	Area (ha)	Identification Method	Condition Class	EEC	Estimate percent cleared value	Site Value Score
		the Central Coast						
Site 2								
1	Dry Sclerophyll Forest (Shrubby)	Disturbed HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	2.00	Detailed floristics for the site were ground-truthed by RPS (2015).	Moderate / Good_Poor	Not commensurate with an EEC	45%	54.17
2	Dry Sclerophyll Forest (Shrubby)	HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	1.93	Detailed floristics for the site were ground-truthed by RPS (2015).	Moderate / Good	Not commensurate with an EEC	45%	59.55
3	Wet sclerophyll forests (grassy)	HU 798: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	0.10	Detailed floristics for the site were ground-truthed by RPS (2015).	Moderate / Good	Not commensurate with an EEC	42%	48.09



TITLE: FIGURE 6: VEGETATION ZONE MAP-
SITE 1

LOCATION: COAL LOGISTICS
NEWSTAN

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

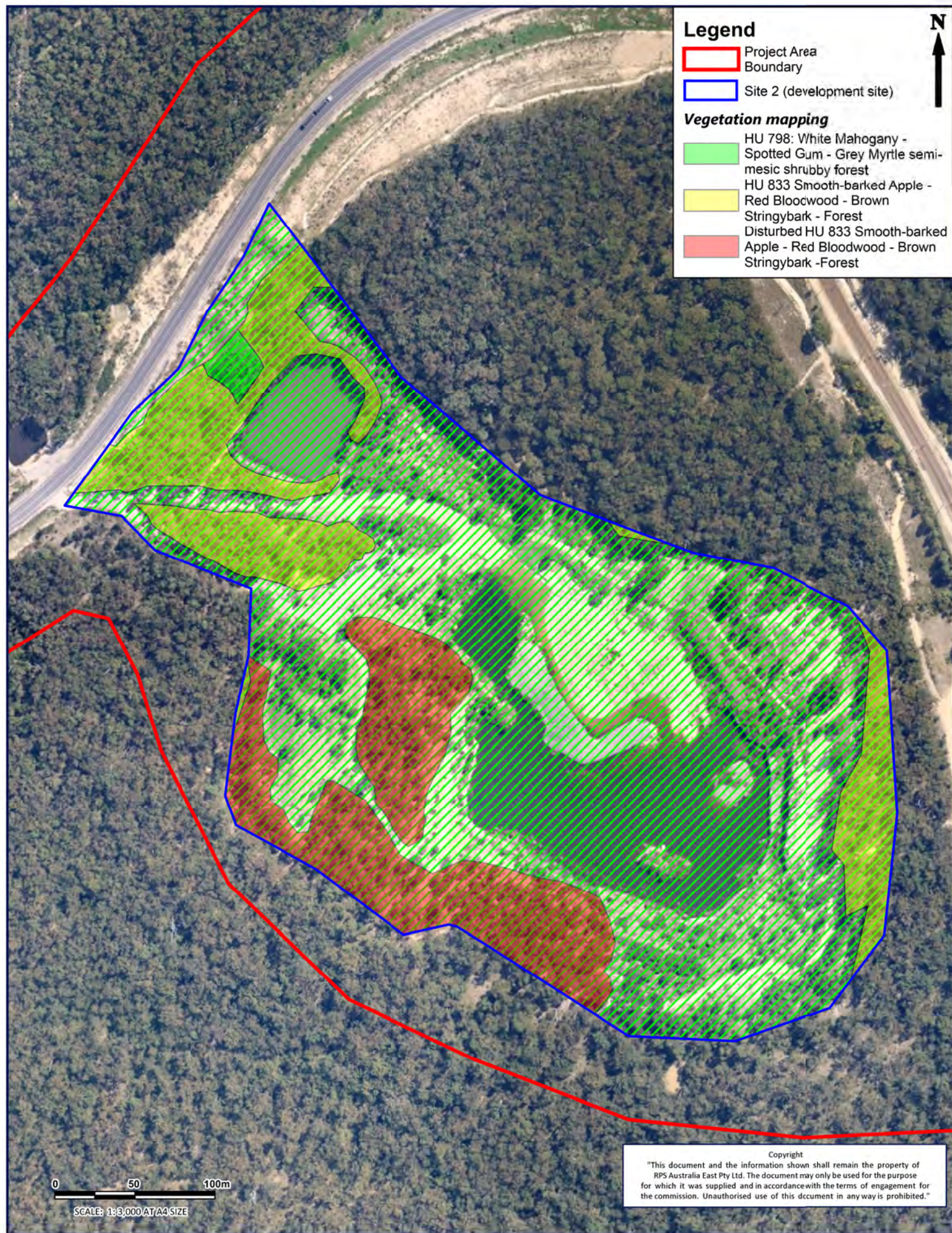
DATE: 18/06/2015
PURPOSE: REPORT FIGURE

LAYOUT REF: J:\JOBS\Centennial\All Jobs\113119 Coal Logistics\30 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): A4 (2A)

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TITLE: FIGURE 7: VEG ZONE MAP-
SITE 2

LOCATION: COAL LOGISTICS -
HAWKMOUNT QUARRY

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 18/06/2015
PURPOSE: FIGURE REPORT

LAYOUT REF: J:\085\Centennial\All Jobs\113119 Coal Logistics\30 - Drafting\Workspaces\Eco Report Figures\30 - Drafting\Workspaces\FIGURE 7: VEG ZONE MAP-
VERSION (PLAN BY): A4 (ZA)

CLIENT: CENTENNIAL
JOB REF: PR127982

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2.4.2 Plot and Transect Surveys

A Biobank field survey of the development sites was undertaken by RPS (2015). A total of seven Biobank biometric plots were carried out within the development sites where native vegetation is present which has been subsequently subjected to impact assessment calculations. Each survey site comprised the establishment of a 400m² quadrat (dimension = 20 metre x 20 metre) nested within a larger 0.1 hectare plot (dimension = 20 metre x 50 metre). Data collected within the nested plot comprised full floristics, elevation, slope, aspect, topographic position and soil type. Data collected within the larger plot comprised a census of hollow bearing trees and length of fallen logs. Structural vegetation data (vegetation cover for all strata) was collected along a 50 metre long transect (representing one of the 0.1 ha plot boundary lines). Plot data was recorded on Biobank specific field proformas prepared by OEH.

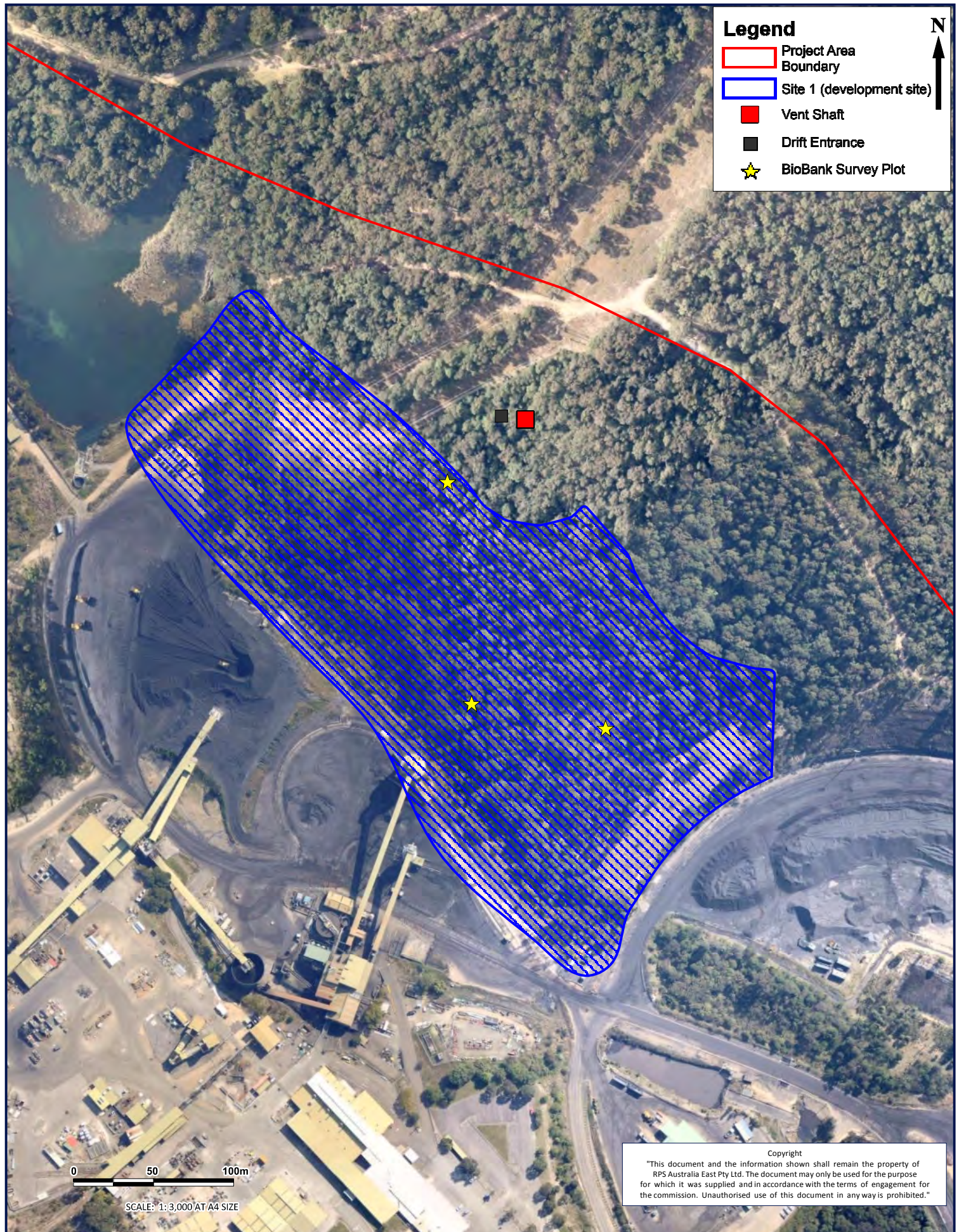
Survey methodologies for site variables recorded (e.g. how foliage cover is calculated for each strata) are detailed in OEH (2014).

Transect/plot data for the sites were entered into the 'Site Values' section of the Credit Calculator and is reproduced below in **Table 4**. The Credit Calculator requires that a minimum number of Biometric plots be carried out for each Vegetation Zone based on the Zone's extant area. The number of plots undertaken meets the Biobank assessment minimum survey effort requirements.

Biobank plot survey sites for the development sites are shown in **Figure 8** and **Figure 9**.

Table 4 Survey Plot / Transect Data – Development Sites

Plot ID #	Plant Species Richness	Native Over-storey Cover	Native Mid Storey Cover	Native Ground Cover - grasses	Native Ground Cover - shrubs	Native Ground Cover - other	Exotic Plant Cover	# Tree Hollows	Overstorey Regeneration	Length Fallen Logs (m)	Easting (GDA 94-MGA 56)	Northing (GDA 94-MGA 56)
Site 1												
HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands – Moderate/Good (1 plots completed; minimum 1 plots required)												
1	41	40.50	7.50	68.00	28.66	62.66	0.00	0	0.50	5.00	366,914	6,350,446
HU 803: Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast – Moderate/Good (2 plots completed; minimum 2 plots required)												
2	34	38.16	10.66	53.33	39.33	49.33	0.00	1	1.00	34.00	366,831	6,350,462
3	36	41.66	20.33	64.00	28.00	68.00	0.00	0	1.00	8.00	366,815	6,350,600
Site 2												
HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands – Moderate/Good (1 plots completed; minimum 1 plots required)												
4	41	45.00	6.00	68.00	31.33	62.66	0.00	0	1.00	35.00	361,432	6,343,487
HU 798: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley – Moderate/Good (1 plots completed; minimum 1 plots required)												
5	36	20.00	70.00	70.00	2.00	35.00	5.00	0	1.00	27.00	361,432	6,343,598
Disturbed HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands – Moderate/Good_Poor (2 plots completed; minimum 1 plots required)												
6	42	9.66	28.50	71.33	15.33	21.33	26.66	0	1.00	14.00	361,519	6,343,404
7	26	25.80	27.80	46.00	12.60	10.60	3.30	0	1.00	5.00	361,578	6,343,264



TITLE: FIGURE 8: BIOBANK SURVEY PLOT-
SITE 1

LOCATION: COAL LOGISTICS
NEWSTAN

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

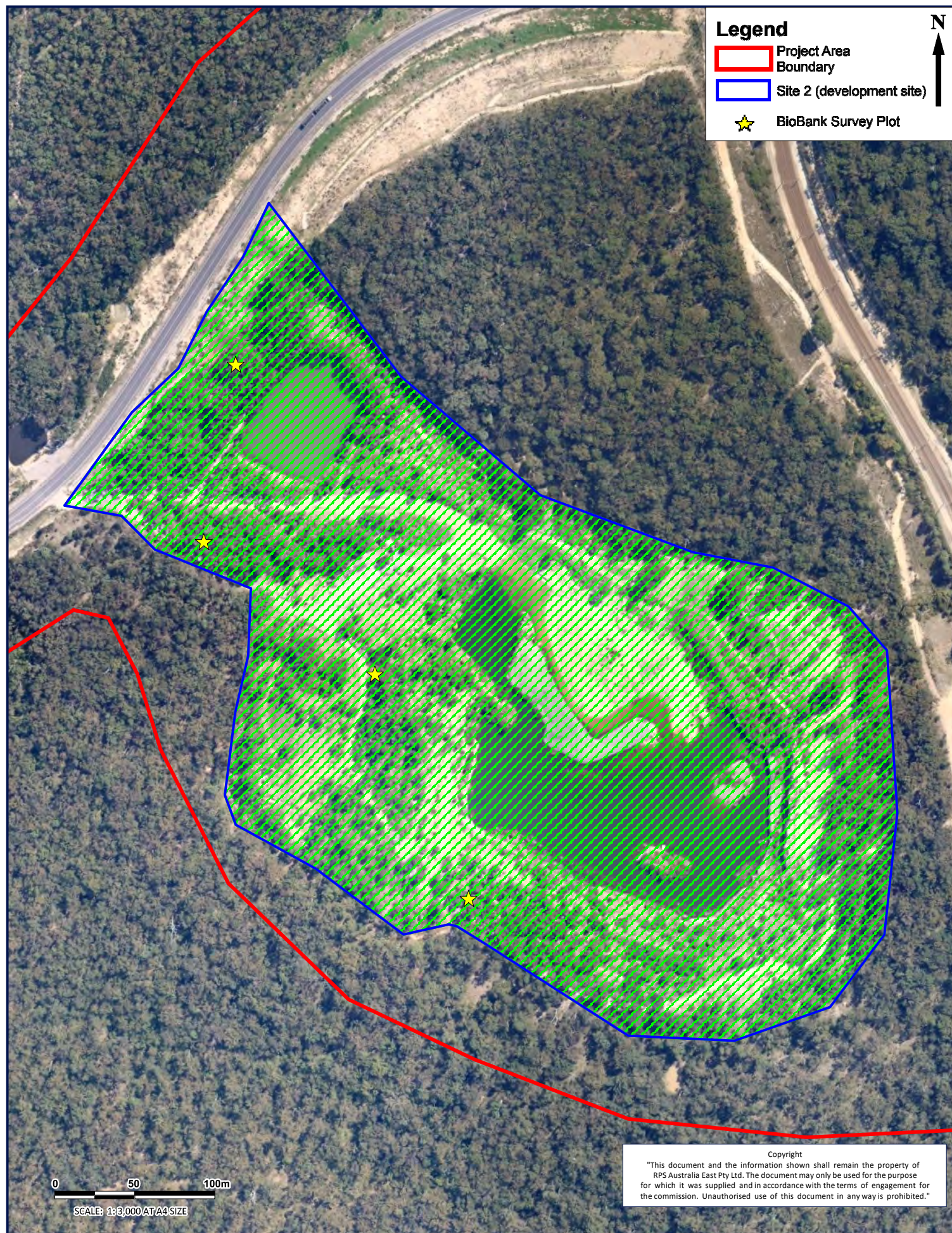
DATE: 18/06/2015
PURPOSE: REPORT FIGURE

LAYOUT REF: 2:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): AW (ZAW)

CLIENT: CENTENNIAL
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TITLE: FIGURE 9: BIOBANK SURVEY PLOT

LOCATION: COAL LOGISTICS -
HAWKMOUNT QUARRY

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 18/06/2015
PURPOSE: FIGURE REPORT

LAYOUT REF: Z:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures\BioBanking\Workspaces\FIGURE 9: BIOBANK SURVEY PLOT.dwg
VERSION (PLAN BY): A (A12A)

CLIENT: CENTENNIAL
JOB REF: PR127982

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2.5 Geographic and Habitat Features

The Biobanking Credit Calculator has considered the habitat values inherent within the proposed development sites and asks whether listed Geographic and Habitat Features (GHFs) associated with specific threatened flora and fauna ecosystem credit-type species occur on the development sites. The GHFs listed below in **Table 5** (Site 1) and **Table 6** (Site 2) were chosen in the Credit Calculator as being relevant to the proposed development sites (i.e. having broad features that match the site habitats). The remaining GHFs listed in the Credit Calculator were considered as not having broad features that match the development sites habitats and thus were not 'ticked' as relevant to the proposed development sites (and were filtered out of the subsequent steps of the BioBank assessment).

Table 5 Geographic and Habitat Features – Site 1 (filtered)

Common name	Scientific name	Feature
Heath Wrinklewort	<i>Rutidosia heterogama</i>	heath on sandy soils, or moist areas in open forest
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	land within 40 m of watercourses, containing hollow-bearing trees, loose bark and/or fallen timber
Common Planigale	<i>Planigale maculata</i>	rainforest, eucalypt forest, heathland, marshland, grassland or rocky areas
Green and Golden Bell Frog	<i>Litoria aurea</i>	land within 100 m of emergent aquatic or riparian vegetation
Green-thighed Frog	<i>Litoria brevipalmata</i>	land within 100 m of semi-permanent or ephemeral ponds or depressions containing leaf litter
Wyong Sun Orchid	<i>Thelymitra sp. adorata</i>	Occurs from 10-40 m a.s.l. in grassy woodland or occasionally derived grassland in well-drained clay loam or shale derived soils. The vegetation type in which the majority of populations occur (including the largest colony) is a Spotted Gum - Ironbark Forest

Table 6 Geographic and Habitat Features – Site 2 (filtered)

Common name	Scientific name	Feature
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels
Wallum Froglet	<i>Crinia tinnula</i>	land within 40 m of swamps, wet or dry heaths or sedge grasslands
Heath Wrinklewort	<i>Rutidosia heterogama</i>	heath on sandy soils, or moist areas in open forest
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	land within 40 m of watercourses, containing hollow-bearing trees, loose bark and/or fallen timber
Eastern Osprey	<i>Pandion cristatus</i>	land within 40 m of fresh/brackish/saline waters of larger rivers or creeks; estuaries, coastal lagoons, lakes and/or inshore marine waters
Common Planigale	<i>Planigale maculata</i>	rainforest, eucalypt forest, heathland, marshland, grassland or rocky areas
Green and Golden Bell Frog	<i>Litoria aurea</i>	land within 100 m of emergent aquatic or riparian vegetation
Green-thighed Frog	<i>Litoria brevipalmata</i>	land within 100 m of semi-permanent or ephemeral ponds or depressions containing leaf litter
Caladenia porphyrea	<i>Caladenia porphyrea</i>	Grows in coastal sclerophyll forest on sandy soils.

3.0 Threatened Species

Threatened species have been classified into two types; 'Ecosystem Credit' and 'Species Credit' type species, as detailed within the Threatened Species Profile Database (TSPD). Ecosystem Credit species are species with habitat needs that can be reliably predicted based on vegetation type and location. The Credit Calculator considers the impacts to these species based on the impact to the vegetation types or localities that they are predicted to occur within. Species Credit species are species with habitat needs that are not reliably predicted by the vegetation type or location. Only species that are considered to be Species Credit species require targeted surveys.

Some species are 'split' with species credits applying to, for example, breeding habitat whereas ecosystem credits applied to foraging habitat for a species. The 'Tg' value of both ecosystem and species type species weights the significance of habitat and in the case of ecosystem credit type species the species with the highest 'Tg' value is applied to the site. 'Tg' value is a representation of a species' life history characteristics, rarity, and the amount of information available on the species.

3.1 Ecosystem Credit Species

The 'Site Survey details' section of the Credit Calculator lists the Ecosystem Credit type species that potentially occur on the development sites, reproduced in **Table 7** (Site 1) and **Table 8** (Site 2) below.

Table 7 Predicted ecosystem type species – Site

Common Name	Scientific Name	Recorded From Within 10km (NSW Wildlife Atlas 2015) Y/N	Recorded From the development site Y/N
Barking Owl	<i>Ninox connivens</i>	Y	N
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis subsp. gularis</i>	N	N
Brown Treecreeper (eastern subspecies)	<i>Climacteris picumnus subsp. victoriae</i>	Y	N
Bush Stone-curlew	<i>Burhinus grallarius</i>	Y	N
Stagonopleura guttata	<i>Diamond Firetail</i>	Y	N
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	Y	N
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	Y	N
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Y	N
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	Y	N
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	Y	N
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis subsp. temporalis</i>	Y	N
Little Eagle	<i>Hieraaetus morphnoides</i>	Y	N
Little Lorikeet	<i>Glossopsitta pusilla</i>	Y	Y
Masked Owl	<i>Tyto novaehollandiae</i>	Y	N
Painted Honeyeater	<i>Grantiella picta</i>	N	N
Powerful Owl	<i>Ninox strenua</i>	Y	N
Scarlet Robin	<i>Petroica boodang</i>	Y	N

Common Name	Scientific Name	Recorded From Within 10km (NSW Wildlife Atlas 2015) Y/N	Recorded From the development site Y/N
Speckled Warbler	<i>Chthonicola sagittata</i>	Y	N
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	Y	N
Square-tailed Kite	<i>Lophoictinia isura</i>	Y	N
Squirrel Glider	<i>Petaurus norfolcensis</i>	Y	N
Swift Parrot	<i>Lathamus discolor</i>	Y	N
Turquoise Parrot	<i>Neophema pulchella</i>	Y	N
Varied Sittella	<i>Daphoenositta chrysoptera</i>	Y	N
Yellow-bellied Glider	<i>Petaurus australis</i>	Y	N
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	Y	N

Of the above listed threatened species only the Little Lorikeet has been previously recorded within the site (RPS 2015).

Table 8 Predicted Ecosystem Type Species – Site 2

Common Name	Scientific Name	Recorded From Within 10km (NSW Wildlife Atlas 2015) Y/N	Recorded From the development site Y/N
Barking Owl	<i>Ninox connivens</i>	Y	N
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis subsp. gularis</i>	N	N
Brown Treecreeper (eastern subspecies)	<i>Climacteris picumnus subsp. victoriae</i>	Y	N
Bush Stone-curlew	<i>Burhinus grallarius</i>	Y	N
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	Y	N
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	Y	N
Flame Robin	<i>Petroica phoenicea</i>	N	N
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Y	N
Glossy Black-Cockatoo	<i>Calyptrorhynchus lathami</i>	Y	N
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	Y	N
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis subsp. temporalis</i>	Y	N
Little Eagle	<i>Hieraaetus morphnoides</i>	Y	N
Little Lorikeet	<i>Glossopsitta pusilla</i>	N	Y
Long-nosed Potoroo	<i>Potorous tridactylus</i>	Y	N
Masked Owl	<i>Tyto novaehollandiae</i>	Y	N
Painted Honeyeater	<i>Grantiella picta</i>	N	N
Powerful Owl	<i>Ninox strenua</i>	Y	N
Scarlet Robin	<i>Petroica boodang</i>	Y	N
Speckled Warbler	<i>Chthonicola sagittata</i>	Y	N

Common Name	Scientific Name	Recorded From Within 10km (NSW Wildlife Atlas 2015) Y/N	Recorded From the development site Y/N
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	Y	N
Square-tailed Kite	<i>Lophoictinia isura</i>	Y	N
Squirrel Glider	<i>Petaurus norfolcensis</i>	Y	N
Swift Parrot	<i>Lathamus discolor</i>	Y	N
Turquoise Parrot	<i>Neophema pulchella</i>	Y	N
Varied Sittella	<i>Daphoenositta chrysoptera</i>	Y	N
Yellow-bellied Glider	<i>Petaurus australis</i>	Y	N
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	Y	N

Of the above listed threatened species only the Little Lorikeet has been assumed to be present based on a nearby record in contiguous habitat (RPS 2015).

Species Credit Species

'Site Survey details', of the Credit Calculator lists the Species Credit type species that potentially occur on the development sites, reproduced in **Table 9** (Site 1) and **Table 10** (Site 2) below.

Table 9 Species Credit Species within Site 1

Common name	Scientific name	BioBanking Survey Period	Site Surveyed During Recommended Period Y/N	Recorded From the Site Y/N	Assumed Presence Y/N
Biconvex Paperbark	<i>Melaleuca biconvexa</i>	All year round	Y	N	N
Black-eyed Susan	<i>Tetralochea juncea</i>	July-December	Y	Y	Identified
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	All year round	Y	N	N
Bynoe's Wattle	<i>Acacia bynoeana</i>	September - March	Y	N	N
Common Planigale	<i>Planigale maculata</i>	All year round	Y	N	N
Diuris bracteata	<i>Diuris bracteata</i>	July - August	Y	N	N
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	All year round	Y	N	N
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	None specified	None specified	N	N
Golden-tipped Bat	<i>Kerivoula papuensis</i>	October- March	Y	N	N
Green and Golden Bell Frog	<i>Litoria aurea</i>	August - March	Y	N	N
Green-thighed Frog	<i>Litoria brevipalmata</i>	October- March	Y	N	N
Grove's Paperbark	<i>Melaleuca groveana</i>	All year round	Y	N	N
Heath Wrinklewort	<i>Rutidosia heterogama</i>	All year round	Y	N	N
Koala	<i>Phascolarctos cinereus</i>	All year round	Y	N	N
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>	November - February	Y	N	N

Common name	Scientific name	BioBanking Survey Period	Site Surveyed During Recommended Period Y/N	Recorded From the Site Y/N	Assumed Presence Y/N
Netted Bottle Brush	<i>Callistemon linearifolius</i>	October – April	Y	N	N
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	September - March	Y	N	N
Red-backed Button-quail	<i>Turnix maculosus</i>	All year round	Y	N	N
Regent Honeyeater	<i>Anthochaera phrygia</i>	All year round	Y	N	N
Rough Doubletail	<i>Diuris praecox</i>	July - August	Y	N	N
Small-flower Grevillea	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	All year round	Y	N	N
Tetradlea glandulosa	<i>Tetradlea glandulosa</i>	July - November	Y	N	N
Thick Lip Spider Orchid	<i>Caladenia tessellata</i>	September - October	Y	N	N
Thick-leaf Star-hair	<i>Astrotricha crassifolia</i>	All year round	Y	N	N
Tranquility Mintbush	<i>Prostanthera askania</i>	September - December	Y	N	N
Variable Midge Orchid	<i>Genoplesium insignis</i>	September - October	Y	N	N
White-flowered Wax Plant	<i>Cynanchum elegans</i>	All year round	Y	N	N
Wyong Sun Orchid	<i>Thelymitra sp. adorata</i>	September - October	Y	N	N

Of the above listed threatened species only Black-eyed Susan has been previously recorded within the site.

The location of Black-eyed Susan record within the Site 1 is shown in **Figure 10**.

Table 10 Species Credit Species within Site 1

Common name	Scientific name	BioBanking Survey Period	Site Surveyed During Recommended Period Y/N	Recorded From the Site Y/N	Assumed Presence Y/N
Black-eyed Susan	<i>Tetradlea juncea</i>	July-December	Y	N	N
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	All year round	Y	N	N
Bynoe's Wattle	<i>Acacia bynoeana</i>	September - March	Y	N	N
Caladenia porphyrea	<i>Caladenia porphyrea</i>	All year round	Y	N	N
Common Planigale	<i>Planigale maculata</i>	All year round	Y	N	N
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	All year round	Y	N	N
Eastern Osprey	<i>Pandion cristatus</i>	All year round	Y	N	N
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	None specified	None specified	N	N
Golden-tipped Bat	<i>Kerivoula papuensis</i>	October- March	Y	N	N
Green and Golden Bell Frog	<i>Litoria aurea</i>	August - March	Y	N	N

Common name	Scientific name	BioBanking Survey Period	Site Surveyed During Recommended Period Y/N	Recorded From the Site Y/N	Assumed Presence Y/N
Green-thighed Frog	<i>Litoria brevipalmata</i>	October- March	Y	N	N
Grove's Paperbark	<i>Melaleuca groveana</i>	All year round	Y	N	N
Heath Wrinklewort	<i>Rutidosia heterogama</i>	All year round	Y	N	N
Koala	<i>Phascolarctos cinereus</i>	All year round	Y	N	N
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	September - April	Y	N	N
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>	November - February	Y	N	N
Netted Bottle Brush	<i>Callistemon linearifolius</i>	October – April	Y	N	N
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	September - March	Y	N	N
Rough Doubletail	<i>Diuris praecox</i>	July - August	Y	N	N
Small-flower Grevillea	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	All year round	Y	Y	Identified
Tetradlea glandulosa	<i>Tetradlea glandulosa</i>	July - November	Y	N	N
Thick-leaf Star-hair	<i>Astrotricha crassifolia</i>	All year round	Y	N	N
Tranquility Mintbush	<i>Prostanthera askania</i>	September - December	Y	N	N
Variable Midge Orchid	<i>Genoplesium insignis</i>	September - October	Y	N	N
Wallum Froglet	<i>Crinia tinnula</i>	All year round	Y	N	N
White-flowered Wax Plant	<i>Cynanchum elegans</i>	All year round	Y	N	N

Of the above listed threatened species only Small-flower Grevillea has been previously recorded within the site.

The location of Small-flower Grevillea record within the Site 2 is shown in **Figure 11**.

3.1.2 Threatened Species Survey Methodologies

The recommended survey periods for the species credit type species are detailed in **Table 9** and **Table 10**. By combining the detailed ecological survey works undertaken by RPS (2015) a comprehensive understanding of the ecological attributes of the site has been obtained over several seasons, and required survey methodologies for species credit species have been met. Where any doubt remained, presence was assumed.

No additional species to those listed above have been recorded within site 2. However, three additional threatened species have been recorded within the Site 1, including:

Grey-headed Flying-fox *Pteropus poliocephalus*

Large-eared Pied Bat *Chalinolobus dwyeri*

Little Bentwing-bat *Miniopterus australis*

The location of records of these additional threatened species within the Site 1 is shown in **Figure 10**.

For the purposes of impact assessment, where these species are “Species Credit Species” they have been added to the Threatened Species Survey results in the Calculator.

3.1.3 Species Polygons

A species polygon has been developed for each of the various threatened ‘Species’ credit species considered as potentially utilising the development sites.

3.1.3.1 [Black-eyed Susan](#)

A total of 376 clumps of this species was been recorded within Site 1 during targeted surveys. The extent of this polygon is shown in **Figure 12**.

3.1.3.2 [Small-flower Grevillea](#)

This species recorded at one single location within Site 2 during targeted surveys. The extent of this polygon is shown in **Figure 13**.

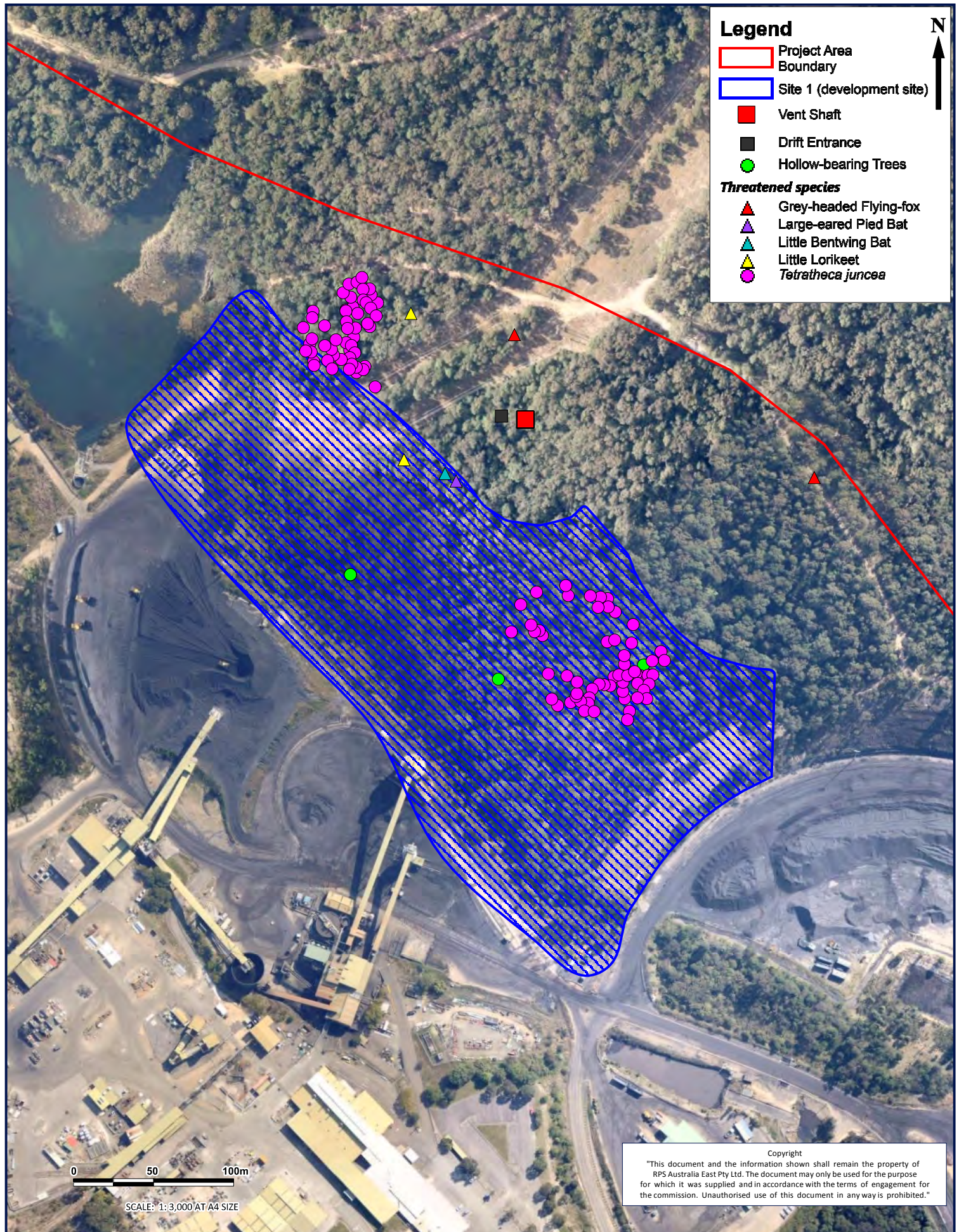
3.1.3.3 [Micro-bats](#)

The Large-eared Pied Bat and Little Bentwing-bat were recorded on Site 1 and are considered to have 4.72 ha of suitable forested habitat therein. The extent of this polygon is shown in **Figure 12**. The remaining areas of the development sites do not contain treed areas, and whilst these species may forage over open areas, the conversion to a development site is not considered to change that potential to any notable limiting degree.

3.2 Identified Populations

The Director General of OEH may develop an ‘Identified Populations’ Database that identifies population(s) of Threatened species present in an area of land that require assessment under the BBAM (either for a Biobank or Development site).

To date, the BBAM has not determined any Identified Populations.



TITLE: FIGURE 10: THREATENED SPECIES-
SITE 1

LOCATION: COAL LOGISTICS
NEWSTAN

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

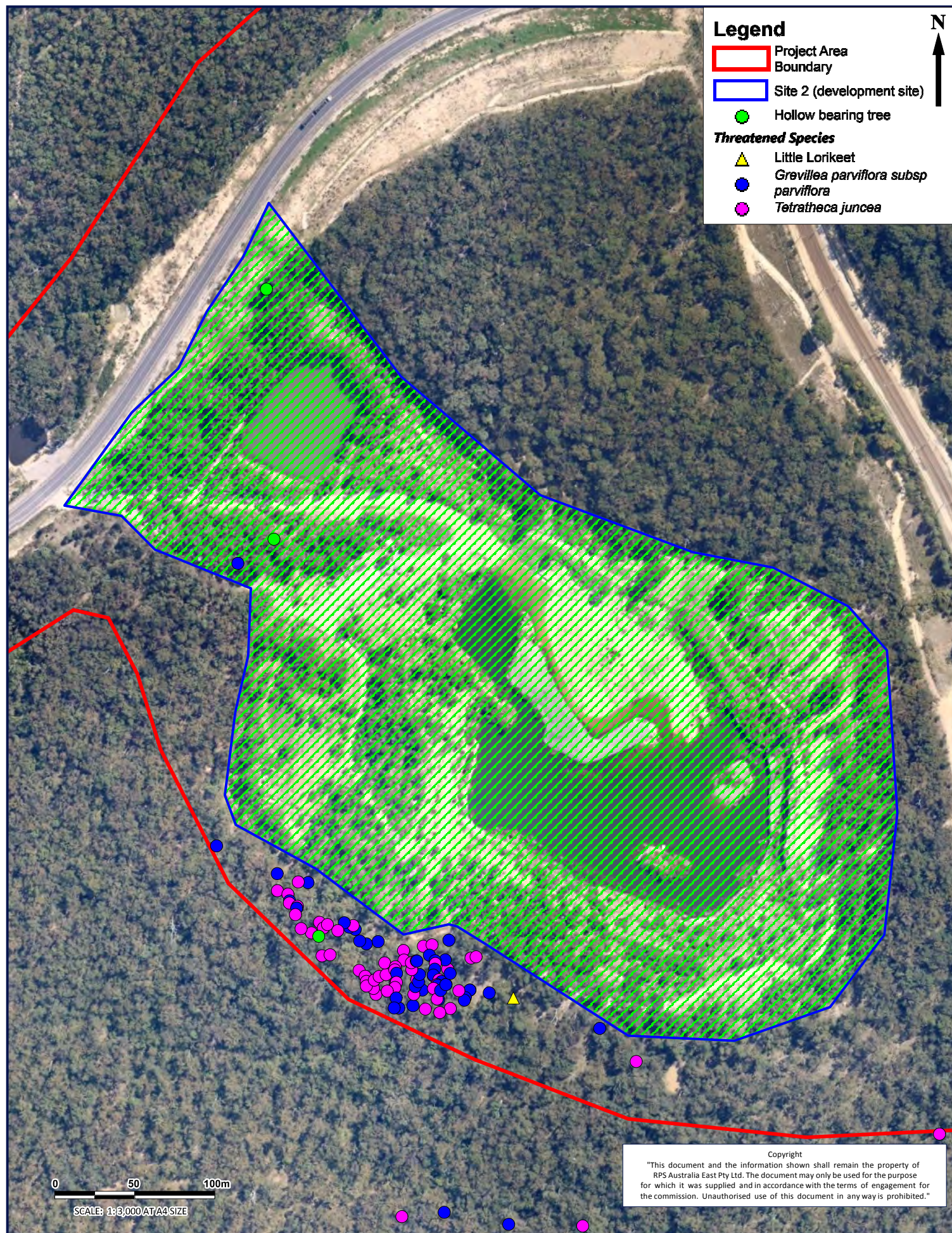
DATE: 18/06/2015
PURPOSE: REPORT FIGURE

LAYOUT REF: 3:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): AW (ZAV)

CLIENT: CENTENNIAL
JOB REF: PR127982

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TITLE: FIGURE 11: THREATENED SPECIES-
SITE 2

LOCATION: COAL LOGISTICS -
HAWKMOUNT QUARRY

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

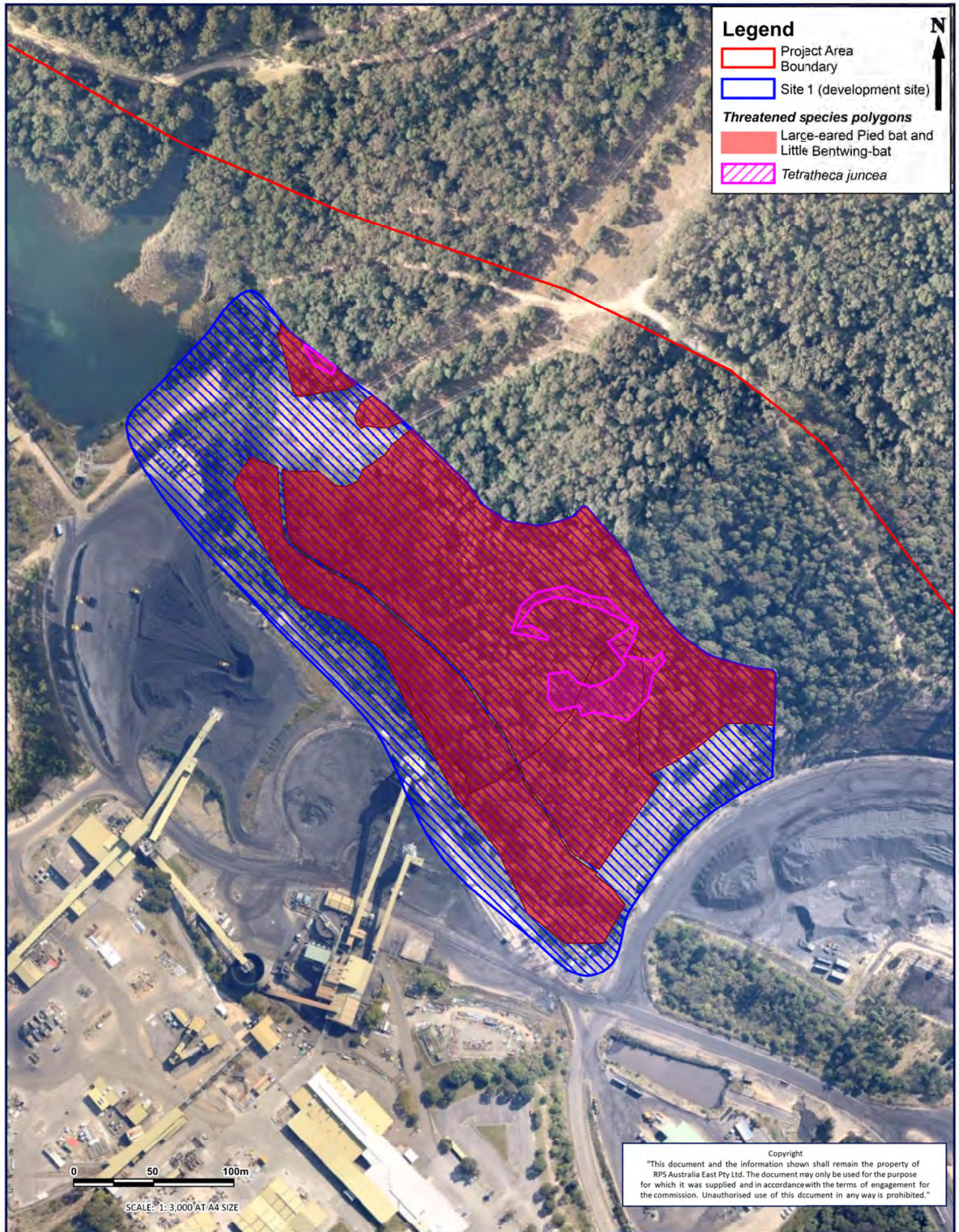
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TITLE: FIGURE 12: THREATENED SPECIES-
POLYGONS - SITE 1

LOCATION: COAL LOGISTICS
NEWSTAN

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

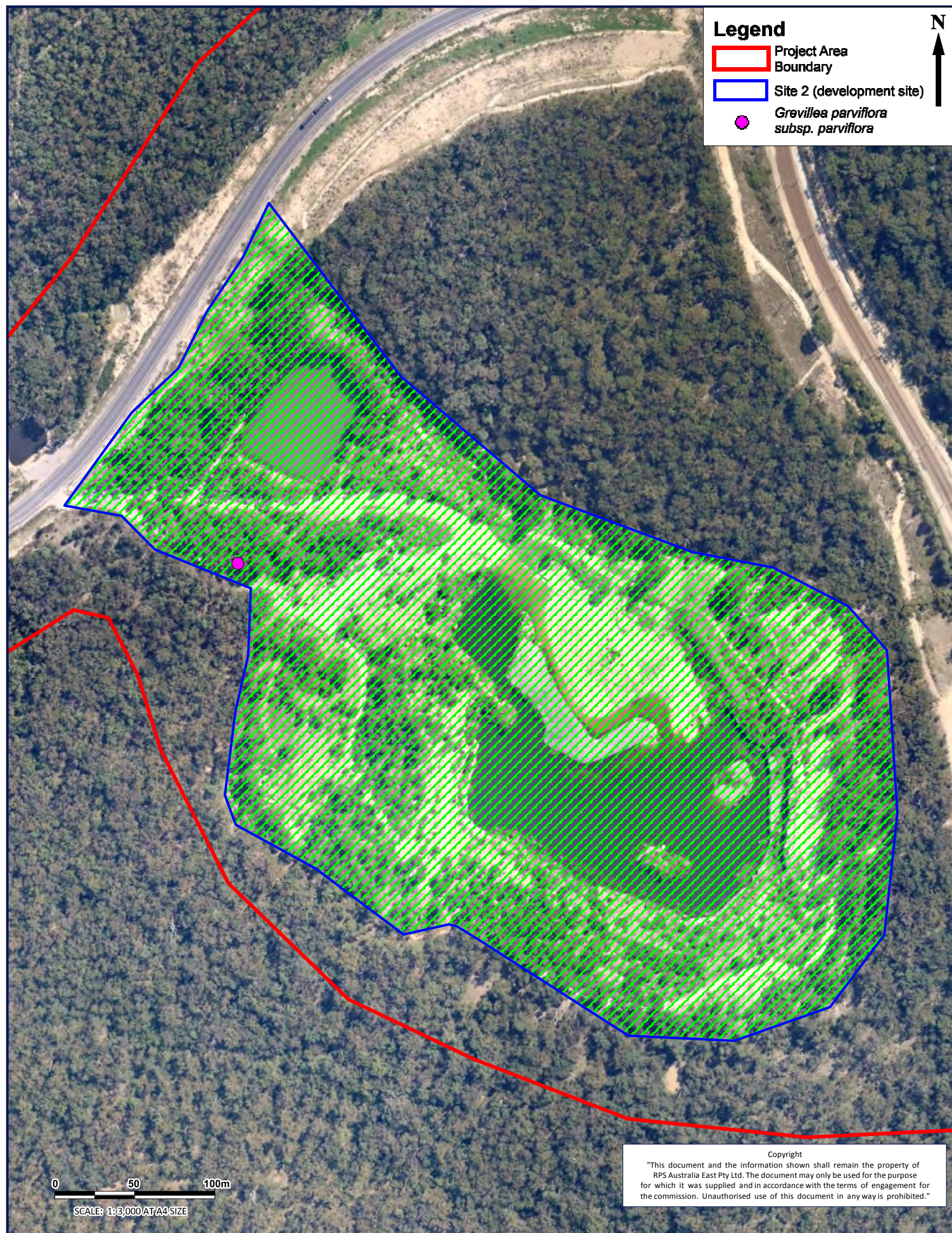
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TITLE: FIGURE 13: THREATENED SPECIES-
POLYGONS - SITE 2

LOCATION: COAL LOGISTICS -
HAWKMOUNT QUARRY

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 18/06/2015
PURPOSE: FIGURE REPORT

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Stage 2 – Impact Assessment (Biodiversity Values)

4.0 Potential Impacts

4.1 Avoidance

Avoidance measures of the Project design include the following:

- Utilising areas that are predominantly already cleared and disturbed;
- Piping of the section of LT Creek that passes through the Newstan Colliery Surface Site to reduce the potential for material from construction and operations at the Newstan Colliery Surface Site entering the waterway and causing potential downstream impacts on water quality;
- Locating surface disturbance footprints adjacent to established access routes so as to limit the amount of vegetation required to be disturbed;
- Re-design of the site boundary for the proposed Site 1 disturbance area to maintain a buffer of vegetation around the disused mine drift entrance known as Bat Alley to reduce the potential for direct impacts on bat species utilising this site;
- Installation of a wall around the proposed coal stockpile area at Site 1 to reduce the potential for impacts from noise and light on bat species utilising Bat Alley;
- Re-design of the Site 1 boundary to avoid 425 clumps of *T. juncea*;
- Re-design of the proposed Site 2 disturbance area to avoid 131 stems of *G. parviflora* subsp. *parviflora* and 219 clumps of *T. juncea*;
- Re-design of the disturbance footprints at both Site 1 and Site 2 to avoid four hollow-bearing trees; and
- Avoiding where possible recorded threatened species, populations or ecological communities listed under the TSC Act 1995 or EPBC 1999.

Based on the impacts identified above, and the limitations also identified in regards to potentially re-siting the development, there is little scope to avoid direct impacts on identified biodiversity values further. There is no other area where the development could be feasibly sited, and the proposed development sites chosen achieve the minimum ecological impact possible for this Project.

4.2 Direct Impacts

The proposed development will result in the following direct impacts at Site 1:

- Loss of 4.72 ha of suitable habitat for the Little Bentwing-bat;
- Loss of 4.72 ha of suitable habitat for the Large-eared Pied Bat; and
- Loss of 376 individual of *Tetratheca juncea*.

The proposed development will result in the following direct impacts at Site 2:

- Loss of 1 individual of *Grevillea parviflora* subsp. *parviflora*.

4.3 Indirect Impacts

The proposed development will result in the following indirect impacts:

- An incremental encroachment on Bat Alley (Drift entrance and vent shaft) which is an important breeding area for two threatened bat species. Refer to **Appendix 1** for further details;
- Downstream impacts on areas subject to mine water discharges. Refer to Appendix 1 for further details; and

- General indirect impacts on surrounding retained areas resulting from a clearing edge interface and construction operations, and to a lesser degree ongoing site operation (noise, lighting, dust etc).

4.4 Mitigation

The following mitigation measures have been recommended to minimise the potential impacts of the Project.

General

- All machinery to be clean of foreign soil and propagative matter to avoid the importation of *Phytophthora cinnamomi* pathogenic fungus (Myrtle Rust) transmission and weed seed dispersal;
- Strict erosion and sediment control measures should be installed, monitored and maintained to prevent the erosion and sedimentation impact on adjacent areas;
- Dust mitigation measures are outlined in SLR (2014) and include, but are not limited to, measures such as watering of roads and sealing of roads, regular maintenance of all vehicles and modifying construction activities during high winds. Ongoing dust monitoring should continue to ensure relevant levels of dust deposition are achieved;
- Minimise potential impacts arising from stormwater runoff into riparian areas by designing and installing appropriate stormwater detention and/or filtering devices;
- Barricade vegetation prior to construction activities to reduce damage from uncontrolled or accidental access;
- Stockpiling of materials should occur within already disturbed areas and not within retained vegetation;
- Strict weed management, monitoring and control practices should be implemented to minimise the spread of exotic species into natural areas within the PAA; and
- The water from the sedimentation basin at Hawkmount Quarry should only be released (via the proposed Hawkmount LDP) after its quality has reached an acceptable level. In addition, the amounts to be released at any one time should be minimised in order to decrease the erosive capability of the discharged water.

Threatened Species

- Vegetation to be removed is to be clearly marked in the field using temporary fencing (flagging tape or similar exclusion tape) so that boundaries are clearly established and to minimise the potential for equipment to accidentally enter areas to be retained;
- Where possible, clearing activities should be timed to avoid removal of hollow-bearing trees during breeding season of threatened species; and
- An ecologist is to be present to supervise clearing of hollow bearing trees within the disturbance footprints and ensure hollow bearing trees are removed in the following manner:
 - (a) Hollow-bearing trees are to be clearly marked (spray paint or flagging tape) by a qualified ecologist within the disturbance footprints prior to any vegetation clearing commencing;
 - (b) Non habitat vegetation should be removed at least one day prior to felling of hollow-bearing trees to encourage resident fauna to self relocate before felling of remaining habitat trees;
 - (c) Immediately prior to the felling of hollow-bearing trees, trees should be given two sharp taps with the machinery arm/bucket to encourage fauna to escape. After waiting 1–2 minutes after tapping the tree, the hollow-bearing tree should be felled as gently as possible; and
 - (d) An ecologist is to inspect each felled hollow-bearing tree (once safe) to recover any injured fauna and seek appropriate treatment and relocate uninjured fauna into vegetation to be retained immediately adjacent to the disturbance footprints.

Bat Alley

The *Strategy for the Conservation of Bats in Derelict Mines* (NPWS 2001, cited in SLR 2014a) will be followed. In addition:

- A 50 metre exclusion or non-disturbance zone will be maintained around Bat Alley; and
- The Project design will incorporate light and sound barrier walls around the proposed ROM coal stockpile in this locality.

Water Discharges

- Newstan Colliery - The stability of LT Creek through the Fassifern Archery Club should be increased with the construction of small placed rock bed control structures in place of current unstable root masses present within the flow area. Quarterly and event based waterway visual inspections of LT Creek should be undertaken during the initial period of increased discharges through Newstan LDP001 until stability of the creek under the new flow regime can be confirmed; and
- Proposed Hawkmount Quarry LDP - The water from the sedimentation basin at Hawkmount Quarry will only be released after its quality has been improved to an acceptable level. In addition, the amounts to be released at any one time will be minimised in order to decrease the erosive capability of the discharged water.

Taking into account inherent design, construction, and economic considerations, the proposed development clearing footprint has been minimised in size as far as possible. Given such, provision of offsets and/or other supplementary measures is the only way that a suitable biodiversity outcome can be achieved in this instance.

Taking into account all relevant planning factors, including biodiversity impacts, the final site development footprint was chosen.

5.0 Thresholds Assessment

5.1 Development Impact Thresholds

Consideration was made against the specific impact threshold criteria spelled out in the FBA.

Impacts that require further consideration by consent authority

- There are no matters listed in Section 9.2 which will be directly impacted upon and therefore, require further consideration by the consent authority.

Impacts for which the assessor is required to determine an offset

- Landscape features – not applicable to FBA;
- The proposed development involves the removal of PCTs (with a site value score or >17) associated with threatened species habitat. Therefore, an offset requirement has been determined via application of the FBA Biobank Calculator.
- As the proposed development will impact on several identified threatened species, an offset requirement has been determined via application of the FBA BioBank Calculator.

Impacts for which the assessor is not required to determine an offset

- All relevant considerations have been captured by above categories.

Impacts that do not require further assessment by the assessor

- All relevant considerations have been captured by above categories.

6.0 Offset Requirements

6.1 Credit Report

The FBA Credit Calculator was 'run' with the data input as described in **Section 2** and generated a Credit Profile for the development sites. The Development Biobank Credit Reports generated by the Credit Calculator for site 1 and site 2 are provided in **Appendix 2** and **Appendix 3** respectively.

The development sites are proposed to be totally cleared and a summary of the Ecosystems Credits required for each are also provided in **Table 11** and **Table 12**. Overall the proposed development sites have generated the need for 453 Ecosystem credits and 5,925 Species credits. The below information was entered into the Credit Converter for Ecosystem credits and Species credits. This calculator is intended for use where there is a shortfall of credits for conservation measures in a biodiversity certification proposal. However, in this case it has been used as a rough guide to inform the proponent of how much land may be required for an offset site. This calculation has resulted in the requirement of approximately 22 hectares for Species credits and approximately 49 hectares for the Ecosystem credits.

Table 11 Summary of Ecosystem Credits Required

Plant Community Type	Area (ha)	Credits
Site 1		
HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	1.22	55
HU 803: Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	3.50	213
Site 2		
HU 833: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	3.93	181
HU 798: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	0.10	4
Total (Site 1 & Site 2)		453

Table 12 Summary of Species Credits Required

Common name	Scientific name	Extent of Impact (individuals or Ha)	Credits
Site 1			
Black-eyed Susan	<i>Tetratheca juncea</i>	376	5,640
Little Bentwing Bat	<i>Miniopterus australis</i>	4.72 ha	61
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	4.72 ha	61
Site 2			
Small flower Grevillea	<i>Grevillea parviflora subsp. parviflora</i>	1	14
Total (Site 1 & Site 2)			5,762

Stage 3 – Biodiversity Offset Strategy

A variety of indirect offset measures are proposed to offset the potential impacts of this Project. Compensatory measures will include translocation trials, installation of nest boxes and research programmes (refer to **Appendix 1** for further details). There is no specific offset site proposed.

7.0 References

NSW Office of Environment and Heritage (2014) *Biobanking Assessment Methodology 2014*, September 2014.

NSW Office of Environment and Heritage (undated). *Draft Operational Manual for using the Biobanking Credit Calculator v2.0*.

NSW Office of Environment and Heritage (2012). *Assessors Guide to using the Biobanking Credit Calculator v2*, April 2012.

OEH Threatened Species, Populations and Ecological Communities website
(<http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/>).

Appendix I

RPS Flora and Fauna Assessment Works (2015)



Northern Coal Logistics Project

Flora and Fauna Assessment

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Approval for Issue

Name	Signature	Date
Rob Dwyer		17.03.2015

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Summary

Introduction

RPS Australia East Pty Ltd (RPS) was engaged by Northern Coal Services Pty Ltd (Northern Coal Services) to undertake a Flora and Fauna Assessment (FFA) as part of an Environmental Impact Statement for the Northern Coal Logistics Project (the Project). Northern Coal Services is seeking approval for the Project under Part 4 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act 1979). The FFA is also designed to satisfy the additional Supplementary Information Requirements from the Commonwealth Department of the Environment (DoE) for approval of the Project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999). The aim of this FFA was to determine the likelihood of the Project having a significant impact on any threatened species, populations or ecological communities listed within the NSW *Threatened Species Conservation Act 1995* (TSC Act 1995) and / or Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) within the Project Application Area (PAA).

Based on the potential for significant impacts upon threatened species listed under the EPBC Act 1999, a referral was submitted (Ref: 2013/6906) to the Commonwealth Department of the Environment (DoE) (formerly the Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC)). As a result of the referral process, the proposed action was deemed to be a Controlled Action and that the Project will need to be assessed through Preliminary Documentation. The controlled action decision letter and request for additional information is provided in **Appendix 1**. This report has been written to satisfy the requirements of the additional information request letter.

The Project comprises both a continuation of existing operations and an upgrade to the surface coal handling and preparation infrastructure at the Newstan Colliery Surface Site and the Mandalong Mine - Cooranbong Entry Site (Cooranbong Entry Site), along with the existing private haul roads and rail loading infrastructure. These facilities are integral to the on-going handling, processing and transport of coal from the underground workings of Newstan Colliery and Mandalong Mine (including the proposed Newstan Colliery Extension of Mining Project and Mandalong Southern Extension Project) for domestic and export markets.

The Project will allow for improved and flexible coal handling arrangements across both the Newstan Colliery and Mandalong Mine to deliver the range of coal products required to meet domestic and export market demands.

Two disturbance footprints are proposed by the Project being:

- Site 1 – Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-developed and upgrade of the coal handling and processing infrastructure within this surface site; and
- Site 2 – an area of approximately 13.9 ha within the Hawkmount Quarry site (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement.

Flora

In total, the Project will result in approximately 21.4 ha of disturbance. Of that area 12.63 ha is already cleared / disturbed with the remaining area made up of 8.75 ha of remnant native vegetation in varying condition. The proposed disturbance footprints are made up of the following:

Site 1

- 3.50 ha of MU 15: Coastal Foothills Spotted Gum - Ironbark Forest;
- 1.22 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 2.78 ha of Cleared (roads, tracks and powerlines).

Site 2

- 2.00 ha of Regrowth Acacia decurrens;
- 1.93 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 0.10 ha of MU 6: Coastal Narrabeen Moist Forest; and
- 9.85 ha of Cleared (roads, tracks and waterbodies).

In total, two threatened flora species were detected within the proposed disturbance footprints. 376 *Tetradlea juncea* (Black-eyed Susan) were recorded within Site 1 and one *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) was recorded within Site 2. Both species are listed as Vulnerable under the TSC Act 1995 and EPBC Act 1999.

Habitat

The habitat within Site 1 was found to be in good condition, with a mixture of mature trees and a juvenile understorey. Fallen timber and a dense groundcover provides suitable shelter for a wide range of terrestrial species, with hollow-bearing trees providing suitable breeding and nesting habitat for avifauna and arboreal species. In addition, the cave (old drift entrance) adjacent to Site 1, which is known as 'Bat Alley', provides potentially important roosting habitat for cave-dwelling bat species. Site 2 was found to be native vegetation that was mostly regrowth with large areas of cleared land and old quarry workings which have since filled with water.

The clearing of vegetation involves the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows, seven small (2–10 cm) and three medium (11–25 cm), have been identified within the five hollow-bearing trees. No large hollows (>25 cm) were identified within the proposed disturbance footprints.

Fauna

In total, four threatened fauna species were recorded within the Project Application Area. The Little Lorikeet (*Glossopsitta pusilla*) was recorded within Site 1 and within close proximity to Site 2. The Grey-headed Flying-fox (*Pteropus poliocephalus*) was recorded within close proximity to Site 1. The Little Bentwing-Bat (*Miniopterus australis*) and Large-eared Pied Bat (*Chalinolobus dwyeri*) were both recorded within Site 1. Each of these species is listed as Vulnerable under the TSC Act 1995. In addition, the Grey-headed Flying-fox and Large-eared Pied Bat are listed as Vulnerable under the EPBC Act 1999.

Potential Impacts

As aforementioned, two threatened flora species were detected within the proposed disturbance footprints, namely *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) and *Tetradlea juncea* (Black-eyed Susan), which are both listed as Vulnerable under the TSC Act 1995 and EPBC Act 1999. As a result of the Project, one individual of *G. parviflora* subsp. *parviflora* (within Site 2) and 376 clumps of *T. juncea* (within Site 1) will be removed.

As part of addressing the Controlled Action decision (**Appendix 1**), RPS conducted targeted seasonal surveys for *Tetradlea juncea* outside of the disturbance footprint area around Site 1. The purpose of

undertaking additional surveys outside of the disturbance footprint was to determine whether the proportion of the 'local population' (as defined in DSEWPAC 2011) within the disturbance footprint constitutes a loss of greater than 25% of the local population. A loss of greater than 25% of plant clumps is considered a 'high risk of significant impacts on Black-eyed Susan' (DSEWPAC, 2011). The immediate surrounding vegetation type (MU30) is preferred habitat for *T. juncea* and following additional targeted surveys it has been established that the individuals within Site 1 are part of a larger subpopulation extending to the north and west which number at least 1,958 clumps. This sub-population estimate is a conservative estimate and additional surveys within the region would most likely result in a much larger estimate of this subpopulation. Given the current information, the removal of 376 clumps equates to the removal of up to approximately 19.2% of the recorded sub-population of *T. juncea*.

Redesign of the disturbance footprint at Site 2 has led to the avoidance of 131 stems of *G. parviflora* subsp. *parviflora*. In addition, RPS has recorded several nearby occurrences of *G. parviflora* subsp. *parviflora* within the Newstan lease area. This includes the recording of 173 stems at three locations within habitat immediately adjacent to the proposed Site 2 disturbance footprints, as well as an additional 230 stems at 54 locations within vegetated habitats all located between 1 km and 4 km from the population recorded within Site 2. Therefore, large amounts of occupied and potential habitat exist for this species in the locality. Due to the avoidance measures enacted and the large amounts of available habitat, the impact assessments undertaken within this report have concluded that the removal of one individual stem of *G. parviflora* subsp. *parviflora* is unlikely to constitute a significant impact.

Three additional threatened flora species (*Syzygium paniculatum*, *Melaleuca biconvexa* and *Maundia triglochinos*) occur or are likely to occur within the riparian zone downstream from the Hawkmount Quarry (Site 2 (refer to **Table 10**)). There is potential for impact upon these species as a result of water discharge from the sedimentation basin and associated LDP at this site. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the Project is unlikely to have a significant impact upon *S. paniculatum*, *M. biconvexa* and *M. triglochinos*.

No threatened ecological communities or populations listed under the TSC Act 1995 or EPBC Act 1999 were detected within the disturbance footprints. However, four Endangered Ecological Communities (EECs) listed under the TSC Act 1995 occur downstream from proposed and existing LDPs. The Water Impact Assessment (GHD 2014) concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the Project is unlikely to have a significant impact upon these EECs.

The Project is likely to remove potential habitat for threatened fauna species, including Glossy Black-Cockatoo (*Calyptrorhynchus lathami*), Gang-gang Cockatoo (*Callocephalon fimbriatum*), Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Varied Sittella (*Daphoenositta chrysoptera*), Little Lorikeet (*Glossopsitta pusilla*), Scarlet Robin (*Petroica boodang*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*). Additionally, habitats within the disturbance footprints provide potential opportunities for threatened mammal species, including Spotted-tail Quoll (*Dasyurus maculatus maculatus*), Squirrel Glider (*Petaurus norfolcensis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Little Bentwing-bat (*Miniopterus australis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Southern Myotis (*Myotis macropus*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Previous surveys using harp traps placed at the entrance of Bat Alley (old drift entrance) near Site 1 detected the Little Bentwing Bat (*Miniopterus australis*) and Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), some of which appeared pregnant (Gunninah 1998b). On release, the bats flew directly into the

mine tunnel, suggesting that it is being used as a roosting and, possibly, nesting site. Due to safety concerns from rock fall, the drift entrance was not examined internally to verify if bats were utilising the mine for roosting purposes. However, the disused mine workings are most likely being utilised for roosting as bats were detected leaving the entrance at dusk.

The original area of the proposed Site 1 disturbance footprint has been redesigned to decrease potential impacts upon microbats utilising the shaft. A vegetation buffer has also been retained to ensure further protection of the microbats species, and additional mitigation measures have been proposed in this report. An annual ongoing monitoring program centred on Bat Alley has commenced.

With the exception of the Spotted-tail Quoll and Squirrel Glider the threatened fauna species which were considered to have potential to occur within the disturbance footprints are highly mobile and occupy large home ranges. Additionally, both of the disturbance footprints are adjacent to large areas of native vegetation providing additional habitat opportunities for those threatened fauna species. The relatively small area (8.75 ha) of native vegetation proposed to be disturbed is not expected to significantly impact upon the threatened fauna species considered, either by direct habitat loss or fragmentation. The potentially important bat roost area known as Bat Alley has been avoided and protected to ensure that no impact to potential breeding opportunities for the Little Bentwing Bat and Eastern Bentwing Bat occur.

The Project will result in an increase in truck movements within the existing private haul routes linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station, Hawkmount Quarry and Cooranbong Entry Site from the current maximum of 28 heavy vehicle movements per hour (14 two way trips per hour) to up to 32 heavy vehicle movements per hour (16 two way trips per hour). Due to the current design measures in place along the haul roads and the relatively small increase in truck movements proposed by the Project, it is anticipated that relatively low levels of incidents involving wildlife will be maintained.

Mine Water Discharges

In addition to the direct surface impacts within Site 1 and Site 2 (disturbance footprints), the Project proposes to increase water discharge through existing Licensed Discharge Points (LDPs) at Cooranbong Entry Site and Newstan Colliery Surface Site), and also establish a new LDP at the Newstan Colliery Surface Site and a new LDP at Hawkmount Quarry.

The Project proposes to increase the volume of surface water discharged via licensed discharge points (LDPs) at the various surface sites within the PAA. Specifically discharge through Newstan LDP001 at Newstan Colliery Surface Site into LT Creek is proposed to be increased from the current approved 11 ML per day to up to 14.5 ML per day. The Project will increase the likelihood of discharges from Newstan LDP003, which is predicted to potentially result in a decrease in maximum discharge from 60 ML/day to 39 ML/day. The discharge through Cooranbong LDP001 at the Cooranbong Entry Site into an unnamed tributary of Muddy Lake is proposed to be increased from the current approved 5 ML per day to up to 8 ML per day.

The proposed Hawkmount Quarry LDP will not be a constant discharge arrangement. During 'construction' phase for the quarry, existing water management storages on site will be dewatered down to manageable levels, where they will be maintained during operations. The estimates of potential maximum discharges as a result of the initial dewatering is expected to be a maximum 142 ML/yr within the first year with approximately the first six months of the construction period requiring an increased pump rate (3 ML/day). This increased pump rate is required to draw down the existing filled storage down to appropriate management levels. The average volume per year of water to be discharged from Hawkmount Quarry LDP during operations is predicted to be 40 ML/yr (0.11 ML/day). This volume is based on the rainfall predicted to fall within the Site 2 catchment and is based on 113 years of re-sampled rainfall data.

The potential impacts from increased mine water discharge include increases in flow and changes to water quality, particularly increases in salinity. Changes to hydrology and water chemistry have potential to impact upon terrestrial flora and fauna that inhabit the affected riparian environments.

Water Quality

GHD (2014) have utilised data collected from a variety of monitoring sites, and water quality values recommended by the ANZECC and ARMCANZ (2000) guidelines to establish site-specific trigger values (SSTVs) for discharges.

The ANZECC and ARMCANZ (2000) guidelines define trigger values as: *'the concentrations (or loads) of the key performance indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur. They indicate a risk of impact if exceeded and should 'trigger' some action, either further ecosystem specific investigations or implementation of management/remedial actions'*.

The water which is to be discharged will be diluted or treated within a water management system. SSTVs have been set for all potential toxicants and have been derived from naturally occurring levels upstream of the site or within tolerance levels for flora and fauna set out by ANZECC and ARMCANZ (2000). Therefore, the discharges are not expected to have an adverse impact on the potentially occurring threatened flora and fauna downstream.

Water Quantity

The expected increase in flows has been assessed for its potential to affect bank stability through erosion. GHD (2014). There is no evidence from the model predictions that the likelihood of the bank instability will be increased as a result of the Project. This has been based on the evaluation of the current and known permissible velocities for different channel conditions and or channel linings. Therefore, potentially occurring flora and fauna downstream are not considered likely to be impacted upon by sedimentation and erosion as a result of the Project.

The LDPs, which are to receive modified discharge rates as a result of the Project, are discussed further in **Section 6.2**.

Impact Mitigation

The surface disturbance footprints for the Project have been designed through the detailed planning processes to avoid impacts to threatened flora species and significant fauna habitat as far as practical. Additionally, a range of measures have been incorporated into the Project (such as light and sound barriers) to further minimise potential impacts to threatened flora and fauna. Further mitigation measures will be adopted by Northern Coal Services during the construction and operational phases of the Project to ensure potential impacts to flora and fauna species are further reduced. In addition, the population of *T. juncea* within Site 1 will be translocated and monitored in accordance with a research program to be developed by Northern Coal Services. The proposed translocation research programme will be designed to build on the existing knowledge gained from previous translocation trials undertaken by Centennial Coal.

A variety of indirect offset measures are proposed to offset the potential impacts of this Project. Compensatory measures will include translocation trials, installation of nest boxes and research programmes. It is proposed as part of the compensation measures to:

- Develop and implement a *Tetratheca juncea* translocation research programme to build on the current knowledge regarding translocation of this species. The 376 clumps of *Tetratheca juncea* from within Site 1 will be translocated and monitored in accordance with the proposed research programme;
- Install nest boxes at a ratio of 1:1 (i.e. one nest box for every habitat hollow removed). The design and

installation of nest boxes will draw on the information obtained from the 5 year research programme undertaken by Centennial Mandalong into the utilisation of different nest box designs and aspects; and

- Fund the development and implementation of a research proposal to investigate genetic patterns among and within populations of *Tetratheca juncea* from a range of habitat types. The benefits of this research will assist in determining whether conservation and offsetting actions can protect the genetic diversity of *Tetratheca juncea*.

The proposed research programme has been developed with a focus on addressing the priority actions identified by the Office of Environment and Heritage and the Commonwealth DoE for *Tetratheca juncea* as part of this species Recovery Plan.

Conclusion

The seven-part tests conducted for threatened flora and fauna species and EECs recorded or considered likely to occur within the two proposed disturbance footprints and surface water discharge locations concluded that the Project is unlikely to have a significant impact (**Appendix 2**). The EPBC Act Assessment of Significant concluded that no Matters of National Environmental Significance which were detected or considered likely to occur within the Project Application Area will be significantly impacted by the Project (**Appendix 3**).

Terms & Abbreviations

Abbreviation	Meaning
API	Aerial Photograph Interpretation
DECCW	Former NSW Department of Environment, Climate Change and Water (now Office of Environment and Heritage)
DoE	Commonwealth Department of the Environment
DPC	NSW Department of Premier and Cabinet
EEC	Endangered Ecological Community
EPA	NSW Environment Protection Authority
EP&A Act 1979	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act 1999	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPL	Environment Protection Licence
GIS	Geographic Information System
GPS	Global Positioning System
HBOC	Hunter Bird Observers Club
KTP	Key Threatening Processes
LDP	Licensed Discharge Point
LGA	Local Government Area
LHCCREMS	Lower Hunter and Central Coast Regional Environment Management Strategy
MNES	Matter of National Environmental Significance
Mtpa	Million tonnes per annum
NPW Act	NSW National Parks and Wildlife Act 1974
OEH	NSW Office of Environment and Heritage
PAA	Project Application Area
PFC	Percentage Foliage Cover
ROTAP	Rare or Threatened Australian Plants
RPS	RPS Australia East Pty Ltd
SEPP	State Environmental Planning Policy
DSEWPAC	Former Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now Commonwealth Department of the Environment)
TSC Act 1995	NSW <i>Threatened Species Conservation Act 1995</i>

1.0 Introduction

RPS Australia East Pty Ltd (RPS) was engaged by Northern Coal Services Pty Ltd (Northern Coal Services) to undertake a Flora and Fauna Assessment (FFA) as part of the Environmental Impact Statement (EIS) for the Northern Coal Logistics Project (the Project). Northern Coal Services is seeking approval for the Project under Part 4 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act 1979). Pursuant to Section 89C of the EP&A Act 1979, and in accordance with the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP), the Project is comprises State significant development (SSD).

The aim of this FFA is to determine the likelihood of the Project having a significant impact upon any threatened species, populations or ecological communities listed within the NSW Threatened Species Conservation Act 1995 (TSC Act 1995) and/or Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999). It also aims to satisfy the Director General's Requirements (DGR's) issued for the Project on 20 March 2012 and re-issued on 7 August 2013 (see **Section 1.4**).

Based on the potential for significant impacts upon threatened species listed under the EPBC Act 1999, a referral was submitted (Ref: 2013/6906) to the Commonwealth Department of the Environment (DoE) (formerly the Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC)). As a result of the referral process, the proposed action was deemed to be a Controlled Action and the Project will need to be assessed through Preliminary Documentation. The controlled action decision letter and request for additional information is provided in **Appendix 1**. In addition to the aims mentioned above, this report has been written to satisfy the requirements of the additional information request letter (see **Section 1.4**).

1.1 Description of the Project

The Project comprises both a continuation of existing operations and an upgrade to the surface coal handling and preparation infrastructure at the Newstan Colliery Surface Site and the Mandalong Mine - Cooranbong Entry Site (Cooranbong Entry Site), along with the existing private haul roads and rail loading infrastructure. These facilities are integral to the on-going handling, processing and transport of coal from the underground workings of Newstan Colliery and Mandalong Mine (including the proposed Newstan Colliery Extension of Mining Project and Mandalong Southern Extension Project) into domestic and export markets.

The Project will allow for improved and flexible coal handling arrangements across Newstan Colliery and Mandalong Mine to deliver the range of coal products required to meet domestic and export market demands.

The primary components of the Project are:

- Re-develop and upgrade the existing coal preparation and handling infrastructure at the Newstan Colliery Surface Site to enable continued utilisation for the receipt, handling and processing of up to 8 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal from the Newstan Colliery (up to 4.5 Mtpa), Awaba Colliery (up to 0.88 Mtpa) and Mandalong Mine (up to 6 Mtpa);
- Continue to utilise the existing coal handling infrastructure at the Cooranbong Entry Site to enable the receipt, handling and processing of up to 6 Mtpa of ROM coal from Mandalong Mine;
- Increase the volume of coal transported from the Cooranbong Entry Site to Newstan Colliery Surface Site, via trucks using existing private haul roads, from 4 to 6 Mtpa;
- Increase the volume of coal transported from the Cooranbong Entry Site to Eraring Power Station, using an existing dedicated overland conveyor, from 4 to 6 Mtpa;

- Increase the volume of coal transported from the Newstan Colliery Surface Site to Eraring Power Station, via trucks using existing private haul roads, from 2 to 4.5 Mtpa;
- Increase the volume of coal transported from the Newstan Colliery Surface Site rail loading facilities by train to the Port of Newcastle and/or Port Kembla (for export) and/or Vales Point Power Station from 3 to 8 Mtpa;
- Continue to transport up to 0.5 Mtpa of middlings by truck via private haul roads from Newstan Colliery Surface Site to Cooranbong Entry Site for subsequent supply to the Eraring Power Station via a dedicated overland conveyor.
- Continue to transport up to 0.88 Mtpa of material (including coal and stone from construction activities undertaken as part of the Newstan Colliery Extension of Mining Project) by truck via private haul roads from the Awaba Colliery Surface Site to the reject emplacement areas at the Newstan Colliery Surface Site;
- Transport reject material from the Newstan Colliery Surface Site to the Newstan Colliery Northern Reject Emplacement Area (NREA), Newstan Colliery Southern Reject Emplacement Area (SREA) and/or Hawkmount Quarry via existing private haul roads;
- Increase the volume of water discharged via licensed discharge points at the Newstan Colliery Surface Site and Cooranbong Entry Site;
- Provide employment for up to 120 full-time personnel;
- Provide a life of operation of 30 years from the granting of development consent; and
- Operate 24 hours per day, seven days per week.

While the majority of land within the Project Application Area (PAA) is already highly disturbed and developed, the Project does comprise two areas of proposed surface disturbance:

- » Site 1 - Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-development and upgrade of the coal handling and processing infrastructure at this site; and
- » Site 2 – An area of approximately 13.9 ha within Hawkmount Quarry (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement.

The Project proposes to increase the volume of surface water discharged via licensed discharge points (LDPs) at the various surface sites within the PAA. Specifically discharge through Newstan LDP001 at Newstan Colliery Surface Site into LT Creek is proposed to be increased from the current approved 11 ML per day to up to 14.5 ML per day. The project will increase the likelihood of discharges from Newstan LDP003, with a predicted decrease in maximum discharge from 60 ML/day to 39 ML/day. The discharge through Cooranbong LDP001 at the Cooranbong Entry Site into an unnamed tributary of Muddy Lake is proposed to be increased from the current approved 5 ML per day to up to 8 ML per day.

The proposed Hawkmount Quarry LDP will not be a constant discharge arrangement. During the initial 'construction' phase, existing water management storages on site will be dewatered down to manageable levels, to be maintained during the operation phase. The estimate of potential maximum discharges as a result of the initial dewatering is expected to be a maximum of 142 ML/yr. This increased pump rate is required to draw down the existing filled storage down to appropriate management levels. The average volume per year of water to be discharged from Hawkmount Quarry LDP during operations is predicted to be 40 ML/yr (0.11 ML/day). This volume is based on the rainfall predicted to fall within the Site 2 catchment and is based on 113 years of re-sampled rainfall data.

A reach of the North Arm of LT Creek just downstream from Newstan LDP001 is proposed to be enclosed into a pipeline in order to mitigate any potential contamination from the increase in coal stockpile. The pipe will enclose LT Creek from the downstream side of the By-Wash Dam in the upper catchment to the south of

the rail loading facility. This pipe will be built to withstand the predicted increase in discharge. An Aquatic Ecology Impact Assessment prepared by Cardno (2013) to assess the impacts associated with the pipeline proposal (refer to **Appendix 8**).

The haulage of coal and reject material along private haul roads is expected to result in an increase in truck movements from 28 movements per hour (14 two way trips per hour) to up to 32 movements per hour (16 two way trips per hour).

1.2 Site Particulars

Locality	The Project Application Area (PAA) is located between Fassifern and Dora Creek, on the western side of Lake Macquarie approximately 25 km south-west of Newcastle, NSW.
LGA	Lake Macquarie
Area	The PAA encompasses 503 ha. The proposed disturbance footprints include Site 1, with a proposed disturbance footprint of approximately 7.5 ha, and Site 2, with a proposed disturbance footprint of 13.9 ha... For the purposes of this ecological assessment Site 1 and Site 2 will be referred to separately when depicting the localities of specific impacts. However, Site 1 and Site 2 will be referred to collectively as the 'disturbance footprints' within the impact assessment.
Boundaries	Site 1 is located within the Newstan Colliery Surface Site and is adjacent to an area of native vegetation. Site 2 is located within the Hawkmount Quarry area adjacent to the Cooranbong Private Haul Road, with native vegetation to the north and south.
Current Land Use	The Newstan Colliery Surface Site is currently owned and operated by Centennial Newstan Pty Limited and comprises coal handling and processing infrastructure, reject emplacement areas, water management infrastructure, rail loading infrastructure and mine support infrastructure. The site is accessed from Miller Road, which traverses through the site, and the Main Northern Railway Line traverses immediately to the east. Site 1 comprises undeveloped land that predominantly consists of native vegetation, with a powerline easement dissecting the northwest corner. The Cooranbong Entry Site is currently owned and operated by Centennial Mandalong Pty Limited and comprises coal handling and processing infrastructure, water management infrastructure and mine support infrastructure. The site is accessed from Gradwells Road (from Dora Creek) and is connected to Newstan Colliery Surface Site via private haul roads. Hawkmount Quarry is located on Crown land under a permissive occupancy held by Lake Macquarie City Council (LMCC). It comprises a disused quarry located adjacent to the Cooranbong Private Haul Road. The quarry has not been used for extraction purposes for several years, and there is no evidence of any closure or rehabilitation activities. Site 2 comprises mostly cleared/disturbed land, with some native vegetation. The private haul roads that link the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Cooranbong Entry Site, Hawkmount Quarry and Eraring Power Station are:

- Newstan-Eraring Private Haul Road - owned by Eraring Energy and links the Newstan Colliery Surface Site to the Eraring Power Station.
- Cooranbong Private Haul Road – owned by Centennial Mandalong Pty Limited and links the Cooranbong Entry Site to the Newstan Colliery Surface Site via the Newstan-Eraring Private Haul Road.
- Awaba Private Haul Road – owned by Centennial Newstan Pty Limited and links the Awaba Colliery Surface Site to the Newstan-Eraring Private Haul Road.

Topography The PAA is located in gently undulating terrain. Numerous drainage lines are present throughout the PAA, which ultimately drain eastwards into Lake Macquarie.

1.3 Scope of the Study

The scope of this FFA is to:

- undertake a desktop assessment of relevant ecological assessments within and adjacent to the PAA;
- undertake relevant database searches of threatened flora and fauna species, populations and ecological communities within a 10 km radius of the PAA;
- identify threatened flora and fauna species, populations and ecological communities known or likely to occur within the proposed disturbance footprints;
- identify vascular plant species found within the proposed disturbance footprints;
- identify and map existing vegetation communities;
- consider the direct and indirect impacts associated with the proposed increase in surface water discharge via licensed discharge points;
- undertake seven part tests under the TSC Act to assess the potential of the Project to have a significant impact on any threatened species, populations or ecological communities (listed under the TSC Act) known or likely to occur within the proposed disturbance footprints (including the areas which have the potential to be impacted upon as a result of surface water discharges) and/or their immediate vicinity;
- assess the potential of the Project to have a significant impact on any Matters of National Environmental Significance (listed under the EPBC Act) known or likely to occur within the proposed disturbance footprints and/or their immediate vicinity; and
- provide all relevant information as required by government agencies and stakeholders, specifically Department of Planning and Infrastructure (DP&I) (Director General's Requirements), DoE, NSW Environment Protection Authority (EPA), NSW Office of Environment and Heritage (OEH) and Forests NSW.

1.4 Environmental Assessment Requirements

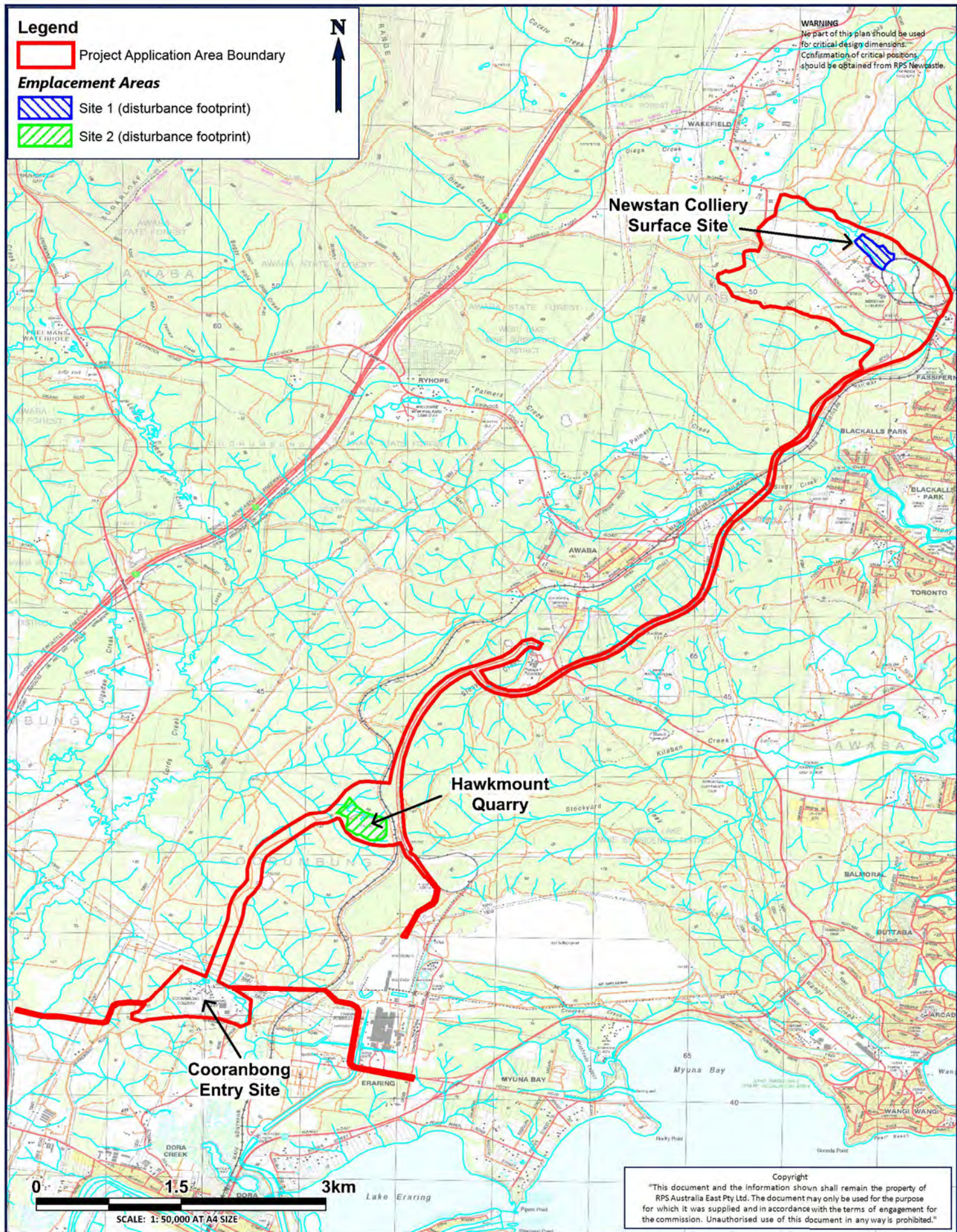
Environmental Assessment Requirements were issued for the Project by the Director General for the Department of Planning and Infrastructure on 20 March 2012 and re-issued on 7 August 2013. This report addresses the Director General's Requirements (DGRs), along with additional information requirements in response to the controlled action decision for EPBC reference 2013/6906 made by DoE (refer to **Appendix 1**). **Table 1** below lists the DGRs (including the EPA's requirements) and DoE's requirements relevant to this assessment and where they have been addressed in this report.

Table 1 Environmental Assessment Requirements

Requirement	Report section addressing requirement
Director General Requirements	
Measures taken to avoid, reduce or mitigate impacts on biodiversity	Section 7
Accurate estimates of proposed vegetation clearing	Table 8
A detailed assessment of potential impacts of the development on any:	-
1. Terrestrial or aquatic threatened species or populations and their habitats and endangered ecological communities;	Section 6
2. Groundwater dependant ecosystems; and	Section 6.1.5
3. Regionally significant remnant vegetation or vegetation corridors	Section 4.6.2
A comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term	Section 7.3
NSW Environment Protection Authority (Scenario 2 – Where a proposal is assessed outside the BioBanking Assessment Methodology)	
1. The EIS should include a detailed biodiversity assessment, including assessment of impacts on threatened biodiversity, native vegetation and habitat. This assessment should address the matters included in the following sections.	Section 6
2. A field survey of the site should be conducted and documented in accordance with relevant guidelines, including:	-
▪ the Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (DECC, 2009)	Section 3
▪ Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DEC, 2004), and	Section 3
▪ Threatened species survey and assessment guideline information on www.environment.nsw.gov.au/threatenedspecies/surveyassessmentqdlns.htm .	Section 3
If a proposed survey methodology is likely to vary significantly from the above methods, the proponent should discuss the proposed methodology with the Environment Protection Authority (EPA) prior to undertaking the EIS, to determine whether the EPA considers that it is appropriate.	-
Recent (less than five years old) surveys and assessments may be used. However, previous surveys should not be used if they have:	-
▪ been undertaken in seasons, weather conditions or following extensive disturbance events when the subject species are unlikely to be detected or present, or	Section 3.2
▪ utilised methodologies, survey sampling intensities, timeframes or baits that are not the most appropriate for detecting the target subject species.	Section 3.2
Unless these differences can be clearly demonstrated to have had an insignificant impact upon the outcomes of the surveys. If a previous survey is used, any additional species listed under the TSC Act since the previous survey took place, must be surveyed for.	-
Determining the list of potential threatened species for the site must be done in accordance with:	-
▪ Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DEC, 2004); and	Section 3.1
▪ Guidelines for Threatened Species Assessment (Department of Planning, July 2005).	Section 3.1
The EPA Threatened Species website http://www.environment.nsw.gov.au/threatenedspecies/ and the Atlas of NSW Wildlife database must be the primary information sources for the list of threatened species present. The BioBanking Threatened Species Database, the Vegetation Types databases (available on EPA website at: http://www.environment.nsw.gov.au/biobanking/biobankin.qtspd...htm ; and http://www.environment.nsw.gov.au/biobankin.q/vegtypedatabase.htm . respectively.	Section 3.1

Requirement	Report section addressing requirement
Other data sources (e.g. PlantNET, Online Zoological Collections of Australian Museums (http://www.ozcam.orql), previous or nearby surveys etc.) may also be used to compile the list.	-
3. The EIS should contain the following information as a minimum: a. The requirements set out in the Guidelines for Threatened Species Assessment (Department of Planning, July 2005) b. Description and geo-referenced mapping of the PAA (and spatial data files), e.g. overlays on topographic maps, satellite images and /or aerial photos, including details of map datum, projection and zone, all survey locations, vegetation communities (including classification and methodology used to classify), key habitat features and reported locations of threatened species, populations and ecological communities present in the subject site and PAA. c. Description of survey methodologies used, including timing, location and weather conditions. d. Details, including qualifications and experience of all staff undertaking the surveys, mapping and assessment of impacts as part of the EIS. e. Identification of national and state listed threatened biota known or likely to occur in the PAA and their conservation status. f. Description of the likely impacts of the proposal on biodiversity and wildlife corridors, including direct and indirect and construction and operation impacts. Wherever possible, quantify these impacts such as the amount of each vegetation community or species habitat to be cleared or impacted, or any fragmentation of a wildlife corridor.	- Appendix 2 Figures 1-7 Section 3 Appendix 7 Table 10 Section 6
g. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to avoid or minimise impacts, including details about alternative options considered and how long term management arrangements will be guaranteed. h. Description of the residual impacts of the proposal. If the proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected (see the requirements for this at point 6 below). i. Provision of specific Statement of Commitments relating to biodiversity.	Section 7 Section 7.3 Section 8
4. An assessment of the significance of direct and indirect impacts of the proposal must be undertaken for threatened biodiversity known or considered likely to occur in the PAA based on the presence of suitable habitat. This FFA must take into account: a. the factors identified in s.5A of the EP&A Act, and b. the guidance provided by The Threatened Species Assessment Guideline – The Assessment of Significance (DECC, 2007) which is available at: http://www.environment.nsw.gov.au/resources/threatenedspecies/tsaq uide07393.pdf	Table 10 Appendix 2
5. Where an offsets package is proposed by a proponent for impacts to biodiversity (and a BioBanking Statement has not been sought) this package should: - meet the EPA's Principles for the use of biodiversity offsets in NSW, which are available at: www.environment.nsw.gov.au/biocertification/offsets.htm; - identify the conservation mechanisms to be used to ensure the long term protection and management of the offset sites; - include an appropriate Management Plan (such as vegetation or habitat) that has been developed as a key amelioration measure to ensure any proposed compensatory offsets, retained habitat; and - enhancement features within the disturbance footprints and/or impact mitigation measures (including proposed rehabilitation and/or monitoring programs) are appropriately managed and funded.	- Section 7.3 - -

Requirement	Report section addressing requirement
6. Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby NSW estate reserved under the National Parks and Wildlife Act 1974 or any marine and estuarine protected areas under the Fisheries Management Act 1994 or the Marine Parks Act 1997 should be considered. Refer to the Guidelines for developments adjoining land and water managed by the Office of Environment and Heritage 2010.	Section 6
7. With regard to the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, the assessment should identify any relevant Matters of National Environmental Significance and whether the proposal has been referred to the Commonwealth or has already been determined to be a controlled action.	-
Department of the Environment – EPBC Act (Extract from Appendix 6)	
1. Details about the local population of the Black-eyed Susan (<i>Tetratheca juncea</i>), including an estimate of the number of individuals/clumps present in the vicinity of the project area derived from surveys in accordance with the methods recommended in the department's publication "Referral guidelines for the vulnerable Black-eyed Susan, <i>Tetratheca juncea</i> " (August 2011), available at: www.environment.gov.au/epbc/publications/black-eyed-susan.html .	Section 4.4.2.2
2. Using the information gained from 1. above, an assessment of the residual impact to the Black-eyed Susan (<i>Tetratheca juncea</i>) including whether the proposed action will result in: – indirect impacts, for example from dust, altered hydrology and/or edge effects; – loss of greater than 25% of plant clumps within the affected area; or – fragmentation of a subpopulation by greater than 500m within native vegetation, or 100m within degraded or cleared vegetation.	Section 6.4.1 and Section 6.6
3. Details of the proposed impact avoidance, mitigation and monitoring actions, including sediment and erosion control, weed and <i>Phytophthora cinnamomi</i> controls, and the proposed barrier to reduce noise and light impacts to bat species utilising the abandoned mine drift entrance.	Section 7
4. Details of the proposed translocation trial for Black-eyed Susan (<i>Tetratheca juncea</i>) and <i>Grevillea parviflora</i> subsp. <i>Parviflora</i> . Please note that the department (DoE) does not support translocation as a mitigation measure. Translocation may be considered as part of an offset package, where its long-term success has been established using rigorous scientific methods.	Section 7.3.1
5. Where impacts cannot be avoided or mitigated, an offset package to compensate for any predicted or potential residual significant impacts on matters of national environmental significance. Offsets should demonstrate consistency with the Commonwealth EPBC Act Environmental Offsets Policy (October 2012, or subsequent versions), available at www.environment.gov.au/epbc/publications/environmental-offsets-policy.html Please find attached the department's information requirements in relation to EPBC Act offset proposals.	Section 7
6. Rehabilitation and decommissioning plans, including how these activities may impact threatened species.	Section 7.3.2
7. Other information, as relevant to the controlling provision, listed threatened species and communities.	-



TITLE: FIGURE 1: PROJECT LOCALITY

LOCATION: COAL LOGISTICS
PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 20/12/2012
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\Centennial\All Jobs\113119 Coal
Logistics\10 - Drafting\Workspaces\
Eco Report Figures
VERSION (PLAN BY): D A4 (JS-NW)

CLIENT: CENTENNIAL COAL
JOB REF: 113119-1

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2.0 Qualifications and Licensing

2.1 Qualifications

This report was written by Paul Hillier BEnvSc, Andrew Smith PhD BSc, Lauren Vanderwyk (BSc) , Ziggy Andersons (BSc) and Arne Bishop (BEnvSc) of RPS.

The academic qualifications and professional experience of all RPS consultants involved in the Project are documented in **Appendix 7**.

2.2 Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S100536 (Valid 31 December 2014);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2014);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2016); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim File No: 01/1522 & Ref No: AW2001/014) issued by NSW Agriculture (Valid 22 May 2014).

2.3 Certification

As the principal author, I, Ziggy Andersons, make the following certification:

- The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the PAA;
- Commonwealth, state and local government policies and guidelines formed the basis of project surveying methodology, or where the survey work has been undertaken with specified departures from industry standard guidelines, details of which are discussed and justified in Section 3.6; and
- All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the Animal Research Act 1995, National Parks and Wildlife Act 1974 and the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.

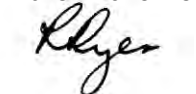
Signature of Principal Author and Certifier:



Ziggy Andersons

Ecology Manager
March 2014

March 2015 Review and Amendment



Rob Dwyer

Ecology Manager
March 2015

3.0 Methodology

Database searches, literature reviews and a variety of field survey techniques were employed by RPS for this FFA in order to describe the ecological attributes and detect any threatened fauna or flora species across the PAA and particularly within the disturbance footprints. Field surveys were undertaken on:

- 13 April 2012 (preliminary survey);
- 14–18 May 2012 (targeted threatened flora surveys, vegetation mapping and fauna surveys);
- 17–19 September 2012 (targeted threatened flora searches);
- 3–4 October 2012 (targeted frog searches);
- 11 October 2012 (targeted threatened flora surveys);
- 10–11 January 2013 (targeted threatened flora searches)
- 26 August 2013 (targeted threatened flora searches)
- 6 September 2013 (targeted threatened flora searches);
- 9–11 September 2013 (targeted threatened flora searches); and
- 16–20 September 2013 (fauna surveys).

Surveys methods included vegetation community verification and various fauna survey methods including Elliott trapping, harp trapping, hair tubes, bat echolocation, spotlighting, call playback, diurnal bird and herpetological surveys, habitat assessments and opportunistic surveys. Targeted searches for threatened flora and fauna species were also undertaken. The flora and fauna surveys are described in further detail in the below sections.

3.1 Desktop Assessment

Database searches were undertaken to identify State and Commonwealth records of threatened entities and Commonwealth matters of national environmental significance (NES). Databases interrogated for this purpose were:

- The NSW Wildlife Atlas which is managed by the OEH. A coordinate search using the boundary of the PAA was undertaken to determine threatened species records listed under the TSC Act to within 10 kilometres of the PAA (accessed January 2014).
- The Protected Matters Search Tool which is managed by the DoE. A coordinate search using the boundary of the PAA was undertaken to determine threatened species records listed under the EPBC Act to within 10 kilometres of the PAA (accessed January 2014).

In addition to the above a review of the following was undertaken:

- aerial photograph interpretation (API) and literature reviews to determine the broad categorisation of vegetation within the PAA;
- review of the Lower Hunter and Central Coast Regional Environment Management Strategy Vegetation Survey, Classification and Mapping (LHCCREMS) (NPWS 2000);
- review of Bell, S. and Driscoll, C. (2012). Vegetation Mapping of Lake Macquarie LGA: Stage 3 (report to Lake Macquarie City Council);
- a review of Geographic Information System (GIS) data including (but not limited to) aerial photography, topographic maps, wetland mapping under the State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP 14) and soil landscapes; and

- collective knowledge gained from extensive work in the area.

3.1.1 Literature Review

A literature review was undertaken to assist in identifying distributions, suitable habitats and known records of threatened species, populations and community's within the PAA to help guide the field survey program. Information sources included:

- Cumberland Ecology (2007). Newstan Colliery, modification to development consent, SEE, Ecological Impact Assessment;
- Cumberland Ecology (2008). Newstan Colliery, Longwall Panel 25, REF, Ecological Impact Assessment;
- Eco Biological (2005). Awaba Outbye SMP;
- Gunninah (1998). Proposed waste emplacements and coal handling facilities upgrade. Flora and fauna assessment. Newstan Colliery. October 1998;
- HLA (2006). Flora and Fauna Impact Assessment Upgrade to Existing Ash Dam Eraring Power Station. Flora and Fauna Report. Appendix E. February 2006;
- Hunter Eco (2008a). Awaba East Exploratory Drilling Program REF Stage 1 – Ecology. A Report for Centennial Coal;
- Hunter Eco (2008b). Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora investigation;
- Hunter Eco (2009). Awaba East Exploratory Drilling Program REF Stage 2 – Ecology. A Report for Centennial Coal;
- Umwelt / Gunninah (1998). Life Extension Project 1998 Flora and Fauna Assessment and SIS;
- Umwelt (2004). Centennial Newstan Longwall 22–23 Flora and Fauna Assessment; and
- Umwelt (2005). Summer targeted rare plants survey works for the Awaba open cut mine development environmental impact statement. Letter report to Centennial Coal. April 2005.

3.2 Flora Survey

3.2.1 Vegetation Mapping

Seven flora quadrats were completed within the proposed disturbance sites (three in Site 1 and four in Site 2) on the 29-30 April 2013. Flora quadrats were undertaken with reference to current NSW mapping standards whereby floristic data was collected using a six point Braun-Blanquet cover abundance scale. The applied Braun-Blanquet cover abundance scale assigns each species to one of these six cover abundance classes, which are considered indicative of the dominance of these species within the quadrat. Additionally, structural features of the vegetation within the quadrat and other relevant habitat features (e.g. soil type; presence of rock; slope) were also recorded. All quadrats were 20 metres by 20 metres (400 square metres in area).

In addition to the quadrats, seven Rapid Data Points (RDP) were undertaken to verify LHCCREMS (NPWS 2000) and Vegetation Mapping of Lake Macquarie LGA: Stage 3 (Bell and Driscoll 2012) (Vegetation Mapping of Lake Macquarie LGA: Stage 3 covers Site 2 only). The RDP methodology involves the recording of vegetation community structure and dominant species within each strata. Three RDPs in Site 1 and three in Site 2 were undertaken on 14-18 May 2012.

Further vegetation identification was undertaken while in transit across the proposed disturbance footprints and in the course of targeted threatened flora surveys.

3.2.2 Significant Flora Survey

Targeted threatened flora searches were undertaken within the two proposed disturbance footprints on 13 April 2012, 14–18 May 2012, 17–19 September 2012, 11 October 2012, 10–11 January 2013, 26 August 2013, 6 September 2013 and 9–11 September 2013. **Table 2** provides a list of those flora species that have been identified during desktop assessments, as well as several additional species that are known to occur within the Lake Macquarie local area and along the Central Coast of NSW.

As part of addressing the controlled action decision (**Appendix 1**), RPS conducted targeted seasonal surveys for *Tetradlea juncea* (*T. juncea*) outside of the Site 1 disturbance footprint area. The purpose of undertaking additional surveys outside of the disturbance footprint was to determine whether the proportion of the 'local population' (as defined in DSEWPAC (2011)) within the disturbance footprint constitutes a loss of greater than 25% of the local population. A loss of greater than 25% of plant clumps is considered a 'high risk of significant impacts on Black-eyed Susan' (DSEWPAC, 2011).

T. juncea surveys were conducted in line with methods recommended by the DoE (DSEWPAC, 2011). This methodology is based on a methodology developed by Payne *et al* (2002). These standardised best practice recording and counting methodologies for *T. juncea* clumps were utilised. These methodologies include the basic definitions and what constitutes a single clump (individual clumps are separated by more than 30 cm (Payne *et al*. 2002)) and how to delineate an important local population (groups of individual clumps separated by no more than 500 m in intact native vegetation and 100 m in disturbed vegetation (DSEWPAC 2011)).

Table 2 Threatened Flora Species likely to occur within the PAA, flowering periods and recommended survey timing (seasonality)

Threatened Flora Species	Recommended Survey Time	January	February	March	April	May	June	July	August	September	October	November	December
<i>Acacia bynoeana</i>	Survey Anytime	X								X	X		
<i>Angophora inopina</i>	Survey Anytime	X											
<i>Caladenia tessellata</i>	Survey Only During Flowering									X	X		
<i>Callistemon linearifolius</i>	Survey Anytime	X								X	X		
<i>Corybas doweringii</i>	Survey Only During Flowering								X				
<i>Corunastylis</i> sp. <i>Charmhaven</i>	Survey Only During Flowering	X											
<i>Cryptostylis hunteriana</i>	Survey Only During Flowering	X											
<i>Cynanchum elegans</i>	Survey Anytime								X	X	X		
<i>Diuris praecox</i>	Survey Only During Flowering								X				
<i>Eucalyptus camfieldii</i>	Survey Anytime												
<i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i>	Survey Anytime	X											
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Survey Anytime								X	X			
<i>Maundia triglochinosoides</i>	Survey Only During Flowering	X											

Threatened Flora Species	Recommended Survey Time	January	February	March	April	May	June	July	August	September	October	November	December
<i>Melaleuca biconvexa</i>	Survey Anytime										X		
<i>Pelargonium</i> sp. <i>Striatellum</i> (G.W.Carr 10345)	Survey Only During Flowering										X		
<i>Prasophyllum</i> sp. <i>Wybong</i> (C.Phelps ORG 5269)	Survey Only During Flowering										X		
<i>Pterostylis gibbosa</i>	Survey Only During Flowering								X	X	X		
<i>Rhizanthella slaterii</i>	Survey Only During Flowering										X		
<i>Rutidosia heterogama</i>	Survey Best During Flowering	X									X		
<i>Senecio spathulatus</i>	Flowers sporadically at other times												
<i>Senna acclinis</i>	Survey Only During Flowering	X								X			
<i>Syzygium paniculatum</i>	Survey Anytime												
<i>Streblus pendulinus</i>	Survey Anytime	X											
<i>Tetradlea glandulosa</i>	Survey Anytime								X	X			
<i>Tetradlea juncea</i>	Survey Only During Flowering									X			
<i>Thelymitra</i> sp. 'Adorata'	Survey Only During Flowering									X			

3.3 Fauna Survey

Fauna surveys were undertaken within the two proposed disturbance footprints. Trapping transects included, terrestrial fauna and microchiropteran bats (microbats) trapping, microbat echolocation call recording, avifauna surveys, herpetofauna surveys, spotlighting, secondary indications (e.g. scats, scratches and diggings) and incidental observations.

The location and effort of each survey methodology was determined based on the diversity and quality of fauna habitat located within the proposed disturbance footprints.

3.3.1 Arboreal Trapping

Arboreal trapping was undertaken within the two proposed disturbance footprints using Elliott B size traps. Traps were mounted on brackets set at approximately 2 m height on trees with a Diameter at Breast Height (DBH) greater than 30 cm. Traps were baited with a rolled oats, peanut butter and honey mixture and the tree trunks were sprayed liberally with a brown sugar and water mixture each day in the late afternoon. Traps were checked early each morning. The location of each trap line is shown on **Figure 2** and **Figure 3**.

Arboreal traps targeted arboreal mammals such as the threatened Squirrel Glider (*Petaurus norfolkensis*) which has been detected previously from the surrounding area. A total of 80 arboreal trap nights were undertaken in May 2012 across two trapping transects.

3.3.2 Terrestrial Trapping

Terrestrial trapping was undertaken using Elliott A, Elliott B traps and cage traps. Traps were baited with rolled oats, peanut butter and honey. Cage traps were baited with chicken necks or chicken thighs. Traps were checked early each morning, with any captures identified and released at point of capture. Traps were re-baited where necessary. The location of each trap line is shown on **Figure 2** and **Figure 3**.

Terrestrial traps targeted small terrestrial mammals such as dasyurids (e.g. antechinus) and rodents (e.g. rats and mice). A total of 202 trap nights of Elliott A traps, 200 trap nights of Elliott B traps and 48 trap nights of cage traps were undertaken in May 2012 and September 2013 across two trapping transects.

3.3.3 Hair Funnels

Surveys within the two proposed disturbance footprints were undertaken using Faunatech hair tubes over four nights at each site. These were baited with rolled oats, peanut butter and honey.

Hair tubes targeted small-medium mammals such as dasyurids (e.g. Antechinus), rodents (e.g. rats and mice), gliders and bandicoots. A total of 80 arboreal trap nights and 80 terrestrial trap nights were undertaken in September 2013 across two trapping transects.

Any hair samples retrieved during the survey were sent to Barbara Triggs at 'Dead Finish' for analysis.

3.3.4 Bat Trapping – Harp Traps

An active bat roost cave, in the form of a disused mine shaft (Bat Alley), is known to occur within close proximity to Site 1. Two harp traps were placed in front of the main cave roost entrance (drift entrance) along a track to the north of Site 1 over four consecutive nights by RPS. Traps were checked early each morning, with any captured bats identified and released at point of capture. The location of each trap line is shown on **Figure 2**.

A total of eight harp trap nights were undertaken within Site 1 during surveys.

Additionally, a monitoring program was undertaken at Bat Alley by Fly By Night Bat Surveys Pty Ltd accompanied by an RPS Ecologist to monitor microbat species presence and to assess any likely impacts as a result of the Project. Anabats and harp traps were typically placed at the entrance of Northumberland Number 1 mine, with a second detector placed at the nearby shaft to the workings. On a single occasion (August 2012), the anabats were accompanied by the use of an infrared camera to assess microbat activity and enable an individual count.

Four surveys were undertaken during the monitoring period of Bat Alley including 30 and 31 August 2012, 5 and 6 December 2012, 18 January 2013 and 11 and 13 March 2013.

3.3.5 Microbat Echolocation Call Recording

Microbat echolocation calls were recorded using two Anabat II Detector and CF ZCAIM units set to remotely record for the entire night (6pm to 6am). Two Anabats were placed within close proximity to Bat Alley to the north of Site 1 over four nights in May 2012, resulting in eight nights of bat call recording.

Site 1 had four consecutive nights of sampling, with emphasis placed on those areas deemed likely to provide potential foraging and flyway sites for microbats. The location of the microbat call survey is shown on **Figure 2**. Bat call analysis was undertaken by Anna McConville who is experienced in the analysis of bat echolocation calls.

3.3.6 Avifauna Survey

The presence of avifauna within the two proposed disturbance footprints was determined via targeted diurnal and nocturnal surveys as well as opportunistic observations during fieldwork. These surveys were scheduled for peak activity periods i.e. dawn and dusk, and were undertaken in areas that displayed high bird activity or had favourable habitat features such as flowering trees. Birds were identified by either direct observation or by recognition of calls. Other distinctive identification features included nests, feathers and owl regurgitation pellets. The potential for threatened avifauna to use the proposed disturbance footprints was also assessed by identification of habitat attributes and their capacity to support threatened species that are known to occur in the wider locality. Nocturnal surveys (refer to **Section 3.4.8** and **Section 3.4.9**) were undertaken to detect nocturnal bird species.

3.3.7 Herpetofauna Survey

Opportunistic herpetofauna searches were conducted during fauna surveys and when moving throughout the proposed disturbance footprints with a focus on suitable habitat areas. Known occurrences of threatened herpetofauna species from the region were taken into account during assessment of onsite habitat, to determine the potential for the proposed disturbance footprints to support such species.

Targeted diurnal and spotlighting surveys for threatened species were also undertaken.

3.3.8 Spotlighting

Spotlighting was undertaken via the use of 35-Watt hand-held spotlights and head torches during walking and vehicular transects. A total of eight person hours of spotlighting was carried out across the proposed disturbance footprints as shown in **Figure 2** and **Figure 3**. The call playback methodology was also undertaken during spotlighting.

3.3.9 Call Playback

Call-playback surveys were undertaken for aural recognition of threatened owl and mammal species with the potential to occur within the PAA and particularly within the proposed disturbance footprints. Pre-recorded calls were broadcast in an effort to elicit vocal responses or to attract an owl or mammal to the playback site. The calls were broadcast through an amplification system (a hand held megaphone) designed to project the sound for at least one kilometre under still night conditions.

As described by Kavanagh and Peake (1993) and Debus (1995), the call of each species was broadcast for at least five minutes, followed by five minutes of listening, and stationary spotlighting. Following the final broadcast and listening, the area was spotlighted on foot. Species broadcasted included Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebricosa*), Masked Owl (*Tyto novaehollandiae*), Koala (*Phascolarctos cinereus*), Squirrel Glider (*Petaurus norfolcensis*) and Yellow-bellied Glider (*Petaurus australis*). The locations of the call playback sites are shown in **Figure 2** and **Figure 3**.

3.3.10 Secondary Indications and Incidental Observations

Opportunistic sightings of secondary indications of resident fauna were noted. Such indicators included:

- Distinctive scats and scents left by mammals;
- Collection of predator scats for analysis;
- Nests made by various guilds of birds;
- Whitewash, regurgitation pellets and prey remains from owls;
- Skeletal material of vertebrate fauna;

- Calls of fauna;
- Footprints left by mammals;
- Chewed she-oak (*Allocasuarina* spp.) cones indicative of feeding by Glossy Black-Cockatoo (*Calyptorhynchus lathamii*);
- Chewed fruit remains indicative of past feeding by frugivorous birds such as fruit-doves; and
- Any other obvious signs of fauna occupation.

WARNING
No part of this plan should be used
for critical design dimensions.
Confirmation of critical positions
should be obtained from RPS Newcastle.

Legend

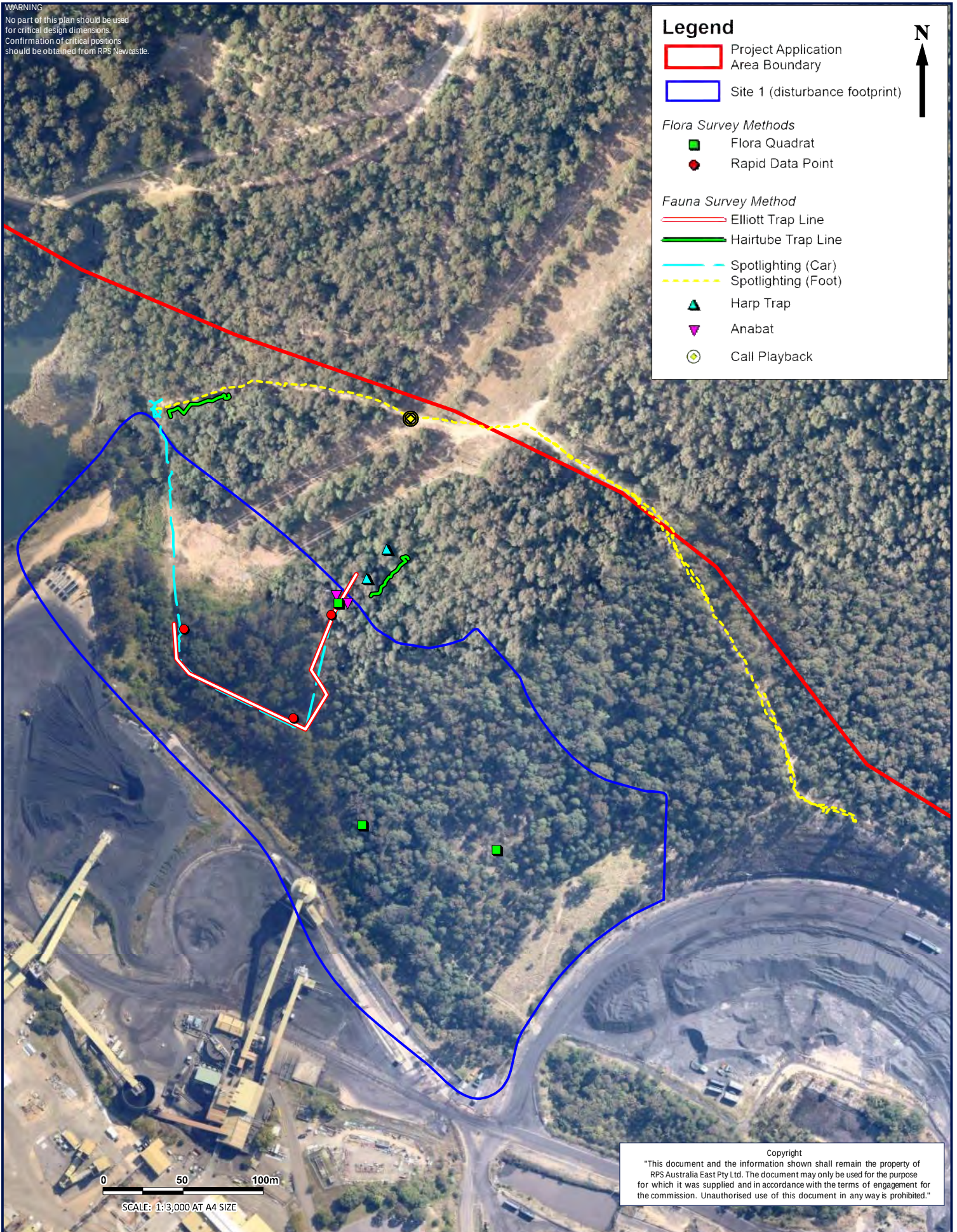
- Project Application Area Boundary
- Site 1 (disturbance footprint)

Flora Survey Methods

- Flora Quadrat
- Rapid Data Point

Fauna Survey Method

- Elliott Trap Line
- Hairtube Trap Line
- Spotlighting (Car)
- Spotlighting (Foot)
- Harp Trap
- Anabat
- Call Playback



0 50 100m
SCALE: 1:3,000 AT A4 SIZE

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TITLE: FIGURE 2: SITE 1 FLORA AND
FAUNA SURVEY EFFORT

LOCATION: COAL LOGISTICS
PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 23/01/2014
PURPOSE: ECOLOGY

LAYOUT REF: 3:\JOBS\Centennial\All Jobs\113119 Coal Logistics\
10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): F A4 (PH-AB)

CLIENT: CENTENNIAL
JOB REF: 113119-2

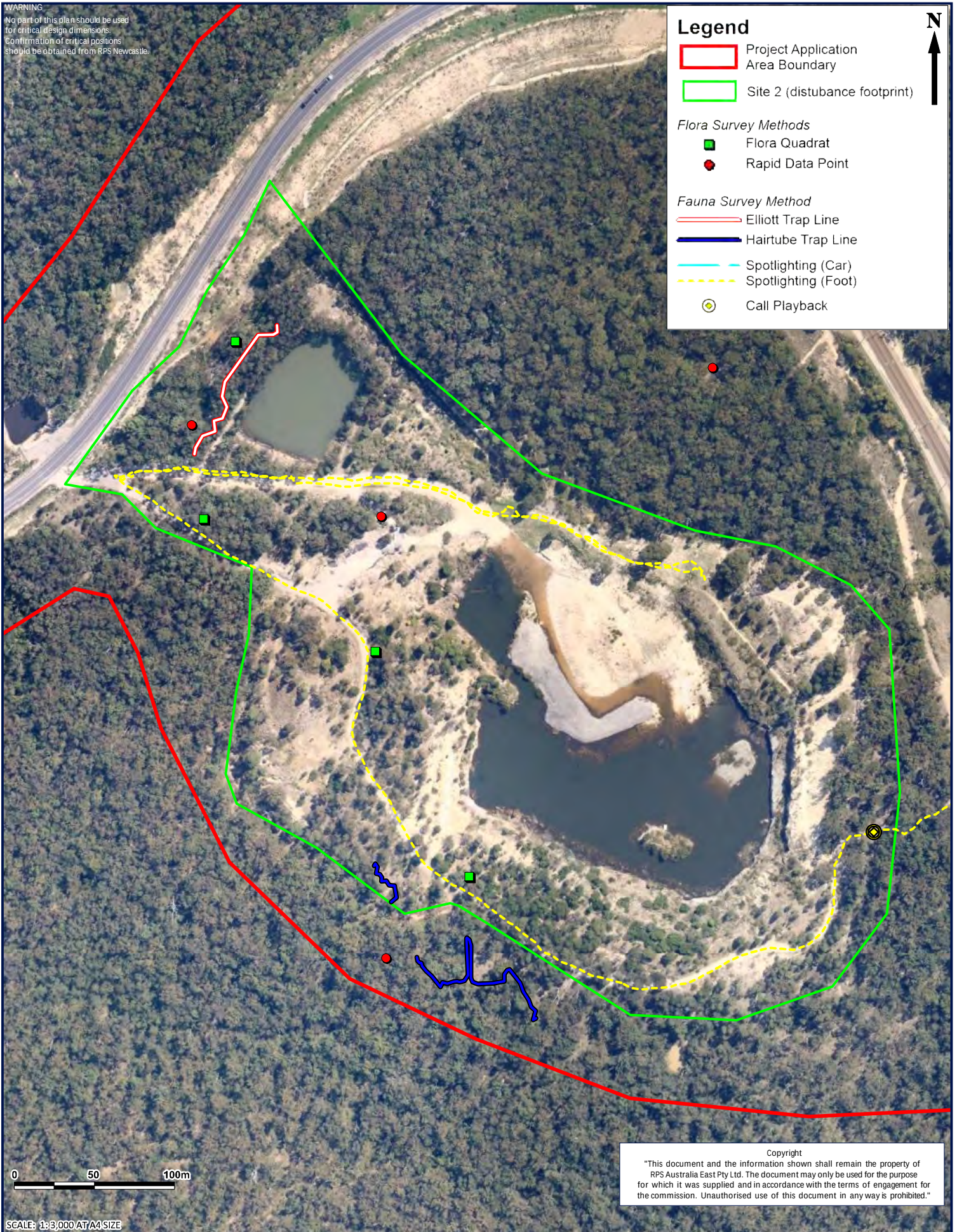
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WARNING
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Legend

- Project Application Area Boundary
- Site 2 (disturbance footprint)
- Flora Survey Methods**
 - Flora Quadrat
 - Rapid Data Point
- Fauna Survey Method**
 - Elliott Trap Line
 - Hairtube Trap Line
 - Spotlighting (Car)
 - Spotlighting (Foot)
 - Call Playback



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TITLE: FIGURE 3: SITE 2 FLORA AND
FAUNA SURVEY EFFORT

LOCATION: COAL LOGISTICS
PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 23/01/2014
PURPOSE: ECOLOGY

LAYOUT REF: 3:\JOBS\Centennial\All Jobs\113119 Coal Logistics\
10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): E A4 (PH-AB)

CLIENT: CENTENNIAL
JOB REF: 113119-2

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3.4 Habitat Survey

An assessment of the relative habitat value present within the two proposed disturbance footprints was undertaken. This FFA focused primarily on the identification of specific habitat types and resources within the proposed disturbance footprints favoured by known threatened species from the region. The assessment also considered the potential value of the proposed disturbance footprints (and surrounds) for all major guilds of native flora and fauna.

Habitat assessment was based on the specific habitat requirements of each threatened fauna species in regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements. Consideration was given to contributing factors including topography, soil, light and hydrology for threatened flora and assemblages.

3.5 State Environmental Planning Policy No. 44 (Koala Habitat Protection)

Assessment of potential koala habitat under SEPP 44 requires the following steps be undertaken:

The first consideration – Is the land 'Potential Koala Habitat'?

If the total tree cover contains 15% or more of the koala food tree species listed in Schedule 2 of SEPP 44 then it is deemed to be 'Potential Koala Habitat'. Identification of 'Potential Koala Habitat' requires the determination of the presence of 'Core Koala Habitat'.

The second consideration – Is the land 'Core Koala Habitat'?

'Core Koala Habitat' is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (females with young), recent sightings and historical records of a Koala population. Under SEPP 44, identification of "Core Koala habitat" requires that a plan of management accompanies the Development Application (DA).

3.6 Survey Effort

The level of survey effort is in accordance line with the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC 2004). These guidelines use a concept of 'stratification units' in order to recommend the amount of flora and fauna survey effort to be undertaken over a given area. It is recommended that the survey area be initially stratified on biophysical attributes (eg. landform, geology, elevation, slope, soil type, aspect), followed by vegetation structure (eg. forest, woodland, shrubland), and then floristics (eg. species or specific vegetation communities).

Both Site 1 and Site 2 contain similar vegetation types dominated by dry sclerophyll woodlands and forests, with a small area of moist forest (refer to **Section 4.4**). Within the combined area of Sites 1 and 2 totalling 21.38 ha, approximately 8.75 ha of native vegetation occurs within the two sites. The vegetation types provide similar habitats for those threatened fauna that have potential to occur. Due to the similarities in vegetation and associated habitat availability, considering all native vegetation within the proposed disturbance footprints as one stratification unit is warranted. Hence, the survey effort undertaken is in accordance with DEC (2004) for target threatened fauna species and fauna species in general.

In order to appropriately identify each vegetation community within the disturbance footprints, flora survey effort was undertaken in accordance with DEC (2004), with each individual vegetation community representing a separate stratification unit. In addition, seasonal targeted surveys occurred throughout the disturbance footprints on several occasions. Targeted flora surveys were significantly in excess of recommended survey effort.

3.7 Survey Limitations

The limitations associated with this survey and report is presented herewith. In instances where surveys were not able to reliably detect a particular species or guild, a precautionary approach has been adopted; as such 'assumed presence' of known and expected threatened species, populations and ecological communities has been made where relevant and scientifically justified to ensure a holistic assessment.

3.7.1 Flora Species

The cryptic nature of a number of flora species means that surveys may not have been able to detect species, despite being present. There is a range of common albeit cryptic plant species that have a brief flowering period and hence small 'window' of effective 'detectability'. In addition, the seasonality of surveys also places limits on the number of flora species identified. Therefore, some threatened species not detected cannot be discounted off-hand due to seasonality and other factors, and are therefore, addressed in terms of their potential for occurrence based on ecological factors and previous records.

Survey effort and timing sought to reduce this limitation by undertaking targeted surveys within the flowering periods of all threatened flora known from the locality.

3.7.2 Fauna Species

The presence of fauna species within a particular area is not static over time and may be seasonal or in response to the availability of a particular resource. The flowering and fruiting plant species that attract some nomadic or migratory threatened species, often fruit or flower in cycles spanning a number of years. Furthermore, these resources might only be accessed in some areas during years when resources more accessible to threatened species fail. As a consequence threatened species may be absent from some areas where potential habitat exists for extended periods.

3.7.3 Data Availability and Accuracy

The collated threatened flora and fauna species records provided by the Atlas of NSW Wildlife for the region are known to vary in accuracy and reliability. This is often due to the reliability of information provided to OEH for collation and/or the need to protect specific threatened species locations. During the review of threatened species records sourced from Atlas of NSW Wildlife, consideration has been given to the date and accuracy of each threatened species record in addition to an assessment of habitat suitability within the PAA and particularly the disturbance footprints.

Similarly, EPBC Protected Matters Searches provide a list of threatened species and communities that have been recorded within 10 km or which are predicted to have suitable habitat within the wider area. Records from the EPBC Protected Matters Search are therefore, subject to the same inherent inaccuracy issues as State derived databases.

In order to address these limitations in respect to data accuracy, threatened species records have been used to provide a guide only to the types of species which occur within the locality of the PAA. Consequently, habitat assessments and the results of surveys conducted within the disturbance footprints have been used to assess the likelihood of occurrence of threatened species, populations and ecological communities to occur.

4.0 Results

4.1 Database Search

4.1.1 Potentially Occurring Threatened Flora

Based on suitable habitat available in the area, a search of the NSW Wildlife Atlas database and a Protected Matters Search was undertaken in January 2014 to identify potentially occurring threatened flora species within the locality (10 km radius of the PAA) (**Table 3**). This list included threatened flora species and flora populations listed under the TSC Act 1995 and/or EPBC Act 1999. A total of 24 threatened flora species and one threatened flora population were identified as having potential to exist within the locality (**Table 3**).

Table 3 Threatened flora species occurring and potentially occurring within a 10 km site radius of the PAA

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
Plants				
<i>Acacia bynoeana</i>	Bynoe's Wattle	E	V	67
<i>Angophora inopina</i>	Charmhaven Apple	V	V	949
<i>Asterolasia elegans</i>	-	E	E	0
<i>Callistemon linearifolius</i>	Netted Bottle Brush	V	-	41
<i>Corybas dowlingii</i>	Red Helmet Orchid	E	-	1
<i>Cryptostylis hunteriana</i>	Leafless-tongue Orchid	V	V	9
<i>Cynanchum elegans</i>	White-flowered Wax Plant	E	E	2
<i>Diuris praecox</i>	Rough Doubletail	V	V	0
<i>Eucalyptus camfieldii</i>	Camfield's Stringybark	V	V	0*
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	145
<i>Maundia triglochinoides</i>	-	V	-	7
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	V	V	151
<i>Pelargonium</i> sp. Stiatellum (G.W.Carr 10345)	Omeo Stork's-bill	-	E	0
<i>Persicaria elatior</i>	Tall Knotweed	V	V	1
<i>Prasophyllum</i> sp. Wybong (C.Phelps ORG 5269)	a leek-orchid	-	CE	0
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	E	E	0
<i>Rhizanthella slateri</i>	Eastern Underground Orchid	V	E	0
<i>Rutidosia heterogama</i>	Heath Wrinklewort	V	V	2
<i>Senecio spathulatus</i>	Coast Groundsel	E	-	1
<i>Streblus pendulinus</i>	Sia's Backbone	-	E	0
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	E	V	8

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
<i>Tetradlea glandulosa</i>	Glandular Pink-bell	V	V	0
<i>Tetradlea juncea</i>	Black-eyed Susan	V	V	1585
<i>Zannichellia palustris</i>	-	E	-	1
Population				
<i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i> population in the Wyong and Lake Macquarie Local Government Areas.		E Pop	-	4

Status (TSC Act 1995):

CE – Endangered Species

E – Endangered Species

E (pop) – Endangered Population

V – Vulnerable Species

Status (EPBC Act 1999):

CE – Endangered Population

E – Endangered Species

V – Vulnerable Species

4.1.2 Potentially Occurring Threatened Fauna Species

Based on suitable habitat available in the locality, a search of the NSW Wildlife Atlas database and a Protected Matters Search were undertaken in January 2014 to identify potentially occurring threatened fauna species within the locality (10 km radius of the PAA) (**Table 4**). This list included threatened fauna species and populations listed under the TSC Act 1995 and/or EPBC Act 1999. A total of 69 threatened fauna species were identified as having potential to exist within the locality (**Table 4**).

Table 4 Potential Threatened Fauna Species

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
Birds				
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E	15
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E	0
<i>Burhinus grallarius</i>	Bush Stone-curlew	E	-	1
<i>Calidris ferruginea</i>	Curlew Sandpiper	E	C, J, K	5
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V	-	9
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	-	67
<i>Charadrius mongolus</i>	Lesser Sand-plover	V	C, J, K	1
<i>Chthonicola sagittata</i>	Speckled Warbler	V	-	2
<i>Circus assimilis</i>	Spotted Harrier	V	-	1
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	-	7
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	22
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	E	0
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E	-	11
<i>Epthianura albifrons</i>	White-fronted Chat	V	-	4
<i>Erythrotriorchis radiatus</i>	Red Goshawk	CE	V	1
<i>Falco subniger</i>	Black Falcon	V	-	0
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-	46

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V	-	1
<i>Haematopus longirostris</i>	Pied Oystercatcher	E	-	3
<i>Hieraaetus morphnoides</i>	Little Eagle	V	-	5
<i>Irediparra gallinacea</i>	Comb-crested Jacana	V	-	3
<i>Ixobrychus flavicollis</i>	Black Bittern	V	-	9
<i>Lathamus discolor</i>	Swift Parrot	E	E	19
<i>Lophoictinia isura</i>	Square-tailed Kit	V	-	1
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V	-	1
<i>Neophema pulchella</i>	Turquoise Parrot	V	-	4
<i>Ninox connivens</i>	Barking Owl	V	-	4
<i>Ninox strenua</i>	Powerful Owl	V	-	80
<i>Oxyura australis</i>	Blue-billed Duck	V	-	1
<i>Pandion cristatus</i>	Eastern Osprey	V	-	23
<i>Petroica boodang</i>	Scarlet Robin	V	-	6
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	-	1
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V	-	2
<i>Ptilinopus superbus</i>	Superb Fruit-Dove	V	-	2
<i>Rostratula australis</i>	Australian Painted Snipe	E	V	2
<i>Stagonopleura guttata</i>	Diamond Firetail	V	-	1
<i>Sternula nereis nereis</i>	Fairy Tern	-	V	0
<i>Stictonetta naevosa</i>	Freckled Duck	V	-	1
<i>Tyto novaehollandiae</i>	Masked Owl	V	-	56
<i>Tyto tenebricosa</i>	Sooty Owl	V	-	21
Mammals				
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	-	1
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll	V	E	19
<i>Petaurus australis</i>	Yellow-bellied Glider	V	-	39
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-	158
<i>Petrogale penicillata</i>	Brush-tail Rock-wallaby	E	V	0
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	-	2
<i>Phascolarctos cinereus</i>	Koala	V	V	30
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo (SE mainland)	V	V	3
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	-	V	0
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	73
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	-	4
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	-	49
<i>Phoniscus papuensis</i> (Syn <i>Kerivoula papuensis</i>)	Golden-tipped Bat	V	-	9
<i>Miniopterus australis</i>	Little Bentwing-bat	V	-	94
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V	-	89
<i>Myotis macropus</i>	Southern Myotis	V	-	19

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	-	41
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	-	8
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	11
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	-	8
Frogs				
<i>Crinia tinnula</i>	Wallum Froglet	V	-	4
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	V	3
<i>Litoria aurea</i>	Green and Golden Bell Frog	E	V	0
<i>Litoria brevipalmata</i>	Green-thighed Frog	V	-	2
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	V	V	0
<i>Mixophyes balbus</i>	Stuttering Frog	E	V	37
<i>Mixophyes iteratus</i>	Giant Barred Frog	E	E	0
<i>Pseudophryne australis</i>	Red-crowned Toadlet	V	-	2
Reptiles				
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	E	V	0
<i>Hoplocephalus stephensii</i>	Stephens' Banded Snake	V	-	3

Status (TSC Act 1995):

CE – Endangered Species

E – Endangered Species

E (pop) – Endangered Population

V – Vulnerable Species

Status (EPBC Act 1999):

CE – Critically Endangered Species

E – Endangered Species

V – Vulnerable Species

C – CAMBA

J – JAMBA

K – ROKAMBA

4.1.3 Literature Review**4.1.3.1 Significant Flora**

A total of five threatened flora species listed under TSC Act 1995 and/or the EPBC Act 1999 have been recorded in the areas surrounding the PAA by previous ecological surveys (**Table 5**).

Table 5 Flora of Conservation Significance Previously Recorded in the wider area

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Source
<i>Acacia bynoeana</i>	Bynoe's Wattle	E	V	Umwelt 2005, Cumberland Ecology 2007, 2008 HunterEco 2008a, 2008b, 2009a
<i>Angophora inopina</i>	Charmhaven Apple	V	V	Cumberland Ecology 2007, 2008 HunterEco 2008a, 2009a
<i>Callistemon linearifolius</i>	Netted Bottlebrush	V	-	Umwelt 2004
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	Umwelt 2005 Eco Biological 2005 Cumberland Ecology 2007, 2008 Hunter Eco 2008a, 2008b

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Source
<i>Tetralochea juncea</i>	Black-eyed Susan	V	V	Umwelt 1998, 2004, 2005 Eco Biological 2005; HLA 2006 Cumberland Ecology 2007, 2008 Hunter Eco 2008a, 2008b

4.1.3.2 Significant Fauna

Ten threatened fauna species listed under TSC Act 1995 and/or the EPBC Act 1999 have been recorded in the area surrounding the PAA by previous ecological surveys (**Table 6**).

Table 6 Fauna of Conservation Significance Recorded in the Area

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Source
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Gunninah 1998; HLA 2006
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	-	HLA 2006
<i>Miniopterus australis</i>	Little Bentwing-bat	V	-	Gunninah 1998; HLA 2006 Cumberland Ecology 2007
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V	-	Gunninah 1998; HLA 2006
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	-	Cumberland Ecology 2007; HLA 2006
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-	Gunninah 1998
<i>Pteropus poliocephalus</i>	Grey-headed Flying –fox	V	V	Cumberland Ecology 2007; HLA 2006
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat	V	-	Cumberland Ecology 2007
<i>Tyto novaehollandiae</i>	Masked Owl	V	-	Cumberland Ecology 2007
<i>Tyto tenebricosa</i>	Sooty Owl	V	-	Cumberland Ecology 2007

4.2 Weather Conditions

The prevailing weather conditions during the fauna survey period are presented in **Table 7**.

Table 7 Prevailing Weather Conditions

Parameters	14 May 2012	15 May 2012	16 May 2012	17 May 2012	16 September 2013	17 September 2013	18 September 2013	19 September 2013
Temperature °C	10–17	8–19	10–19	9–19	9-18	14-22	12-25	6-24
Rain (24hrs to 9:00am) mm	0.0	0.0	0.0	0.0	0.0	14.6	1.6	0.0
Sun Rise	06:37	06:37	06:38	06:39	05:52	05:50	05:49	05:47
Sun Set	17:04	17:03	17:02	17:02	17:46	17:47	17:47	17:48
Moon Rise	00:18	01:14	02:10	03:04	14:23	15:29	16:34	17:38
Moon Set	13:05	13:36	14:06	14:37	03:09	03:53	04:33	05:12

4.3 Flora Survey

4.3.1 Vegetation Community Mapping

4.3.1.1 Project Application Area

A review of previous vegetation mapping undertaken over the proposed disturbance footprints revealed that LHCCREMS (NPWS 2000) mapped the entire area of Site 1 as Coastal Plains Smooth-barked Apple Woodland. Site 2 was mapped by NPWS (2000) as predominately cleared land, with Coastal Plains Smooth-barked Apple Woodland, Riparian Melaleuca Swamp Woodland and Coastal Plains Scribbly Gum Woodland around the edges of this site. The Vegetation Mapping of Lake Macquarie LGA: Stage 3 (Bell and Driscoll 2012) also mapped Site 2 as predominately cleared, with Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland on the edges.

Surveys and ground-truthing recorded five vegetation communities and/or discernible areas within the proposed disturbance footprints, namely:

- Coastal Narrabeen Moist Forest;
- Coastal Foothills Spotted Gum - Ironbark Forest;
- Coastal Plains Smooth-barked Apple Woodland;
- Regrowth *Acacia decurrens*; and
- Cleared, roads, tracks and waterbodies

Table 8 provides the areas of these communities / areas within each site. **Figure 4** and **Figure 5** provide the final vegetation maps of the proposed disturbance footprints incorporating results of RPS flora ground-truthing surveys.

Table 8 Vegetation Communities or Delineated Areas Confirmed within the PAA

Vegetation Community / Delineated Area	Analogous to LHCCREMS MU	Corresponds to TSC Act 1995 EEC	Area (ha)		Total Area (ha)
			Site 1	Site 2	
Coastal Narrabeen Moist Forest	MU 6	-	-	0.10	0.10
Coastal Foothills Spotted Gum - Ironbark Forest	MU 15	-	3.50	-	3.50
Coastal Plains Smooth-barked Apple Woodland	MU 30	-	1.22	1.93	3.15
Regrowth <i>Acacia decurrens</i>	None	-	-	2.00	2.00
Cleared, roads, tracks and waterbodies	None	-	2.78	9.85	12.63
Total Area (ha)			7.5	13.9	21.38

The following section provides a brief outline of the dominant floral characteristics of each identified vegetation community based on RPS field surveys. The below vegetation community descriptions are derived from flora surveys undertaken within the proposed disturbance footprints.

Coastal Narrabeen Moist Forest (LHCCREMS MU 6)**Plate 1 Coastal Narrabeen Moist Forest**

Description:	A small patch of this vegetation community occurs within the west of Site 2. Coastal Narrabeen Moist Forest is a tall moist open vegetation community found in sheltered aspects and gullies.
Canopy Layer:	15 to 20 m – 20% Percentage Foliage Cover (PFC). Dominant species were <i>Eucalyptus acmenoides</i> (White Mahogany) and <i>Callicoma serratifolia</i> (Black Wattle).
Shrub Layer:	1 – 3 m - 70% PFC. Dominated by <i>Melaleuca linariifolia</i> (Flax-leaved Paperbark), <i>Backhousia myrtifolia</i> (Grey Myrtle), <i>Glochidion ferdinandi</i> (Cheese Tree), <i>Acacia longifolia</i> (Sydney Golden Wattle), <i>Dodonaea triquetra</i> (Large-leaf Hop-bush), <i>Breynia oblongifolia</i> (Coffee Bush) and <i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i> .
Ground Layer:	To 1 m – 40-60% PFC. Dominant species included <i>Oplismenus aemulus</i> (Australian Basket Grass), <i>Gahnia clarkei</i> (Tall Saw-sedge), <i>Adiantum aethiopicum</i> (Common Maidenhair), <i>Imperata cylindrica</i> (Blady Grass), <i>Entolasia marginata</i> (Bordered Panic) and <i>Echinopogon ovatus</i> (Forest Hedgehog Grass).
Classification:	This community is not commensurate with any threatened ecological community listed under the TSC Act 1995 or EPBC Act 1999.
Total Area	Approximately 0.10 ha (Site 2)

Coastal Foothills Spotted Gum – Ironbark Forest (LHCCREMS MU 15)

Plate 2 Coastal Foothills Spotted Gum – Ironbark Forest

Description:	This vegetation community occurred over the majority of Site 1. Coastal Foothills Spotted Gum - Ironbark Forest is typically a moderately tall open forest dominated by ironbark species.
Canopy Layer:	20 m – 40% PFC. The dominant canopy species were <i>Corymbia maculata</i> (Spotted-gum) with, <i>Angophora costata</i> (Smooth-barked Apple), <i>Eucalyptus crebra</i> (Narrow-leaved Ironbark), <i>Eucalyptus umbra</i> (Broad-leaved White Mahogany) and <i>Eucalyptus acmenoides</i> (White Mahogany).
Shrub Layer:	1-2 m – 20-30% PFC. Dominant shrub species included <i>Dodonaea triquetra</i> (Large-leaf Hop-bush), <i>Persoonia linearis</i> (Narrow-leaved Geebung), <i>Podolobium ilicifolium</i> (Native Holly), <i>Acacia longifolia</i> (Sydney Golden Wattle) and <i>Lissanthe strigosa</i> (Peach Heath)
Ground Layer:	0m to 0.5 m – 50-60% PFC. Dominant species included <i>Lomandra multiflora</i> (Many-flowered Mat-rush), <i>Lomandra filiformis</i> (Wattle Mat-rush), <i>Pratia purpurascens</i> (Whiteroot), <i>Entolasia stricta</i> (Wiry Panic) and <i>Microlaena stipoides</i> (Weeping Grass).
Classification:	This community is not commensurate with any threatened ecological community listed under the TSC Act 1995 or EPBC Act 1999.
Total Area:	Approximately 3.50 ha (Site 1)

Coastal Plains Smooth-barked Apple Woodland (LHCCREMS MU 30)

Plate 3 Coastal Plains Smooth-barked Apple Woodland

Description:	This vegetation community occurred within the east of Site 1 and within the south and east of Site 2. This community is a dry and shrubby forest with an open mid layer.
Canopy Layer:	20 to 25 m – 40-60% PFC. Dominant species included <i>Angophora costata</i> (Smooth-barked Apple), <i>Corymbia gummifera</i> (Red Bloodwood), <i>Eucalyptus umbra</i> (Broad-leaved White Mahogany) and <i>Eucalyptus capitellata</i> (Brown Stringybark),
Shrub Layer:	1.5 to 3 m – 10-30% PFC. Dominant shrub species included; <i>Allocasuarina littoralis</i> (Black She-oak), <i>Persoonia linearis</i> (Narrow-leaved Geebung), <i>Dodonaea triquetra</i> (Large-leaf Hop-bush) and <i>Acacia longifolia</i> (Sydney Golden Wattle).
Ground Layer:	0 to 0.5 m – 70% PFC. Dominant species included <i>Entolasia stricta</i> (Wiry Panic), <i>Imperata cylindrica</i> (Blady Grass), <i>Pteridium esculentum</i> (Bracken), <i>Microlaena stipoides</i> (Weeping Grass), <i>Dianella caerulea</i> (Blue Flax Lily) and <i>Lomandra obliqua</i> .
Classification:	This community is not commensurate with any threatened ecological community listed under the TSC Act 1995 or EPBC Act 1999.
Total Area	Approximately 1.22 ha (Site 1) and 1.93 ha (Site 2)

Regrowth *Acacia decurrens* (No LHCCREMS equivalent)**Plate 4 Regrowth *Acacia decurrens***

Description:	Two areas classified as <i>Acacia decurrens</i> regrowth occurred within the south/centre of Site 2. This vegetation type is moderately disturbed with scattered trees and a sparse ground cover.
Canopy Layer:	To 10 m – 30% PFC. Dominant species included <i>Corymbia maculata</i> (Spotted Gum) and <i>Eucalyptus punctata</i> (Grey Gum).
Shrub Layer:	1.5 to 3 m – 40% PFC. Dominant shrub species included; <i>Acacia decurrens</i> (Black Wattle), <i>Allocasuarina littoralis</i> (Black She-oak) and <i>Hakea sericea</i> (Needlebush).
Ground Layer:	0 to 0.5 m – 50% PFC. Dominant species included <i>Entolasia stricta</i> (Wiry Panic), <i>Rytidosperma racemosum</i> , <i>Cynodon dactylon</i> (Couch), <i>Juncus usitatus</i> , <i>Microlaena stipoides</i> (Weeping Grass) and <i>Dianella caerulea</i> (Blue Flax Lily).
Classification:	This community is not commensurate with any MU or any threatened ecological community listed under the TSC Act 1995 or EPBC Act 1999.
Total Area	Approximately 2.00 ha (Site 2)

Cleared / Disturbed Lands (No MU)

All areas classified as Cleared/Disturbed Lands are areas where the native tree and shrub cover has been mostly removed. These areas retain less than three percent canopy cover i.e. widely spaced isolated trees. Areas of Cleared/Disturbed Lands do not include areas of regrowth native vegetation.

Examples of areas classified as Cleared/Disturbed Lands within the two proposed disturbance footprints include:

- Cleared lands;
- Waterbodies;
- Roads, tracks and associated verges; and
- Infrastructure.

Total area: 2.78 ha (Site 1) and 9.85 ha (Site 2).

4.3.1.2 Riparian Vegetation Below Licensed Discharge Points

A review of LHCCREMS (NPWS 2000) and *Vegetation Mapping of Lake Macquarie LGA: Stage 3* (Bell and Driscoll 2012) has been undertaken for the riparian habitats associated with the licensed discharge points: Newstan LDP001, LDP002 and LDP003 at Newstan Colliery Surface Site; Cooranbong LDP001 and LDP002 at the Cooranbong Entry Site; and a proposed LDP at Hawkmount Quarry.

Vegetation downstream of Newstan LDP001, LDP002 and LDP003 transitions from woodland on the hills and slopes through to floodplain and estuarine communities where LT Creek discharges into Lake Macquarie. Newstan LDP001 and LDP002 vegetation consists of MU30 – Coastal Plains Smooth-barked Apple Woodland in the upper reaches through to MU15 – Coastal Foothills Spotted Gum-Ironbark Forest (LDP003 also contains; MU 11 – Coastal Sheltered Apple-Peppermint Forest and MU 111a – Lake Macquarie Snappy Gum Forest, at this point) as the terrain begins to flatten. From the upper tidal extent of LT Creek to where it discharges into Lake Macquarie vegetation is comprised of pockets of floodplain and estuarine communities (MU38 – Redgum Rough Barked Apple Forest (EEC) and MU42 – Riparian Melaleuca Swamp Woodland (EEC)) amongst residential development.

Vegetation mapping along the unnamed tributary, which receives water from Cooranbong LDP001 and LDP002, consists of MU37 – Swamp Mahogany – Paperbark Forest (EEC). This unnamed tributary enters into Muddy Lake, where vegetation transitions into cleared land, with pockets of MU43 – Estuarine Paperbark Scrub Forest and MU40 – Swamp Oak – Rushland Forest (EEC). The vegetation where Muddy Lake discharges into Lake Macquarie is fringed by MU47 – Mangrove - Estuarine Complex and Saltmarsh (EEC).

The vegetation downstream of the proposed sedimentation basin and associated LDP at Hawkmount Quarry transitions from woodland on the hills and slopes through to floodplain and estuarine communities where it discharges into Lake Macquarie. The name of the creek that this LDP will discharge in to changes name as it flows towards Lake Macquarie; it is known as Lords Creek in the upper reaches near the quarry; it becomes Jigadee Creek as the terrain flattens; and as it widens out and becomes tidal it is named Dora Creek. The vegetation consists of MU30 – Coastal Plains Smooth-barked Apple Woodland and MU 11 – Coastal Sheltered Apple-Peppermint Forest in the upper reaches (Lords Creek) and MU37 – Swamp Mahogany – Paperbark Forest (EEC), MU 5 – Alluvial Tall Moist Forest, MU42 – Riparian Melaleuca Swamp Woodland (EEC), MU 31 – Coastal Plains Scribbly Gum Woodland as the terrain begins to flatten (Jigadee Creek). From the upper tidal extent of Dora Creek to where it discharges into Lake Macquarie vegetation is comprised of pockets of floodplain communities (MU38 – Redgum Rough Barked Apple Forest (EEC), MU42

– Riparian Melaleuca Swamp Woodland (EEC), MU 123 - Cooranbong Blackbutt Tall Forest and MU40 – Swamp Oak – Rushland Forest (EEC)) amongst cleared farm land and residential development.

4.3.2 Threatened Flora

Two threatened flora species were recorded within the proposed disturbance footprints (Site 1 and Site 2) during targeted threatened species searches or in the course of other vegetation mapping activities (**Table 9**, **Figure 4** and **Figure 5**). These species have also been previously recorded within the wider area. The Project will remove habitat and individuals of two threatened flora species, namely *Tetradlea juncea* and *Grevillea parviflora* subsp. *parviflora*.

Table 9 Threatened Flora Recorded within Site 1 and site 2

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	-	1
<i>Tetradlea juncea</i>	Black-eyed Susan	V	V	376	

Figures 4 and 5 shows the locations of all threatened flora detected within the proposed disturbance footprints.

4.3.2.2 *Grevillea parviflora* subsp. *parviflora*

A total of 132 stems of *G. parviflora* subsp. *parviflora* were recorded within the original layout of Site 2. However, the boundary of Site 2 was re-designed to avoid impacts upon 131 of the 132 stems of *G. parviflora* subsp. *parviflora*, therefore; only one individual stem is proposed to be removed by the Project.

4.3.2.3 *Tetradlea juncea*

A total of 376 *T. juncea* clumps are located and proposed to be removed within Site 1. The original layout of Site 1 contained an additional 425 clumps of *T. juncea* to the immediate north of Site 1 (refer to **Figure 4**). However, a redesign of Site 1 has avoided impacts to the additional 425 clumps. The immediate surrounding vegetation type (MU30) at Site 1 is preferred habitat for *T. juncea* and following additional targeted surveys it has been established that the individuals within Site 1 are part of a larger subpopulation extending to the north and west and number at least 1,958 clumps (refer to **Figure 6**). Due to the noted availability of potential habitat surrounding Site 1, which wasn't surveyed, additional surveys within the region would most likely result in a much larger estimate of the local population. Given the current information, the removal of 376 clumps within Site 1 equates to the removal of up to 19.2% of the recorded subpopulation of *T. juncea*, however the actual percentage is likely to be substantially less.

The original layout of Site 2 also contained 219 *T. juncea* clumps. However, following the re-design of the site layout, all 219 recorded clumps of *T. juncea* within Site 2 will be avoided.

4.4 Fauna Survey

A total of 48 fauna species were detected within the proposed disturbance footprints during surveys, including six terrestrial mammal species, two arboreal mammal species, one species of megachiropteran bat, four species of microchiropteran bats, 30 bird species, one reptile species and four amphibian species. Four threatened fauna species listed under the EPBC Act 1999 and/or TSC Act 1995 were recorded during RPS surveys:

- Little Lorikeet (*Glossopsitta pusilla*) (listed as Vulnerable under the TSC Act 1995);
- Grey-headed Flying-fox (*Pteropus poliocephalus*) (listed as Vulnerable under the TSC Act 1995 and

EPBC Act 1999);

- Large-eared Pied bat (*Chalinolobus dwyeri*) (listed as Vulnerable under the TSC Act 1995 and EPBC Act 1999); and
- Little bentwing-bat (*Miniopterus australis*) (listed as Vulnerable under the TSC Act 1995).

In addition, to the threatened fauna species recorded by RPS, six other fauna species listed under TSC Act 1995 and/or the EPBC Act 1999 have been recorded in the surrounding area by previous ecological surveys (**Table 6**).

The results for each group are discussed further below. **Appendix 4** lists all fauna species recorded within each site. Refer to **Figure 4** and **Figure 5** for threatened fauna locations.

4.4.1 Terrestrial Mammals

A total of five Bush Rats (*Rattus fuscipes*), four Black Rats (*Rattus rattus*), seven Brown Antechinus (*Antechinus stuartii*), one Dusky Antechinus (*Antechinus swainsonii*) and one short-beaked Echidna (*Tachyglossus aculeatus*) were captured during terrestrial/arboreal trapping across the proposed disturbance footprints. Hair tubes had a single specimen from a *Rattus* species, most likely one of the two species captured during trapping. Two Swamp Wallabies (*Wallabia bicolor*) were observed during spotlighting.

4.4.2 Arboreal Mammals

Two arboreal mammal species were recorded within the proposed disturbance footprints. Common Ringtail Possums (*Pseudocheirus peregrinus*) were observed within both Site 1 and Site 2 during spotlighting. Sugar Gliders (*Petaurus breviceps*) were trapped in arboreal Elliott traps at Site 1 and Site 2. No threatened arboreal mammal species listed under the TSC Act 1995 or EPBC Act 1999 were detected.

4.4.3 Bats

Several Grey-headed Flying-foxes, which are listed as Vulnerable under both the TSC Act 1995 and EPBC Act 1999, were recorded during spotlighting. Both Eastern Horseshoe Bat (*Rhinolophus philippinensis*) and Little Forest Bat (*Vespadelus vulturnus*) were captured within the harp traps in Site 1. A total of four species of microchiropteran bats were identified from Anabat echo-location call recording surveys of Site 1, namely:

- Eastern Horseshoe Bat (*Rhinolophus megaphyllus*);
- White-striped Freetail Bat (*Tadarida australis*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (listed as Vulnerable under both the TSC Act 1995 and EPBC Act 1999); and
- Little Bentwing-bat (*Miniopterus australis*) (listed as Vulnerable under the TSC Act 1995).

The results of the bat call analysis provided in **Appendix 6**.

4.4.3.1 Bat Alley

An old drift entrance and vent shaft is located adjacent to the northern boundary of Site 1 known locally as 'Bat Alley'. Previous surveys using harp traps placed at the entrance of the drift have detected the Little Bentwing Bat (*Miniopterus australis*) and Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), some of which appeared pregnant (Gunninah 1998b). On release, the bats flew directly into the mine tunnel, suggesting that it is being used as a roosting and, possibly, a nesting site. Due to safety concerns from rock fall, the drift entrance was not examined internally to verify if bats were utilising the mine for roosting purposes. However, the mine is most likely being utilised for roosting as bats were detected leaving the entrance at dusk.

The original footprint of the proposed Site 1 disturbance footprint was redesigned to decrease potential impacts upon microbats utilising this shaft. A vegetation buffer has also been retained to ensure further protection of the microbats species from the project. An annual ongoing monitoring program centred on the shaft has commenced.



Plate 5 Harp traps deployed at 'Bat Alley'

Monitoring results of Bat Alley by Fly By Night Bat Surveys Pty Ltd (Hoye 2012a, 2012b, 2013a and 2013b) recorded numerous microbat species through echolocation and direct capture. Hoye (2012b:1) states "the low number of bats recorded at adit and shaft may indicate that the workings are not being used for breeding". Although Gunninah (1998b) made observations of potentially pregnant females, pregnancies were not confirmed (nor detailed as to how they were considered pregnant) and the larger context of the situation established through periodic monitoring by a bat specialist indicates that the adit and shaft are likely to only be utilised for roosting and not breeding purposes.

4.4.4 Avifauna Survey

A total of 30 bird species were recorded within the proposed disturbance footprints during the survey period. The most commonly recorded species were Yellow-faced Honeyeater (*Lichenostomus chrysops*), Grey Fantail (*Rhipidura fuliginosa*), Superb Fairy-wren (*Malurus cyaneus*), Lewin's Honeyeater (*Meliphaga lewinii*), Eastern Spinebill (*Acanthorhynchus tenuirostris*) and Mistletoebird (*Dicaeum hirundinaceum*).

The threatened Little Lorikeet (*Glossopsitta pusilla*), which is listed as Vulnerable under the TSC Act 1995, was observed flying over both sites.

4.4.5 Herpetofauna

Targeted and opportunistic surveys were conducted for amphibians and reptiles within the proposed disturbance footprints. Two common amphibian species were recorded during spotlighting and included Whirring Treefrog (*Litoria revelata*) and Common Eastern Froglet (*Crinia signifera*). Three additional amphibian species were recorded during surveys of LT Creek namely; Eastern Dwarf Tree Frog (*Litoria fallax*), Broad Palmed Frog (*Litoria latopalmata*) and Peron's Tree Frog (*Litoria peronii*). A red-bellied black snake (*Pseudechis porphyriacus*) was captured in an Elliott B trap. No threatened herpetofauna species listed under the TSC Act 1995 or EPBC Act 1999 were detected.

4.5 Habitat Survey

4.5.1 Terrestrial Habitats

Habitats within the proposed disturbance footprints were assessed for their potential to support native fauna species including threatened fauna recorded from the wider locality. Broad habitat types recorded within the proposed disturbance footprints included; open forest/woodland areas, riparian areas, and cleared/disturbed areas.

Open forest communities provide moderately suitable habitat for a number of terrestrial mammal species. They also provide abundant foraging resources such as foliage, pollen, nectar and invertebrates for possums, gliders and flying-foxes. Common Ringtail Possums (*Pseudocheirus peregrinus*) were detected during spotlighting and Sugar Gliders (*Petaurus breviceps*) were captured during trapping, which confirms that gliders are present as was expected. No Koalas or signs of their presence were detected during the surveys.

The supply of nectar attracts insect populations, which provide foraging opportunities for a range of microbat species that occur within the locality. In addition, the hollow-bearing trees within the proposed disturbance footprints provide roosting and nesting habitat for a number of microbat species. Bat Alley (drift entrance) adjacent to Site 1 provides roosting opportunities for cave dwelling species such as the Large-eared Pied Bat (*Chalinobus dwyeri*), which is listed as Vulnerable under both the TSC Act 1995 and EPBC Act 1999.

The clearing of vegetation involves the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows were recorded including; seven small hollows (2–10 cm) of a size suitable for microbats and small gliders and three medium (11–25 cm) sized hollows suitable for medium sized mammals, such as Brush-tailed Possums. The medium hollows may also be sufficient to provide sub-optimal breeding/nesting habitat for owl and large parrot species. However, no large hollows (>25 cm) which provide important breeding/roosting habitat for these species were identified within the proposed disturbance footprints. The forested areas also provide suitable foraging resources, nesting and roosting opportunities for a variety of sedentary and breeding-migrant bird species. There are also fallen logs, dead stags, and ground debris providing sheltering opportunities for a wide range of terrestrial mammals, reptiles and amphibian species.

Stands of *A. littoralis* and *A. torulosa* are favoured food sources of the Glossy Black-Cockatoo (*Calyptorhynchus lathami*) and were found in Site 2, suggesting this species may utilise the area. Terrestrial mammal species, such as Bush Rats (*Rattus fuscipes*) and Brown Antechinus (*Antechinus stuartii*), were found to be reasonably abundant within the disturbance footprints and are likely to provide hunting opportunities for the Masked Owl (*Tyto novaehollandiae*). Furthermore, Common Ringtail Possums were detected in Site 1 and are a known food source for Powerful Owls (*Ninox strenua*).

4.5.2 Corridors and Habitat Linkages

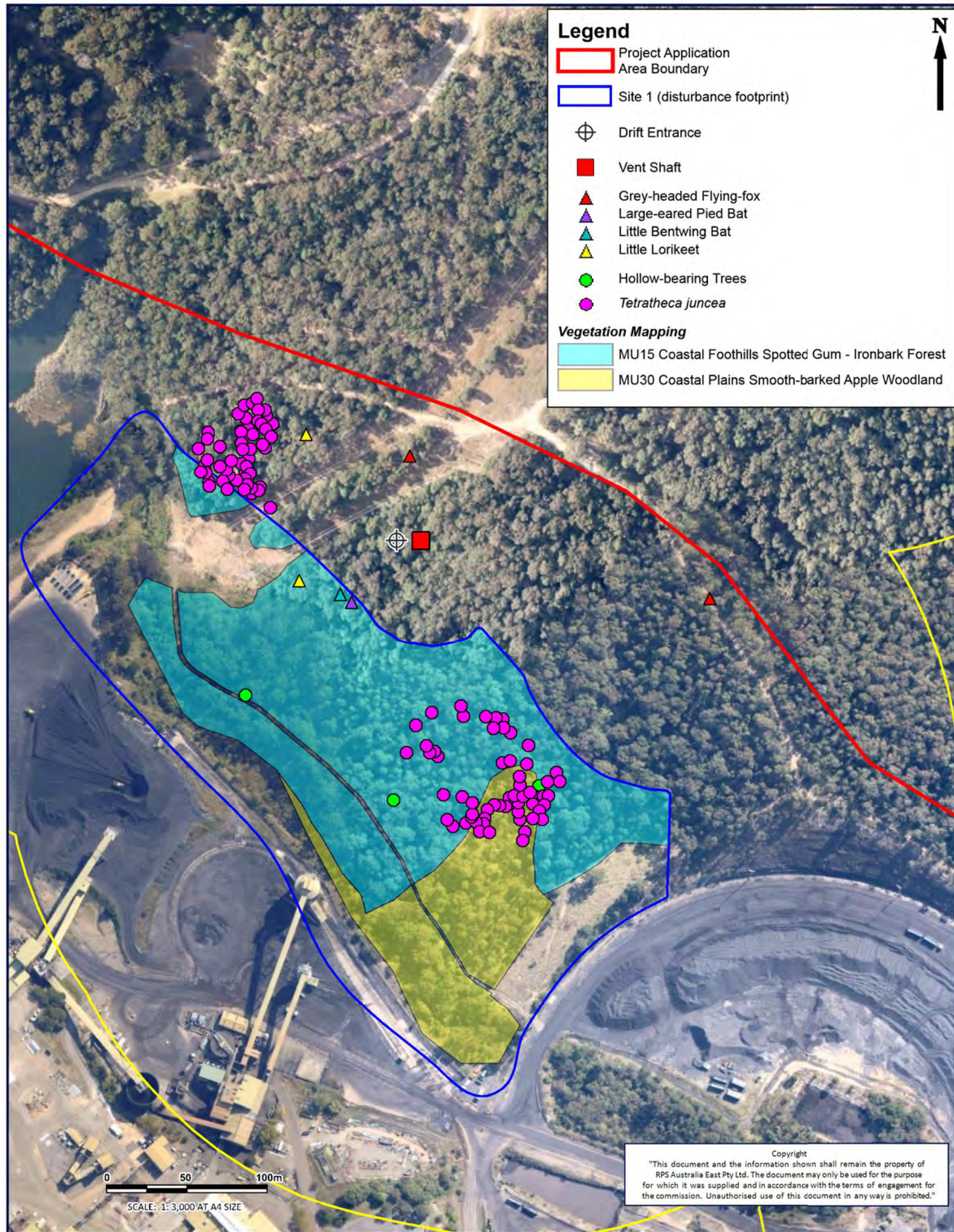
The Lake Macquarie Native Vegetation and Corridors Map (Lake Macquarie City Council 2011) detail a mixture of 'Corridor of Remnant Native Vegetation', 'Corridor of Partially Cleared Remnant Native Vegetation', and 'Partially Cleared Remnant Vegetation' at both Sites 1 and 2. Both sites were adjacent to 'Widely Interfaced Crossing Point'. Site 1 had limited value as a corridor and habitat linkage as it is bordered on its southern and eastern side by a coal stockpile and other coal handling infrastructure. Site 2 consists of mostly cleared lands and regrowth vegetation and is surrounded by remnant vegetation. Therefore, the corridor and habitat linkage value of Site 2 is also limited.

4.6 State Environmental Planning Policy No. 44 (Koala Habitat Protection)

Lake Macquarie LGA is listed in Schedule 1 of SEPP 44 and therefore the Project is subject to SEPP 44 assessment. One of the species recorded within the disturbance footprints is listed under Schedule 2 of

SEPP 44 as a primary feed tree. This feed tree species was detected within Site 1, namely *Eucalyptus punctata* (Grey Gum). However, this tree species was recorded at densities below the 15% composition threshold. Therefore, Site 1 does not constitute 'Potential Koala Habitat' and consequently it does not constitute 'Core Koala Habitat' either. Furthermore, no other signs of Koalas were detected within Site 1. No feed trees were found within Site 2 and no signs of Koalas were detected. Therefore, despite the presence of primary Koala feed trees in the disturbance footprints, they do not occur in the density required for any part of the disturbance footprints to be defined as "Potential" or "Core" Koala habitat. Targeted searches for Koala scat in association with feed trees did not identify the presence of Koalas.

Under SEPP 44, identification of "Core Koala habitat" requires that a plan of management accompanies the Development Application (DA). However, no activities that may disturb areas containing "Potential" or "Core" koala habitat are proposed. Therefore, a plan of management is not considered necessary in this instance.



TITLE: FIGURE 4: SITE 1 VEGETATION
COMMUNITIES, THREATENED FLORA
& FAUNA & HOLLOW-BEARING TREES

LOCATION: COAL LOGISTICS
PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

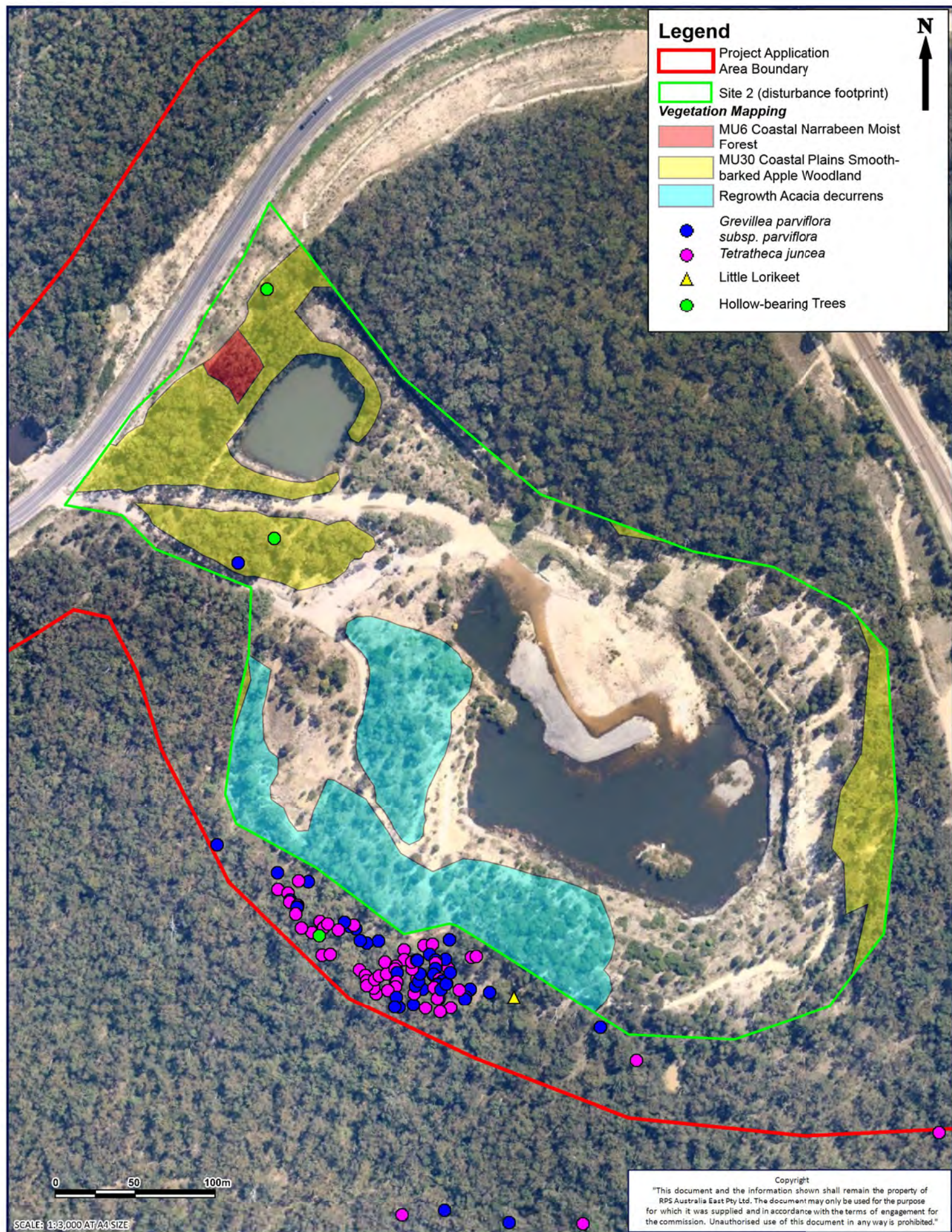
DATE: 23/01/2014
PURPOSE: ECOLOGY

LAYOUT REF: J:\OBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): C A4 (AS-NW-AB)

CLIENT: CENTENNIAL
JOB REF: 113119-1

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
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RPS



TITLE: FIGURE 5: SITE 2 VEGETATION COMMUNITIES, THREATENED FLORA & FAUNA & HOLLOW-BEARING TREES

LOCATION: COAL LOGISTICS PROJECT

DATUM: (GDA 94)
 PROJECTION: MGA ZONE 56

DATE: 23/01/2014
 PURPOSE: ECOLOGY

LAYOUT REF: J:\OBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
 VERSION (PLAN BY): D A4 (PH-AB)

CLIENT: CENTENNIAL
 JOB REF: 113119-1

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WARNING
No part of this plan should be used
for critical design dimensions.
Confirmation of critical positions
should be obtained from RPS Newcastle.

Legend

- Project Application Area Boundary
- Site 1 Boundary
- T. juncea to be conserved
- T. juncea to be removed
- 250m Buffer



TITLE: FIGURE 6: TETRATHECA JUNCEA
MAPPING

LOCATION: COAL LOGISTICS
PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 19/09/2013
PURPOSE: ECOLOGY

LAYOUT REF:
VERSION (PLAN BY): JS (B A4)

CLIENT: CENTENNIAL
JOB REF: 113119-1

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5.0 Threatened Species and Communities Assessment

5.1 Identification of Subject Species and Communities

Threatened flora and fauna species (listed under the TSC Act 1995 and/or the EPBC Act 1999) that have been recorded within a 10 km radius of the PAA (the locality) have been considered within this assessment. Threatened flora and fauna species and EECs known from the broader area have also been addressed where considered applicable. Each species / community was considered for its potential to occur within the proposed disturbance footprints (Site 1 and Site 2). In addition, some EECs have been considered for their potential to occur within the areas which are proposed to be subjected to an increase in surface water discharge (refer to GHD 2014).

This assessment deals with the following heads of consideration in tabulated form (refer to **Table 10** overleaf):

'Species / Community / Population' – Lists each threatened species / EEC known or considered likely to occur within the locality. The status of each threatened species under the TSC Act 1995 and the EPBC Act 1999 are also provided.

'Habitat Description' – Provides a brief account of the species / community / population and the preferred habitat attributes required for the existence / survival of each species / community.

'Likelihood of Occurrence on Site' – Assesses the likelihood of each species / community to occur within the disturbance footprints in terms of the aforementioned habitat description and taking into account local habitat preferences, results of current field investigations, data gained from various sources (such as OEH Atlas of NSW Wildlife and DoE Protected Matters Search Tool) and previously gained knowledge via fieldwork undertaken within RPS and other ecological assessments in the locality and the adjacent areas.

'Potential for Impact' – Assesses the potential of each species/community/population to be impacted upon within the disturbance footprints. In addition, some endangered ecological communities have been considered for their potential to be impacted upon within the areas which are proposed to be subjected to an increase in mine water discharge (refer to GHD 2014).

Table 10 Assessment of Likelihood of Occurrence of Threatened Species and Communities

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Plants			
<i>Acacia bynoeana</i> Bynoe's Wattle (E, V*)	Small, prostrate shrub found in low heath, open woodland, dry sclerophyll, generally on loamy clays and sand. Occurs from the Lower Hunter south to the Southern Highlands.	This species was not detected during extensive field work across the disturbance footprint; however, it has been recorded in the surrounding area previously by Umwelt (2005), Cumberland Ecology (2007, 2008) and Hunter Eco (2008a, 2008b). A review of these studies has found that this species has been recorded locally predominately within Coastal Plains Scribbly Gum Woodland, but also within Coastal Plains Smooth Barked Apple Forest. This species has potential to be missed, even during its flowering period. This species has potential to occur within the disturbance footprints.	Due to this species being recorded in several surveys of the surrounding area and within 10 km of the PAA, there is potential for impact on this species habitat within the disturbance footprints. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 as well as an AoS (EPBC Act) in Appendix 3 .
<i>Angophora inopina</i> Charmhaven Apple (V, V*)	Small to medium tree found in shallow sandy soils in open woodland, swamp woodland and wet heath. The main occurrences of this species are in the Wyong and Lake Macquarie LGA's (from Charmhaven to Wyee and Morisset, and north to near Toronto), with disjunct populations also in Port Stephens LGA (south of Karuah).	This conspicuous species was not detected during extensive field work across the disturbance footprints. This species is unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints, thus, it is unlikely to be affected by the proposed activities. Therefore, an AoS is not required for this species.
<i>Asterolasia elegans</i> (E, E*)	Occurs on Hawkesbury sandstone. Found in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (<i>S. glomulifera</i> subsp. <i>glomulifera</i>), Smooth-barked Apple (<i>A.costata</i>), Sydney Peppermint (<i>E. piperita</i>), Forest Oak (<i>A. torulosa</i>) and Christmas Bush (<i>C. gummiferum</i>).	Poor habitat for this species occurs throughout the disturbance footprints and it has not been recorded during previous studies of the surrounding area. The known distribution of this species is restricted to the Hawkesbury/Nepean Catchment Management Authority boundary. This species is unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Caladenia tessellata</i> Tessellated Spider Orchid (E, V*)	Small terrestrial herb found in grassy dry sclerophyll woodland on clay loam or sandy soils. Small (6cm x 5mm), single leaf regrow's every year. Flowers between Sept-Nov. Species have been found in <i>Corymbia maculata</i> (Spotted Gum) - <i>Eucalyptus fibrosa</i> (Ironbark) grassy open forests in the Lower Hunter Valley. Locally, this species has been recorded from Munmorah State Conservation Area.	The nearest known population of this species is Munmorah State Conservation Area, approximately 17km to the south west of the PAA. The absence of records closer to the PAA indicates that this species is unlikely to occur.	This species is to occur and therefore, unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
<i>Callistemon linearifolius</i> Netted Bottle Brush (V)	Shrub that grows in dry sclerophyll forest on the coast and adjacent ranges. Re-sprouting / juvenile specimens difficult to distinguish from other <i>Callistemon</i> species such as <i>C. rigidus</i> (Stiff Bottlebrush) or <i>C. linearis</i> (Narrow-leaved Bottlebrush) without the aid of flowering parts. Significant populations recently found within the HEZ and Werakata National Park.	This conspicuous species was not detected during extensive field work across the disturbance footprints. This species is unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints, thus, is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
<i>Cryptostylis hunteriana</i> Leafless-tongue Orchid (V, V*)	A very rare leafless, saprophytic orchid, which has a symbiotic relationship with a mycorrhizal fungi which provides the plant with all its nutrient requirements. This orchid remains underground for the majority of its lifecycle, flowering periodically when conditions are optimal to reproduce. This species is extremely cryptic as it does not flower every year. Known to occur within a range of habitats including woodlands to swamp heaths. Within the Hunter region larger populations have been typically found in woodland dominated by <i>E. racemosa</i> (Scribbly Gum) and it prefers areas with an open grassy understorey. The species typically prefers moist sandy soils in sparse to dense heath and sedgeland, or moist to dry clay loams in coastal forests.	The disturbance footprints contain vegetation that is suitable habitat for this species. Preferred habitat tends to be Scribbly Gum Woodland (Hunter Eco 2008a; RPS, 2010; Umwelt, 2004) (which occurs extensively in wider area). This species was not recorded by RPS or previous surveys. However, due to the cryptic nature of the species and the wide range of habitats where it has been recorded, it cannot be entirely discounted from occurring within the disturbance footprints. Therefore, there is potential for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 , as well as an AoS (EPBC Act 1999) in Appendix 3 .
<i>Cynanchum elegans</i> White-flowered Wax Plant (E, E*)	The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; <i>Leptospermum laevigatum</i> (Coastal Tea-tree) Coastal Banksia <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> coastal scrub; Forest Red Gum <i>Eucalyptus tereticornis</i> aligned open forest and woodland; Spotted Gum <i>Corymbia maculata</i> aligned open forest and woodland; and Bracelet Honey-myrtle <i>Melaleuca armillaris</i> scrub to open scrub.	This species was not detected during extensive field work across the disturbance footprints. The disturbance footprints do not contain suitable dry rainforest vegetation that this species prefers. This species is unlikely to occur within the disturbance footprints.	No potential habitat is present in the within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Corybas dowlingii</i> Red Helmet Orchid (E)	<i>Corybas dowlingii</i> is restricted to the central coast and Hunter regions of New South Wales where it is currently known from the Port Stephens, Bulahdelah, Lake Macquarie and Freemans Waterhole areas. It is known from the local government areas of Cessnock, Great Lakes, Lake Macquarie and Port Stephens. It occurs in sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200 m	This species was not detected during extensive field work across the disturbance footprints. It is not known to commonly occur in the area. However, as potential habitat does occur within the disturbance footprints, it cannot be entirely discounted from occurring within the disturbance footprints. Therefore, there is potential for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Corunastylis</i> sp. Charmhaven (CE)	<i>Corunastylis</i> sp. Charmhaven (NSW896673) is currently only known from the Wyong Shire of NSW where it is restricted to a single location in the Gorokan / Charmhaven area. It occurs within low woodland to heathland with a shrubby understorey and ground layer. Dominants include <i>Allocasuarina littoralis</i> , <i>Leptospermum juniperinum</i> , <i>Melaleuca nodosa</i> , <i>Callistemon linearis</i> and <i>Schoenus brevifolius</i> .	Whilst little other information has been released, the available information suggests that this species could occur in Map Unit (MU) 23: Narrabeen Impeded Wet Heath or MU 31: Narrabeen Doyalson Coastal Woodland as mapped by <i>The natural vegetation of the Wyong Local Government Area, Central Coast, New South Wales</i> (Bell, 2002). The literature, therefore, indicates that this species is restricted to a low woodland or heathland with a more coastal influence than what exists within the disturbance footprints. This species is unlikely to occur.	Due to the lack of suitable habitat for this species occurring within the disturbance footprints, it is unlikely to be affected by the Project; therefore, an AoS for this species is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Diuris praecox</i> Rough Doubletail (V, V*)	A small, terrestrial herb, which grows on hills and slopes of near-coastal districts in open forests, which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year and produces leaves and flowers in winter. In the Hunter Valley, this species has been recorded in <i>Corymbia maculata</i> (Spotted Gum) - <i>Eucalyptus fibrosa</i> (Ironbark) open forest, <i>Eucalyptus pilularis</i> (Blackbutt) open forest, <i>Eucalyptus haemastoma</i> (Scribbly Gum) woodland, <i>Eucalyptus piperita</i> (Sydney Peppermint) - <i>Angophora costata</i> (Smooth-barked Apple) forest as well as <i>Eucalyptus tereticornis</i> (Forest Red Gum), <i>Melaleuca</i> and <i>Casuarina glauca</i> dominated riparian or swamp areas.	This species was not detected during field surveys and no records exist within 10 km of the disturbance footprints. The preferred hill top habitats of this species do not exist within the disturbance footprints. This species is unlikely to occur.	Due to the lack of suitable habitat for this species occurring within the disturbance footprints, it is unlikely to be affected by the Project; therefore, an AoS for this species is not required.
<i>Eucalyptus camfieldii</i> Camfield's Stringybark (V, V*)	A small/medium sized tree with a scattered distribution from Waterfall in the south to Raymond Terrace in the north. Occurs in exposed coastal environments on shallow sandy soils derived from Hawkesbury Sandstone. Often found growing with Scribbly Gum, Brown Stringybark and Narrow Leaf Stringybark.	Although some suitable habitat occurs within the disturbance footprints, this conspicuous species was not detected during extensive field surveys. The closest known population occurs in Norah Head, 40km south of the disturbance footprints (TSSC, 2008). Therefore, this species is unlikely to occur within the disturbance footprints.	The disturbance footprints are out of the main range for this species and based on low occurrences it is considered unlikely to be affected by the proposed activities; therefore, an AoS is not required for this species.
<i>Grevillea parviflora</i> subsp. <i>parviflora</i> Small-flower Grevillea (V, V*)	Occurs in light, clayey soils in woodlands. Most plants appear capable of suckering from a rootstock. Relatively widespread within the Cessnock LGA. Occurs within Werakata National Park. Much confusion surrounds the taxonomy of this species and other similar <i>Grevillea</i> taxa and a NPWS-funded study of the species is currently in progress.	This species was detected during surveys in the Site 2 and has been recorded within the surrounding area by Umwelt (2005), Eco biological (2005), Cumberland Ecology (2007;2008), Hunter Eco (2008a;2008b) and RPS (2011; April 2012).	Due to this species being recorded within Site 2, there is potential for impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 as well as an AoS (EPBC Act 1999) in Appendix 3 .
<i>Maundia triglochinosides</i> (V)	Grows in swamps, lagoons, dams, channels, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. Associated with wetland species e.g. <i>Triglochin procerum</i> .	This species was not detected during extensive field work across the disturbance footprints. However, this species has been recorded within close proximity (~120 metres) to Jigadee Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area which will receive water discharges from the proposed Hawkmount Quarry LDP.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Melaleuca biconvexa</i> Biconvex Paperbark (V, V*)	A shrub to small tree, which grows in poorly drained areas on the Central Coast with outlying populations at Jervis Bay and Port Macquarie. Records in the Hunter Region are confined to western Lake Macquarie (Atlas of NSW Wildlife data). It may occur in dense stands adjacent to watercourses, in association with other <i>Melaleuca</i> species or as an understorey species in wet forest.	This species was not detected during extensive field work across the disturbance footprints. However, this species has been recorded within close proximity (~15 metres) to Jigadee Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area which will receive water discharges from the proposed Hawkmount Quarry LDP.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 as well as an AoS (EPBC Act 1999) in Appendix 3 .
<i>Pelargonium</i> sp. <i>Striatellum</i> (G.W.Carr 10345) Omeo Stork's-bill (E*)	A tufted perennial herb known to occur within the South Eastern Highlands, South East Corner IBRA Bioregions and the Hawkesbury-Nepean, Murrumbidgee, Southern Rivers and North East Natural Resource Management Regions. This species grows in exposed lake beds or just above the high water mark of intermittently inundated or ephemeral lakes.	No suitable habitat exists within the disturbance footprints for this species and it has not been recorded during field surveys within the surrounding area or in the 10 km search. Therefore, it is considered unlikely to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints for this species, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required.
<i>Prasophyllum</i> sp. Wybong (C.Phelps ORG 5269) (CE*)	<i>Prasophyllum</i> sp. Wybong is a terrestrial orchid with a single flower spike with several fragrant flowers. Seven known populations of this species occurs within the Brigalow Belt South, Sydney Basin, New England Tablelands, NSW South Western Slopes IBRA Bioregions, Border Rivers-Gwydir, Namoi, Hunter-Central Rivers and Central West Natural Resource Management Regions. It mainly grows in open eucalypt woodland and grassland. The area of occupancy of this species has been estimated to 1.5 km2.	The disturbance footprints are located outside of the distribution range of this species and it was not recorded during field surveys of the disturbance footprints or within the surrounding region. Due to the very restricted geographic distribution of this species, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
<i>Pterostylis gibbosa</i> Illawarra Greenhood (E, E*)	Ground-dwelling orchid which grows in open forest or woodland on flat or gently sloping land with poor drainage. It is a deciduous orchid that is only visible above the ground between late summer and spring, only when soil moisture levels can sustain its growth. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark (<i>E. crebra</i>), Forest Red Gum (<i>E. tereticornis</i>) and Black Cypress Pine (<i>C. endlicheri</i>).	This species has not been recorded within 10 km of the disturbance footprints and was not detected by RPS or previous surveys. The disturbance footprints are not situated within this species known distribution. It is therefore, considered unlikely to occur.	This species was not recorded within the disturbance footprints or within 10 km of the disturbance footprints, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
<i>Rhizanthella slateri</i> Eastern Underground Orchid (V, E*)	<i>Rhizanthella slateri</i> is an underground orchid with a whitish, fleshy underground stem to 15 cm long and 15 mm diameter. In NSW, it is currently only known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. At each location, only a few individuals are known. However, <i>R. slateri</i> is difficult to detect, it is usually located when the soil is disturbed, and there may well be more locations of the species within its known range. The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available.	This species was not detected during extensive field work across the disturbance footprints. It is not known or predicted to occur in wider the area (DoE 2014). Therefore, it is considered unlikely to occur.	This species was considered unlikely to occur and therefore, unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Rutidosia heterogama</i> Heath Wrinklewort (V, V*)	This rare species grows mostly in heath, often along disturbed roadsides. It grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides. It is chiefly found in coastal districts from Maclean to the Hunter Valley, and inland to Torrington. Populations have been found on the Central Coast and Lake Macquarie regions in recent years.	This species was not detected within the disturbance footprints during RPS field surveys; however, 2 records exist within a 10 km radius of the disturbance footprints (OEH 2014). A small amount of disturbed suboptimal moist forest habitats occur within the disturbance footprints. However, the preferred heath habitat does not occur within the disturbance footprints. Therefore, it is unlikely to occur.	This species was considered unlikely to occur and therefore, unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
<i>Senecio spathulatus</i> Coast Groundsel (E)	Coast Groundsel occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park. It occurs in coast Groundsel grows on frontal dunes.	This species was not detected during extensive field work across the disturbance footprints. Its preferred habitat of frontal dunes does not occur within the disturbance footprints. Therefore, it is considered unlikely to occur.	This species was considered unlikely to occur and therefore, unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
<i>Streblus pendulinus</i> Siah's Backbone (E*)	<i>Streblus pendulinus</i> is a large shrub or tree with red fleshy fruits (5-8 mm long). The Australian distribution of this species ranges from Cape York Peninsula to Milton, south-east NSW and Norfolk Island. On the mainland it grows in rainforest or gallery forest.	This conspicuous species was not detected during extensive field work across the disturbance footprints. Its preferred habitat of rainforest or gully forest does not occur within the disturbance footprints. Therefore, it is considered unlikely to occur.	This species was not recorded during field surveys and no suitable habitat exists within the disturbance footprints. Thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
<i>Syzygium paniculatum</i> Magenta Lilly Pilly (E, V*)	A shrub to small tree found in sub-tropical and littoral rainforest on sandy soils or sheltered gullies mostly near water courses. Distributed between Bulahdelah and Jervis Bay. Hunter Region records are confined to the Lake Macquarie hinterland (Atlas of NSW Wildlife data).	There is no suitable habitat (littoral rainforest) present within the disturbance footprints for this species. However, this species has been recorded within close proximity (~20 metres) to Dora Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area which will receive water discharges from the proposed Hawkmount Quarry LDP.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 as well as an AoS (EPBC Act 1999) in Appendix 3 .
<i>Tetradlea glandulosa</i> Glandular Pink-bell (V, V*)	A low growing, spreading shrub (20 - 50 cm high) with pale pink to light lilac pink coloured flowers. This species occurs within the Hawkesbury–Nepean, Hunter–Central Rivers and Sydney Metro Natural Resource Management Regions where it grows in sandy or rocky heath, dry and open woodlands. Associated species include <i>C. gummifera</i> , <i>A. bakeri</i> and <i>E. capitellata</i> .	The disturbance footprints are located outside of the distribution range of this species and it was not recorded during field surveys or by previous surveys. It is therefore, considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints or within the surrounding region, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
<i>Tetradlea juncea</i> Black-eyed Susan (V, V*)	Occurs in a variety of forested and heathy habitats. Locally found in Open Forests and Woodlands with dense, undisturbed understorey, often in association with <i>A. costata</i> / <i>C. gummifera</i> on slopes with south-easterly aspects.	This species was detected in both Site 1 and Site 2 during targeted flora surveys. This species has been recorded in previous surveys throughout the wider area within several vegetation communities (Gunninah 1998; Umwelt 2004, 2005; Eco biological 2005; Cumberland Ecology 2007, 2008; Hunter Eco 2008a, 2008b; RPS 2011).	Due to this species being recorded within the disturbance footprints, there is potential for impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 as well as an AoS (EPBC Act 1999) in Appendix 3 .
<i>Zannichellia palustris</i> (E)	In NSW, known only from the lower Hunter. Grows in fresh or slightly saline stationary or slowly flowing water.	Suboptimal habitat for this species occurs along the creekline within Site 1. However, no individuals were recorded by RPS or previous surveys. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints or in previous studies, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Endangered Populations			
<i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i> Camfield's Eucalypt (E-pop)	This species usually occurs from the Goulburn Valley on the Central West slopes to Hill Top on the Central Coast. The endangered population in the Lake Macquarie and Wyong local government areas is at the north-eastern limit of the species range and is quite separate from other known populations. The majority of the population occurs within Wyong in the Porter's Creek and the Wallarah Creek catchments. This species is associated with low moist areas alongside drainage lines and adjacent to wetlands. It is often found in woodland on sandy soils. The endangered population occurs on sandy alluvium within a floodplain community which also supports <i>Eucalyptus robusta</i> (Swamp mahogany), <i>E. tereticornis</i> (Forest Red Gum), <i>E. gummifera</i> (Sydney Bloodwood) as well as Melaleuca (Paperbark) species.	No population of this species was recorded during flora surveys across the disturbance footprints, however, it was recorded in the surrounding area by RPS (April 2012). Therefore, it is considered unlikely for this species to occur within the disturbance footprints.	No suitable habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Herpetofauna			
<i>Heleioporus australiacus</i> Giant Burrowing Frog (V, V*)	Generally restricted to sandstone areas of the Sydney Basin. Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. Spends more than 95% of its time in non-breeding habitat in areas up to 300 m from breeding sites. Whilst in non-breeding habitat it burrows below the soil surface or in the leaf litter.	This species is generally restricted to Hawkesbury Sandstone which is not present within the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Hoplocephalus bungaroides</i> Broad-headed Snake (E, V*)	Largely confined to Triassic sandstones, including the Hawkesbury, Narellan and Shoalhaven formations, within the coast and ranges. Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer.	Suitable habitats for this species (sandstone escarpments with rock shelters etc) are not present within the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Hoplocephalus stephensii</i> Stephens' Banded Snake (V)	Rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Stephens' Banded Snake is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day. At night, it hunts frogs, lizards, birds and small mammals.	Due to the presence of suitable habitat, this species has potential to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Litoria littlejohni</i> Little John's Tree Frog (V, V*)	A pale brown frog with dark speckles which occurs along permanent rocky creeks with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. Occurs on the plateaus and eastern plains of the Great Dividing Range. Records within the Hunter Region occur from within the Watagan State Forest.	Suitable habitats for this species (permanent rocky creeks) are not present within the disturbance footprints. Furthermore, this species typically prefers habitats within sandstone escarpments such as the Watagan Mountains to the south of the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Litoria aurea</i> Green and Golden Bell Frog (E, V*)	Inhabits swamps, lagoons, streams and ponds as well as dams, drains and storm water basins. Thought to be displaced from more established sites by other frog species, thus explaining its existence on disturbed sites. Previously widespread within the region, but now sparsely distributed within the Lower Hunter and Central Coast areas. A relatively stable population occurs on Kooragang Island.	The field survey did not record this species within the disturbance footprints. This species only persists in areas which exhibit a saline influence and records from Western Lake Macquarie are historical only. Therefore, it is considered unlikely to occur within the disturbance footprints.	Due to the current isolated populations of this species and lack of suitable habitat within the disturbance footprints, it is unlikely to occur and thus unlikely to be affected by the proposed activities within the disturbance footprints. Therefore, AoS for this species is not required.
<i>Litoria brevipalmata</i> Green-thighed Frog (V)	Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. It prefers wetter forests in the south of its range, but extends into drier forests in northern NSW and southern Queensland.	Suitable habitats for this species (rainforest and moist eucalypt forest) are not present within the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Mixophyes balbus</i> Stuttering Frog (E, V*)	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Breed in streams during summer after heavy rain, outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Eggs are laid on rock shelves or shallow riffles in small, flowing streams.	Suitable habitats for this species (rainforest and wet, tall open forests in the foothills and escarpment and undisturbed rocky streams) are not present within the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Mixophyes iteratus</i> Giant Barred Frog (E, E*)	Mostly restricted to wet sclerophyll forest and rainforest, including Antarctic Beech forest. Usually found within close proximity to permanent running water (Robinson, M, 1998). Hunter Region records are largely confined to the Watagan National Park and to the north of Heaton State Forest (Atlas of NSW Wildlife data).	Suitable habitats for this species (wet sclerophyll forest and rainforest) are not present within the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Crinia tinnula</i> Wallum Froglet (V)	Wallum Froglets are found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They occur in sedgelands, wet heathlands, paperbark swamps and drainage lines within other vegetation communities. They will also persist in disturbed areas. The species breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches.	Suitable habitats for this species are not present within the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Pseudophryne australis</i> Red-crowned Toadlet (V)	It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or capping.	This species is generally restricted to Hawkesbury Sandstone which is not present within the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Avifauna			
<i>Anthochaera phrygia</i> Regent Honeyeater (CE, E*)	Nomadic Honeyeater that disperses to non-breeding areas, including the coast, in winter, where flowering trees are sought. Within the region, mostly recorded in Box-Ironbark Eucalypt associations along creek flats, river valleys and foothills. Coastal swamp forests in Lower Hunter are used when more western resources fail. The main feed tree for coastal areas is <i>E. robusta</i> (Swamp Mahogany). Hunter records are more common in near coastal areas such as Cessnock LGA. Feed trees in this region are <i>C. maculata</i> (Spotted Gum), <i>E. fibrosa</i> (Broad-leaved Ironbark), <i>E. crebra</i> (Narrow-leaved Ironbark) and various stringybark sp.. Nests mainly west of the divide, although local breeding attempts have occurred at Quorrobolong.	This species was not recorded during field surveys, however, preferred winter-flowering tree species (<i>E. robusta</i> and <i>C. maculata</i>) are known from the region. Therefore, there is potential for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 , as well as an AoS (EPBC Act 1999) in Appendix 3 .

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Botaurus poiciloptilus</i> Australasian Bittern (E, E*)	The distribution of this species ranges from south-east Queensland to south-east South Australia, Tasmania and south-west of Western Australia. Preferred habitat includes permanent and seasonal freshwater habitats. It forages in shallow water in wetlands with tall dense vegetation (Garnett et al. 2010).	This species was not recorded during field surveys and no suitable habitat exists within the sites. Therefore, it is considered unlikely to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
<i>Burhinus grallarius</i> Bush Stone-curlew (E)	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.	This species was not recorded during field surveys and no suitable habitat exists within the disturbance footprints. It is therefore, considered unlikely to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
<i>Calidris ferruginea</i> Curlew Sandpiper (E)	This species has a widespread distribution in NSW east of the Great Divide, particularly in coastal regions. The Curlew Sandpiper inhabits intertidal mudflats in estuaries and bays, lakes and lagoons.	No suitable habitat in the form of mudflats, estuaries or lagoons occurs within the disturbance footprints. Therefore, it is unlikely to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
<i>Callocephalon fimbriatum</i> Gang-gang Cockatoo (V)	In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. Move to lower altitudes in winter, preferring more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. Favours old growth attributes for nesting and roosting.	This species was not detected during field surveys. However, potential foraging habitat occurs within Site 1. Therefore, this species has the potential to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Calyptorhynchus lathami</i> Glossy Black-Cockatoo (V)	Occurs in forests and woodlands where it forages predominantly on <i>Allocasuarina</i> cones. Requires large Eucalypt tree hollows for nesting. Sparse occurrences on the valley floor, but resident in ranges and adjacent areas surrounding the Hunter Valley. Most commonly encountered around the south and south western areas of the lake and in the Watagan Mountains N.P. These locations have good stands of <i>Allocasuarina</i> sp., especially <i>A. littoralis</i> (Black She-oak).	It is considered that the disturbance footprints provide potential foraging habitat for this species within the scattered occurrences of <i>Allocasuarina littoralis</i> and <i>A. torulosa</i> . However, this species or evidence of it (chewed <i>Allocasuarina</i> sp. cones) was not observed within the disturbance footprints during field surveys. Some tree hollows located within the disturbance footprints may also provide nesting habitat for this species; however, preferred nesting is typically located within high densities of <i>Allocasuarina</i> sp. which were not observed within the disturbance footprints. Therefore, there is potential for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Charadrius mongolus</i> Lesser Sand Plover (V)	When in Australia, this migratory species inhabits sheltered bays, harbours and estuaries with large intertidal sand flats or mudflats. Prey includes molluscs, worms, crustaceans and insects. Low numbers of this species visit the Hunter estuary during the austral summer.	The survey did not record this species within the disturbance footprints. The disturbance footprints lack suitable habitat as this species primarily inhabits coastal areas. It is therefore, considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Chthonicola sagittata</i> Speckled Warbler (V)	Occupies Eucalypt and Cypress woodlands in drier coastal areas and on the western slopes of the Great Dividing Range. Appears unable to persist in districts where no forested fragments larger than 100 ha remain. Occurs in the central and southern Hunter Region where suitable habitat exists. Associated with extensive stands of <i>B. spinosa</i> (Blackthorn) in some areas (HBOC).	This species was not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species which is typically found in more western habitats. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
<i>Circus assimilis</i> Spotted Harrier (V)	Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Hunts for small terrestrial mammals including bandicoots, bettongs and rabbits. Nest constructed in open or remnant woodland.	This species was not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species which is typically found in more open grassland habitats. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
<i>Climacteris picumnus victoriae</i> Brown Treecreeper (V)	Frequents drier forests and woodlands, particularly open woodland lacking a dense understorey. Also found in grasslands in proximity to wooded areas where there are sufficient logs, stumps and dead trees nearby. Occasionally found in mallee and <i>E. camaldulensis</i> (River Red Gum) forest bordering wetlands with an open understorey of <i>Acacia</i> sp., <i>Muehlenbeckia</i> sp. (Lignum), <i>Typha</i> sp. (Cumbungi) and <i>Poa</i> sp. (grasses). Feeds on invertebrate larvae and small insects, particularly ants. Utilises hollows for roosting/nesting.	This species was not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species which is typically found in more western habitats. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
<i>Daphoenositta chrysoptera</i> Varied Sittella (V)	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	The species has not been recorded within the wider area by any previous surveys although some suitable habitat is present in the form of rough-barked and smooth-barked gums. It is therefore, considered as having potential to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Dasyornis brachypterus</i> Eastern Bristlebird (E, E*)	The Eastern Bristlebird occurs in three separate populations; one in south-east Queensland and north-east NSW and the other two south of Wollongong (NSW). It inhabits a wide range of habitats including sedgeland, heathland, schlerophyll forest, woodland and rainforest.	The disturbance footprints are located outside of the known distribution range of this species. It is therefore, considered unlikely to occur within the disturbance footprints.	Due to the current isolated populations of this species, it is considered unlikely to be affected by the proposed activities within the disturbance footprints. Therefore, AoS for this species is not required.
<i>Ephippiorhynchus asiaticus</i> Black-necked Stork (E)	Inhabits swamps associated with river systems and large permanent pools but sometimes appears on the coast or in estuaries. It has also been recorded on farm dams and sewage treatment ponds. Within the Hunter Region it occurs spasmodically on freshwater or estuarine wetlands, along coastal and near coastal environments such as Gloucester.	The disturbance footprints lack potential habitat suitable for this species having no swamps, permanent pools or estuarine habitats. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Epthianura albifrons</i> White-fronted Chat (V)	<i>Epthianura albifrons</i> is found in damp open habitats, particularly estuarine and marshy grounds, as well as wetlands containing Saltmarsh, bordered by open grasslands or lightly timbered lands (Higgins et al. 2001). The species is also observed in open grasslands and sometimes in low shrubs bordering wetland areas. Inland, the White-fronted Chat is often observed in open grassy plains, saltlakes and salt pans that are along the margins of rivers and waterways (Higgins et al. 2001; Barrett et al. 2003). The species is sensitive to human disturbance and is not found in built areas. <i>Epthianura albifrons</i> (White-fronted Chat) is endemic to Australia, extending across the southern half of Australia. Found mostly in temperate to arid climates and very rarely seen in sub-tropical areas, <i>E. albifrons</i> occupies foothills and lowlands below 1000 m above sea level (Higgins et al. 2001; Barrett et al. 2003).	No suitable habitat in the form of saltmarsh, estuaries or open grassy plains occurs within the disturbance footprints. Therefore, it is unlikely to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Erythroriarchis radiatus</i> Red Goshawk (CE, V*)	The Red Goshawk is sparsely distributed from western Kimberley to the northeastern NSW. Preferred habitat in NSW includes subtropical rainforest and Melaleuca forest along coastal rivers. Records in NSW are rare.	The disturbance footprints are located outside of the known distribution range of this species and no potential habitat is present. It is therefore, considered unlikely to occur within the disturbance footprints.	Out of range and no potential habitat is present within the disturbance footprints. Thus, this species is unlikely to be affected by the proposed activities; therefore, AoS for this species is not required.
<i>Falco subniger</i> Black Falcon (V)	The Black Falcon inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. The Black Falcon is usually associated with streams or wetlands, visiting them in search of prey and often using standing dead trees as lookout posts. Habitat selection is generally influenced more by prey densities than by specific aspects of habitat floristics or condition, although in agricultural landscapes the Black Falcon tends to nest in healthy, riparian woodland remnants with a diverse avifauna. Much of the best habitat of the Black Falcon in New South Wales is likely to occur on private land (i.e. agricultural or pastoral land), rather than in reserves.	This species was not detected within the Study Area during field surveys. They are generally not found along the Central Coast as they prefer arid and semi-arid areas. Therefore it is considered unlikely to occur within the Study Area based on population occurrence records.	No potential habitat is present in the Study Area, and thus this species is unlikely to be affected by the Project, therefore an AoS for this species is not required.
<i>Glossopsitta pusilla</i> Little Lorikeet (V)	<i>Glossopsitta pusilla</i> extends from Cairns to Adelaide coastally and to inland locations. Commonly found in dry, open eucalypt forests and woodlands. Can be found in roadside vegetation to woodland remnants. <i>G. pusilla</i> feeds on abundant flowering Eucalypts, but will also take nectar from <i>Melaleuca</i> sp and <i>Mistletoe</i> sp. <i>E. albens</i> (White Box) and <i>E. melliodora</i> (Yellow Box) are favoured food sources on the western slopes in NSW. On the eastern slopes and coastal areas favoured food sources are <i>C. maculata</i> (Spotted Gum), <i>E. fibrosa</i> (Broad-leaved Ironbark), <i>E. robusta</i> (Swamp Mahogany) and <i>E. pilularis</i> (Blackbutt). Nesting takes place in hollow-bearing trees.	This species was recorded during diurnal surveys flying over both sites. Suitable habitat for this highly mobile species exists within flowering canopy species within the disturbance footprints and potential nesting sites exist in hollow-bearing trees.	The proposed activities may impact on this species habitat A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Haematopus fuliginosus</i> Sooty Oystercatcher (V)	Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. Forages on exposed rock or coral at low tide for foods such as limpets and mussels.	No potential habitat exists within the disturbance footprints with this species inhabiting primarily coastal estuarine areas. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Haematopus longirostris</i> Pied Oystercatcher (E)	This species prefers undisturbed sandy shell-grit or pebble beaches, sandspits and sandbars, tidal mudflats and estuaries, coastal islands. Occasionally rocky reefs, shores rock-stacks, brackish or saline wetlands. Also grassy paddocks, golf-courses or parks near coast. Forages for molluscs, crustaceans, polychaetes, ascidians, echinoderms and small fish, probes for worms in short wet grass. In the Hunter, this species is relatively common in the Hunter Estuary in small numbers and more common on the open beaches and river mouths around sandspits.	No potential habitat exists within the disturbance footprints with this species inhabiting primarily coastal estuarine areas. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Hieraaetus morphnoides</i> Little Eagle (V)	Can be found across most of Australia, but more commonly found near coastal to inland regions in NSW and Victoria. This species is part-migratory to nomadic and dispersive in some areas.	Due to the presence of suitable habitat, this species has potential to occur within the disturbance footprints.	This species is highly mobile, with large home ranges, of which the site may represent an incremental part. Thus, it is unlikely to be affected by the proposed activities; therefore, AoS for this species is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Irediparra gallinacea</i> Comb-crested Jacana (V)	This species inhabits mostly deep permanent freshwater wetlands that are abundant with floating aquatic vegetation that forms dense mats or rafts on the surface of the water. Known to breed within the Hunter as far south as Mandalong. Has been known to arrive at suitable temporary vegetation e.g. Rathluba Lagoon at East Maitland. Hunter records have regularly come from Colliery Dam in the Mulbring area, which contains floating aquatic vegetation. Breeding records have also been recorded from Colliery Dam.	The field survey did not record this species within the disturbance footprints. The site lacks permanent freshwater wetlands with floating aquatic vegetation. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Ixobrychus flavicollis</i> Black Bittern (V)	Solitary species, living near water (estuarine to brackish) in mangroves and other trees which need to form only a narrow fringe of cover. A riparian species that occasionally ventures into the open within estuarine habitats. Sedentary resident along Dora and Stockton Creeks in western Lake Macquarie has also been recorded semi-regularly in the Paterson River but is likely to occur in any brackish to estuarine forested coastal creeks in the lower NSW coast.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat suitable for this species, having no estuarine or brackish wetland habitat. Therefore, it is considered unlikely to occur across the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Lathamus discolor</i> Swift Parrot (E, E*)	On the mainland this species frequents Eucalypt forests and woodlands with large trees having high nectar production during winter. Mainland winter foraging sites often vary from year to year. Nests only in Tasmania, but regularly visits the Hunter Region in winter. Visits the Hunter Region when food sources are abundant or food sources are lacking in other areas. Food sources used in the Hunter include <i>E. robusta</i> (Swamp Mahogany) on the coast, and near coastal to inland <i>Lathamus discolor</i> uses <i>C. maculata</i> (Spotted Gum), <i>E. fibrosa</i> (Broad-leaved Ironbark) and <i>E. crebra</i> (Narrow-leaved Ironbark). Occasional records have come from <i>E. alba</i> (White Box) and <i>E. sideroxylon</i> (Mugga Ironbark). These food source trees have been recorded as roosting sites for <i>L. discolor</i> .	This species was not recorded within the disturbance footprints during field surveys. Preferred winter-flowering tree species (<i>E. robusta</i> and <i>C. maculata</i>) are known from the wider area and the NSW Atlas shows several records from the Awaba district. Therefore, there is potential for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 as well as an AoS (EPBC Act 1999) in Appendix 3 .
<i>Neophema pulchella</i> Turquoise Parrot (V)	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	This species was not recorded within the disturbance footprints during field surveys. Potential foraging, nesting and roosting habitat exists, however, chance of occurrence is considered low as only a few records exist within the 10 km radius of the disturbance footprints (Atlas of NSW Wildlife data). Therefore, it is considered unlikely to occur.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, an AoS for this species is not required.
<i>Lophoictinia isura</i> Square-tailed Kite (V)	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. Nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.	This species was not recorded during field surveys. The Square-tailed Kite occurs in a wide variety of habitats, some of which are present within the disturbance footprints. However, this uncommon species is rarely observed in the local area. It is therefore, considered as having potential to occur.	Despite there being potential for this species to occur, due to the small amount of potential habitat to be removed or modified, in relation to the large home range of the species, it is unlikely to be affected by the proposed activities. Therefore, an AoS for this species is not required.
<i>Oxyura australis</i> Blue-billed Duck (V)	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached. Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (deep water in large permanent wetlands) suitable for this species. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Pandion cristatus</i> Eastern Osprey (V)	Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern NSW coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south eastern Australia. There are few records from inland areas.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (large wetlands and ocean with medium sized fish species) suitable for this species. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Petroica boodang</i> Scarlet Robin (V)	Ranges from SE Qld to the Victoria coast into South Australia. Also occurs in Western Australia in the south west. <i>P. boodang</i> occur in single, pairs, in summer, forages in stringybark, other eucalypt woodland, from stumps, low branches (Pizzey and Knight 2007). Perches prominently, flying down swiftly to seize prey. Is part migratory in which in autumn/winter moves to more open habitats. Habitat are foothill forests, woodlands, watercourses, in autumn/winter more open habitats, river red gum woodlands, golf courses, parks, orchards and gardens (Pizzey and Knight 2007).	This species has not been recorded within surrounding area by any previous surveys although Some suitable habitat is present in the form of stringybark and red gums. It therefore, has potential to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Melanodryas cucullata cucullata</i> Hooded Robin (south-eastern form) (V)	This species prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (open woodlands) suitable for this species. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Stagonopleura guttata</i> Diamond Firetail (V)	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum <i>Eucalyptus pauciflora</i> Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Has been recorded in some towns and near farm houses.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (open woodlands) suitable for this species. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Pomatostomus temporalis temporalis</i> Grey-crowned Babbler (eastern subspecies) (V)	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (open woodlands) suitable for this species. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Ptilinopus regina</i> Rose-crowned Fruit-Dove (V)	Rose-crowned Fruit-doves occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful. They feed entirely on fruit from vines, shrubs, large trees and palms, and are thought to be locally nomadic as they follow the ripening of fruits.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (rainforest) suitable for this species. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Ptilinopus superbus</i> Superb Fruit-Dove (V)	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (rainforest) suitable for this species. Therefore, it is considered unlikely to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Ninox connivens</i> Barking Owl (V)	The Barking Owl is found throughout continental Australia except for the central arid regions. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains (especially the Pilliga) and in some northeast coastal and escarpment forests. They inhabit woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile soils.	This species was not recorded during owl call back or nocturnal spotlighting surveys. This species is rarely recorded in coastal regions; however, a number of widely scattered records for this species occur within the Lower Hunter. However, the possibility that the disturbance footprints are part of the home range of individuals or pairs is considered unlikely. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, an AoS for this species is not required.
<i>Ninox strenua</i> Powerful Owl (V)	Occurs in wet or dry sclerophyll forests and woodlands where suitable prey species occur (being predominantly arboreal mammals). Requires large hollows, usually in Eucalypt trees, for nesting. Roosts in dense vegetation within such areas. Roosts in dense vegetation within such species as <i>S. glomulifera</i> (Turpentine), <i>A. littoralis</i> (Black She-Oak), <i>A. melanoxydon</i> (Blackwood), <i>A. floribunda</i> (Rough-barked Apple), <i>E. cupressiformis</i> (Cherry Ballart) and <i>M. nodosa</i> (Ball Honeymyrtle). Many coastal records exist across the Hunter region.	This species was not recorded during owl call back or nocturnal spotlighting surveys and has not been detected by previous surveys. Potential prey species such as Common Ringtail Possums are present within the disturbance footprints and potential roosting habitat exists within some denser riparian vegetation. Therefore, there is potential for this species to occur within the disturbance footprints.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Rostratula australis</i> Australian Painted Snipe (E, V*)	This species has a widespread distribution along the east coast of Australia. Preferred habitats include shallow freshwater wetlands, swamps and inundated grassland.	No suitable habitat present across the disturbance footprints. This species is therefore, considered unlikely to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, and therefore, an AoS for this species is not required.
<i>Sternula nereis nereis</i> Fairy Tern (V*)	Fairy Terns utilise a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands, beaches and spits. Fairy Terns nest in small colonies on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries, and on open sandy beaches.	This species is restricted to coastal environments which are not present within the disturbance footprints. Therefore, it is considered unlikely to occur across the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Stictonetta naevosa</i> Freckled Duck (V)	Found in association with large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers. Disperses during extensive inland droughts when it may be found along the east coast. Nests in dense vegetation at or near water level. Forages for aquatic vegetation.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential dispersive nesting habitat (in dense vegetation at or near water level) suitable for this species. Therefore, it is considered unlikely to occur within the disturbance footprints.	No preferred habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Tyto novaehollandiae</i> Masked Owl (V)	Found in a range of habitats, locally within sclerophyll forests and woodlands where appropriate/preferred prey species occur (being predominantly terrestrial mammals). Requires large Eucalypt hollows for nesting and prefers to roost in these hollows as well.	This species has been recorded within the wider area previously by Cumberland Ecology (2007). Suitable habitat and prey items are available throughout the disturbance footprints. Terrestrial prey items (Bush Rats, Antechinus) were also captured throughout the disturbance footprints. It is therefore, considered likely to occur within the disturbance footprints.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Tyto tenebricosa</i> Sooty Owl (V)	Occurs in wet Eucalypt forest and rainforest with tall emergent trees, often in easterly facing gullies. Within these areas this species hunts for a range of mainly mammalian prey at all levels of the forest strata, even recorded feeding on ground (RPS ecologist pers. obs.). Roosts in tree hollow or dense canopy vegetation. Also nests in large Eucalypt tree hollows. Most Hunter records exist from the Watagan mountains (OEH 2014), but this species has also been observed to the southwest of Awaba (RPS per obs.).	This species was not recorded by RPS during targeted owl call back and nocturnal spotlighting surveys, although it has been previously recorded by Cumberland Ecology (2007). This species is therefore, considered likely to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Mammals			
<i>Cercartetus nanus</i> Eastern Pygmy-possum (V)	Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (<i>Pseudocheirus peregrinus</i>) dreys or thickets of vegetation, (eg. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.	Suboptimal habitat occurs for this species within the disturbance footprints, however, it was not detected during field surveys and no local records exist. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and only suboptimal habitat exists, thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
<i>Dasyurus maculatus maculatus</i> Spotted-tailed Quoll (V, E*)	Found in a variety of forested habitats. This species creates a den in fallen hollow logs or among rocky outcrops. Generally does not occur in otherwise suitable habitats that are in close proximity to urban development. Hunter Region records are largely confined to the surrounding ranges (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. Road kill animals have been recorded in the past 10 years in Western Lake Macquarie, suggesting that at least a transient population does occur. Suitable foraging and den habitat exists within all vegetation communities within the disturbance footprints, in particular in areas with large fallen logs and hollow-bearing trees. Therefore, it is considered as having potential to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 , as well as an AoS (EPBC Act 1999) in Appendix 3 .
<i>Petaurus australis</i> Yellow-bellied Glider (V)	Usually associated with tall, mature wet Eucalypt forest. Also known from tall dry open forest and mature woodland. The diverse diet of this species is primarily made up of Eucalypt nectar, sap, honey dew, manna and invertebrates found under decorticating bark and pollen. Tree hollows for nest sites are essential, as are suitable food trees in close proximity. Most records in the Lower Hunter Region occur in the Watagan Mountains and other areas exhibiting significant stands of forest (OEH 2014).	This species or feeding incisions on tree trunks were not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species with no tall, mature and wet Eucalypt forests present. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and suboptimal habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Petaurus norfolcensis</i> Squirrel Glider (V)	Occurs in eucalypt forests and woodlands where it feeds on sap exudates and blossoms. In these areas tree hollows are utilised for nesting sites. This species also requires winter foraging resources when the availability of normal food resources may be limited, such as winter-flowering shrub and small tree species. Widely distributed across the lower hunter region (OEH 2014).	This species was recorded within the surrounding area by Gunninah (1998) and adjacent to the disturbance footprint by RPS. The disturbance footprints provide suitable resources for this species in the form of eucalypts and tree hollows. Therefore, it is considered likely to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Petrogale penicillata</i> Brush-tailed Rock Wallaby (E, V*)	Occurs in forests and woodlands along the Great Divide and on the western slopes in escarpment country with rocky outcrops, steep rocky slopes, gorges, boulders and isolated rocky areas. The majority of populations favour north-facing aspects, but some southern aspects have been recorded. Apart from the critical rock structure <i>Petrogale penicillata</i> also requires adjacent vegetation types, associated types include, dense rainforest, wet sclerophyll, vine thicket, dry sclerophyll forest and open forest. They also require suitable caves and rocky overhangs for shelter and also for 'lookout' posts. Records exist from the Watagan Mountains where it is associated with the above habitats (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. No suitable habitat exists within the disturbance footprints with no critical rock structures present. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and only suboptimal habitat exists, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Phascogale tapoatafa</i> Brush-tailed Phascogale (V)	Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Agile climber foraging preferentially in rough barked trees of 25 cm DBH or greater. Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Females have exclusive territories of approximately 20 - 40 ha, while males have overlapping territories often greater than 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 (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species with general lack of hollows for nesting. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and suboptimal habitat exists within the disturbance footprints, thus, this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Phascolarctos cinereus</i> Koala (V, V*)	Occurs in forests and woodlands where it requires suitable feed trees (particularly <i>Eucalyptus</i> spp.) and habitat linkages. Will occasionally cross open areas, although it becomes more vulnerable to predator attack and road mortality during these excursions. Records from the Lower Hunter Region are largely confined to the greater Port Stephens area, the Lake Macquarie hinterland and the Watagan Mountains, with a small number of records from Cessnock LGA (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. Potential habitat occurs in the communities containing Forest Red Gum, Grey Gum, Scribbly Gum and Swamp Mahogany vegetation communities, or be it suboptimal. Local records exist, however, a local population, should it exist is likely to occur at low density. Despite this, as individual occurrence cannot be ruled out, it is considered to have the potential to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and only suboptimal habitat exists, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Potorous tridactylus tridactylus</i> Long-nosed Potoroo (V, V*)	Prefers cool rainforest, wet sclerophyll forest and heathland. Sleeps by day in a nest on the ground, and digs for succulent roots, tubers, fungi and subterranean insects. Some diggings seemingly attributable to this species may belong to <i>Isodon macrourus</i> (Northern Brown Bandicoot). Records exist from the Karuah vicinity (Gunninah 1999) and the Gosford LGA (OEH 2014).	This species or diggings were not recorded within the disturbance footprints during field surveys and suitable habitat is not present. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and suboptimal habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Pteropus poliocephalus</i> Grey-headed Flying-fox (V, V*)	This species forages over a large area for nectar/fruits. Seasonally roosts in communal base camps situated within wet sclerophyll forests or rainforests. Frequently observed to forage in flowering Eucalypts. May occur anywhere within the Hunter Region where food or roosting resources are available.	This species was recorded within Site 1. Limited roosting habitat exists along the creekline, however, foraging habitat is prevalent with the occurrence of potential flowering and fruiting feed trees within the disturbance footprints and adjacent areas.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 , as well as an AoS (EPBC Act 1999) in Appendix 3 .

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Pseudomys novaehollandiae</i> New Holland Mouse (V*)	This species has a patchy distribution within open woodlands, heathlands and in hind dune vegetation throughout Eastern Australia. In the Hunter Region the species stronghold is in the Myall Lakes region.	This species is typically found in more sparse, open habitats. Suitable habitat does not occur within the disturbance footprints. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and only suboptimal habitat exists, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Chalinolobus dwyeri</i> Large-eared Pied Bat (V, V*)	This species forages in tall open forests and the edges of rainforest. It roosts in mine shafts and similar structures. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of <i>H. ariel</i> (Fairy Martin), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies. The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy. Hunter Region records for this species are largely confined to the Watagan Mountains, but it has been recorded on the southern side of Port Stephens (OEH 2014).	This species was recorded during field surveys by RPS and it has been recorded within the wider area previously by Cumberland Ecology (2007) and HLA (2006). Suitable roosting habitat occurs within the cave located in Site 1, with possible foraging habitat throughout the woodland areas of the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 , as well as an AoS (EPBC Act 1999) in Appendix 3 .
<i>Falsistrellus tasmaniensis</i> Eastern False Pipistrelle (V)	This species is found in a variety of forest types such as open forests, woodlands and wetter sclerophyll forests (usually with trees >20m). This species roosts in tree hollows and caves. Appears to locally favour upland habitats. A limited number of records occur on the central coast and the Lower Hunter Region (OEH 2014).	This species has been recorded within the wider area by HLA (2006). Foraging habitat within the disturbance footprints are suitable for supporting this species. Possible roosting habitat also exists within the numerous tree hollows across the disturbance footprints and the cave located in Site 1 (Bat Alley). Therefore, it is considered likely to occur within the disturbance footprints.	The proposed activities may impact on this species habitat A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Miniopterus australis</i> Little Bentwing-bat (V)	Prefers to forage in well-vegetated areas, such as within wet and dry sclerophyll forests and rainforests. Requires caves or similar structures for roosting habitat. Largely confined to more coastal areas in the Lower Hunter Region (OEH 2014).	This species was recorded by RPS in Site 1 during field surveys. Suitable roosting habitats occur across the disturbance footprints within the numerous tree hollows and in the cave in Site 1.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Miniopterus schreibersii oceanensis</i> Eastern Bentwing-bat (V)	This species utilises a range of habitats for foraging, including rainforest, wet and dry sclerophyll forests, woodlands and open grasslands. Requires caves or similar structures for roosting habitat. Widely distributed across the Lower Hunter Region (OEH 2014).	This species has been recorded within the wider area by Gunninah (1998) and HLA (2006). Potential roosting habitat occurs in the cave located in Site 1. Therefore, it is considered likely to occur within the disturbance footprints.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Mormopterus norfolkensis</i> Eastern Freetail-bat (V)	This species is distributed south of Sydney extending north into south-eastern Queensland. There are no records west of the Great Dividing Range. Most records of this species have been reported from dry Eucalypt forest and woodland. It is expected that open forested areas and the cleared land adjacent to bushland, constitutes important habitat for this species. It is a predominantly tree-dwelling species, roosting in hollows or behind loose bark in mature Eucalypts. Widely distributed across the Lower Hunter Region (OEH 2014).	This species was recorded within the wider area previously by Cumberland Ecology (2007) and HLA (2006). Possible roosting habitat also exists within the numerous tree hollows across the disturbance footprints. Therefore, it is considered likely to occur within the disturbance footprints.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Phoniscus papuensis</i> (<i>Syn. Kerivoula papuensis</i>) Golden-tipped Bat (V)	Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. Also recorded in tall open forest, <i>Casuarina</i> -dominated riparian forest and coastal <i>Melaleuca</i> forests. Roost mainly in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests, also in tree hollows, dense foliage and epiphytes; located in rainforest gullies on small first- and second-order streams. Will fly up to two kilometres from roosts to forage in rainforest and sclerophyll forest on mid and upper-slopes.	This species was not recorded across the disturbance footprints during field surveys. Habitats within the disturbance footprints are considered to be suitable for this species, or be it suboptimal. However, only scattered records for this species exists within the locality. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and few records exist for this species, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
<i>Myotis macropus</i> Southern Myotis (V)	Usually found near bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to their roost site. Although usually recorded foraging over wet areas, it also utilises a variety of wooded habitats adjacent to such areas including rainforest, wet and dry sclerophyll forest, woodland, and swamp forest. Roosts in small colonies of between 15 and several hundred individuals in caves, mines and disused railway tunnels. A number of records from the Central Coast, with fewer numbers in the Lower Hunter Region (OEH 2014) and Central Hunter Region (RPS pers. obs.).	This species was not recorded within the disturbance footprints or the wider area during previous surveys. However, potential roosting habitat occurs within the cave in Site 1, with possible foraging habitat within the open water habitats in Site 2. Therefore, it is considered as having potential to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Saccolaimus flaviventris</i> Yellow-bellied Sheath-tail-bat (V)	Range of habitats from rainforest to arid shrubland, roosts in tree-hollows. A limited number of records occur on the central coast and the Lower Hunter Region (OEH 2014).	This species has been previously recorded within the surrounding area during field surveys by Cumberland Ecology (2007). Foraging habitat within the disturbance footprints are considered likely to support this species. Possible roosting habitat also exists within the numerous tree hollows of the disturbance footprints. Therefore, it is considered likely to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
<i>Scoteanax rueppellii</i> Greater Broad-nosed Bat (V)	Forages in moister gullies and wet sclerophyll forests as well as in lightly wooded areas and open spaces/ecotones. This species roosts in tree hollows and is relatively widespread within the Lower Hunter Region (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. Possible roosting habitat exists within the numerous tree hollows of the disturbance footprints. Therefore, it is considered as having potential to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Vespadelus troughtoni</i> Eastern Cave Bat (V)	A cave dweller, known from wet sclerophyll forest and tropical woodlands from the coast and Dividing Range to the drier forests of the semi-arid zone. It has been found roosting in small groups in sandstone overhangs, in mine tunnels and occasionally in buildings. In all situations, the roost sites are frequently in reasonably well-lit areas. The distribution of this species is largely to the north of the Hunter Region (Strahan 1995).	This species was not recorded across the disturbance footprints during field surveys. Habitats within the disturbance footprints are considered to be suitable for the species and potential roosting habitat also exists within the cave located in Site 1. However, only scattered records for this species exists within the locality. Therefore, it is considered unlikely to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and few records exist for this species, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Threatened Ecological Communities			
Themeda Grassland on sea cliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregions (E)	Community occurring on sandstone, old sand dunes and basalt, which is characterised by <i>Themeda australis</i> (Kangaroo Grass). <i>T. australis</i> within the community is sometimes limited to only a few metres square, but on some substrates, such as old sand dunes the community can be relatively extensive in size. <i>T. australis</i> within the community is often stunted and prostrate as are the shrubs and trees occurring within the community. In the Lower Hunter and Central Coast regions this community occurs on coastal landforms with <i>Pimelea linifolia</i> (Slender Rice Flower), <i>Westringia fruticosa</i> (Coast Rosemary), and <i>Banksia integrifolia</i> (Coastal Banksia) the most commonly associated species.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered unlikely to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions (E)	Found on gentle slopes arising from depressions and drainage flats on Permian sediments of the Hunter Valley floor in the Sydney Basin and NSW North Coast Bioregions. Dominant canopy species include <i>Eucalyptus tereticornis</i> , <i>E. amplifolia</i> (Cabbage Gum) and <i>E. moluccana</i> (Grey Box) with scattered other Eucalypt species also present. Classified by the Lower Hunter Central Coast Regional Biodiversity Conservation Strategy (LHCCREMS) as Map Unit (MU) 19.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered unlikely to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E, CE*)	Littoral rainforest occurs on both sand dunes and on soils derived from underlying rocks. Littoral Rainforest is a closed forest in structure, and the species composition is strongly influenced by the close proximity to the ocean. The floristic composition consists of predominantly rainforest species with evergreen mesic or coriaceous leaves. Several species have compound leaves, and vines may be a major component of the canopy. Littoral Rainforest comprises the <i>Cupaniopsis anacardioides</i> – <i>Acmena</i> spp. alliance of Floyd (1990). This alliance as described by Floyd includes five sub-alliances – <i>Syzygium luehmannii</i> – <i>Acmena hemilampra</i> , <i>Cupaniopsis anacardioides</i> , <i>Lophostemon confertus</i> , <i>Drypetes</i> – <i>Sarcomelicope</i> – <i>Cassinia</i> – <i>Podocarpus</i> and <i>Acmena smithii</i> – <i>Ficus</i> - <i>Livistona</i> – <i>Podocarpus</i> . While the canopy is dominated by rainforest species, scattered emergent individuals of sclerophyll species, such as <i>Angophora costata</i> (Smooth-barked Apple), <i>Banksia integrifolia</i> (Coastal Banksia), <i>Eucalyptus botryoides</i> (Bangalay) and <i>E. tereticornis</i> (Forest Red Gum) occur in many stands.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered unlikely to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.
Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion (E)	This community is widespread throughout the central to lower Hunter Valley, with forests between Cessnock and Beresfield forming the core of its distribution. This community is dominated by <i>Corymbia maculata</i> (Spotted Gum) and <i>Eucalyptus fibrosa</i> (Broad-leaved Ironbark) with occasional occurrences of <i>E. punctata</i> (Grey Gum) and <i>E. crebra</i> (Grey Ironbark). Classified by the Lower Hunter Central Coast Regional Biodiversity Conservation Strategy (LHCCREMS) as Map Unit (MU) 17.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered unlikely to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E)	Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include <i>Eucalyptus tereticornis</i> (Forest Red Gum), <i>E. amplifolia</i> (Cabbage Gum), <i>Angophora floribunda</i> (Rough-barked Apple) and <i>A. subvelutina</i> (Broad-leaved Apple). Correlates with LHCCREMS communities - 'Central Hunter Riparian Forest' Map Unit (MU) 13, 'Wollombi Redgum-River Oak Woodland' MU14 and 'Redgum Roughbarked Apple Swamp Forest' MU38.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. However, areas of 'Redgum Roughbarked Apple Swamp Forest' ((MU38) NPWS, 2000) are mapped as occurring within the lower reaches of the Newstan LDP and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This community (MU38) is considered to be commensurate with River-Flat Eucalypt Forest on Coastal Floodplains (EEC).	The proposed activities may impact on this community. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
White Box Yellow Box Blakely's Red Gum Woodland (E) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CE*)	White Box Yellow Box Blakely's Red Gum Woodland (commonly referred to as Box-Gum Woodland) is an open woodland community (sometimes occurring as a forest formation), in which the most obvious species are one or more of the following: <i>Eucalyptus albens</i> (White Box), <i>E. melliodora</i> (Yellow Box) and <i>E. blakelyi</i> (Blakely's Red Gum). Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered unlikely to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E)	The most widespread and abundant dominant trees include <i>Eucalyptus robusta</i> (Swamp Mahogany), <i>Melaleuca quinquenervia</i> (Broad-leaved Paperbark) and, south from Sydney, <i>Eucalyptus botryoides</i> (Bangalay) and <i>Eucalyptus longifolia</i> (Woollybutt). Other trees may be scattered throughout at low abundance or may be locally common at few sites. Shrubs include <i>Acacia longifolia</i> , <i>Dodonaea triquetra</i> , <i>Ficus coronata</i> , <i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i> and <i>Melaleuca</i> spp. The groundcover is composed of abundant sedges, ferns, forbs, and grasses including <i>Gahnia clarkei</i> , <i>Pteridium esculentum</i> , <i>Hypolepis muelleri</i> , <i>Calochlaena dubia</i> , <i>Dianella caerulea</i> , <i>Viola hederacea</i> , <i>Lomandra longifolia</i> , <i>Entolasia marginata</i> and <i>Imperata cylindrica</i> .	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. However, areas of 'Riparian Melaleuca Swamp Woodland ' ((MU42) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. In addition, areas of 'Swamp Mahogany – Paperbark Forest'(MU37) are mapped as occurring within the lower reaches of the Newstan LDPs and the proposed Hawkmount Quarry LDP. Both of these areas will potentially be subject to an increase in mine water discharge and these communities (MU42 and MU37) are considered to be commensurate with Swamp Sclerophyll Forest on Coastal Floodplains (EEC).	The proposed activities may impact on this community. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E)	This community is found on the coastal floodplains of NSW. It has a dense to sparse tree layer in which <i>Casuarina glauca</i> (Swamp Oak) is the dominant species northwards from Bermagui. Other trees including <i>Acmena smithii</i> (Lilly Pilly), <i>Glochidion</i> spp. (cheese trees) and <i>Melaleuca</i> spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and <i>Melaleuca ericifolia</i> is the only abundant tree in this community south of Bermagui. The understorey is characterised by frequent occurrences of vines, <i>Parsonsia straminea</i> , <i>Geitonoplesium cymosum</i> and <i>Stephania japonica</i> var. <i>discolor</i> , a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. However, areas of 'Swamp Oak – Rushland Forest' ((MU40) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This vegetation community (MU40) is considered to be commensurate with Swamp Oak Floodplain Forest (EEC).	The proposed activities may impact on this community. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 3 .
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E)	Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. Characteristic plants include <i>Baumea juncea</i> , <i>Juncus krausii</i> , <i>Sarcocornia quinqueflora</i> , <i>Sporobolus virginicus</i> , <i>Triglochin striata</i> , <i>Isolepis nodosa</i> , <i>Samolus repens</i> , <i>Selliera radicans</i> , <i>Suaeda australis</i> and <i>Zoysia macrantha</i> . Occasionally mangroves are scattered through the saltmarsh. Tall reeds may also occur, as well as salt pans.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered unlikely to occur within the disturbance footprints. An area of 'Mangrove - Estuarine Complex and Saltmarsh ' ((MU47) NPWS, 2000) is mapped as occurring within the lower reaches of the Cooranbong Entry site which will potentially be subject to an increase in mine water discharge. This community is considered to be commensurate with Coastal Saltmarsh.	The proposed activities may impact on this community. A 7-part test of significance (TSC Act 1995) has been applied to this species in Appendix 2 .

Notes: (V) = Vulnerable Species listed under the NSW TSC Act 1995.
(E) = Endangered Species listed under the NSW TSC Act 1995.
(E-pop) = Endangered population of a Species listed under the NSW TSC Act 1995.
(CE) = Critically Endangered Species listed under the NSW TSC Act 1995.
(V*) = Vulnerable Species listed under the Commonwealth EPBC Act 1999.
(E*) = Endangered Species listed under the Commonwealth EPBC Act 1999.
(CE*) = Critically Endangered Species listed under the Commonwealth EPBC Act 1999.

6.0 Predicted Impacts

6.1 Surface Impacts

The Project involves surface disturbance at two sites being Site 1 and Site 2. Site 1 will be the location of additional coal handling infrastructure at the Newstan Colliery Surface Site. Site 2 at the Hawkmount Quarry will be utilised for coarse reject emplacement. The two proposed surface disturbance footprint areas total 21.38 ha and require the modification of both native vegetation and cleared / disturbed land.

6.1.1 Vegetation

The Project proposes a total disturbance footprint (Site 1 plus Site 2) of 21.38 ha. Of this, 6.75 ha is existing as relatively intact native vegetation comprising MU 6 Coastal Narrabeen Moist Forest (0.10 ha), MU 15 Coastal Foothills Spotted Gum – Ironbark Forest (3.50 ha) and MU 30 Coastal Plains Smooth-barked Apple Woodland (3.15 ha). The remainder of the proposed footprint exists as regenerating modified native vegetation (2 ha) and Cleared / Disturbed Land (12.63 ha (refer to **Figure 4** and **Figure 5**)).

The native vegetation communities are not commensurate with any threatened ecological communities listed within the TSC Act 1995 and/or EPBC Act 1999.

6.1.2 Habitat

The native vegetation to be removed as a result of the Project within Site 1 and Site 2, totals 8.75 ha. This vegetation provides suitable habitat for a number of common and threatened flora and fauna species which are known to occur within similar vegetation types in the locality.

The vegetation types which are to be impacted upon are common and widespread in the locality. A further 12.63 ha of Cleared / Disturbed Land in the form of roads and existing infrastructure is located within the proposed disturbance area.

The clearing of vegetation involves the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows, seven small (2–10 cm) and three medium (11–25 cm), have been identified within the five hollow-bearing trees. No large hollows (>25 cm) were identified within the proposed disturbance footprints.

6.1.3 Threatened Species

Within the 8.75 ha of native vegetation, which is proposed to be impacted upon, approximately 376 clumps of *Tetratheca juncea* are present and proposed to be removed from within Site 1, and a single specimen of *Grevillea parviflora* subsp. *parviflora* is present and proposed to be removed from within Site 2.

The original layout of Site 1 contained an additional 425 clumps of *T. juncea* to the immediate north of Site 1 (refer to **Figure 4**). However, a re-design of Site 1 has avoided impacts to these additional 425 clumps.

The initial layout for Site 2 involved the removal of 132 specimens of *G. parviflora* subsp. *parviflora* and 219 clumps of *T. juncea*. The layout of Site 2 boundary has been re-designed to avoid all clumps of *T. juncea* and all but one *G. parviflora* subsp. *parviflora* stem (refer to **Figure 5**).

Further information pertaining to the significance of these impacts upon listed threatened species is provided in **Section 6.5**.

6.1.4 SEPP 44 – Koala Habitat Protection

SEPP 44 applies to the Lake Macquarie Local Government Area. This policy states that there is potential habitat for the Koalas (*Phascolarctos cinereus*) if there is 15% density or more of Koala feed trees as listed in Schedule 2 of SEPP 44. One feed tree species was detected within Site 1 namely *Eucalyptus punctata* (Grey Gum) but was below the 15% composition threshold. No other signs of Koalas were detected within Site 1. No feed trees were found within Site 2 and no signs of koalas were detected. Therefore, both Site 1 and Site 2 do not constitute 'Potential' or 'Core' Koala habitat as defined by SEPP 44

6.1.5 Groundwater Dependent Ecosystems

This section relates to potential impacts upon groundwater dependent ecosystems (GDEs) as a result of the Project. Whilst changes to surface water discharge is a component of the Project, underground mining and changes to groundwater systems as a result of the Project are not and therefore, have not been considered herewith.

For the purposes of this report the definitions for GDEs, within the following three literature sources, have been adopted:

- The NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002) defines GDEs as: *'Ecosystems which have their species composition and their natural ecological process determined by groundwater'* (ARNCANZ & ANZECC, 1996 as cited in DLWC, 2002).
- Identifying groundwater dependent ecosystems, A guide for land and water managers (Eamus, 2009) defines GDEs as: *'ecosystems whose current composition, structure and function are reliant on a supply of groundwater'*
- Risk assessment guidelines for groundwater dependent ecosystems (Serov *et. al.*, 2012) defines GDEs as: *'any ecosystem that uses groundwater at any time or for any duration in order to maintain its composition and condition'*.

Given this, a single vegetation type within the proposed disturbance footprints is considered to have the potential to be influenced by groundwater flows and, therefore, may be considered as a GDEs. This vegetation type is Coastal Narrabeen Moist Forest (MU 6). Approximately, 0.10 ha of this community is proposed to be removed from within Site 2. This community is part of the drainage line that runs into Lords Creek and is fed by overflow of the sedimentation basin within Site 2. LHCCREMS (NPWS, 2000) vegetation mapping downstream between the site and Lords Creek shows similar vegetation along this drainage line, namely MU 42 Riparian Melaleuca Swamp Woodland. Bell and Driscoll (2012) did not recognise this community, however mapped MU 37 Swamp Mahogany - Paperbark Forest further downstream along Lords Creek.

Whilst the Project may involve the removal the 0.10 ha of Coastal Narrabeen Moist Forest, earthworks and other activities that may impact on the groundwater system are not proposed at Site 2. Therefore, the Project is unlikely to impact upon GDEs outside of the PAA.

6.2 Mine Water Discharge

6.2.1 SEPP 14 – Coastal Wetlands

The Coal Logistics project will not be directly impacting upon any SEPP 14 Coastal Wetlands. Potential indirect impacts will be associated with discharges from the Licensed Discharge Points. The SEPP 14 wetlands recorded within the locality occur at the confluences of the watercourses and Lake Macquarie, in the majority of cases the LDPs are a considerable distance from the wetlands and are relatively high up in their respective catchments.

This Project will continue the discharge of water from LDPs at the Newstan Colliery Surface Site and Cooranbong Entry Site, and also establish a LDP at Hawkmount Quarry for surface water discharge. The potential impacts from increased mine water discharge include increases in flow and changes to water quality, particularly increases in salinity.

Newstan Colliery Surface Site

- Newstan LDP001 – discharges in to LT Creek. Seeking an increase to the volumetric discharges from the current approved 11 ML per day to 14.5 ML per day.
- Newstan LDP002 – discharges in to LT Creek during significant rainfall events.
- Newstan LDP003 - proposed new LDP for the SREA to discharge into the south arm of LT Creek during significant rainfall events.
- Newstan LDP017 - discharges via the Stony Creek pipeline into Stony Creek when water levels in to the Fassifern Underground Storage exceed 16.6 metres below ground level during wet weather periods. No change to this LDP as a result of the Project.

Cooranbong Entry Site

- Cooranbong LDP001 – discharges in to an unnamed drainage path that reports to Muddy Lake. The project will be seeking approval for an increase to the volumetric discharges from the current approved 5 ML per day to up to 8 ML per day.
- Cooranbong LDP002 – discharges in to an unnamed drainage path that report to Muddy Lake during prolonged wet weather.

Hawkmount Quarry

- Hawkmount Quarry LDP - proposed new LDP for the proposed Sediment Dam at Hawkmount Quarry to discharge into an unnamed tributary of Lords Creek.

Water Quality

GHD (2014) have used data which has been collected from a monitoring sites, combined with levels recommended by the ANZECC and ARMCANZ (2000) to establish site-specific trigger values (SSTVs) for discharges.

ANZECC and ARMCANZ (2000) define trigger values as: *‘the concentrations (or loads) of the key performance indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur. They indicate a risk of impact if exceeded and should ‘trigger’ some action, either further ecosystem specific investigations or implementation of management/remedial actions’.*

The water which is to be discharged will be diluted or treated within a water management system. SSTVs have been set for all potential toxicants and as they are derived from naturally occurring levels upstream or within tolerance levels for flora and fauna set out by ANZECC and ARMCANZ (2000). Therefore, the discharges are not expected to have an adverse impact on the recorded SEPP 14 wetlands or potentially occurring threatened flora and fauna downstream.

Water Quantity

The expected increase in flows has been assessed for its potential to affect bank stability through erosion. GHD (2014) noted that there is no evidence from the model predictions that the likelihood of the bank instability will be increased as a result of the Project. This has been based on the evaluation of the sites current values and known permissible velocities for different channel conditions and or channel linings. Therefore, the increases in discharges are not expected to have an adverse impact on the creek stability

downstream. Consequently, recorded SEPP 14 wetlands and potentially occurring flora and fauna downstream are not considered likely to be impacted upon by sedimentation and erosion as a result of the Project.

6.2.2 Newstan LDP001

The Project proposes to increase the water discharge via Newstan LDP001 at Newstan Colliery Surface Site from the currently approved 11 ML/day to 14.5 ML/day. It is predicted that the increased discharge will potentially result in creek geomorphic stability and water quality impacts on the receiving waters of the north arm of LT Creek.

Due to the potential for contamination of LT Creek as a result of increased coal stockpile size (Site 2), part of the north arm of LT Creek just downstream from Newstan LDP001 is proposed to be enclosed into a pipeline. The pipe will enclose LT Creek from the downstream side of the By-Wash Dam in the upper catchment to the south of the rail loading facility. This pipe will be built to withstand the predicted increase in discharge. An Aquatic Ecology Impact Assessment prepared by Cardno (2013) to assess the impacts associated with the pipeline proposal is contained in **Appendix 8**.

The Project will require the discharge of 14.5 ML/day at the commencement of the Project, as such there will not be a gradual increase to the daily discharge rate. In its current form, the north arm of LT Creek is relatively stable with a decent level of vegetation through the creek. From Newstan LDP001 down to the tidal channel feeding into Lake Macquarie, the creek can be characterised through six typical reach types. Of most significance and at highest risk for potential geomorphic change, as a result of increased discharges through Newstan LDP001, is the extent around the Fassifern Archery Club (southern side of Miller Road). It is expected that under increased discharges of 14.5 ML/day the hydraulic nature of LT Creek will change minimally under dry conditions, considering waterway velocity, water depth and extent. The stability of the creek through the Archery Club will be increased with the construction of small placed rock bed control structures in place of current unstable root masses present within the flow area. Quarterly and event based waterway visual inspections of LT Creek will be undertaken during the initial period of increased discharges through Newstan LDP001 until stability of the creek under the new flow regime can be confirmed.

Considering rainfall events, an estimation of a peak 1 year ARI storm event down the north arm of LT Creek to the railway culvert indicated that existing and proposed discharges via Newstan LDP001 account for approximately 4 and 6 percent of flow, respectively. Given the size of the catchment contributing to the north arm of LT Creek (240 ha at the railway culvert), the creek has significant capacity to cater for runoff events and it is unlikely that the increase in discharge of 14.5 ML/day will create any additional impact.

Vegetation downstream of Newstan LDP001, LDP002 and LDP003 transitions from woodland on the hills and slopes, through to floodplain and estuarine communities where LT Creek discharges into Lake Macquarie. This riparian zone contains vegetation communities which are potentially commensurate with two EECs listed under the TSC Act (refer to **Section 4.4.1.2** and **Table 10**). Therefore, the potential for impact upon these communities is further assessed via 7-part tests within **Appendix 2**.

Salt and metal loads discharged to the receiving environment of the north arm of LT Creek will subsequently increase with the increased volumetric discharge through Newstan LDP001, although concentrations will generally remain unchanged. From the recent previous increases in discharges from 7 to 11 ML/day, aquatic ecology monitoring has indicated no significant impact. It is expected that the further increase in discharges from 11 to 14.5 ML/day will have similar results. It is predicted that the mixing zone will remain within the extents of the By-Wash Dam under the increased discharge regime of the Project.

6.2.3 Piping of LT Creek

A reach of the North Arm of LT Creek just downstream from Newstan LDP001 is proposed to be enclosed into a pipeline in order to mitigate any potential contamination from the increase in coal stockpile. The pipe will enclose LT Creek from the downstream side of the By-Wash Dam in the upper catchment to the south of the rail loading facility. This pipe will be built to withstand the predicted increase in discharge. An Aquatic Ecology Impact Assessment prepared by Cardno (2013) to assess the impacts associated with the pipeline proposal (refer to **Appendix 8**).

With the extension of piping of LT Creek, it is expected that velocities would be greater than occurring within areas of the original creek. Changes in grade and flow area would most likely result in velocity changes. These predicted changes are to be mitigated as part of the Project through the construction of flow baffles and other energy dissipating devices along with scour protection of remaining natural creek areas.

6.2.4 Proposed Newstan LDP LDP003

The proposed LDP003 is to cater for emergency discharge from the Clean Water Dam only where the dam manages water from the southern reject emplacement area. The clean water dam level is managed through pumping to other storages around site. The water quality for LDP003 when discharges occur typically contains; total suspended solids (TSS) – 29mg/L (50th percentile) with a conductivity of 484 uS/cm. pH is around neutral with a 95th percent of 8.5.

From water balance modelling the existing conditions indicate that discharges from proposed LDP003 occur very rarely, approximately 1.3% of days supporting the fact that it is an emergency discharge location. As a result of the project it is expected that the likelihood of discharges will increase to approximately 3.6% of days. This increase in likelihood of discharge is as a result of the need to manage more water at the surface of Newstan due to the extension of the underground increasing the groundwater make.

The project will increase the likelihood of discharges from LDP003, as indicated though it is predicted to have a decrease in maximum discharge from 60 ML/day to 39 ML/day (0.45 m³/s). This daily predicted maximum discharge from the proposed LDP003 is expected to be managed through the existing creek conditions.

Clean water diversions are in place to the north and south of the clean water dam and continue to convey water to the south arm of LT Creek. The water balance has not modelled runoff from these clean water diversion but would provide a better indication to overall flow regime to the creek. GHD (2014) will include these into the model making a comment on their operation.

Vegetation downstream of Newstan LDP003 is the same as that which is listed for above for Newstan LDP001. Therefore, this riparian zone contains vegetation communities which are potentially commensurate with two EECs listed under the TSC Act (refer to **Section 4.4.1.2** and **Table 10**). Therefore, the potential for impact upon these communities is further assessed via 7-part tests within **Appendix 2**.

The SSTVs for LDP003 will be set with respect to both the Newstan SSTVs for LDP001 and EPA water quality limits that exist. There is no evidence from the model predictions that the likelihood of the bank stability will be increased as a result of the Project. This has been based on the evaluation of the site currently and known permissible velocities for different channel conditions and or channel linings. Therefore, the discharges are not expected to have an adverse impact on the potentially occurring threatened flora and fauna downstream.

6.2.5 Cooranbong LDP001

Mine affected water will be discharged at the Cooranbong Entry Site via Cooranbong LDP001 into an unnamed waterway which flows into Muddy Lake, which flows in to Lake Macquarie. The upper sections of

the waterway were identified as a low sinuosity fine grained creek. As the waterway heads south, an electrical easement and access track form a dam like structure on the creek which has formed a large pool over time. As the waterway heads south towards Muddy Lake, it can be classified back to a low sinuosity fine grained stream type before entering the coastal lagoon Muddy Lake, a SEPP 14 Wetland.

Overall, the waterway is generally well vegetated and stable, with significant lengths consisting of a low capacity channel inset within 'swampy' environments, allowing overbank flows to dissipate readily. Muddy Lake is an estuarine coastal lagoon/wetland connected to Lake Macquarie via an aqueduct that crosses the Eraring Power Station cooling water inlet canal. This allows for tidal and freshwater flows to be exchanged between Muddy Lake and Lake Macquarie without being influenced by the cooling water discharges from Eraring Power Station.

The Project proposes to increase the permissible daily discharge from the current approved 5 ML/day (although currently discharging on average around 1.59 ML/day) to up to 8 ML/day, though typically discharges will be on average 7.1 ML/day, considering an end of mine year of 2036. This value is based in the maximum predicted inflow of groundwater in to the Mandalong Mine underground workings (dewatered to Cooranbong Entry Site) of 5.9 mega litres per day towards the cessation of mining in 2035 and an allowance for contributing rainfall volumes (GHD 2014).

Using the predicted peak discharges through Cooranbong LDP001 during periods of heavy rainfall the potential increase in depth within Muddy Lake has been predicted to be 30 mm (GHD 2014). As this wetland occurs within a relatively flat coastal plains landscape with a relatively low average channel gradient of 0.003 m/m an increase of water depth in millimetres will, in some places, potentially result in a relatively minor lateral increase to the wetland boundary.

The increase in discharge will cause a modest change in the natural discharge regime through the upper reaches and potentially will cause a low level change further downstream. However, the waterway downstream of Cooranbong LDP001 is generally stable, well-vegetated and of relatively low gradient. This means that discharge flows will be of low energy and would be incapable of generating any significant geomorphic response. Based on this assessment no significant impact on the morphology of the waterway downstream of Cooranbong LDP001 is expected from the proposed increased discharge of 8 ML/day (GHD 2014).

Estuarine coastal lagoon/wetland ecosystems are highly adaptive to variable water level conditions. This variability is based on three parameters; frequency, duration and depth of flow events. Plant community boundaries occur along a gradient from those that require constant inundation (submerged macrophytes) to those that can tolerate regular inundation (emergent macrophytes), those that can tolerate periodic inundation (Riparian Vegetation) to those that can only tolerate very infrequent and short duration flooding (surrounding woodland etc).

Vegetation mapping along the unnamed waterway, which receives water from the Cooranbong LDP001 and LDP002, contains vegetation communities which are potentially commensurate with three EECs listed under the TSC Act (refer to **Section 4.4.1.2** and **Table 10**). The potential for impact upon these communities is further assessed via 7-part tests within **Appendix 2**.

Due to the extended duration of the predicted increased water levels there is likely to be a lateral gradient shift within the aquatic and riparian vegetation communities. Increased discharges through Cooranbong LDP001 will be incremental from 2015 through to a predicted maximum at the end of mining in 2036, therefore, the impact will be spread over 21 years, which should allow for vegetation communities to adjust to the altered flow regimes predicted. This increase in water flow is therefore, not enough to result in any significant impacts to the aquatic and riparian vegetation within the Muddy Lake wetland.

6.2.6 Proposed Hawkmount Quarry LDP

Hawkmount Quarry, in which there is an existing pool of water, is proposed to be dewatered and this water discharged in to a proposed sedimentation basin before being discharged from the site via a proposed new LDP in to Lords Creek. Ongoing dewatering (after heavy rainfall events) will also take place via a pipeline into a proposed sedimentation basin for subsequent discharge via the new LDP. The Hawkmount Quarry LDP will not be a constant discharge arrangement. During 'construction' phase for the quarry, existing water management storages on site will be dewatered down to manageable levels, where they will be maintained during operations. Discharges will only occur as a result of rainfall which will involve; 1. Capture water, 2. Treat water and 3. dewatering the volume to the downstream environment at a controlled rate. The intention is to apply standard water management techniques used in construction of this site.

Water balance modelling has been undertaken by GHD (2014) for the complete timeline of the project, it considers the initial requirements of dewatering and the maintenance during operation. The estimates of potential maximum discharges as a result of the initial dewatering is expected to be a maximum 142 ML/yr within the first year with approximately the first six months of the construction period requiring an increased pump rate (3 ML/day). This increased pump rate is required to draw down the existing filled storage down to appropriate management levels. Average volume per year of water contributing to the creek during operations from 113 years of re-sampled rainfall data = 40 ML/yr (0.11 m³/s).

There is no evidence from the model predictions that the likelihood of the bank stability will be increased as a result of the Project. This has been based on the evaluation of the site currently and known permissible velocities for different channel conditions and or channel linings. Downstream of the haul road an existing energy dissipation device will further mitigate any potential variation in the average discharge velocity as it mitigates downstream of the discharge point.

As the Hawkmount Quarry is a proposed operation and not current, the water quality assessment will be categorising the existing water quality conditions, which will develop from surrounding catchments, and then predict what the likely sources of degradation to water quality will be. It is the intention of the project to have suitable water quality at the point of dewatering into the downstream environment and not have a potential water quality change within the tributary of Lords Creek. The water quality will be assessed against the trigger values set out by ANZECC and ARMCANZ (2000). SSTVs have been set for all potential toxicants and as they are derived from naturally occurring tolerance levels for flora and fauna they are not expected to have an adverse impact on the potentially occurring threatened flora and fauna downstream.

The vegetation downstream of the proposed sedimentation basin and Hawkmount LDP transitions from woodland on the hills and slopes through to floodplain and estuarine communities where the water flows into Lake Macquarie. The name of the creek that the Hawkmount LDP will discharge into changes name as it flows towards Lake Macquarie; it is known as Lords Creek in the upper reaches near the quarry; it becomes Jigadee Creek as the terrain flattens; and where it widens out and becomes tidal it is named Dora Creek. This riparian zone contains vegetation communities which are potentially commensurate with three EECs listed under the TSC Act (refer to **Section 4.4.1.2** and **Table 10**). The potential for impact upon these communities is further assessed via 7-part tests within **Appendix 2**.

Three threatened flora species (*Syzygium paniculatum*, *Melaleuca biconvexa* and *Maundia triglochinos*) occur or are likely to occur within the riparian zone downstream from Hawkmount Quarry (Site 2 (refer to **Table 10**)). There is potential for impact upon these species as a result of the water discharge via the proposed Hawkmount LDP. Therefore, potential impacts are further assessed via 7-part tests within **Appendix 2**.

In summary, mitigation of potential water quality impacts will be undertaken through activities to apply treatments to the water captured within the sedimentation basin before discharging it downstream. This will

be supported with water quality monitoring which can be in the vicinity of the species identified. In addition, the amounts to be released at any one time will be minimised in order to decrease the erosive capability of the discharged water.

6.3 Increased Truck Movements

The Project will result in an increase in truck movements along the existing private haul roads linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station, Cooranbong Entry Site and Hawkmount Quarry from the current maximum of 28 movements per hour (14 two way trips per hour) to 32 movements per hour (16 two way trips per hour). The increase in truck movements along these private haul roads poses a potential adverse impact upon native fauna due to an increased risk of collisions with wildlife.

The Cooranbong Private Haul Road, which comprises 3.4 km linking the Cooranbong Entry Site to the Newstan-Eraring Private Haul Road, has been designed and constructed to minimise the potential for impacts to wildlife as a result of truck movements. Three fauna underpasses and three fauna overpasses have been installed along this stretch of private haul road. The installation of these structures is designed to reduce the potential for wildlife entering on to the haul road itself while still maintaining connectivity to adjacent intact native vegetation. Monitoring of these structures was undertaken via remote sensing infrared cameras in October 2010 and March 2011 by Ecobiological. Swamp Wallaby, Red Fox, Eastern Grey Kangaroo and Brushtail Possum were recorded utilising the underpasses. There was no fauna species recorded utilising the overpasses during these monitoring events, however, coal haul truck drivers have provided anecdotal evidence of fauna utilising the overpasses.

Fauna fencing has been installed on the eastern side of the Cooranbong Private Haul Road to funnel fauna into the underpasses and reduce the potential for them entering the haul road corridor. Additionally, the entire western perimeter of the haul road has been fenced to reduce the potential for fauna entering the haul road corridor. Fauna escape passages have been installed in the fencing along the western perimeter to allow for fauna that enter the haul road corridor to escape without having to re-enter back on to the haul road, reducing the potential for collisions with trucks. Speed limits are also in force along all haul roads to restrict vehicles to a maximum of 80 km/hour.

Monitoring and recording of injured wildlife along the 3.4 km stretch of the Cooranbong Private Haul Road has been undertaken since the haul road became operational in 2010. Monitoring of incidents involving wildlife along the Newstan-Eraring Private Haul Road indicates an average of two incidents a year involving wallabies.

Due to the current design measures in place along the haul roads and the relatively small increase in truck movements proposed by the Project, it is anticipated that relatively low levels of incidents involving wildlife will be maintained. Further measures to minimise and/or mitigate potential impacts on native fauna are detailed in **Section 7** of this report.

6.4 Indirect Impacts

6.4.1 Air Quality

Dust emissions generated from increased vehicular and operational activities and wind erosion within the sites are likely to incrementally increase atmospheric pollutants into the air. SLR (2014) conducted dispersion modelling at eight scenarios associated with operations at Newstan Colliery Surface Site and two scenarios associated with the operations at the Cooranbong Entry Site. The results concluded that the annual average of deposited dust, Total Suspended Particulate matter concentrations, PM₁₀ concentrations and PM_{2.5} concentrations were unlikely to exceed the relevant criterion for both the Newstan Colliery Surface

Site and the Cooranbong Entry Site. Where parameters were found to marginally exceed the relevant criterion for 24-hour averages, mitigation measures were recommended to ensure emissions were reduced.

The Annual Average and 24-hour Average deposition of Particulate Matter parameters fell below the relevant criterion outlined by the Environmental Protection Authority (EPA) and World Health Organisation (WHO) (SLR 2014). These levels have been set to protect both human and non human life. Thus, it can be concluded that since the particulate matter deposition levels determined by SLR (2014) are lower than those predicted to affect humans, it is unlikely that any flora and fauna occurring on site, including threatened species, are to be significantly impacted by dust emissions.

6.5 Key Threatening Processes

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act 1995. There are seven KTPs that have the potential to affect the PAA as a consequence of the Project, these being:

- Loss of hollow-bearing trees;
- Removal of dead wood and dead trees;
- Clearing of native vegetation;
- Infection of native plants by *Phytophthora cinnamomi*;
- Invasion, establishment and spread of *Lantana camara* (Lantana);
- Anthropogenic climate change;
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae; and
- Invasion of native plant communities by exotic perennial grasses.

“Loss of hollow-bearing trees”

The Project will require the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows, seven small (2–10 cm) and three medium (11–25 cm), have been identified within the five hollow-bearing trees. No large hollows (>25 cm) were identified within the proposed disturbance footprints. Consequently, the Project will contribute to the Key Threatening Process “Removal of Hollow-bearing Trees”.

“Removal of dead wood and dead trees”

The Project will require the removal of a small area of dead trees and ground debris and as such will contribute to the KTP “Removal of Dead Wood and Dead Trees” in a small capacity.

“Infection of native plants by *Phytophthora cinnamomi*”

The proposal has the potential to contribute to this KTP due to the regular occurrence of vehicles within the disturbance footprints that could be carrying and spreading the fungus. Appropriate mitigation measures involving vehicles within the disturbance footprints will provide an opportunity to ameliorate this KTP. Provided the mitigation measures provided in **Section 7.2.1** of this report are adhered to, the project is unlikely to significantly contribute to this process.

“Clearing of Native Vegetation”

The Project will require the removal of approximately 8.75 ha of native vegetation and as such is likely to incrementally contribute to the KTP “Clearing of Native Vegetation” on a small scale.

“Invasion, establishment and spread of Lantana, (*Lantana camara*)”

The Project has potential to contribute to the KTP “*Lantana camara*” due to the dense thickets of *L. camara* located in Site 1. *L. camara* could be encouraged to spread as a result of the disturbances being created. The Project will provide an opportunity to enact a weed control program to ameliorate this KTP.

“Anthropogenic Climate Change”

The Project will contribute to the KTP “Human Caused Climate Change” due to the small amount of clearing proposed and the greenhouse gas emissions to be generated by the Project. The contribution and impact from the Projects contribution is considered to be insignificant.

“Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae”

The Project may increase the level of stress and lower resistance of some members of the family Myrtaceae due to slight alteration of their habitat within the PAA. Exotic Rust Fungi may be introduced into the PAA by increased movement of plant, vehicles and workers across the PAA. It is expected that anti-contamination procedures be enacted for personnel and equipment to minimise the chance of infection.

“Invasion of native plant communities by exotic perennial grasses”

The Project is unlikely to directly contribute to the KTP “Invasion of native plant communities by exotic perennial grasses” due to only a small area of surface vegetation to be removed for the Project. However, some disturbed areas within the PAA already contain exotic perennial grasses. The Project will provide an opportunity to enact a weed control program to ameliorate this KTP

6.6 Matters of National Environmental Significance

Considerations have been made under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999). An EPBC Act 1999 Protected Matters Search was undertaken within the DoE on-line database (accessed January 2014) to generate a list of those matters of National Environmental Significance (NES) within 10 km of the PAA, which may have the potential to occur within the proposed disturbance footprints. This data, combined with other local knowledge and records, was utilised to assess whether the type of activity proposed within the PAA will have, or is likely to have a significant impact upon a matter of NES, or on the environment of Commonwealth land.

Additionally, a referral was submitted (Ref: 2013/6906) to the DoE. As a result of the referral process, the proposed action has been deemed to be a Controlled Action and, as such, the Project needs to be assessed through Preliminary Documentation. It was determined that the proposed action was likely to have a significant impact on 'Listed threatened species and communities (s18/18A)'. Whilst this section has considered all protected matters, particular attention has been afforded to listed threatened species in order to satisfy the requirements of the additional information.

The matters of NES and site-specific responses are listed below.

World Heritage Properties

The PAA is not a World Heritage Property, and is not in close proximity to any such area. Therefore, the proposal will not impact upon any World Heritage Property.

National Heritage Places

The PAA is not a National Heritage Place, and is not in close proximity to any such area. Therefore, the proposal will not impact upon any National Heritage Place.

Wetlands of International Importance (declared Ramsar wetlands)

The Ramsar listed Hunter Estuary Wetland, which comprises Kooragang Nature Reserve and Shortland Wetlands, is located approximately 30 km north of the PAA. The proposed activity of clearing is not expected to have an impact on any connected body of water; therefore, the proposal will not impact upon the Hunter Estuary Wetland.

The Great Barrier Reef Marine Park

The Great Barrier Reef Marine Park does not occur within or adjacent to the PAA, therefore, the proposal will not impact upon any areas of the Great Barrier Reef Marine Park.

Commonwealth Marine Area

The PAA is not a Commonwealth Marine Area, and is not in close proximity to any such area. Therefore, the proposal will not impact upon any Commonwealth Marine Area.

Nationally listed threatened species and ecological communities

A total of 41 threatened species (five of which are wholly marine) and two threatened ecological communities listed under the EPBC Act 1999 have been recorded or have suitable habitat within a 10 km radius of the PAA. The Project will remove habitat and individuals of two threatened flora species, namely *Tetratheca juncea* and *Grevillea parviflora* subsp. *parviflora*.

Grevillea parviflora subsp. *parviflora*

A total of 132 stems of *G. parviflora* subsp. *parviflora* were recorded within the original layout of Site 2. However, the boundary of Site 2 was re-designed to avoid impacts upon 131 stems of *G. parviflora* subsp. *parviflora*, therefore, only one individual stem is to be removed as part of the Project.

Tetratheca juncea

A total of 376 *T. juncea* clumps are located and proposed to be removed from within Site 1. The original layout of Site 1 contained an additional 425 clumps of *T. juncea* to the immediate north of Site 1 (refer to **Figure 4**). However, a redesign of Site 1 has avoided impacts to these 425 clumps.

The original layout of Site 2 contained 219 *T. juncea* clumps. However, following the re-design of the site layout, all 219 recorded clumps of *T. juncea* within Site 2 will be avoided as part of the Project. Therefore, the Project proposes the direct removal of the 376 clumps at Site 1 only.

The EPBC Act referral guidelines for *T. juncea* (DSEWPaC 2011) define a population as an important population if it meets any of the following criteria:

- (1) has greater than 1000 plant clumps;
- (2) an area of habitat has an average estimated plant clump density of 20 clumps/hectare or greater;
- (3) occurs in rare habitat;
- (4) in an area of “important habitat” as defined in Maps provided in DSEWPaC (2011) and has greater than 500 plant clumps;

- (5) occurs at or near the distributional limits of Black-eyed Susan; and
- (6) occurs in close proximity to a protected area (e.g. National Park) where Black-eyed Susan is known to occur. Close proximity refers to:
 - (a) within 500 m if connected by a suitable habitat corridor such as native vegetation; or
 - (b) within 100 m over disturbed habitat or non-native vegetation.

Populations of *T. juncea* within the PAA constitute important populations based on the above definitions as it is comprised of greater than 1,000 clumps.

The proposed action involves the removal of 376 clumps of *T. juncea* from Site 1. The immediate surrounding vegetation type (MU30) is preferred habitat for *T. juncea* and following additional targeted surveys it has been established that the individuals within Site 1 are part of a larger subpopulation extending to the north and west which number at least 1,958 clumps (refer to **Figure 6**). This sub-population estimate is a conservative estimate and additional surveys within the region would most likely result in a much larger estimate of this subpopulation. Given the current information, the removal of 376 clumps equates to the removal of up to approximately 19.2% of the recorded sub-population of *T. juncea*.

The information gained above has been utilised to conduct an assessment of the significance of the residual impact to the Black-eyed Susan (*Tetralthea juncea*) as guided by **Appendix 1** and DSEWPAC (2011), including whether the proposed action will result in:

- **Indirect Impacts, for example from dust, altered hydrology and/or edge effects;**

As previously discussed in **Section 6.4.1**, SLR (2014) concluded that particulate matter deposition would not increase above those predicted by the EPA and WHO to impact human health. Therefore, it is unlikely that dust emissions produced by activities occurring on site will significantly impact upon the remaining *Tetralthea juncea*.

The altered hydrology is unlikely to significantly impact upon the *T. juncea* populations which are to be retained, because, they occur at a higher altitude than the disturbance footprints.

The increase in edge effects may impact upon the *T. juncea* populations which are to be retained. However, many populations persist in areas which are exposed to edge effects particularly those which persist within powerline easements (*Pers. obs.*). **Figure 6** depicts some locations of individuals which are persisting within powerline easements and which are subjected to edge effects such as; increased competition from weed species, increased dust and increased UV levels as a result of a reduction surrounding shade from overstorey plant species.

- **Loss of greater than 25 % of plant clumps within the affected area; or**

As aforementioned, the removal of 376 clumps equates to the removal of approximately 19.2% of the recorded subpopulation of *T. juncea*.

- **Fragmentation of a subpopulation by greater than 500m within native vegetation, or 100m within degraded or cleared land.**

Site 1 occurs immediately north of already cleared areas associated with the Newstan Colliery Surface Site. The removal of the 376 clumps of *T. juncea* and associated habitat will incrementally fragment habitat between recorded clumps to the east and west of Site 1 and increase the distance between *T. juncea* recorded to the immediate north and south of Site 1. Habitats surrounding the recorded *T. juncea* subpopulation and Site 1 are predominately vegetation and maintain connectivity for this sub-population. Areas outside of Site 1, which were not surveyed for *T. juncea* are likely to contain additional plants

comprising part of the subpopulation. Therefore, whilst the Project incrementally fragments the subpopulation it does not constitute isolation of any areas containing potential or known habitat for *T. juncea*.

Nationally listed migratory species

A total of 23 migratory species listed under the EPBC Act 1999 have been recorded or have suitable habitat within a 10 km radius of the PAA.

A total of six of the listed migratory species inhabit wetland and seven species are strictly marine and have, therefore, not been considered further in this report as no suitable habitat exists within the PAA.

The following seven species are terrestrial migratory species and have potential to occur within the proposed disturbance footprints. Of these species, only the Regent Honeyeater is listed under the EPBC Act 1999.

- Regent Honeyeater (*Anthochaera phrygia*);
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*);
- White-throated Needletail (*Hirundapus caudacutus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Black-faced Monarch (*Monarcha melanopsis*);
- Satin Flycatcher (*Myiagra cyanoleuca*); and
- Rufous Fantail (*Rhipidura rufifrons*)

Due to the small amount of habitat proposed to be removed, the Project is unlikely to substantially modify, destroy or isolate an area of important habitat, result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat or seriously disrupt the lifecycle of an ecological significant proportion of the population of a migratory species.

Summary Statement:

Based on the above and with reference to the assessment within **Appendix 3**, it is considered that the Project, whilst unlikely to be significant, will reduce the area of occupied habitat for threatened species listed under the EPBC Act 1999. A referral was submitted under the EPBC Act and the Project was deemed a controlled action due to the clearing of native vegetation known to provide habitat for threatened species such as *Tetratheca juncea*. Furthermore, a letter written by DoE (**Appendix 1**) outlines the decision on the referral, including that the Project is to be assessed by preliminary documentation. **Appendix 1** specifically requests additional information to be supplied in order to assess the relevant impacts of the action, therefore, all attempts have been made to provide the requested further information within this FFA.

6.7 Cumulative Impacts

Wallarrah 2 Coal Project

The Wallarrah 2 Coal Project proposes underground extraction of export quality thermal coal with associated surface facilities and infrastructure. The project is comprised of an underground longwall mine, a coal handling plant (dry processing only) and storage facilities, rail loop and loading infrastructure, an underground drift entry, ventilation shafts and gas management facility.

The combined Wallarrah and Great Northern Seams, averaging around 6 m thick, will be mined by a longwall system, conveyed to the surface via a drift conveyor system and processed to produce 4-5 million Tpa of product coal from the mine. The coal processing consists of crushing only and, because the mine will not require a coal washing plant, no tailings or bulk reject will be produced. Water generated by the mine will be

used in the crushing and stockpiling process and any excess water will be treated before discharge or transfer to appropriate re-use.

The Wallarah 2 Coal Project consists of the following surface and underground impact areas:

- Buttonderry Area – ventilation shafts and surface infrastructure (5 ha);
- Tooheys Road Area – coal handling infrastructure and rail loop (80 ha + 117 ha = 197 ha);
- Hue Hue Road Ecological Offset Investigation Area (75 ha + 159 ha = 234 ha);
- Western Area – the Western Mining Lease Area (includes Jilliby State Conservation Area (SCA), Wyong State Forest (SF), Yarramalong and Dooralong Valleys (defined as the proposed subsidence zone)); and
- Eastern Mining Areas – predominantly near and under the southern half of Tuggerah Lake.

The direct impacts will be restricted to areas of surface infrastructure totalling 202 ha. Threatened flora and habitats proposed to be removed for the proposed rail loop and other facilities include *Angophora inopina* and *Tetratheca juncea*. Additionally, the construction of a proposed rail crossing and access road will impinge on an area of River Flat Eucalypt Forest on Coastal Floodplain EEC in addition to direct impacts to 3.2 ha of Lower Hunter Spotted Gum Ironbark Forest EEC. In relation to the Northern Coal Logistics Project, the Wallarah 2 Coal Project would represent a cumulative loss of individuals and habitat of *T. juncea*, as well as habitat for threatened fauna species.

Indirect impacts primarily from the expected subsidence are expected to affect vegetation within the Jilliby SCA, Wyong SF, Yarramalong and Dooralong Valleys. To offset these impacts up to 234 ha of land may be set aside as ecological offsets for the proposal.

After due consideration of the relevant key thresholds assessment criteria, as set out within Draft Guidelines for Threatened Species Assessment for Part 3A Applications, the Wallarah 2 Coal Project is not expected to have a significant impact on the ecology within the project application area, including threatened flora, threatened fauna or EECs that are known or expected to occur therein. This is due to the low levels of impact expected from the subsidence resulting from the longwall mining.

The proposed Wallarah 2 Coal Project is approximately 17km to the south of the Northern Coal Logistics Project, with townships such as Morisset and Wyee fragmenting direct habitat connectivity between the two projects. For plants and many fauna species with low mobility, the habitats within and surrounding the projects would likely contain separate local populations for these species.

Mandalong Southern Extension Project

The Mandalong Southern Extension Project proposes the extension of the existing Mandalong Mine (longwall mine) located west of Wyee on the western side of Lake Macquarie. The Mandalong Southern Extension Project application area extends from Wyee to Lemon Tree and encompasses most of the suburbs of Jilliby, Lemon Tree, Wyee and Mandalong. The proposed mine extension area covers approximately 4,467 ha.

The proposed Mandalong South Surface Site and access road corridor encompass a total area of approximately 20 ha. This impact area is comprised of approximately 4.4 ha of Cleared / Disturbed Land and 15.6 ha of native vegetation. The native vegetation consists of Map Unit 15 – Coastal Foothills Spotted Gum / Ironbark Forest which is not commensurate with any threatened ecological community listed within the TSC Act 1995 or EPBC Act 1999. All individuals of the recorded threatened plant species (*G. parviflora* subsp. *parviflora*, *T. juncea* and *M. biconvexa*) were recorded outside the areas proposed to be used for the provision of surface infrastructure.

Maximum first and final subsidence ranges from 0.16 m to 1.35 m. Subsidence can lead to potential impacts to flora and fauna through habitat modification resulting from surface cracking, soil erosion due to slumping and changes in gradients, mixing increases of groundwater and surface water and hydrological changes to groundwater and surface water, including ponding.

Surface cracks of between 20 mm and 70 mm are predicted above low lying areas and up to 400 mm wide on steep slopes and ridge crests. The crack depths are likely to range between 5 m and 10 m but could reach 15 m to 20 m at some locations on steep slopes.

The main habitat types that are considered to be affected by surface cracking are those that permanently or semi-permanently waterlogged, either by surface or groundwater influences. The creek beds of 3rd and 4th order streams, which would contain these habitats, are considered very unlikely to develop cracks due to the strain properties of surface alluvium along these streams. Therefore, freshwater aquatic or swamp habitats are unlikely to be affected by surface cracking.

The subsidence from longwall panels can lead to increased ponding. Existing ponding depths range from 0.1 m to 1.4 m along existing watercourses. Potential ponding depths may increase to a range between 0.15 m and 1.9 m after the proposed mining is complete within longwalls 25 to 64. The minor subsidence impacts are expected to have a minor or temporary effect on ponding within the local watercourses and are not likely to significantly affect riparian vegetation, EECs or threatened species or their habitat.

The affects of longwall mining subsidence on wetlands has been monitored for the existing Mandalong Mine operations, using floristic diversity and abundance, and water analysis of several nutrient and chemical components, and abiotic properties. The results indicated that despite one of the wetlands being subject to subsidence for at least 12 months, there was no detectable impact when compared to control sites. These results indicate that increased ponding from subsidence has not had a significant adverse affect on the local wetlands.

The seven-part tests under the TSC Act 1995 and Assessment of Significance under the EPBC Act 1999 conducted for threatened flora and fauna species recorded or considered likely to occur within the site concluded that the proposal will not have a significant impact on threatened species or ecological communities recorded or suspected to occur within the project application area for the Mandalong Southern Extension Project.

No threatened flora species have been recorded within the proposed clearing footprint for the Mandalong Southern Extension Project. Additionally, the impacts of subsidence are not expected to significantly impact upon recorded or potentially occurring threatened species. In relation to the Northern Coal Logistics Project, the Mandalong Southern Extension Project would represent a cumulative loss of habitat for threatened fauna species that have potential to occur, including the loss of hollow-bearing trees and foraging resources, as a result of required vegetation clearing to accommodate the proposed Mandalong South Surface Site and access road.

7.0 Avoidance, Mitigation and Offset Strategy

7.1 Avoidance

Avoidance measures of the Project design include the following:

- utilising areas that are predominantly already cleared and disturbed;
- piping of the section of LT Creek that passes through the Newstan Colliery Surface Site to reduce the potential for material from construction and operations at the Newstan Colliery Surface Site entering the waterway and causing potential downstream impacts on water quality;
- locating surface disturbance footprints adjacent to established access routes so as to limit the amount of vegetation required to be disturbed;
- re-design of the site boundary for the proposed Site 1 disturbance area to maintain a buffer of vegetation around the disused mine drift entrance known as Bat Alley to reduce the potential for direct impacts on bat species utilising this site;
- installation of a wall around the proposed coal stockpile area at Site 1 to reduce the potential for impacts from noise and light on bat species utilising Bat Alley;
- re-design of the Site 1 boundary to avoid 425 clumps of *T. juncea*;
- re-design of the proposed Site 2 disturbance area to avoid 131 stems of *G. parviflora* subsp. *parviflora* and 219 clumps of *T. juncea*;
- re-design of the disturbance footprints at both Site 1 and Site 2 to avoid four hollow-bearing trees; and
- avoiding where possible recorded threatened species, populations or ecological communities listed under the TSC Act 1995 or EPBC 1999.

7.2 Mitigation

The following mitigation measures have been recommended to minimise the potential impacts of the Project.

General

- All machinery to be clean of foreign soil and propagative matter to avoid the importation of *Phytophthora cinnamomi* pathogenic fungus (Myrtle Rust) transmission and weed seed dispersal.
- Strict erosion and sediment control measures should be installed, monitored and maintained to prevent the erosion and sedimentation impact on adjacent areas;
- Dust mitigation measures are outlined in SLR (2014) and include, but are not limited to, measures such as watering of roads and sealing of roads, regular maintenance of all vehicles and modifying construction activities during high winds. Ongoing dust monitoring should continue to ensure relevant levels of dust deposition are achieved;
- Minimise potential impacts arising from stormwater runoff into riparian areas by designing and installing appropriate stormwater detention and/or filtering devices;
- Barricade vegetation prior to construction activities to reduce damage from uncontrolled or accidental access;
- Stockpiling of materials should occur within already disturbed areas and not within retained vegetation;
- Strict weed management, monitoring and control practices should be implemented to minimise the spread of exotic species into natural areas within the PAA; and
- The water from the sedimentation basin at Hawkmount Quarry should only be released (via the proposed

Hawkmount LDP) after its quality has reached an acceptable level. In addition, the amounts to be released at any one time should be minimised in order to decrease the erosive capability of the discharged water.

Threatened Species

- Vegetation to be removed is to be clearly marked in the field using temporary fencing (flagging tape or similar exclusion tape) so that boundaries are clearly established and to minimise the potential for equipment to accidentally enter areas to be retained.
- Where possible, clearing activities should be timed to avoid removal of hollow-bearing trees during breeding season of threatened species; and
- An ecologist is to be present to supervise clearing of hollow bearing trees within the disturbance footprints and ensure hollow bearing trees are removed in the following manner:
 - (a) Hollow-bearing trees are to be clearly marked (spray paint or flagging tape) by a qualified ecologist within the disturbance footprints prior to any vegetation clearing commencing;
 - (b) Non habitat vegetation should be removed at least one day prior to felling of hollow-bearing trees to encourage resident fauna to self relocate before felling of remaining habitat trees;
 - (c) Immediately prior to the felling of hollow-bearing trees, trees should be given two sharp taps with the machinery arm/bucket to encourage fauna to escape. After waiting 1–2 minutes after tapping the tree, the hollow-bearing tree should be felled as gently as possible; and
 - (d) An ecologist is to inspect each felled hollow-bearing tree (once safe) to recover any injured fauna and seek appropriate treatment and relocate uninjured fauna into vegetation to be retained immediately adjacent to the disturbance footprints.

Bat Alley

The *Strategy for the Conservation of Bats in Derelict Mines* (NPWS 2001, cited in SLR 2014a) will be followed. In addition:

- A 50 metre exclusion or non-disturbance zone will be maintained around Bat Alley
- The Project design will incorporate light and sound barrier walls around the proposed ROM coal stockpile in this locality.

Water Discharges

- Newstan Colliery - The stability of LT Creek through the Fassifern Archery Club should be increased with the construction of small placed rock bed control structures in place of current unstable root masses present within the flow area. Quarterly and event based waterway visual inspections of LT Creek should be undertaken during the initial period of increased discharges through Newstan LDP001 until stability of the creek under the new flow regime can be confirmed.

Proposed Hawkmount Quarry LDP - The water from the sedimentation basin at Hawkmount Quarry will only be released after its quality has been improved to an acceptable level. In addition, the amounts to be released at any one time will be minimised in order to decrease the erosive capability of the discharged water.

7.3 Offsets

A variety of indirect offset measures are proposed to offset the potential impacts of this Project. Compensatory measures will include translocation trials, installation of nest boxes and research programmes. It is proposed as part of the compensation measures to:

- Develop and implement a *Tetratheca juncea* translocation research programme to build on the current knowledge regarding translocation of this species. The 376 clumps of *Tetratheca juncea* from within Site

1 will be translocated and monitored in accordance with the proposed research programme;

- Install nest boxes at a ratio of 1:1 (i.e. one nest box for every habitat hollow removed). The design and installation of nest boxes will draw on the information obtained from the 5 year research programme undertaken by Centennial Mandalong into the utilisation of different nest box designs and aspects; and
- Fund the development and implementation of a research proposal to investigate genetic patterns among and within populations of *Tetratheca juncea* from a range of habitat types. The benefits of this research will assist in determining whether conservation and offsetting actions can protect the genetic diversity of *Tetratheca juncea*.

The proposed research programme has been developed with a focus on addressing the priority actions identified by the Office of Environment and Heritage and the Commonwealth DoE for *Tetratheca juncea* as part of this species Recovery Plan.

7.3.1 Proposed Translocation Trial

Centennial Coal has previously undertaken a translocation trial in association with the construction of the Cooranbong – Awaba Private Haul Road. The translocation trial was approved for *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea*.

Translocation was carried out between 27 April 2009 and 6 May 2009 inclusive. There was one recipient site for *Grevillea parviflora* subsp. *parviflora* and three sites for *Tetratheca juncea*. These sites have been monitored for five years commencing November 2009 with the fifth and final annual monitoring report completed in November 2013. Monitoring was carried out by Driscoll, C (Jan 2010, Nov 2010, Nov 2011, Nov 2012 and Nov 2013) and the respective monitoring reports are contained in **Appendix 9**.

Results from the fifth and final annual monitoring report, Driscoll (Nov 2013), indicates mixed results for the two species translocated.

In relation to *Grevillea parviflora* subsp. *parviflora*, translocation of this taxon appears to have been a success with the population established, consisting of robust mature plants along with a range of early successional plants. There was no evidence of fruit production despite consistent flowering so it is likely that the smaller plants are clones sprouting from underground rhizomes.

In relation to *Tetratheca juncea* Driscoll (Nov 2013) confirmed the three aims of the translocation experiment as:

1. To compare translocating individual clumps (Site 2) with using an excavator to move large groups of clumps (Sites 3 and 4);
2. At Site 2, to determine whether loosening of soil around the recipient hole facilitated vegetative spread compared with unloosened soil;
3. At Site 3, to determine whether translocating *Tetratheca juncea* using an excavator could assist in rehabilitating a highly disturbed area.

Driscoll (Nov 2013) noted that these aims were thwarted by heavy grazing of the translocated *Tetratheca juncea* by herbivores at all three sites. Grazing pressure was such that the translocated clumps were not able to establish themselves. Importantly Driscoll (Nov 2013) stated that comparison can be made with a *Tetratheca juncea* translocation experiment conducted at Gwandalan (Driscoll and Bell 2008) where herbivory was not a problem. That experiment was subdivided into ten groups of ten clumps each, all located in a variety of habitat types. In favourable habitat survival was as high as 90% after five years.

In summary, although the translocation trial for *Tetratheca juncea* associated with the construction of the Cooranbong – Awaba Private Haul Road has not been immensely successful there are some lessons that have been learnt from it, including exclusion fencing, and possibly some initial watering which could potentially increase the success rate.. Notwithstanding, translocation of *Tetratheca juncea* is still considered a viable option, as per the translocation experiment conducted at Gwandalan (Driscoll and Bell 2008), as the alternative of simply removing the individuals is assured to impact upon all of them. Conversely, the transplant of *Grevillea parviflora* subsp. *parviflora* has been immensely successful and it is highly recommended as a mitigation measure.

As such, Northern Coal Services will commit to developing and implementing a *T. juncea* translocation research program to build on the current knowledge regarding translocation of this species. *T. juncea* from within Site 1 will be translocated and monitored in accordance with the research program. The progress and outcome of the translocation program will be reported annually in the Project's Annual Environmental Management Report/Annual Review.

7.3.2 Rehabilitation and Decommissioning Strategy

A Decommissioning and Rehabilitation Strategy for the Project has been prepared by SLR Consulting Australia (2014). This Strategy proposes to decommission some of the more developed parcels of land and to control sediments and contaminants which may be left behind before releasing the land into either industrial or public use. Some areas are still open to discussion and final post-mining land use will depend upon relevant stakeholder input.

The tailings and reject emplacement areas are proposed to be rehabilitated to native bushland and grasses. Private haul roads may either be dedicated as public roads or rehabilitated. Newstan Colliery Surface Site & Cooranbong Entry Site are likely to be utilised for industrial-based land use. Hawkmount Quarry will be rehabilitated to native vegetation commensurate with pre-operation ecological communities. This proposed rehabilitation would increase habitat availability for endemic flora and fauna and consequently, it would be advantageous to potentially occurring threatened species within the locality.

8.0 Conclusion

RPS was engaged by Northern Coal Services to undertake a FFA of the PAA for the Northern Coal Logistics Project. Within the PAA there are two proposed disturbance footprints, these being Site 1 (undeveloped land within the existing Newstan Colliery Surface Site) and Site 2 (within the disused Hawkmount Quarry site). By conducting flora and fauna survey using a range of methods across these proposed disturbance footprints and reviewing previous ecological surveys carried out within the region, the likely ecological issues for the Project have been identified.

Based on the potential for significant impacts upon threatened species listed under the EPBC Act 1999, a referral was submitted (Ref: 2013/6906) to the DoE. As a result of the referral process, the proposed action was deemed to be a Controlled Action and the Project is required to be assessed using Preliminary Documentation. The controlled action decision letter and request for additional information is provided in **Appendix 1**. This report has been written to satisfy the requirements of the additional information request letter.

Two disturbance footprints are proposed by the Project being:

- Site 1 – Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-developed and upgrade of the coal handling and processing infrastructure within this surface site; and
- Site 2 – an area of approximately 13.9 ha within the Hawkmount Quarry site (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement.

In total, the Project will result in approximately 21.38 ha of disturbance. Of that area 12.63 ha is already cleared / disturbed with the remaining area made up of 8.75 ha of remnant native vegetation in varying condition. The proposed disturbance footprints are made up of the following:

Site 1

- 3.50 ha of MU 15: Coastal Foothills Spotted Gum - Ironbark Forest;
- 1.22 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 2.78 ha of Cleared (roads, tracks and powerlines).

Site 2

- 2.00 ha of Regrowth *Acacia decurrens*;
- 1.93 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 0.10 ha of MU 6: Coastal Narrabeen Moist Forest; and
- 9.85 ha of Cleared (roads, tracks and waterbodies).

In total, two threatened flora species were detected within the proposed disturbance footprints, namely *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) and *Tetradlea juncea* (Black-eyed Susan), which are both listed as Vulnerable under the TSC Act 1995 and EPBC Act 1999. As a result of the Project, one individual of *G. parviflora* subsp. *parviflora* (within Site 2) and 376 clumps of *T. juncea* (within Site 1) will be removed.

Three additional threatened flora species (*Syzygium paniculatum*, *Melaleuca biconvexa* and *Maundia triglochinosides*) occur or are likely to occur within the riparian zone downstream from the Hawkmount Quarry

(Site 2 (refer to **Table 10**)). There is potential for impact upon these species as a result of water discharge from the sedimentation basin and associated LDP at this site. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the Project is unlikely to have a significant impact upon *S. paniculatum*, *M. biconvexa* and *M. triglochinosoides*.

No threatened ecological communities or populations listed under the TSC Act 1995 or EPBC Act 1999 were detected within the disturbance footprints. However, four Endangered Ecological Communities (EECs) listed under the TSC Act 1995 occur downstream from proposed and existing LDPs. The Water Impact Assessment (GHD 2014) concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the Project is unlikely to have a significant impact upon these EECs.

The clearing of vegetation involves the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows, seven small (2–10 cm) and three medium (11–25 cm), have been identified within the five hollow-bearing trees. No large hollows (>25 cm) were identified within the proposed disturbance footprints.

The Project is likely to remove potential habitat for threatened fauna species, including Glossy Black-Cockatoo (*Calyptrorhynchus lathami*), Gang-gang Cockatoo (*Callocephalon fimbriatum*), Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Varied Sittella (*Daphoenositta chrysoptera*), Little Lorikeet (*Glossopsitta pusilla*), Scarlet Robin (*Petroica boodang*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*). Additionally, habitats within the disturbance footprints provide potential opportunities for threatened mammal species, including Spotted-tail Quoll (*Dasyurus maculatus maculatus*), Squirrel Glider (*Petaurus norfolcensis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Little Bentwing-bat (*Miniopterus australis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Southern Myotis (*Myotis macropus*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Previous surveys using harp traps placed at the entrance of Bat Alley (old drift entrance) near Site 1 detected the Little Bentwing Bat (*Miniopterus australis*) and Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*). The original area of the proposed Site 1 disturbance footprint has been redesigned to decrease potential impacts upon microbats utilising Bat Alley. A vegetation buffer has also been retained to ensure further protection of the microbats species, and additional mitigation measures have been proposed in this report. An annual ongoing monitoring program centred on Bat Alley has commenced.

With the exception of the Spotted-tail Quoll and Squirrel Glider the threatened fauna species which were considered to have potential to occur within the disturbance footprints are highly mobile and occupy large home ranges. Additionally, both of the disturbance footprints are adjacent to large areas of native vegetation providing additional habitat opportunities for those threatened fauna species. The relatively small area (8.75 ha) of native vegetation proposed to be disturbed is not expected to significantly impact upon the threatened fauna species considered, either by direct habitat loss or fragmentation. The potentially important bat roost area known as Bat Alley has been avoided and protected to ensure that no impact to potential breeding opportunities for the Little Bentwing Bat and Eastern Bentwing Bat occur.

The Project will result in an increase in truck movements within the existing private haul routes linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station, Hawkmount Quarry and Cooranbong Entry Site from the current maximum of 28 heavy vehicle movements per hour (14 two way trips per hour) to up to 32 heavy vehicle movements per hour (16 two way trips per hour). Due to the current design measures in place along the haul roads and the relatively small increase in truck movements

proposed by the Project, it is anticipated that relatively low levels of incidents involving wildlife will be maintained.

In addition to the direct surface impacts within Site 1 and Site 2 (disturbance footprints), the Project proposes to increase water discharge through existing Licensed Discharge Points (LDPs) at Cooranbong Entry Site and Newstan Colliery Surface Site), and also establish a new LDP at the Newstan Colliery Surface Site and a new LDP at Hawkmount Quarry.

The water which is to be discharged will be diluted or treated within a water management system. SSTVs have been set for all potential toxicants and as they are derived from naturally occurring levels upstream or within tolerance levels for flora and fauna set out by ANZECC and ARMCANZ (2000). GHD (2014) noted that there is no evidence from the model predictions that the likelihood of the bank stability will be increased as a result of the Project. This has been based on the evaluation of the site currently and known permissible velocities for different channel conditions and or channel linings. Therefore, the discharges are not expected to have an adverse impact on the potentially occurring threatened flora and fauna downstream.

The surface disturbance footprints for the Project have been designed through the detailed planning processes to avoid impacts to threatened flora species and significant fauna habitat as far as practical. Additionally, a range of measures have been incorporated into the Project (such as light and sound barriers) to further minimise potential impacts to threatened flora and fauna. Further mitigation measures will be adopted by Northern Coal Services during the construction and operational phases of the Project to ensure potential impacts to flora and fauna species are further reduced and the population of *T. juncea* within Site 1 will be translocated and monitored in accordance with a research program to be developed by Northern Coal Services. The proposed translocation research programme will be designed to build on the existing knowledge gained from previous translocation trials undertaken by Centennial Coal.

The seven-part tests conducted for threatened flora and fauna species and EECs recorded or considered likely to occur within the two proposed disturbance footprints and surface water discharge locations concluded that the Project is unlikely to have a significant impact (**Appendix 2**). The EPBC Act Assessment of Significant concluded that no threatened species which were detected or considered likely to occur, will be significantly impacted by the Project (**Appendix 3**).

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Appendix I

Decision on Referral – Letter from the Department of Environment



EPBC Ref: 2013/6906

Mrs Mary-Anne Crawford
Group Approvals Manager
Centennial Northern Coal Services Pty Limited
PO Box 1000
Toronto NSW 2283

Dear Mrs Crawford

Mary-Anne

**Decision on referral
Northern Coal Logistics Project (EPBC 2013/6906)**

Thank you for submitting a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This is to advise you of my decision about the proposed action, to upgrade coal preparation, infrastructure, transport and water management activities at the existing Northern Coal Services Site, to the west of Lake Macquarie in New South Wales.

As a delegate of the Minister for Sustainability, Environment, Water, Population and Communities, I have decided that the proposed action is a controlled action and, as such, requires assessment and a decision on approval under the EPBC Act before it can proceed.

It appears that the proposed action is likely to have a significant impact on the following matters protected by the EPBC Act:

- Listed threatened species and communities (s18/18A)

For example, based on the information available in the referral, the proposed action is likely to have a significant impact because:

- it involves the clearing of approximately 9.6 ha of native vegetation that is known to provide habitat for nationally threatened species, including *Tetratheca juncea*.

Please note that this decision only relates to the potential for significant impact on the specific matters protected by the Australian Government under Chapter 2 of the EPBC Act.

I have also decided that the project will need to be assessed through preliminary documentation. A copy of the document recording these decisions is enclosed.

Each assessment approach requires different levels of information and involves different steps. All levels of assessment will include a public consultation phase, in which any third parties can comment on the proposed action.

Details on the assessment process for the project and the responsibilities of the proponent are set out in the enclosed fact sheet. Further information is available from the department's website at www.environment.gov.au/epbc.

While I have determined that your project will be assessed by preliminary documentation, I require some further information to be able to assess the relevant impacts of the action. Under section 95A of the EPBC Act I request you provide the following further information:

1. Details about the local population of the Black-eyed Susan (*Tetralochea juncea*), including an estimate of the number of individuals/clumps present in the vicinity of the project area derived from surveys in accordance with the methods recommended in the department's publication "Referral guidelines for the vulnerable black-eyed susan, *Tetralochea juncea*" (August 2011), available at: www.environment.gov.au/epbc/publications/black-eyed-susan.html.
2. Using the information gained from 1. above, an assessment of the residual impact to the Black-eyed Susan (*Tetralochea juncea*) including whether the proposed action will result in:
 - Indirect impacts, for example from dust, altered hydrology and/or edge effects.
 - Loss of greater than 25% of plant clumps within the affected area, or
 - Fragmentation of a subpopulation by greater than 500 m within native vegetation, or 100 m within degraded or cleared vegetation.
3. Details of proposed impact avoidance, mitigation and monitoring actions, including sediment and erosion control, weed and *Phytophthora cinnamomi* controls, and the proposed barrier to reduce noise and light impacts to bat species utilising the abandoned mine drift entrance.
4. Details of the proposed translocation trial for Black-eyed Susan (*Tetralochea juncea*) and *Grevillea parviflora* subsp. *parviflora*. Please note that the department does not support translocation as a mitigation measure. Translocation may be considered as part of an offset package, where its long-term success has been established using rigorous scientific methods.
5. Where impacts cannot be avoided or mitigated, an offset package to compensate for any predicted or potential residual significant impacts on matters of national environmental significance. Offsets should demonstrate consistency with the Commonwealth EPBC Act Environmental Offsets Policy (October 2012, or subsequent versions), available at www.environment.gov.au/epbc/publications/environmental-offsets-policy.html. Please find attached the department's information requirements in relation to EPBC Act offset proposals.
6. Rehabilitation and decommissioning plans, including how these activities may impact threatened species.
7. Other information, as relevant to the controlling provision, listed threatened species and communities.

In any correspondence with the department please quote the title of the action and EPBC reference, as shown on the beginning of this letter. You can send information to us:

by letter NSW Section
South-Eastern Australia Environment Assessments
Department of Sustainability, Environment, Water, Population &
Communities
GPO Box 787
CANBERRA ACT 2601

by email tess.burdon@environment.gov.au

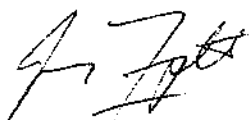
Once the department receives satisfactory information, a direction to publish will be issued so that the preliminary documentation is made available for public comment.

Please also note that once a proposal to take an action has been referred under the EPBC Act, it is an offence under Section 74AA to take the action while the decision making process is on-going (unless that action is specifically excluded from the referral or other exemptions apply). This provision of the EPBC Act carries a maximum penalty of \$425,000. The EPBC Act is available on line at:
www.environment.gov.au/epbc/about/index.html.

The department has recently published an *Environmental Impact Assessment Client Service Charter* (the Charter) which outlines the department's commitments when undertaking environmental impact assessments under the EPBC Act. A copy of the Charter can be found at: www.environment.gov.au/epbc/publications/index.html.

If you have any questions about the referral process or this decision, please contact the project manager, Tess Burdon, by email to tess.burdon@environment.gov.au, or telephone 02 6274 1841 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely



James Tregurtha
Assistant Secretary
South-Eastern Australia Environment Assessments

26 July 2013

Information requirements for EPBC Act offset proposals

- Details in relation to the proposed offsets package, including:
 - the location and size, in hectares, of any offset site(s);
 - maps clearly showing for each offset site:
 - the relevant ecological features;
 - the landscape context; and
 - the cadastre boundary.
 - the current tenure arrangements (including zoning and ownership) of any proposed offset sites;
 - confirmed records of presence (or otherwise) of relevant protected matter(s) on the offset site(s); and
 - detailed information regarding the presence and quality of habitat for relevant protected matter(s) on the offset site. The quality of habitat should be assessed in a manner consistent with the approach outlined in the document titled *How to use the offset assessment guide* available at: <http://www.environment.gov.au/epbc/publications/environmental-offsets-policy.html>.
- Provide information and justification regarding how the offsets package will deliver a conservation outcome that will maintain or improve the viability of the protected matter(s) consistent with the *EPBC Act environmental offsets policy* (October 2012) including:
 - management actions that will be undertaken that improve or maintain the quality of the proposed offset site(s) for the relevant protected matter(s). Management actions must be clearly described, planned and resourced as to justify any proposed improvements in quality for the protected matter(s) over time;
 - the time over which management actions will deliver any proposed improvement or maintenance of habitat quality for the relevant protected matter(s);
 - the risk of damage, degradation or destruction to any proposed offset site(s) in the absence of any formal protection and/or management over a foreseeable time period (20 years). Such risk assessments may be based on:
 - presence of pending development applications, mining leases or other activities on or near the proposed offset site(s) that indicate development intent;
 - average risk of loss for similar sites; and
 - presence and strength of formal protection mechanisms currently in place.
 - the legal mechanism(s) that are proposed to protect offset site(s) into the future and avert any risk of damage, degradation or destruction.
- Provide information regarding how the proposed offsets package is additional to what is already required, as determined by law or planning regulations, agreed to under other schemes or programs or required under an existing duty-of-care.
- The overall cost of the proposed offsets package; including costs associated with, but not limited to:
 - acquisition and transfer of lands/property;
 - implementation of all related management actions; and
 - monitoring, reporting and auditing of offset performance.

Appendix 2

TSC Act 1995 Assessment of Significance (7-Part Test)

Threatened Flora and Fauna

Section 6 identified the following species as requiring an assessment of significance under the seven part test;

Flora

Endangered Species

- *Acacia bynoeana*
- *Corybas dowlingii*

Vulnerable Species

- *Maundia triglochinoides*
- *Grevillea parviflora* subsp. *parviflora*
- *Cryptostylis hunteriana*
- *Tetratheca juncea*
- *Syzygium paniculatum*
- *Melaleuca biconvexa*

Fauna

Critically Endangered Species

- Regent Honeyeater

Endangered Species

- Swift Parrot

Vulnerable Species

- Glossy Black-Cockatoo
- Squirrel Glider
- Gang-gang Cockatoo
- Grey-headed Flying-fox
- Varied Sittella
- Large-eared Pied Bat
- Little Lorikeet
- Eastern Bentwing-bat
- Powerful Owl
- Eastern Freetail-bat
- Masked Owl
- Yellow-bellied Sheath-tailed Bat
- Sooty Owl
- Eastern False Pipistrelle
- Scarlet Robin

Endangered Ecological Communities

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

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

Threatened Flora

- *Acacia bynoeana* (Bynoe's Wattle)

Acacia bynoeana is endemic to NSW and is currently known from 34 locations with a total population estimated to consist of only a few hundred individuals. It occurs mainly in the Blue Mountains area, south of Dora Creek-Morisset to Berrima and the Illawarra region, as well as near Kurri Kurri in the Hunter Valley. Occurring mainly in heath and dry sclerophyll forest, this species is found in sandy and well-drained soils. Associated overstorey species often include; *Eucalyptus haemastoma*, *Corymbia gummifera* and *E. sclerophylla*.

This species was not detected during extensive field work across the disturbance footprints, however, it has been recorded in the surrounding area previously by Umwelt (2005), Cumberland Ecology (2007, 2008) and Hunter Eco (2008a, 2008b). A review of these studies found that this species has been recorded locally predominately within Coastal Plains Scribbly Gum Woodland, but also within Coastal Plains Smooth Barked Apple Forest.

This species was not detected within the disturbance footprints, despite targeted surveys being performed during September (the start of their flowering period). This species can, however, be difficult to detect amongst other vegetation due to its small stature and semi-decumbant growth form. Therefore, its presence within either Site 1 or Site 2 cannot be discounted. The proposal will remove potentially occupied habitats, however, as there is no Coastal Plains Scribbly Gum Woodland within either site, which this species has been predominately recorded within nearby, there is less likelihood of this species occurring in large numbers. The clearing as a result of the Project will not affect populations of this species known to occur in the vicinity of the disturbance footprints.

Due to the occurrence of more suitable habitat (Coastal Plains Scribbly Gum Woodland) close by to the disturbance footprints in which this species is known to occur, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Corybas dowlingii* (Red Helmet Orchid)

Corybas dowlingii is restricted to the central coast and Hunter regions of New South Wales where it is currently known from the Port Stephens, Bulahdelah, Lake Macquarie and Freemans Waterhole areas. It grows in sheltered areas such as; gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10–200 m.

Potential habitat occurs within the native vegetation on the disturbance footprints. However, this species was not detected during surveys despite targeted surveys being performed within its flowering period (June–August). Large areas of suitable habitat can also be found adjacent to the disturbance footprints. Due to the relatively small area to be cleared and the large extent of suitable habitat surrounding the disturbance footprints, the Project is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Cryptostylis hunteriana* (Leafless-tongue Orchid)

The distribution of the species ranges from East Gippsland in Victoria through coastal NSW and up to southern Queensland. *Cryptostylis hunteriana* grows in a wide variety of habitats including heathy woodlands, coastal areas and sedgeland on often moist and sandy soils. The Central Coast populations

have been observed in Coastal Plains Scribbly Gum Woodland communities with *E. haemastoma* and *C. gummifera*. A population has been observed in Freemans Waterhole, Awaba State Forest in Coastal Plains Smooth-barked Apple Woodland with common overstorey species such as *E. capitellata*, *E. umbra* and *Angophora costata*.

This species is cryptic and can be very difficult to identify outside of its flowering season (November–February). Targeted surveys for *C. hunteriana* were conducted in January and they failed to identify this species within the disturbance footprints. However, with Coastal Plains Smooth-barked Apple Woodland occurring in both sites and Coastal Plains Scribbly Gum Woodland present in the adjacent area, there is potential that *C. hunteriana* is present in the area. Due to the relatively small area to be cleared and the large extent of suitable habitat surrounding the disturbance footprints, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea)

Grevillea parviflora subsp. *parviflora* is endemic to NSW and has a widespread but patchy distribution. It occurs on sandstone in the Sydney region, in Kurri Kurri and Heddons Greta in the Lower Hunter Valley and Awaba on the Central Coast. This species grows in a wide range of habitats from heathy to scrubby woodlands and often along roads in relatively open and disturbed areas with very infertile soil.

G. parviflora subsp. *parviflora* is capable of suckering from underground rhizomes. Due to this habit it is often difficult to determine the numbers of plants present at a site and population estimates are essentially a reflection of the number of suckers rather than individual plants. Populations may, therefore, be smaller and less genetically diverse than they appear.

RPS has recorded several nearby occurrences of this species within the Newstan lease area. This includes the recording of 173 stems at three locations within habitat immediately adjacent to the proposed Site 2 footprint, as well as an additional 230 stems at 54 locations within vegetated habitats, all located between 1 km and 4 km from the population recorded within Site 2.

G. parviflora subsp. *parviflora* was primarily detected in the southern portion of Site 2. Little information is available on the ecology of this species, including the distance in which sucker stems (rhizomatous ramets) can appear from parent plants. On average, the recorded 173 stems occurred in patches of 3 or 4, with one patch recorded as having 16 stems. Due to the limited information available for this species, including the ecology surrounding seed dispersal (hence affecting genetic diversity), determining whether the recorded population is part of an important population is difficult. Therefore, the precautionary approach has been taken and further consideration has been afforded to this species. A boundary re-alignment of Site 2 has been undertaken to avoid impacts upon 131 stems of this species. Due to this avoidance strategy, only one individual stem of *G. parviflora* subsp. *parviflora* is proposed to be removed as a result of the Project.

A small area of habitat (Site 1: 4.72 ha of native vegetation and Site 2: 2.03 ha of native vegetation) will be removed as a result of constructing surface facilities at the two sites. Site 2 is currently occupied habitat for this species. Although, this species was detected within Site 2 and one individual will be removed as a result of the proposal, its widespread distribution within the surrounding area is large enough to support the population of this species. The surrounding individuals are within large areas of intact vegetated habitat.

This species is relatively common in the larger area (surveys in the southern part of Site 2 and has been recorded within the surrounding area by Umwelt (2005), Eco biological (2005), Cumberland Ecology (2007; 2008), Hunter Eco (2008a; 2008b) and RPS (2011; April 2012) and due to its wide distribution and habitat requirements the proposed development will represent a relatively small impact on potential habitat. With a large amount of potential habitat occurring within the greater locality, the proposed development is not likely

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

- *Tetradlea juncea* (Black-eyed Susan)

Tetradlea juncea is endemic to NSW and its current distribution ranges from the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. This species grows within dense understoreys, mainly in open woodlands on cooler southern aspects with infertile soils. Associated canopy species include *A. costata*, *E. haemastoma*, *E. capitellata* and *C. gummifera*. A preference for ridges or upper slopes has been observed for this species.

Targeted surveys for *T. juncea* were performed during its flowering period September and October, in accordance with the EPBC 1999 survey guidelines for the species. The species is considered to be common in the local area due the wide spread distribution of suitable habitat (Gunninah 1998; Umwelt 2004, 2005; Eco biological 2005; Cumberland Ecology 2007, 2008; Hunter Eco 2008a, 2008b; RPS 2011).

T. juncea was found within the original Site 1 and Site 2 layouts with 376 and 219 clumps occurring respectively. A boundary re-alignment of Site 2 has been undertaken to avoid all the 219 *T. juncea* clumps present. Similarly, a redesign of the boundary for Site 1 to avoid a potential bat cave also led to the avoidance of 425 clumps in the northern corner of the area. The vegetation immediate surrounding Site 1 has been surveyed further for the presence of *T. juncea* to determine whether the population located within the disturbance footprints is in fact part of a larger population of at least 1,958 clumps. This sub-population estimate is a conservative estimate and additional surveys within the region would most likely result in a much larger estimate of the local population. Given the current information, the removal of 376 clumps equates to the removal of up to approximately 19.2% of the recorded sub-population of *T. juncea*. The proposed action involves the removal of 4.72 ha of known and potential habitat at Site 1 and 3.93 ha at Site 2.

In relation to dust impacts, SLR (2014) concluded that particulate matter deposition would not increase above those predicted by the EPA and WHO to impact human health. Therefore, it is unlikely that dust emissions produced by activities occurring on site will significantly impact upon the remaining *Tetradlea juncea*.

T. juncea is abundant within the wider area (within 10 km) with multiple known sub-populations. Even though the removal of 376 *T. juncea* clumps from the sites will reduce the size of the local population by up to 19.2%, there is sufficient occurrence of habitat and connectivity for this species in the immediate and wider area to maintain a viable population throughout the area. The area of habitat to be removed is comparatively small with a large amount of potential habitat occurring within the greater locality. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Maundia triglochinos*

Maundia triglochinos is restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong. It grows in swamps, lagoons, dams, channels, creeks or shallow freshwater 30–60 cm deep on heavy clay, low nutrients. This species was not detected during surveys despite targeted surveys. This species has been recorded within close proximity (~120 metres) to Jigadee Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek are of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, then impacts upon this riparian species are considered unlikely. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial

enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Melaleuca biconvexa*

A shrub to small tree, which grows in poorly drained areas on the Central Coast with outlying populations at Jervis Bay and Port Macquarie. Records in the Hunter Region are confined to western Lake Macquarie (Atlas of NSW Wildlife data). It may occur in dense stands adjacent to watercourses, in association with other *Melaleuca* species or as an understorey species in wet forest. Potential habitat for this species exists along the creekline within Site 1; however, it was not detected during flora surveys by RPS or by previous studies. This species has been recorded within close proximity (~15 metres) to Jigadee Creek, which are the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, then impacts upon this riparian species are unlikely. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Syzygium paniculatum*

A shrub to small tree found in sub-tropical and littoral rainforest on sandy soils or sheltered gullies mostly near watercourses. Distributed between Bulahdelah and Jervis Bay. Hunter Region records are confined to the Lake Macquarie hinterland (Atlas of NSW Wildlife data). There is no suitable habitat (Littoral Rainforest) present within the disturbance footprints for this species. However, this species has been recorded within close proximity (~20 metres) to Dora Creek, which are the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek are of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, then impacts upon this species are unlikely. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Threatened Fauna

Woodland/Forest Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathamii*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Scarlet Robin (*Petroica boodang*).

The Little Lorikeet was the only species of TSC Act 1995 listed Woodland/Forest birds detected during fauna surveys within the disturbance footprints. This species feeds on nectar and pollen primarily from flowering eucalypts but also melaleucas and mistletoes. Thus, the proposal may affect potential foraging habitat for this species. Little Lorikeets nest in hollow openings mainly in smooth-barked eucalypts such as *E. viminalis*, *E. blakelyi* and *E. dealbata*. These tree species were not detected across the disturbance footprints and consequently only marginal breeding habitat occurs for Little Lorikeets within the disturbance footprints.

Neither the Regent Honeyeater or Swift Parrot were detected within the disturbance footprints, however, the habitat is suitable for foraging during winter migration. Both species commonly feed on nectar produced by winter-flowering eucalypts such as *E. albens*, *C. maculata* and *C. gummifera* and hence, potential foraging habitat for these species may be impacted by the proposal. The proposal represents an incremental loss of potential foraging habitat for these species. The sites are within larger areas of commensurate habitat for these species, which may attract them during favourable conditions. Thus, it is unlikely that the proposal will affect the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

Both the Varied Sittella and Scarlet Robin feed on invertebrates taken from tree trunks, dead branches, logs and other woody debris. The proposal represents an incremental loss of potential foraging habitat for these species. The sites are within larger areas of commensurate habitat for these species, which may attract them during favourable conditions. Thus, it is unlikely that the proposal will affect the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

Within NSW, the Glossy Black-Cockatoo shows a strong preference for *Allocasuarina littoralis* and *Allocasuarina torulosa*, which were both detected during flora surveys of Site 2 and consequently, potential habitat occurs within the disturbance footprints. However, this species or evidence of it (chewed *Allocasuarina* sp. cones) were not observed within the disturbance footprints during field surveys. There exists an abundance of the two preferred feed trees for Glossy Black-Cockatoo within the local area, hence the removal of these trees within the disturbance footprints are not likely to significantly affect the species. Only a small number of breeding records are available for the species, which may relate to the scarcity of hollow-bearing trees or the lack of connectivity between nests and foraging opportunities. Potential nesting habitat may therefore, be impacted by the proposal as a result of the removal of the hollow-bearing trees within the disturbance footprints. Due to the higher abundance of *A. littoralis* and *A. torulosa* in the wider area it is unlikely that the disturbance footprints would be of significant conservation priority for the Glossy Black-Cockatoo. Thus, it is unlikely that the proposal will affect the life cycle of the Glossy Black-Cockatoo such that a viable local population of the species is likely to be placed at risk of extinction.

In summer the Gang-gang Cockatoo are generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter it may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. Whilst potential foraging habitat and breeding habitat occurs for this species (particularly within Site 1) this species was not detected. Due to the small area of potential habitat to be removed, it is unlikely that the proposal will affect the life cycle of the Gang-gang Cockatoo such that a viable local population of the species is likely to be placed at risk of extinction.

Forest Owls

- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

These forest owl species occur in wet or dry sclerophyll forests and woodlands in the coastal, tablelands and to the western plains of NSW where they hunt for a range of mammalian prey. These species nest in large

hollows, preferably Eucalypt trees. Roosting can also occur in dense canopy vegetation, commonly within *S. glomulifera*, *A. littoralis* and *A. melanoxylon*. These owls are specialist predators of arboreal marsupials such as the Common Brushtail Possum, Greater Glider, Sugar Glider and Grey-headed Flying-fox. In addition, some terrestrial mammals commonly taken include the Bush Rat and Brown Antechinus. A high density of small mammals (many of which are hollow-dependent), is required for a suitable foraging habitat for these Forest Owls.

Both the Masked Owl and Sooty Owl have been observed within the wider area as part of previous studies, however, none of the forest owls were detected during fauna surveys within the disturbance footprints. Apart from Greater Gliders, all of the common prey-species as well as hollow-bearing trees were detected during surveys of the disturbance footprints. The medium hollows may also be sufficient to provide sub-optimal breeding/nesting habitat for owl and large parrot species. However, no large hollows (>25 cm) which provide important breeding/roosting habitat for these species were identified within the proposed disturbance footprints. The proposal may therefore, impact on potential foraging nesting and roosting habitat for the three forest owls within the disturbance footprints. However, due to their widespread distributions, it is considered unlikely that the proposal will affect the life cycle of the Forest Owls such that a viable local population of the species is likely to be placed at risk of extinction.

- Spotted-tail Quoll (*Dasyurus maculatus maculatus*)

The distribution of the Spotted-tail Quoll ranges from South Queensland to Kosciuszko NP, mainly within 200 km of the coast. A total of 44 known sites have been recorded in NSW, however, detailed distribution and abundance records of this species are absent due to the scale of its entire range. The Spotted-tail Quoll inhabits a wide variety of forest types including rainforest, wet and dry sclerophyll forest, coastal heathlands and woodlands. Habitat requirements include hollow logs, hollow-bearing trees, rock shelters or other suitable den sites as well as relatively dense vegetation for foraging. This species is an opportunistic carnivore and hunts a wide range of prey such as small mammals like possums, gliders and rats as well as birds, reptiles and invertebrates.

The Spotted-tail Quoll was not recorded within the disturbance footprints during fauna surveys although the area is considered suitable in terms of both food supply and shelter. The loss of large hollow logs and hollow-bearing trees as a result of the proposal has been identified as a potential threat to the species. However, due to the nearby human activities associated with the mining operations, it is unlikely that this species has a den in this location. The proposal will represent an incremental loss of potential hunting habitat for this species, however, it is considered unlikely that the proposal will affect the life cycle of the Spotted-tail Quoll such that a viable local population of the species is likely to be placed at risk of extinction.

- Squirrel Glider (*Petaurus norfolcensis*)

The distribution of the Squirrel Glider ranges from western Victoria up to north Queensland mainly inland of the Great Dividing Range. A separate population exists along the coast between southern QLD and southern NSW. The species is widely distributed in the Hunter region and has been recorded within adjacent areas of the disturbance footprints. Squirrel Gliders inhabit dry sclerophyll forests, woodlands and swamp forests where it feeds on sap exudates and blossoms. Hollow-bearing trees are used as dens for shelter and breeding and are consequently an essential part of the habitat.

This species was not recorded within the disturbance footprints despite targeted surveys. However, due to previous records within the wider area and the suitability of the disturbance footprints in terms of both food supply and shelter, it is considered likely that Squirrel Gliders are utilising the disturbance footprints. The loss of hollow-bearing trees as a result of the proposal has been identified as a potential threat to the species. However, due to the large amount of suitable habitat surrounding the sites, the proposal will not affect the life cycle of the Squirrel Glider such that a viable local population of the species is likely to be placed at risk of extinction.

- Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox is distributed from Melbourne, Victoria up to Bundaberg in Queensland and mainly inhabits sclerophyll forests, woodlands, subtropical and temperate rainforests as well as heaths and swamps. The selection of habitat is dependent on the availability of foraging opportunities in the form of nectar, pollen and fruits. Common feed trees include Eucalyptus, Melaleuca and Banksia. Grey-headed Flying-foxes are known to migrate long distances in response to foraging availability as nectar and pollen varies over time. Communal roost sites are commonly located in close proximity to a reliable food source and near water bodies, in coastal areas within rainforest patches, mangroves or riparian vegetation.

Grey-headed Flying-foxes were detected adjacent to Site 1 and have been observed within the wider area in previous studies. Foraging habitat is present within the disturbance footprints as well as potential roosting habitat along the creekline or near the waterbodies. However, it is unlikely that an existing base camp would go undetected during surveys as the Grey-headed Flying-foxes form large aggregations and return to the same camp every day. It can therefore be considered that this species only uses the site for foraging on a transient basis. Potential impacts of the proposal of this species would therefore be limited to the removal of foraging opportunities. Due to the widespread distribution of potential feed trees within the region and migration patterns of this species, it is considered unlikely that the proposal will affect the life cycle of the Grey-headed Flying-fox such that a viable local population of the species is likely to be placed at risk of extinction.

Cave-roosting bats

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- Little Bentwing-bat (*Miniopterus australis*).

Both the Little Bentwing-bat and Eastern Bentwing-bat have a widespread distribution ranging from Cape York to NSW with Eastern Bentwing-bat spreading down to Central Victoria. Large-eared Pied Bat has a more restrictive distribution ranging from Shoalwater Bay, QLD south to Ulladulla in NSW. However, most of the known distribution of this species occurs in NSW. These insectivorous bats commonly inhabit wet and dry sclerophyll forests as well as rainforests. All these species require caves or similar structures with specific characteristics for roosting purposes. Suitable roost sites are not common and should therefore be considered of high conservation significance.

The presence of these cave-roosting bat species have been reported in the wider area and RPS detected both the Large-eared Pied Bat and Little Bentwing-bat in Site 1. Suitable roosting habitat exists within the cave (drift entrance) adjacent to Site 1. There is a minimum distance of approximately 30 metres between the cave entrance and the proposal, which will retain connectivity between roost sites and native vegetation. Therefore, the proposal will not affect the life cycle of the above cave-roosting bats such that a viable local population of the species is likely to be placed at risk of extinction.

Hollow-roosting Bats

- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Southern Myotis (*Myotis macropus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

All the hollow-roosting Bats have widespread distributions ranging mainly in coastal areas from southern QLD to Victoria with the exception of the Yellow-bellied Sheath-tail-bat, which is distributed over most of Australia. The Southern Myotis prefers wetland habitat near estuaries and large lakes while all the other Hollow-roosting bats inhabit wet or dry sclerophyll forests, rainforests or woodlands. These species roost mainly in tree hollows but also under bark and in crevices. The Southern Myotis roost in caves and similar habitats as well as tree hollows.

None of these species were detected during fauna surveys of the disturbance footprint, however, all of them except the Southern Myotis and Greater Broad-nosed Bat have been recorded in the wider area previously. The *Eucalyptus* woodland within the disturbance footprints provides potential habitat for both feeding and/or roosting, therefore, the site does represent potential breeding habitat for all Hollow-roosting bat species with the exception of the Southern Myotis. However, due to the widespread distribution of these species it is considered unlikely that the proposal will affect the life cycle of the above Hollow-roosting bats such that a viable local population of the species is likely to be placed at risk of extinction.

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

There was no endangered population considered to have a potential of occurring within the disturbance footprints. Therefore, the above assessment is not applicable.

- (g) **In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- (i) **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
 - (ii) **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

No endangered ecological communities or critically endangered ecological communities occur within the disturbance footprints. However, the following endangered ecological communities are mapped as occurring within the areas which are proposed to receive increased mine water discharges as a result of the Project:

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Redgum Roughbarked Apple Swamp Forest' ((MU38) NPWS, 2000) are mapped as occurring within the lower reaches of the Newstan LDP and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This community (MU38) is commensurate with River-Flat Eucalypt Forest on Coastal Floodplains (EEC).

A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Given this, it is likely that the water which is proposed to be released will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. Therefore, impacts upon this vegetation community are considered unlikely.

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Riparian Melaleuca Swamp Woodland' ((MU42) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. In addition, areas of 'Swamp Mahogany – Paperbark Forest' (MU37) are mapped as occurring within the lower reaches of the Newstan LDPs and the proposed Hawkmount Quarry LDP. Both of these areas will potentially be subject to an increase in mine water discharge and these communities (MU42 and MU37)

are commensurate with Swamp Sclerophyll Forest on Coastal Floodplains (EEC).

- A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Given this, it is likely that the water which is proposed to be released will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. Therefore, impacts upon this vegetation community are considered unlikely. Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Swamp Oak – Rushland Forest' ((MU40) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This vegetation community (MU40) is commensurate with Swamp Oak Floodplain Forest (EEC).

- A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Given this, it is likely that the water which is proposed to be released will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. Therefore, impacts upon this vegetation community are considered unlikely. Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

An area of 'Mangrove - Estuarine Complex and Saltmarsh ' ((MU47) NPWS, 2000) is mapped as occurring within the lower reaches of the Cooranbong Entry site which will potentially be subject to an increase in mine water discharge. This community is commensurate with Coastal Saltmarsh EEC.

- (h) A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Given this, it is likely that the water which is proposed to be released will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. Therefore, impacts upon this vegetation community are considered unlikely. **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,**

Flora

- *Acacia bynoeana*

This species was not detected within the disturbance footprints, however, marginal habitat exists within the Coastal Plains Smooth-barked Apple Woodland (MU30) and Coastal Foothills Spotted Gum – Ironbark Forest (MU15) in both sites. Consequently, approximately 4.72 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

- *Corybas dowlingii*

This species was not detected within the disturbance footprints, however, marginal habitat exists within the Coastal Plains Smooth-barked Apple Woodland (MU30) and Coastal Foothills Spotted Gum – Ironbark Forest (MU15) in both sites. Consequently, approximately 4.72 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

- *Cryptostylis hunteriana*

This species was not detected within the disturbance footprint, however, suitable habitat occurs within the Coastal Plains Smooth-barked Apple Woodland (MU30). Consequently, approximately 1.22 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively as a result of the proposed activities.

- *Grevillea parviflora* subsp. *parviflora*

This species was detected in Site 2 within the Coastal Plains Smooth-barked Apple Woodland (MU30) and the *Acacia decurrens* regrowth area. Consequently, approximately 1.22 ha and 3.93 ha of suitable habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

- *Tetratheca juncea*

This species was detected in Site 1 within the Coastal Plains Smooth-barked Apple Woodland (MU30) and Coastal Foothills Spotted Gum – Ironbark Forest (MU15). Consequently, approximately 4.72 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

- *Maundia triglochinos*

No areas of habitat are to be removed by the Project. However, this species has been recorded within close proximity (~120 metres) to Jigadee Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the disturbance footprints and the area which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek are of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this riparian species are considered unlikely.

- *Melaleuca biconvexa*

No areas of habitat are to be removed by the Project. However, this species has been recorded within close proximity (~15 metres) to Jigadee Creek, which are the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this riparian species are considered unlikely.

- *Syzygium paniculatum*

There is no suitable habitat (Littoral Rainforest) present within the disturbance footprints for this species. However, this species has been recorded within close proximity (~20 metres) to Dora Creek, which are the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek are of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this riparian species are considered unlikely.

Fauna

Woodland/Forest Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);

- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Scarlet Robin (*Petroica boodang*).

Potential foraging and breeding habitat for all Woodland/Forest bird species occurs within the disturbance footprints. All these species could potentially forage within the disturbance footprints, however, the hollows which occur within the disturbance footprints are too small for breeding or roosting habitats for the larger parrots and the Swift Parrot, only breeds in Tasmania. Consequently, a total of 4.72 ha and 3.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

Forest Owls

- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

Both potential foraging and breeding habitat for all Forest Owl species exists within the disturbance footprints. Consequently, a total of 4.72 ha and 3.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities. A total of three medium hollows (11–25 cm), have been identified within the disturbance footprints, of which some may be sufficient to provide sub-optimal habitat for these species. However, no large hollows (>25 cm) which provide important breeding/roosting habitat for these species were identified within the proposed disturbance footprints.

- Spotted-tail Quoll (*Dasyurus maculatus maculatus*)

Both potential foraging and breeding habitat for *the* Spotted-tail Quoll exists within the disturbance footprints. Consequently, a total of 4.72 ha and 3.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities. In addition, five hollow-bearing trees will be removed, which provide important breeding/roosting habitat for this species.

- Squirrel Glider (*Petaurus norfolcensis*)

Both potential foraging and breeding habitat exist within the disturbance footprints for the Squirrel Glider. Consequently, a total of 4.72 ha and 3.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities. In addition, five hollow-bearing trees will be removed, which provide important breeding/roosting habitat for this species.

- Grey-headed Flying-fox (*Pteropus poliocephalus*)

Both potential foraging and breeding habitat exist within the disturbance footprints for the Grey-headed Flying-fox. Consequently, a total of 4.72 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

Cave-roosting bats

- Large eared Pied Bat (*Chalinolobus dwyeri*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- Little Bentwing-bat (*Miniopterus australis*).

Potential foraging habitat occurs across the extent of each site for all three Cave-roosting bats. Approximately, a total of 7.5 ha and 13.9 ha of potential foraging habitat will be removed from Site 1 and Site

2 respectively. However, the cave roosting habitat utilised by these species will be whole retained and protects as a result of the proposed activities.

Hollow-roosting Bats

- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Southern Myotis (*Myotis macropus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

The disturbance footprints provide suitable foraging and breeding habitat for all the hollow-roosting Bats except the Southern Myotis, which prefers wetlands at Site 2. Consequently, a total of 7.5 ha and 13.9 ha of potential foraging habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities. In addition, at least six hollow-bearing trees will be removed, which provide important breeding/roosting habitat.

Endangered Ecological Communities

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Redgum Rough-barked Apple Swamp Forest' ((MU38) NPWS, 2000) are mapped as occurring within the lower reaches of the Newstan LDP and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This community (MU38) is considered to be commensurate with River-Flat Eucalypt Forest on Coastal Floodplains (EEC). Provided the water which is proposed to be released is of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, then modifications to the habitat of this vegetation community are considered unlikely.

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Riparian Melaleuca Swamp Woodland ' ((MU42) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. In addition, areas of 'Swamp Mahogany – Paperbark Forest'(MU37) are mapped as occurring within the lower reaches of the Newstan LDPs and the proposed Hawkmount Quarry LDP. Both of these areas will potentially be subject to an increase in mine water discharge and these communities (MU42 and MU37) are considered to be commensurate with Swamp Sclerophyll Forest on Coastal Floodplains (EEC). Provided the water which is proposed to be released is of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Swamp Oak – Rushland Forest' ((MU40) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This vegetation community (MU40) is considered to be commensurate with Swamp Oak Floodplain Forest (EEC). Provided the water which is proposed to be released is of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by

GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

An area of 'Mangrove - Estuarine Complex and Saltmarsh ' ((MU47) NPWS, 2000) is mapped as occurring within the lower reaches of the Cooranbong Entry site which will potentially be subject to an increase in mine water discharge. This community is considered to be commensurate with Coastal Saltmarsh. Provided the water which is proposed to be released is of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this vegetation community are considered unlikely.

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

Due to the small area of the disturbance footprints and the large extent of surrounding vegetation, no fragmentation or isolation of habitats is likely to occur for any of the species as a result of the proposal.

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

Flora

- *Acacia bynoeana*

Only marginal habitat occurs within the disturbance footprints for this species, hence the habitat present on the disturbance footprints are considered not to be significantly important for the long-term survival of the species in the locality.

- *Corybas dowlingii*

Only marginal habitat occurs within the disturbance footprints for this species, hence the habitat present on the disturbance footprints are considered not to be significantly important for the long-term survival of the species in the locality.

- *Cryptostylis hunteriana*

Due the present of large amounts of suitable habitat found outside the disturbance footprint, the habitat present on the disturbance footprints are considered not to be significantly important for the long-term survival of the species in the locality.

- *Grevillea parviflora* subsp. *parviflora*

Due the present of large amounts of suitable habitat found outside the disturbance footprint, the habitat present on the disturbance footprints are considered not to be significantly important for the long-term survival of the species in the locality.

- *Tetratheca juncea*

Due to the presence of large amounts of suitable habitat found outside the disturbance footprints, the habitat present within the disturbance footprints are considered not to be significantly important for the long-term survival of this species in the locality.

- *Maundia triglochinoides*

The southern boundary of Site 1 provides sub-optimal habitat as the substrate is sandy. Due the suboptimal nature of the habitat for this species, the habitat present on the Site 1 is considered not to be significantly important for the long-term survival of the species in the locality. Furthermore, the water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, impacts upon this riparian species' habitat are considered unlikely.

- *Melaleuca biconvexa*

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, impacts upon this riparian species' habitat are considered unlikely

- *Syzygium paniculatum*

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, impacts upon this riparian species' habitat are considered unlikely.

Fauna

Woodland/Forest Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathamii*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Scarlet Robin (*Petroica boodang*).

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of these species, populations or ecological communities in the locality.

Forest Owls

- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of these species, populations or ecological communities in the locality.

- Spotted-tail Quoll (*Dasyurus maculatus maculatus*)

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of this species, population or ecological community in the locality.

- Squirrel Glider (*Petaurus norfolcensis*)

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of this species, population or ecological community in the locality.

- Grey-headed Flying-fox (*Pteropus poliocephalus*)

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of this species, population or ecological community in the locality.

Cave-roosting Bats

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- Little Bentwing-bat (*Miniopterus australis*).

The cave (drift entrance) adjacent to Site 1 will have a minimum of approximately 30 m from the proposal and will have connective with the native vegetation retained. Therefore, the habitat for the above cave-roosting species to be removed is considered to not be significant for the long-term survival of these species due to the scarcity of suitable breeding/roosting sites.

Hollow-roosting Bats

- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Southern Myotis (*Myotis macropus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of these species, populations or ecological communities in the locality.

Endangered Ecological Communities

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, modifications to the habitat of this vegetation community are considered unlikely.

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

No areas of critical habitat occur within the disturbance footprints.

- (j) **Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan**

Flora

Of the threatened flora species under consideration within this assessment, none of the species had a recovery plan or threat abatement plan.

Woodland/Forest Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathamii*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Scarlet Robin (*Petroica boodang*).

Of the threatened woodland/forest birds under consideration within this assessment, none of the species has a recovery plan or threat abatement plan.

Forest Owls

- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

As potential habitat will be removed during the current proposal, the proposal would be inconsistent with objective 5 (minimise loss and fragmentation of owl habitat areas) of the large forest owl recovery plan (DEC 2006).

- Spotted-tail Quoll (*Dasyurus maculatus maculatus*)

As potential habitat will be removed during the current proposal, the proposal would be inconsistent with objective 4.1 (reduce the rate of loss and fragmentation of Spotted-tailed Quoll habitat) of the Spotted-tailed Quoll draft recovery plan (Long and Nelson 2004).

- Squirrel Glider (*Petaurus norfolcensis*)

No recovery or threat abatement plans have been developed for the Squirrel Glider at this stage.

- Grey-headed Flying-fox (*Pteropus poliocephalus*)

As potential habitat will be removed during the current proposal, the proposal would be inconsistent with objective 1 (to identify and protect foraging habitat) and 2 (to protect and increase the extent of key winter and spring foraging habitat) of the Grey-headed Flying-fox draft recovery plan (DECCW 2009).

Cave-roosting Bats

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- Little Bentwing-bat (*Miniopterus australis*).

As potential habitat will be removed during the current proposal, the proposal would be inconsistent with objective 2, Action 2.1 (Protection of known roosts and associated foraging habitats and management of threats) of the Large-eared Pied Bat recovery plan (DERM 2011).

No recovery or threat abatement plans have been developed for the Eastern Bentwing-bat or Little Bentwing-bat at this stage.

Hollow-roosting Bats

- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Southern Myotis (*Myotis macropus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

No recovery or threat abatement plans have been developed any of the Hollow-roosting Bats at this stage.

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

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act 1995. Each of the KTPs considered relevant to the proposal are described in **Section 6.4**.

Appendix 3

EPBC Act: Assessments of Significance

Assessment of Significance for Vulnerable and/or Endangered Flora

Significant Impacts	<i>Acacia bynoeana</i>	<i>Cryptostylis hunteriana</i>	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	<i>Tetradlea juncea</i>	<i>Melaleuca biconvexa</i>	<i>Syzygium paniculatum</i>
Lead to a long-term decrease in the size of an important population.	Unlikely. Although there is potential for the species to occur within the disturbance footprints, it would be a small number of individuals therefore, it would not constitute a significant proportion of the population. The impacts of the proposal are therefore, not expected to lead to a long-term decrease in the size of an important population.	Unlikely . This species was not recorded within the disturbance footprints, however, based on habitat preference, it is likely that <i>C. hunteriana</i> is present within the disturbance footprints. Due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to lead to a long-term decrease in the size of an important population.	Unlikely. This species was detected within the disturbance footprints and one individual plant will be removed as a result of the proposal. However, due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to lead to a long-term decrease in the size of an important population.	Unlikely. This species was detected within the disturbance footprints and 376 individual clumps will be removed as a result of the proposal. However, due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to lead to a long-term decrease in the size of an important population.	Unlikely. There is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, Therefore, impacts upon this riparian species are not expected to lead to a long-term decrease in the size of an important population.	Unlikely. There is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, Therefore, impacts upon this riparian species are not expected to lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of the species.	Potential. This species was not detected within the disturbance footprints, however, due to its inconspicuous appearance, there is potential for it to occur within the disturbance footprints. There is therefore, potential that its area of occupancy within the disturbance footprints will be reduced as a result of the proposed activities.	Potential. This species was not detected within the disturbance footprints, however, due to its inconspicuous appearance out of the flowering period, there is potential for it to occur within the disturbance footprints. There is therefore, potential that its area of occupancy within the disturbance footprints will be reduced as a result of the proposed activities.	Yes. This species was detected within the disturbance footprints and one clump of clonal stems will be removed from Site 2 as a result of the proposal. The area of its occupancy will therefore, be reduced.	Yes. This species was detected within the disturbance footprints and approximately 376 individual clumps will be removed from Sites 1 as a result of the proposal. The area of its occupancy will therefore, be reduced.	Unlikely. The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, Therefore, the area of its occupancy of this species would not be reduced.	Unlikely. The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, Therefore, the area of its occupancy of this species would not be reduced.
Fragment an existing important population into two or more populations.	Potential. There is potential for populations to exist within the disturbance footprints. Fragmentation of populations may therefore, occur as a result of the proposed action.	Potential. There is potential for populations to exist within the disturbance footprints. Fragmentation of populations may therefore, occur.	Unlikely. The disturbance footprints are surrounded by occupied habitat, with strong connectivity. The local population would not become fragmented as a result of this proposal.	Unlikely. The disturbance footprints are surrounded by occupied habitat, with strong connectivity. The local population would not become significantly fragmented as a result of this proposal. Only 10 individual clumps within the identified subpopulation of 1,958 will be potentially fragmented from 440m to 680m from the closest meta-population.	Unlikely. As the population known to occur south of the PAA is not affected to be reduced by the Project, no fragmentation of populations is expected.	Unlikely. As the population known to occur south of the PAA is not affected to be reduced by the Project, no fragmentation of populations is expected.
Adversely affect habitat critical to the survival of a species.	No. No critical habitat is known within the disturbance footprints and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	No. No critical habitat is known within the disturbance footprints and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	No. No critical habitat is known within the disturbance footprints and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	No. No critical habitat is known within the disturbance footprints and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	No. No critical habitat is known within the disturbance footprints of downstream and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	No. No critical habitat is known within the disturbance footprints of downstream and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population.	Potential. There is potential for populations to exist within the disturbance footprints. The impacts of the proposal may therefore, disrupt the breeding cycle of a population.	Unlikely. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.	Unlikely. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.	Unlikely. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.	Unlikely. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.	Unlikely. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely. Only marginal habitat occurs within the disturbance footprints for this species, hence no quality habitat will be removed to the extent that the species is likely to decline.	Unlikely. Suitable habitat occurred within the disturbance footprints however, due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to remove primary habitat to the extent that this species is likely to decline.	Unlikely. Suitable habitat occurred within the disturbance footprints however, due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to remove quality habitat to the extent that this species is likely to decline.	Unlikely. Only marginal habitat occurs within the disturbance footprints for this species, hence no primary habitat will be removed to the extent that the species is likely to decline.	Unlikely. The proposed minor changes to flow and water quality are unlikely to affect the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely. The proposed minor changes to flow and water quality are unlikely to affect the availability or quality of habitat to the extent that the species is likely to decline.

Significant Impacts	<i>Acacia bynoeana</i>	<i>Cryptostylis hunteriana</i>	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	<i>Tetradlea juncea</i>	<i>Melaleuca biconvexa</i>	<i>Syzygium paniculatum</i>
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	Unlikely. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	Unlikely. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	Unlikely. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	Unlikely. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	Unlikely. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.
Introduce disease that may cause the species to decline.	Unlikely. The pathogen <i>Phytophthora cinnamomi</i> is a key threatening process causing species to decline and is widespread in coastal forests. However, this species or its preferred habitat is not known to be susceptible to <i>P. cinnamomi</i> .	Unlikely. This species or its preferred habitat is not known to be susceptible to <i>P. cinnamomi</i> . As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	Potential. This species occur in habitat that may be adversely affected by <i>P. cinnamomi</i> . As a consequence the proposed activities have the potential to introduce diseases that may cause this species to decline.	Unlikely. This species or its preferred habitat is not known to be susceptible to <i>P. cinnamomi</i> . As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	Unlikely. The proposed minor changes to flow and water quality are unlikely to introduce disease that may cause the species to decline.	Unlikely. The proposed minor changes to flow and water quality are unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species.	Unlikely. More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	Unlikely. There have been more records of this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	Unlikely. This species is relatively widespread within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	Unlikely. More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	Unlikely. The proposed minor changes to flow and water quality are unlikely interfere with the recovery of the species.	Unlikely. The proposed minor changes to flow and water quality are unlikely interfere with the recovery of the species.

Assessment of Significance for Vulnerable and/or Endangered Fauna

Significant Impacts	Grey-headed Flying-fox	Large-eared Pied bat
Lead to a long-term decrease in the size of an important population.	Unlikely. This species is highly mobile and will not be losing any significant habitat due to the proposed activities within the disturbance footprints. Therefore, no long-term decrease in population size will occur.	Unlikely. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Therefore, its roosting habitat will not be affected by the proposal. Furthermore, the small area of foraging habitat to be cleared is considered unlikely to lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of the species.	Unlikely. No primary breeding habitat is being cleared as a result of the proposed activities and although potential feed trees are present it is not a limiting factor. Therefore, the area of occupancy will not be reduced.	Unlikely. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Therefore, its roosting habitat will not be affected by the proposal. Large areas of potential foraging habitat will be retained in the locality. Therefore, it is considered that the small amount to foraging habitat clearing will not reduce the area of occupancy of the species.
Fragment an existing important population into two or more populations.	Unlikely. This species is highly mobile and it is therefore, unlikely that existing populations will be fragmented.	Unlikely. This species is highly mobile and it is therefore, unlikely that existing populations will be fragmented.
Adversely affect habitat critical to the survival of a species.	Unlikely. This species is highly mobile and critical habitat for this species survival does not exist within the disturbance footprints.	Unlikely. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Therefore, its roosting habitat will not be affected by the proposal. Therefore, no critical habitat for this species survival will be affected by the proposal.
Disrupt the breeding cycle of a population.	Unlikely. The area is mainly used for foraging not breeding and this species is capable of moving to other nearby areas easily if required.	Unlikely. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Therefore, its roosting habitat will not be affected by the proposal. A wall will prevent disturbance from noise or light from the mining activities. Therefore, the proposal is likely to disrupt the breeding cycle of the population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely. This species is highly mobile and the removal of potential foraging habitats within the disturbance footprints are not likely to cause the species to decline.	Unlikely. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. A wall will prevent disturbance from noise or light from the mining activities. Furthermore, this species is highly mobile and the removal of potential foraging habitats within the disturbance footprints are not likely to cause the species to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely. There are no invasive species associated with the decline of this species.	Unlikely. There are no invasive species associated with the decline of this species.
Introduce disease that may cause the species to decline.	Unlikely. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	Unlikely. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.
Interfere substantially with the recovery of the species.	Unlikely. No there is suitable habitat for this species in surrounding areas and this species is highly mobile-capable of moving freely to available habitat. Therefore, the proposed activity will not interfere substantially with the recovery of this species.	Unlikely. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Furthermore, this species is highly mobile and the removal of potential foraging habitats within the disturbance footprints are not likely to interfere substantially with the recovery of this species.

Assessment of Significance for Endangered Species

Significant Impacts	Swift Parrot	Regent Honeyeater	Spotted-tail Quoll
Lead to a long-term decrease in the size of a population.	Unlikely. This species was not recorded within the disturbance footprints, however, suitable foraging habitat is present. This species is highly mobile and will not be losing any significant habitat due to the proposed activities within the disturbance footprints. Therefore, no long-term decrease in population size will occur.	Unlikely. This species was not recorded within the disturbance footprints, however, suitable foraging habitat is present. This species is highly mobile and will not be losing any significant habitat due to the proposed activities within the disturbance footprints. Therefore, no long-term decrease in population size will occur.	Unlikely. This species was not recorded within the disturbance footprints, however, suitable foraging and breeding habitat is present. However, due to its widespread distribution and habitat requirements, it is considered unlikely that the impacts of the proposal will lead to a long-term decrease in the size of a population.
Reduce the area of occupancy of the species.	Unlikely. This highly mobile species was not recorded within the disturbance footprints so it is unlikely that its area of occupancy within the disturbance footprints will be reduced as a result of the proposed activities.	Unlikely. This highly mobile species was not recorded within the disturbance footprints so it is unlikely that its area of occupancy within the disturbance footprints will be reduced as a result of the proposed activities.	Unlikely. Due to its widespread distribution, the probability that this species is occupying the site is low. It is therefore, considered unlikely that the impacts of the proposed activities would reduce the area of occupancy of this species.
Fragment an existing important population into two or more populations.	No. No existing populations are known within the disturbance footprints so it is unlikely that any populations will be fragmented as a result of this project.	No. No existing populations are known within the disturbance footprints so it is unlikely that any populations will be fragmented as a result of this project.	Unlikely. This species is highly mobile and it is therefore, unlikely that existing populations will be fragmented.
Adversely affect habitat critical to the survival of a species.	No. This species is highly mobile and critical habitat for this species survival does not exist within the disturbance footprints.	No. This species is highly mobile and critical habitat for this species survival does not exist within the disturbance footprints.	Unlikely. The area affected is not considered critical habitat and is unlikely to affect the survival of this species.
Disrupt the breeding cycle of a population.	Unlikely. The area is potentially used for foraging not breeding and this species is capable of moving to other nearby areas easily if required.	Unlikely. The area is potentially used for foraging not breeding and this species is capable of moving to other nearby areas easily if required.	Unlikely. Due to its widespread distribution and the high mobility of the species, it is considered unlikely that the impacts of the proposed activities would disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely. This species is highly mobile and the removal of potential foraging habitats within the disturbance footprints are not likely to cause the species to decline.	Unlikely. This species is highly mobile and the removal of potential foraging habitat within the disturbance footprints is not likely to cause the species to decline.	Unlikely. Due to its widespread distribution and habitat requirements as well as high mobility, it is not likely that the impacts of the proposed activities will remove or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	Unlikely. It is unlikely that the affected area will experience an increase in invasive species due to the proposed activities.	Unlikely. It is unlikely that the affected area will experience an increase in invasive species due to the proposed activities.	Unlikely. It is unlikely that the affected area will experience an increase in invasive species due to the proposed activities.
Introduce disease that may cause the species to decline.	Unlikely. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	Unlikely. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	Unlikely. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.
Interfere with the recovery of the species.	Unlikely. More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	Unlikely. More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	Unlikely. More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.

Appendix 4

Fauna Species List

Family	Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
Frogs						
Myobatrachidae	<i>Crinia signifera</i>	Common Eastern Froglet	-	-		✓
Hylidae	<i>Litoria peronii</i>	Peron's Tree Frog	-	-	✓	
Hylidae	<i>Litoria revelata</i>	Whirring Treefrog	-	-		✓
Hylidae	<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	-	-	✓	✓
Hylidae	<i>Litoria latopalmata</i>	Broad Palmed Frog	-	-	✓	✓
Reptiles						
Elapidae	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	-	-		✓
Birds						
Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck	-	-		✓
	<i>Aythya australis</i>	Hardhead (White-eyed) Duck	-	-		✓
Cacatuidae	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black Cockatoo	-	-		✓
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	-	-		✓
Climacteridae	<i>Cormobates leucophaea</i>	White-throated Treecreeper	-	-		✓
Corvidae	<i>Corvus coronoides</i>	Australian Raven	-	-	✓	✓
Cuculidae	<i>Cuculus variolosus</i>	Brush Cuckoo	-	-		✓
Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird	-	-		✓
Dicruridae	<i>Rhipidura albiscapa</i>	Grey Fantail	-	-	✓	✓
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	-		✓	✓
	<i>Malurus lamberti</i>	Variegated Fairy-wren	-	-	✓	
Melipagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	-	-		✓
	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	-	-	✓	✓
	<i>Lichenostomus fuscus</i>	Fuscous Honeyeater	-	-		✓
	<i>Manorina melanophrys</i>	Bell Miner	-	-	✓	
	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	-	-	✓	✓
	<i>Melithreptus lunatus</i>	White-naped Honeyeater	-	-	✓	
	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	-	-	✓	✓
	<i>Philemon corniculatus</i>	Noisy Friarbird	-	-		✓
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	-	-		✓
	<i>Acanthiza nana</i>	Yellow Thornbill	-	-		✓
	<i>Pardalotus punctatus</i>	Spotted Pardalote	-	-	✓	
	<i>Pardalotus striatus</i>	Striated Pardalote	-	-		✓
	<i>Sericornis frontalis</i>	White-browed Scrubwren	-	-	✓	
Ploceidae	<i>Neochmia temporalis</i>	Red-browed Finch	-	-	✓	✓
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth	-	-		
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	-	-		
Psittacidae	Glossopsitta pusilla	Little Lorikeet	V	-	✓	✓
	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	-	-	✓	✓
	<i>Trichoglossus rubritorquatus</i>	Red-collared Lorikeet	-	-		
Mammals						
Dasyuridae	<i>Antechinus stuartii</i>	Brown Antechinus	-	-	✓	✓
	<i>Antechinus swainsonii</i>	Dusky Antechinus	-	-		✓
Macropodidae	<i>Wallabia bicolor</i>	Swamp Wallaby	-	-		✓
Muridae	<i>Rattus fuscipes</i>	Bush Rat	-	-	✓	✓
	<i>Rattus Rattus</i>	Black Rat	-	-	✓	✓
Petauridae	<i>Petaurus breviceps</i>	Sugar Glider	-	-	✓	✓
Pseudocheiridae	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	-	-	✓	✓
Pteropodidae	Pteropus poliocephalus	Grey-headed Flying-fox	V	V	✓	

Family	Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
Rhinolophidae	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	-	-	✓	
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	-	-		✓
Vespertilionidae	<i>Vespadelus vulturnus</i>	Little Forest Bat	-	-	✓	
	<i>Chalinolobus dwyeri</i>	Large-eared pied bat	V	V	✓	
	<i>Miniopterus australis</i>	Little bentwing-bat	V	-	✓	

Appendix Key:	✓ = Species Detected
	* = Introduced species
	(E) = Species listed under NSW TSC Act 1995 as Endangered.
	(V) = Species listed under NSW TSC Act 1995 as Vulnerable.
	(V*) = Species listed under the Commonwealth EPBC Act 1999 as Vulnerable
	(E*) = Species listed under the Commonwealth EPBC Act 1999 as Endangered
	(M*) = Species listed under the Commonwealth EPBC Act 1999 as Migratory
	(C) = Species listed under CAMBA
	(J) = Species listed under JAMBA

Appendix 5

Flora Species List

Family	Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
Trees						
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-oak	-	-		✓
	<i>Allocasuarina torulosa</i>	Forest Oak	-	-		✓
Euphorbiaceae	<i>Glochidion ferdinandii</i>	Cheese Tree	-	-		✓
Fabaceae	<i>Acacia irrorata</i> subsp. <i>irrorata</i>	Sydney Green Wattle	-	-	✓	
	<i>Acacia parramattensis</i>	Sydney Green Wattle	-	-		✓
Myrtaceae	<i>Angophora costata</i>	Smooth-barked Apple	-	-	✓	✓
	<i>Corymbia gummifera</i>	Red Bloodwood	-	-	✓	✓
	<i>Corymbia maculata</i>	Spotted Gum	-	-	✓	✓
	<i>Eucalyptus acmenoides</i>	White Mahogany	-	-	✓	
	<i>Eucalyptus capitellata</i>	Brown Stringybark	-	-		✓
	<i>Eucalyptus fibrosa</i>	Broad Leaved Ironbark	-	-	✓	
	<i>Eucalyptus paniculata</i> subsp. <i>paniculata</i>	Grey Ironbark	-	-	✓	
	<i>Eucalyptus piperita</i>	Sydney Peppermint	-	-	✓	✓
	<i>Eucalyptus propinqua</i>	Small Fruited Grey Gum	-	-	✓	
	<i>Eucalyptus punctata</i>	Grey Gum	-	-	✓	
	<i>Eucalyptus resinifera</i> subsp. <i>resinifera</i>	Red Mahogany	-	-	✓	
	<i>Eucalyptus siderophloia</i>	Northern Grey Ironbark	-	-	✓	
	<i>Eucalyptus umbra</i>	Broad-leaved White Mahogany	-	-	✓	✓
	<i>Melaleuca linariifolia</i>	Snow in Summer	-	-	✓	
	<i>Melaleuca stypheloides</i>	Prickly-leaved Tea Tree	-	-	✓	
Shrubs						
Asteraceae	<i>Cassinia uncata</i>	Sticky Cassinia	-	-	✓	
Epacridaceae	<i>Leucopogon lanceolatus</i>	Lance-leaf Beard-heath	-	-		✓
	<i>Breynia oblongifolia</i>	Coffee Bush	-	-	✓	
	<i>Podolobium ilicifolium</i>	Prickly Shaggy Pea	-	-	✓	
	<i>Pultenaea villosa</i>	Hairy Bush-pea	-	-	✓	✓
	<i>Acacia floribunda</i>	White Sally Wattle	-	-	✓	✓
	<i>Acacia longifolia</i> var. <i>longifolia</i>	Sydney Golden Wattle	-	-	✓	✓
	<i>Acacia myrtifolia</i>	Red Stem Wattle	-	-		✓
	<i>Acacia suaveolens</i>	Sweet Scented Wattle	-	-		✓
	<i>Acacia terminalis</i>	Sunshine Wattle	-	-	✓	
	<i>Callistemon salignus</i>	Willow Bottlebrush	-	-	✓	
Pittosporaceae	<i>Bursaria spinosa</i> var. <i>spinosa</i>	Blackthorn	-	-	✓	
	<i>Banksia spinulosa</i>	Hairpin Banksia	-	-		✓
	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V		✓
	<i>Hakea sericea</i>	Needlebush	-	-	✓	
	<i>Lambertia formosa</i>	Mountain Devil	-	-		✓

Family	Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
	<i>Persoonia levis</i>	Broad-leaved Geebung	-	-		✓
	<i>Persoonia linearis</i>	Narrow-leaved Geebung	-	-	✓	✓
Sapindaceae	<i>Dodonaea triquetra</i>	Hop-bush	-	-	✓	✓
Verbenaceae	<i>Lantana camara</i> *	Lantana	-	-	✓	✓
	<i>Verbena bonariensis</i> *	Purple Top	-	-		✓
Ground Cover						
Apiaceae	<i>Centella asiatica</i>	Swamp Pennywort	-	-	✓	
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken	-	-	✓	✓
Doryanthaceae	<i>Doryanthes excelsa</i>	Gymea Lily	-	-	✓	✓
Lindsaeaceae	<i>Lindsaea linearis</i>	Screw Fern	-	-		
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot	-	-	✓	
Lomandraceae	<i>Lomandra fluviatilis</i>		-	-	✓	
	<i>Lomandra obliqua</i>	Twisted Mat-rush	-	-	✓	
Poaceae	<i>Chloris gayana</i> *	Rhodes Grass	-	-		✓
	<i>Entolasia marginata</i>	Bordered Panic	-	-	✓	
	<i>Entolasia stricta</i>	Wiry Panic	-	-	✓	✓
	<i>Eragrostis brownii</i>	Brown's Lovegrass	-	-		✓
	<i>Imperata cylindrica</i>	Blady Grass	-	-	✓	✓
	<i>Joycea pallida</i>	Silvertop Wallaby Grass	-	-		✓
	<i>Melinus repens</i> *	Red Natal Grass	-	-		✓
	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Rice Grass	-	-	✓	✓
	<i>Themeda australis</i>	Kangaroo Grass	-	-	✓	✓
Tremandraceae	<i>Tetratheca thymifolia</i>	Black-eyed Susan	-	-		✓
	<i>Tetratheca juncea</i>	Black-eyed Susan	V	V	✓	✓
Xanthorrhoeaceae	<i>Xanthorrhoea</i> sp.	-	-	-		✓
Fabaceae	<i>Glycine microphylla</i>	Small-leaf Glycine	-	-	✓	
Luzuriagaceae	<i>Eustrephus latifolius</i>	Wombat Berry	-	-	✓	

Appendix Key: ✓ = Species Detected

* = Introduced species

(E) = Species listed under NSW TSC Act 1995 as Endangered.

(V) = Species listed under NSW TSC Act 1995 as Vulnerable.

(V*) = Species listed under the Commonwealth EPBC Act 1999 as Vulnerable

(E*) = Species listed under the Commonwealth EPBC Act 1999 as Endangered

(M*) = Species listed under the Commonwealth EPBC Act 1999 as Migratory

(C) = Species listed under CAMBA

(J) = Species listed under JAMBA

Appendix 6

Anabat Analysis

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BAT CALL ANALYSIS REPORT
Toronto, NSW
RPS Australia East Pty Ltd

8 June 2012

This report has been prepared to document the analysis of digital ultrasonic bat echolocation calls received from a third party. The data was not collected by the author and as such no responsibility is taken for the quality of data collection or for the suitability of its subsequent use.

This report was authored by

A handwritten signature in black ink, appearing to read 'AMC', followed by a period.

Anna McConville
B.Env.Sc.

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1.0 INTRODUCTION

This report has been commissioned by RPS Australia East Pty Ltd to analyse bat echolocation call data (Anabat, Titley Electronics) collected from Toronto, NSW. Data was provided electronically to the author. This report documents the methods involved in analysing bat call data and the results obtained only.

2.0 METHODS

The identification of bat echolocation calls recorded during surveys was undertaken using AnalookW (Version 3.8m) software. The identification of calls was undertaken with reference to Pennay and others (2004) and through the comparison of recorded reference calls from north-eastern NSW and the Sydney Basin. Reference calls were obtained from the NSW database and from the authors personal collection.

Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- Definite - Pass identified to species level and could not be confused with another species
- Probable - Pass identified to species level and there is a low chance of confusion with another species
- Possible - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species
- Species group - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality
- Unknown - Either background 'noise' files or passes by bats which are too short and/or of poor quality to confidently identify.

Call sequences that were less than three pulses in length were not analysed and were assigned to 'Unknown' and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar shape of plotted calls and in these cases calls were assigned to species groups.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

It should be noted that the activity levels recorded at different sites may not be readily able to be compared. Such comparisons are dependent on many variables which need to be carefully controlled during data collection and statistically analysed. Influential variables include wind, rain, temperature, duration of recording, season, detector and microphone sensitivity, detector placement, weather protection devices etc.

Description of the Characteristics Used to Differentiate Species

Miniopterus australis was differentiated from *Vespadelus pumilus* which it overlaps with, by the presence of a down-sweeping tail on pulses. Call sequences which had a majority of pulses containing an up-sweeping tail were assigned to *Vespadelus pumilus*. Call sequences where the

tail was difficult to differentiate and these were assigned to the *Vespadelus pumilus* / *Miniopterus australis* species complex.

3.0 RESULTS

A total of 4620 call sequences were recorded, of which 384 call sequences were able to be analysed (ie were not 'noise' files or bat calls of short length). Of the bat calls, 159 call sequences (41%) were able to be confidently identified (those classified as either definite or probable identifications) to species level (Table 1). Species recorded confidently within the site include:

- *Tadarida australis* (White-striped freetail bat)
- *Chalinolobus dwyeri* (Large-eared pied bat)
- *Miniopterus australis* (Little bentwing bat)
- *Rhinolophus megaphyllus* (Eastern horseshoe bat)

Additional bat species that are known to exist within the locality of the site, but could not be confidently identified to species (those classified as possible or as a species group), include:

- *Chalinolobus morio* (Chocolate wattled bat)
- *Miniopterus schreibersii oceanensis* (Eastern bentwing bat)
- *Vespadelus darlingtoni* (Large forest bat)
- *Vespadelus pumilus* (Eastern forest bat)
- *Vespadelus regulus* (Southern forest bat)
- *Vespadelus troughtoni* (Eastern cave bat)
- *Vespadelus vulturinus* (Little forest bat)

It should be noted that additional bat species may be present within the site but were not recorded by the detectors and habitat assessment should be used in conjunction with these results to determine the likelihood of occurrence of other bat species.

Additionally, bat activity has been shown to decrease in cooler months in Australia and as such sampling during this time is unlikely to identify the full suite of insectivorous bats present within the area.

Table 1 below summarises the results of the bat call analysis

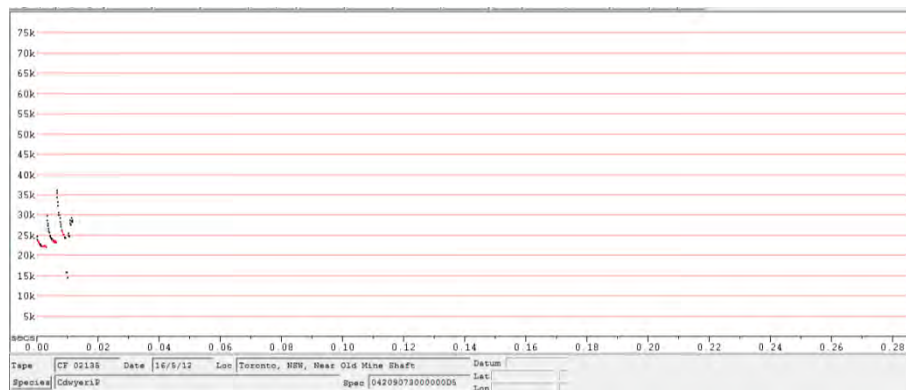
Table 1: Results of bat call analysis (number of passes per site per night)

IDENTIFICATION	Anabat 1 20120514 14/05/2012	Anabat 1 20120514 15/05/2012	Anabat 1 20120514 16/05/2012	Anabat 1 20120516 16/05/2012	Anabat 1 20120516 17/05/2012	Anabat 2 20120514 14/05/2012	Anabat 2 20120514 15/05/2012	Anabat 2 20120514 16/05/2012	Anabat 2 20120516 16/05/2012	Anabat 2 20120516 17/05/2012
DEFINITE										
<i>Miniopterus australis</i>	1	3	-	6	5	10	33	1	26	5
<i>Rhinolophus megaphyllus</i>	1	6	-	1	-	4	13	1	-	-
<i>Tadarida australis</i>	-	-	-	-	-	1	-	-	-	1
PROBABLE										
<i>Chalinolobus dwyeri</i>	-	-	-	1	-	-	-	-	-	-
<i>Miniopterus australis</i>	2	2	-	5	-	1	3	-	4	7
<i>Rhinolophus megaphyllus</i>	1	1	-	-	1	-	5	-	2	1
<i>Vespadelus pumilus</i>	-	-	-	-	-	-	-	-	-	-
POSSIBLE										
<i>Miniopterus australis</i>	-	2	-	-	-	-	-	-	-	-
<i>Rhinolophus megaphyllus</i>	-	-	-	1	-	-	-	-	-	-
<i>Vespadelus pumilus</i>	-	-	-	-	1	-	-	-	-	1
SPECIES GROUPS										
<i>Chalinolobus morio</i> / <i>Miniopterus schreibersii</i> <i>oceanensis</i> / <i>Vespadelus vultumus</i>	-	-	-	-	1	-	-	-	-	-
<i>Chalinolobus morio</i> / <i>Vespadelus pumilus</i> / <i>Vespadelus vultumus</i> / <i>Vespadelus troungtoni</i>	-	2	-	-	9	-	31	-	1	7
<i>Miniopterus australis</i> / <i>Vespadelus pumilus</i>	2	13	-	-	6	-	12	-	2	2
<i>Miniopterus australis</i> / <i>Vespadelus pumilus</i> / <i>Vespadelus troungtoni</i>	-	21	-	1	13	-	6	-	-	-

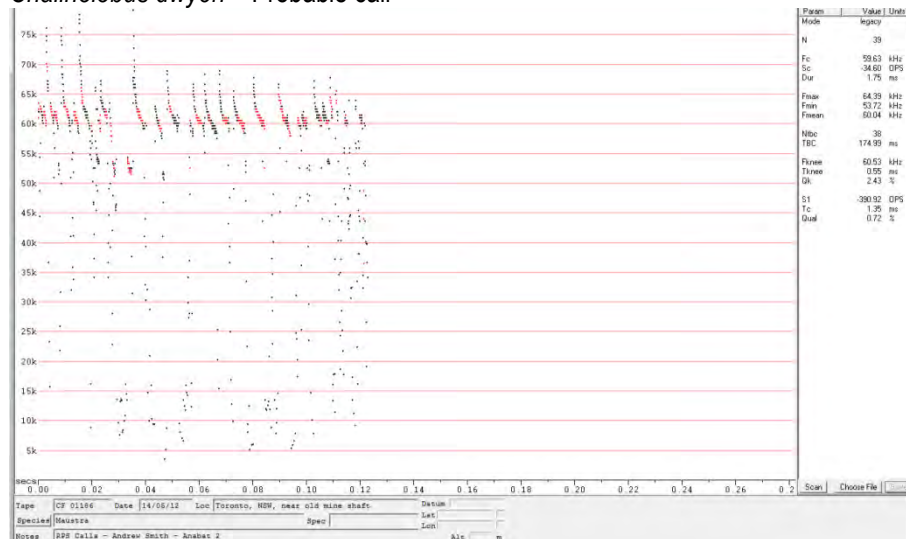
IDENTIFICATION	Anabat 1 20120514 14/05/2012	Anabat 1 20120514 15/05/2012	Anabat 1 20120514 16/05/2012	Anabat 1 20120516 16/05/2012	Anabat 1 20120516 17/05/2012	Anabat 2 20120514 14/05/2012	Anabat 2 20120514 15/05/2012	Anabat 2 20120514 16/05/2012	Anabat 2 20120516 16/05/2012	Anabat 2 20120516 17/05/2012
<i>Miniopterus schreibersii</i> <i>oceanensis</i> / <i>Vespadelus darlingtoni</i> / <i>Vespadelus regulus</i>	1	1	-	2	1	-	-	-	-	-
<i>Miniopterus schreibersii</i> <i>oceanensis</i> / <i>Vespadelus vultumus</i>	-	1	-	1	-	1	6	3	5	13
<i>Vespadelus pumilus</i> / <i>Vespadelus troughtoni</i>	-	2	-	-	9	-	-	-	-	5
<i>Vespadelus pumilus</i> / <i>Vespadelus vultumus</i> / <i>Vespadelus troughtoni</i>	-	7	-	-	-	-	4	-	-	34
UNKNOWN										
Unknown	3	9	2	4	12	2	24	-	11	8
'Noise' files	3	-	-	3	1	494	1437	1118	466	639
TOTAL	14	70	2	25	59	513	1574	1123	517	723
Time of calls recorded (does not necessarily translate to survey effort, simply when calls were recorded)	9:50pm – 5:45am	Entire Night	5:00pm	Entire Night	Entire Night	10:30pm – 6:30am	Entire Night	Day – 6:00pm	Entire Night	Entire Night

4.0 SAMPLE CALLS

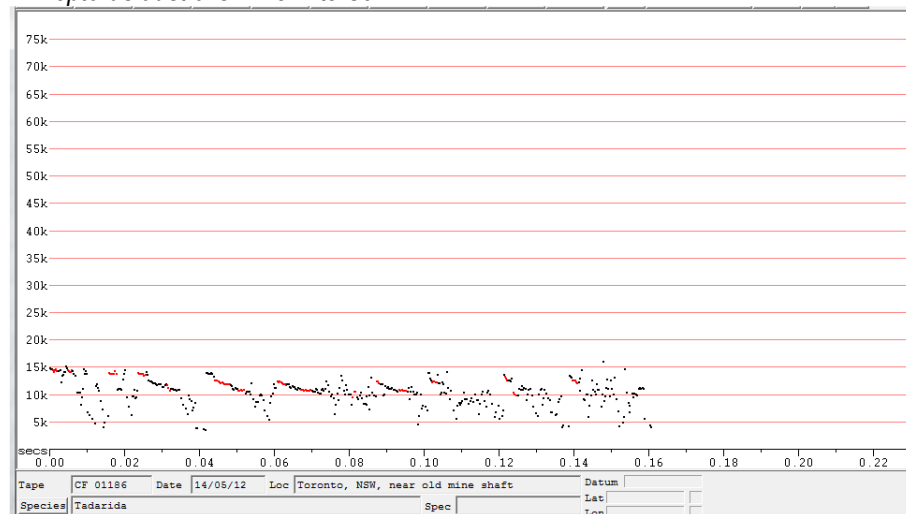
A sample of the calls actually identified from the site for each species is given below.



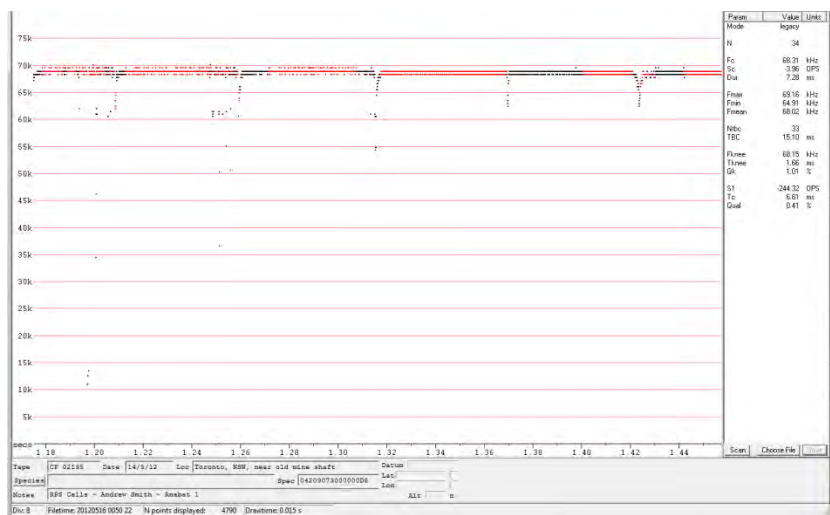
Chalinoborus dwyeri – Probable call



Miniopterus australis – Definite Call



Tadarida australis – Definite Call



Rhinolophus megaphyllus – Definite Call

5.0 REFERENCES

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Appendix 7

Staff Qualifications



Curriculum Vitae

PAUL HILLIER

Senior Ecologist / Project Manager

Newcastle, NSW

Bachelor of Environmental Science (Environmental Management)

AREAS OF EXPERTISE:

Paul has broad range of Ecological Assessment reporting and project management experience from 10 years of professional ecological work both in Australia and abroad. Project experience has primarily included a range of flora and fauna assessment disciplines as required by a wide range of corporate and domestic client requirements. Paul has been employed both within the private and public sector, providing a strong knowledge and understanding of the role of both developers and government in legislation and planning.

Paul has the majority of his experience within the consultancy industry, primarily focussing on the preparation of Flora and Fauna Assessments, EPBC Act Referrals, EPBC Act Preliminary Documents Ecological Monitoring Reports, as well as Construction Environmental Management Plans and Compensatory Habitat Management Plans. Paul has extensive experience with flora and fauna survey methodologies, species identification and targeted threatened flora and fauna surveys. In addition, Paul holds a strong knowledge of Geographic Information Systems mapping and analyses.

SELECTED PROJECT EXPERIENCE:

- **Springvale Mine Extension Project (Centennial Coal)**
Project management, ecological survey, advices, preparation of an EPBC Referral and preparation of an ecological report for a proposed longwall coal mine extension at Springvale Mine on the Newnes Plateau, near Lithgow, NSW.
- **Angus Place Mine Extension Project (Centennial Coal)**
Project management, ecological survey, advices, preparation of an EPBC Referral and preparation of an ecological report for a proposed longwall coal mine extension at Angus Place Mine on the Newnes Plateau, near Lithgow, NSW.
- **Airly Mine Extension Project (Centennial Coal)**
Project management, ecological survey, advices, preparation of an EPBC Referral and preparation of an ecological report for an underground coal mine extension, using partial extraction mining methods, at Airly Mine, near Capertee, NSW. This project also required a presentation to be given to the local community.
- **Neubeck Coal Project (Centennial Coal)**
Project management, ecological survey, advices, preparation of an EPBC Referral and preparation of an ecological report for an opencut coal mine at Blackmans Flat, near Lithgow, NSW.
- **Glasserton Pilot Wells, PEL 1, Gunnedah Basin (Santos)**
Vegetation surveys and ecological assessment to support a Review of Environmental Factors for three coal seam gas pilot wells, near Gunnedah, NSW.
- **White Rock Wind Farm, Glen Innes, NSW (Epuron)**
Ecological surveys, advices and preparation of an ecological report to support an application for a 119 turbine wind farm at White Rock, near Glen Innes, NSW.



Curriculum Vitae

- CONTINUED -

- **Subdivision and Urban Development at Hills Plain, Tamworth, NSW (Marloelle)**
Detailed floristic surveys to determine the condition and extent of the EPBC Act Critically Endangered Ecological Community - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland). Project managed and prepared an EPBC Act Referral and Preliminary Documentation (following a controlled action decision). Preliminary Documentation included successful negotiation of both on-site and off-site offsets, using the EPBC Act environmental offsets policy, to compensate for unavoidable impacts to the derived grasslands component of Box-Gum Woodland.
- **Annual Ecological Monitoring, Wombo Mine (Peabody Energy)**
Project managed and undertook a variety of monitoring surveys over both existing managed woodlands and mine rehabilitation areas. Monitoring survey techniques included, flora quadrats, riparian vegetation transects, fauna surveys and Ecosystem Function Analysis.

PREVIOUS EXPERIENCE:

Ecological Records Officer – West Yorkshire Ecology

2007-2009

Duties included collection and collation of ecological records from across West Yorkshire, United Kingdom; Preparation of fee proposals for ecological services; GIS/ spatial analysis and database management; Database searches and reporting; Liaison with client, stakeholder groups, state and local governing bodies; Review of local planning applications and consequent consultations to local councils.

Ecologist – Harper Somers O'Sullivan

2004-2006

Duties included flora and fauna surveying and survey design; overseeing and contribution to the preparation of complex ecological and environmental reports for both small and large projects; liaison with both the private sector and federal, state and local government department.

MEMBERSHIPS & ACHIEVEMENTS:

NSW Driver's Licence (Class C)

OH&S Induction Training (White Card)

Senior First Aid

Landscape Function Analysis Training

Snake and Spider Safety Awareness for Employees (SSSafe) Training

For Australian Wildlife Needing Aid (FAWNA), NSW Australia



Curriculum Vitae

ZIGGY ANDERSONS

Ecology Manager - Newcastle

Newcastle, NSW

Bachelor of Science Botany Major 2010

AREAS OF EXPERTISE:

Ziggy has a diverse range of experiences in the fields of Ecology and Natural Resource Management. He has worked in the rehabilitation, ecological assessment, environmental management and business development fields across NSW and Qld. Clients have included state government agencies, civil contractors but have predominantly been within the resource sector. Ziggy is experienced in the management of large resource projects including project inception, client liaison, project design, project management, liaising with regulatory agencies and business development.

Ziggy also has experience in ecological assessment methodologies and has a particular interest in ecosystem rehabilitation and plant ID and ecology.

SELECTED PROJECT EXPERIENCE:

Environment

- Flora and Fauna assessment project design
- Flora and fauna identification and habitat assessment
- Targeted threatened flora and fauna surveys
- Delineation and mapping of vegetation communities
- Endangered Ecological Community (EEC) assessment
- Experience with GPS/GIS for project design and mapping
- Conducting Field Surveys for Flora, Fauna and Habitat Identification
- Report Preparation including Fauna and Flora Assessments
- Ecological Monitoring and Reporting
- Vegetation Management Plan Reporting
- Understanding of environmental legislation

Projects

- Black Hill Flora and Fauna Impact Assessment (Diocese of Maitland).
- Centennial Coal Offset Assessment (Newstan, Coal Logistics, Mandalong South, Clarence, Neubeck Expansions. Awaba and Airly Offset Sites).
- Escott Zeolite Mine Flora and Fauna Assessment and Rehabilitation Management Plan.
- Mandalong South Powerline Relocation Flora and Fauna Impact Assessment
- Huntlee Conservation Management Plan
- Huntlee *Persoonia pauciflora* Population Management Plan
- Huntlee Flora and Fauna Management Plan



Curriculum Vitae

- CONTINUED -

- Windmill Hill Offset Management Plan
- Kurri Kurri Rising Main Flora and Fauna Impact Assessment
- Bulga Mine Annual Fauna Monitoring
- Carnley Ave (Blackbutt Reserve) Ecological Constraints Assessment
- Beltana (Bulga) Underground Mine Bat Impact Assessment and Monitoring
- Centennial Angus Place Impact Monitoring

PREVIOUS EXPERIENCE:

Mackay Regional Manager – Kleinfelder Ecobiological (2012)

Ziggy was employed to establish a regional office in Mackay to service the Central and Northern Qld regions. During his employment he was responsible for the whole gamut of activities involved in ecological consultancy including; business development, client liaison, project management, negotiations with regulatory bodies, ecological assessments, report development and review, budgeting, workflow and business management.

Ecological Consultant (Business Owner) – Evergreen Vegetation Consultants (2010-2011)

Ziggy owned and operated his own ecological consultancy business with a significant two year contract with Callide Mine (AngloAmerican). Ziggy was responsible for developing and implementing Management Action Plans that related to an EPBC non-compliance as well as acting in a support role to the environmental department staff. During this period Ziggy was responsible for contractor management (quote review, contract development, contractor management), community liaison, incident investigation and management, reporting and liaising with regulatory agencies, advising senior leadership team on ecological matters etc.

Botanist and Bush Regenerator – Sustainable Resource Management Group (2009-2010)

Ziggy acted as the company's botanist and was part of the Bush Regeneration Team. The company had numerous contracts with the Hunter Valley CMA as well as Landcare groups within the Hunter and Mid North Coast region. He had a range of responsibilities including ecological assessments, report writing, quoting, project management, and team supervision.

VOLUNTEER WORK

- Callide Valley Landcare Chair (October 2009 to 2011)
- Callide Valley Landcare Treasurer (August to October 2009)
- Clean up Australia Day Coordinator, Bohnock, NSW (March 2007)
- Self initiated weed management and revegetation of Charley's Island/ Farquhar Pk, Manning River NSW (2007-2008)

MEMBERSHIPS & ACHIEVEMENTS:

- Drivers Licence (C, MR (Motorcycle), and RMDL (Boat))
- RTD02 ChemCert Chemical Accreditation AQF III
- HLTF301B Apply First Aid Certificate
- 91476NSW Course in Sustainable Private Native Forestry
 - Follow environmental care procedures
 - Operator core knowledge and skills
 - Protect coastal & tableland native forest
 - Apply biodiversity conservation principles



Curriculum Vitae

- CONTINUED -

- Apply silviculture principles
- Qld Black Coal Generic Induction (Surface)
- S1, S2, S3 Supervisor Training (Qld)
- G2 Risk Assessment Training (Qld)
- HLTF301C - Apply First Aid
- Standard 11 Generic Induction Refresher (Qld)
- RIIV201A – Operate Light Vehicle
- RIIV305A – Operate and Maintain a Four-Wheel Drive Vehicle
- Qld BioCondition v2.1 Training



Curriculum Vitae

LAUREN VANDERWYK

Ecologist

Newcastle, NSW

Bachelor of Science, University of Newcastle

AREAS OF EXPERTISE:

During the six years Lauren has been working as an Ecologist, she has gained a broad range of ecological field experience and experience in Ecological Assessment and management reporting in accordance with relevant State and Commonwealth government legislative frameworks. In addition, Lauren has developed numerous Bushfire Threat Assessments and Bushfire Attack Level certificates informed by field surveys and desktop assessments in accordance with Planning for Bushfire Purposes (2006). Her experience within the consulting industry has primarily included a wide range of flora and fauna assessment disciplines as required by a wide range of public and private clients including Centennial Coal, Santos and NSW Roads and Maritime Services. Lauren's knowledge of the Central Coast, Hunter, Greater Lithgow and Liverpool Plains regions has expanded extensively since the commencement of her career.

SELECTED PROJECT EXPERIENCE:

Environment

- Flora and fauna identification and habitat assessment
- Targeted threatened flora and fauna surveys
- Delineation and mapping of vegetation communities
- Endangered Ecological Community (EEC) assessment
- Conducting Field Surveys for Flora, Fauna and Habitat Identification
- Report Preparation including Fauna & Flora Assessments
- Ecological Monitoring and Reporting
- Bushfire Threat Assessment & Management reporting
- Understanding of environmental and bushfire legislation

Ecology

- Northern Beaches Hospital Connectivity and Network Enhancements Project (SMEC) – Preparation of a flora and fauna memorandum for two sites proposed to be developed for the Project. Project tasks included preliminary desktop assessment, interpretation of legislative requirements, targeted field surveys, and assessment of fauna habitat quality and value to threatened species.
- Bulga Mine Annual Fauna Monitoring – Lauren has been involved in an annual monitoring program that spans two operations and involves seasonal bird surveys, habitat assessments and the full spectrum of fauna monitoring methodologies targeting threatened species as well as comprising an overall species list, and providing technical input and annual report writing
- Angus Place Longwalls 900 and 910 Flora and Fauna Monitoring (Centennial Coal Angus Place) – Pre and postmining baseline surveys were undertaken by Lauren including flora and fauna species diversity surveys, vegetation condition assessments and nest box erection. Monitoring of multiple sites provides a comparable data set to display any notable changes as a result of longwall mining within this mining lease area. Swamp vegetation monitoring was a separate component of this project which required a memorandum to

comment on overall swamp health and potential impacts as a result of surrounding mining activities. This project is ongoing.

- Pacific Highway Upgrade-Oxley Highway to Kempsey (NSW Roads and Maritime Services)
Implementation of the Microchiropteran Bat Management Plan prepared for the 37km upgrade of the Pacific Highway between the Oxley Highway and Kempsey on the NSW Mid-north coast. For this project Lauren was involved in the installation of 158 bat roost boxes and the provision of GIS data to inform future monitoring activities.
- Neubeck Open Cut Coal Mine (Centennial Coal) – Flora and fauna field surveys over a three year period and the production of the Flora and Fauna Assessment as part of an overriding Environmental Impact Statement were undertaken for the proposed Neubeck open cut coal mine
- Airly Coal Mine Flora and Fauna Surveys (Centennial Coal) – A range of flora and fauna surveys were undertaken to inform both the Airly Baseline Survey Report and the Airly Flora and Fauna Report
- Lidsdale Siding Biodiversity Management Plan (Centennial Ivanhoe)– Ecological assessments primarily undertaken for Lidsdale Siding Flora and Fauna Report informed the production of the Lidsdale Siding Biodiversity Management Plan, both of which Lauren was involved in. The BMP outlined areas of ecological importance and ecological issues on site with associated management actions
- Coal Seam Gas Exploration (Santos)- On site supervisor for coal seam gas exploration and clearing activities in the Gunnedah region. Lauren ensured that all contractors and staff on site complied with the Review of Environmental Factors with environmental protection a priority during clearing on site

PREVIOUS EXPERIENCE:

Environmental Scientist - Ecobiological (2011)
Primary roles included bush regeneration and the identification of a wide range of native and non-native plant species for rehabilitation of various sites throughout the Hunter and Central Coast regions. Some ecological surveys and Ecological Assessment reporting was carried out during Lauren's time with Ecobiological

Trainee Ecologist - Pygmy Possum Ecological Consulting (2008-2010)
Undertaking ecological field surveys was the primary role at Pygmy Possum Ecological Consulting. Fauna surveys were carried out across the Central Coast, Lake Macquarie and into the Hunter region. Basic reporting and data entry were undertaken throughout Lauren's time with Pygmy Possum Ecological Consulting

VOLUNTEER EXPERIENCE:

- Bush regeneration at Trig Shepards Hill, Bar Beach with Newcastle Landcare (2013);
- Regent Honeyeater habitat restoration in the Capertee region with Birdlife Australia (2012);
- Amphibian (*Litoria citropa*) acoustic research in the Watagan Mountains, NSW with Carl Gerhardt (2012);
- Biodiversity research for independent researchers and Australian Geographic in East Kimberley (2011);
- Amphibian (*Litoria subglandulosa* and *Mixophyes balbus*) research at the New England Tablelands with Marion Anstis, Simon Clulow and Carl Gerhardt (two separate occasions 2010);
- Bandicoot Research in Manly with the Australian Wildlife Conservancy (2010);
- Microbat dietary surveys and tracking at Empire Bay with Leroy Gonsalves (2010);
- Green and Golden Bell frog research at the Sydney Olympic Park (2010);
- Bush-stone Curlew surveys at Empire Bay on the Central Coast undertaking call play back methods (2010).
- Bush regeneration at Wamberal Lagoon Nature Reserve with National Parks and Wildlife Services primarily restoring Littoral Rainforest (EEC) (2007-2010); and



Curriculum Vitae

- CONTINUED -

- Fauna research including pit trapping, Elliot trapping, triangulation (for amphibians) and spotlighting for the Watagans fauna database (2007).

MEMBERSHIPS & ACHIEVEMENTS:

- NSW Driver's Licence (Class C)
- OH&S Induction Training (White Card)
- 4WD course
- ChemCert II certification
- Landscape Function Analysis Training
- Member of the Ecological Society of Australia (ESA)
- Member of Birdlife Australia
- Member of the Australian Mammal Society (AMS)

CONFERENCES:

- Australasian Raptor Conference, Adelaide SA (Attendee) 2013
- National Koala Conference, Port Macquarie NSW (Attendee) 2013
- Society for Conservation Biology Conference - Oceania, Darwin NT (Attendee) 2012



Curriculum Vitae

ARNE BISHOP

Senior Ecologist

Newcastle, NSW

Bachelor of Environmental Science, University of Canberra, 2009

Bachelor of Landscape Architecture, University of Canberra, 2009

Cert IV Horticulture (Landscape) Canberra Institute of Technology, 2003

Cert II Australian Land Conservation and Restoration, Conservation Volunteers Australia, 2001

NSW Driver's Licence (Class C)

AREAS OF EXPERTISE:

Arne began paid employment in environmental management as a part time field assistant for Alison Rowell Environmental Consultancy in 1999. This role included working on flora and fauna surveys, and habitat/vegetation assessment and mapping. The knowledge and experience Arne gained from this role progressed and developed into a sub-consultancy role with full time employment over spring- summer every year until 2010.

In 2001, Arne completed a six month environmental traineeship with Green Corps. This course involved learning about environmental issues and how best to manage them in a practical sense. Arne performed duties such as: pest and weed identification and control; bush regeneration; and natural area restoration.

Arne has also completed several contracts as an environmental consultant for Eco Logical Australia, assisting with threatened species identification and monitoring on a range of projects.

Arne has been employed full-time with RPS at their Newcastle office since January 2011; he quickly progressed from a Field Ecologist role to an Ecologist position in the first 8 months of employment. Arne is currently employed with RPS as a senior ecologist.

All of these above roles have been focused on collating and interpreting scientific information in order to produce recommendations on and resolutions to environmental issues. All aspects of field surveys and reporting associated with these roles have been conducted in accordance with relevant Local, State and Commonwealth government legislative frameworks.

SELECTED PROJECT EXPERIENCE

- **Gunnedah Basin (Santos)**

Conducted multiple projects over approximately two years. These projects included; ecological works for Santos within the Gunnedah Basin covering gas exploration and provision of infrastructure, including, gas pipelines and access tracks. Works included field survey, preparation of advice, impact assessments, EPBC referrals, preparation and implementation of well lease rehabilitation plans, liaison and negotiations with regulators and agencies.

- **Bulga Mine Annual Fauna Monitoring (Glencore)**

Conducted and project managed an annual monitoring program for the past four years. The program spans two operations and involves seasonal bird surveys, habitat assessments, and the full spectrum of fauna monitoring methodologies, provides technical input and document review.

- **Airly Coal Mine Flora and Fauna Surveys and Assessment (Centennial Coal)**

A range of flora and fauna surveys were undertaken to inform both the Airly Baseline Survey Report and the Airly Flora and Fauna Report. Project tasks included; review of specialist reports, interpretation of legislative requirements, targeted field survey, assessment of fauna habitat quality and value to threatened species, identification of project impacts and measures to avoid or mitigate potential impacts.

- **Angus Place and Springvale Extension Projects (Centennial Coal)**



Curriculum Vitae

- CONTINUED -

Ecological surveys were undertaken over a period of 1.5 years to aid in the production of a Flora and Fauna Report for both the Angus Place and Springvale underground mines. The project role included flora and fauna field surveys.

- **Mandalong Mine Extension Project (Centennial Coal)**
Project tasks included preliminary desktop assessment, interpretation of legislative requirements, targeted field survey, assessment of fauna habitat quality and value to threatened species, identification of project impacts and measures to avoid or mitigate potential impacts.
- **Mandalong South Powerline Relocation - Flora and Fauna Impact Assessment (Centennial Coal)**
Conducted targeted threatened seasonal threatened species surveys, client liaison and report development.
- **Beltana Underground Mine Bat Impact Assessment and Monitoring (Glencore)**
Conducted extensive fieldwork to identify potential habitat, assessed habitat using night vision technology and developed report.
- **Subdivision and Urban Development at Hills Plain, Tamworth, NSW (Marloelle)**
Conducted detailed floristic surveys to determine the condition and extent of the EPBC Act Critically Endangered Ecological Community - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland).

PREVIOUS EXPERIENCE:

Part-time field assistant/consultant – Alison Rowell

1999 - 2010

This role included working on flora and fauna surveys, and habitat/vegetation assessment and mapping. The knowledge and experience I have gained from this role has progressed and developed into a sub-consultancy role with full time employment over spring- summer every year.

Environmental consultancy work - Eco Logical Australia

2008 - 10

Arne completed several contracts as an environmental consultant for Eco Logical Australia, assisting with threatened species identification and monitoring on a range of projects.

Green Corps Traineeship - Conservation Volunteers Australian (CVA)

2001

Arne received accredited practical and theoretical training in; First Aid (Level 2, St Johns); Occupational Health and Safety and Environmental Concepts. This training contributed to Certificate II in Australian Land Conservation and Restoration.

MEMBERSHIPS & ACHIEVEMENTS:

Award of Excellence for first place in Conservation Biology and Genetics - University of Canberra.

Landscape Functional Analysis Training

NSW Driver's Licence (Class C)

OH&S Induction Training (White Card)

First Aid Certification

Four Wheel Drive Training and Certification - Out of Town Four Wheel Drive.

Snake and Spider Safety Awareness for Employees (SSSafe) Training

Royal Zoological Society NSW - Membership

Ecological Consultants Association - Membership

Birds Australia membership



Curriculum Vitae

ANDREW SMITH

Ecologist

Newcastle, NSW

Ph.D. (Avian Population Ecology), Bachelor of Science in Environmental Biology (Sub-major: Wildlife Ecology)

NSW Driver's Licence (Class C), 4WD Training

White Card (OH&S Induction Training)

Senior First Aid

Waterways Authority Boating Licence

AREAS OF EXPERTISE:

Andrew has over 10 years experience in Environmental Science with a wide range of industry groups. His skills include project design, data collection, statistical analysis and presentation of scientific data (both written and oral communication). He has produced a large number of ecological reports for the private sector and as peer-reviewed scientific publications. As well as conducting many targeted Swift Parrot and Regent Honeyeater survey throughout the Hunter Valley, Andrew also voluntarily coordinates the Birdlife Australian community surveys of the Mudgee-Wollar Important Bird Area. Also, Andrew used his knowledge of Australian birds to create migration route maps along south-eastern Australia for a large number of bush birds. Currently, Andrew is voluntarily working with staff at Birdlife Australia to produce a Population Viability Analysis for the Powerful Owl population within the Sydney region, a community survey based project which he cofounded.

SELECTED PROJECT EXPERIENCE:

ENVIRONMENT

- Flora and fauna identification and habitat assessment;
- Targeted threatened flora and fauna surveys (e.g. targetting breeding sites for the threatened Regent Parrot at Hattah-Kulkyne National Park during 2012);
- Delineation and mapping of vegetation communities;
- Endangered Ecological Community (EEC) assessment;
- Experience with GPS/GIS for project design and mapping;
- Conducting Field Surveys for Flora, Fauna and Habitat Identification;
- Report Preparation including Fauna and Flora Assessments;
- Ecological Monitoring and Reporting;
- BioBanking data collection, credit calculating and reporting;
- Vegetation Management Plan reporting; and
- Understanding of environmental legislation.



Curriculum Vitae

- CONTINUED -

PREVIOUS EXPERIENCE:

Research Officer – Birds Australia (2010)

Andrew was employed on the Great Eastern Ranges Initiative project: movements and landscape connectivity. The project was funded by the Department of Environment, Climate Change and Water, NSW. Primarily, he mapped the movements and migration routes of several bird species along south-eastern Australia, including the Swift Parrot, Regent Honeyeater, Flame Robin and Scarlet Robin.

Scientific Officer – Department of Industry and Investment (2009)

Andrew was employed under Dr Rod Kavanagh to perform over 100 bird surveys over a large area on the mid-north coast of NSW. This work was performed to help develop a broad scale biological diversity monitoring strategy.

Ph.D Candidate – Australian White Ibis: University of Technology, Sydney (2005–2009)

Andrew investigated the population ecology of the Australian White Ibis (*Threskiornis molucca*) in the urban environment. Andrew compiled detailed information on the breeding, feeding, movement and population dynamics of ibis which is critical for the longer term sustainable management of this species.

Technical Officer – University of Technology, Sydney (2007–2009)

Andrew was employed to help run the practical components for a number of environmental subjects: Wildlife Ecology, Animal Behaviour and Physiology, and Catchment Ecosystems. His role mainly involved teaching students a wide range of wildlife surveying techniques.

MEMBERSHIPS & ACHIEVEMENTS:

- Ecological Consultants Association of NSW (ECA);
- NSW, Royal Zoological Society (RZS);
- Birdlife Australia;
- Australia Bird Study Association;
- A Class Bird Banding Licence;
- Snakes and Spider Safety Awareness (SSSafe) Training; and
- Landscape Functional Analysis Training.

PEER-REVIEWED PUBLICATION:

- Smith, A.C.M., and Munro, U. (2008). Cannibalism in the Australian Pelican *Pelecanus conspicillatus* and Australian White Ibis *Threskiornis molucca*. *Waterbirds* **31**, 632–635.
- Smith, A.C.M., and Munro, U. (2010). Seasonal population dynamics of the Australian White Ibis (*Threskiornis molucca*) in the urban environment. *Emu* **110**, 132–136.
- Smith, A.C.M., and Munro, U. (2011). Local and regional movements of the Australian White Ibis (*Threskiornis molucca*) in eastern Australia. *Corella* **35**, 89–94.
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- Thomas, C.A., Lidums, E., Smith, A.C.M. and Munro, U. (2013). Seasonal abundance shifts by the Australian White Ibis *Threskiornis molucca* across parts of eastern Australia in 2007: a survey using questionnaires. *Corella*. In Press.

Appendix 8

Cardno (2013) Aquatic Ecology Impact Assessment



***Cardno
Ecology Lab***

Shaping the Future

Marine and Freshwater Studies



Newstan Colliery

Aquatic Ecology Impact Assessment for the Northern Coal Logistics Project

Job Number: EL1112084

Prepared for Northern Coal Services



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Cover Image: LT Creek above the Newstan Colliery rail loading facility. Photographer Max Best, Cardno Ecology Lab

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Executive Summary

Cardno Ecology Lab was engaged by Centennial Northern Coal Services Pty Limited (Northern Coal Services) to conduct an aquatic ecology impact assessment to support a development application for the expansion of the coal handling, storage and distribution facilities on site at the Newstan Colliery as part of the Northern Coal Logistics Project (the Project).

As part of the Project, Northern Coal Services proposes to increase the current coal stockpile areas across the upper north arm of LT Creek and install automated coal conveyance and train loading facilities. In order to remove the risk of coal stored in the additional stockpiles from entering LT Creek and being transported downstream, Northern Coal Services propose to pipe a reach of the north arm of LT Creek from the downstream side of By-wash Dam in the upper catchment to the south of the rail loading facility.

This report includes a desktop review, field investigation and aquatic ecology impact assessment for the piping of a section of LT Creek. An additional impact assessment report on changes relating to surface water quality and flow is being prepared by GHD (L. Hammersly, 2013, *letter comm.* 10 April). Field investigations were completed in July 2012 at four sites along LT Creek within, upstream and downstream of the construction zone. Field investigation included assessment of water quality, aquatic habitat, macrophytes, macroinvertebrates and fish. No threatened or endangered flora or fauna were observed during the investigation.

The condition of the existing aquatic ecosystem within and downstream of the proposed development area was identified as moderately degraded based on the interpretation of flora, fauna, water quality and habitat data collected in this and previous investigations. Despite the degraded condition, LT Creek provides valuable aquatic habitat for resident organisms and is part of an interconnected ecosystem stretching from ephemeral creeks in the upper catchment through to the Lake Macquarie estuary.

Key potential impacts identified for the proposed development include: removal of aquatic and terrestrial habitat; increased sediment and water quality issues during construction; direct and indirect impacts on aquatic flora and fauna; increase in flood risk and; further restriction of fish passage through an already restricted creek. Further degradation of this ecosystem can be minimised by implementing effective controls to minimise impacts on water quality, hydrology and the aquatic habitat.

Recommendations were made to assist with the mitigation of potential impacts including: update and implementation of water and sediment management plans; design of infrastructure based on appropriate hydrological modelling; monitoring and control of sediment; improvement of aquatic habitat upstream and/or downstream of the pipeline; implementation of an ongoing aquatic ecology monitoring program.

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Glossary

AUSRIVAS	Australian River Assessment System
AWS	Automated Weather Station
DPI	Department of Primary Industries
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities
EC	Electrical Conductivity
EP&A Act	Environmental Planning and Assessment Act (1979)
EPL	Environmental Protection Licence
EPT	Ephemeroptera, Plecoptera, Trichoptera
ISQG	Interim Sediment Quality Guidelines
LDP	Licensed Discharge Point
NCLP	Northern Coal Logistic Project
NCS	Northern Coal Services
NES	National Environmental Significance
POEO Act	Protection of the Environment Operations Act
RCE	Riparian, Channel and Environment
SIGNAL2	Stream Invertebrate Grade Number Average Level version 2
TOC	Total Organic Carbon
TSS	Total Suspended Solids
WMP	Water Management Plan
WTP	Water Treatment Plant

1 Introduction

Cardno (NSW/ACT) Pty Ltd trading as Cardno Ecology Lab was engaged by Centennial's Northern Coal Services Pty Limited (Northern Coal Services) to conduct an aquatic ecology impact assessment to support a development application for the expansion of the coal handling, storage and distribution facilities on site at the Newstan Colliery (located near the township of Fassifern) as part of the Northern Coal Logistics Project (the Project).

Northern Coal Services is seeking approval for the Project under Part 4 Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), and part of the proposal includes the redevelopment of the Newstan Colliery Surface Site. In order to remove the risk of coal stored in the additional stockpiles from entering LT Creek and being transported downstream, Northern Coal Services are proposing to pipe the length of the north arm of LT Creek from the downstream side of the By-wash Dam to the south toward the rail loading facility (Figure 1-1).

This report outlines findings of desktop and field based assessments completed and provides an assessment of potential impacts on the aquatic ecosystem associated with the proposed piping of LT Creek only.

1.1 Scope of Work

The field assessment component of this study focused specifically on the section of LT Creek where the majority of direct impact is expected to occur, which runs between the Main By-wash Dam weir and the rail loading facility. Consideration has also been given to the aquatic environment upstream and downstream of this section, where impacts may also occur. The estuary of the waterway has been considered in less detail than the supra-tidal aquatic environment, which is the focus of this report.

1.2 Aims

The specific component of the proposed development that relates to the aquatic ecosystem is the piping of a section of the upper north arm of LT Creek. The aim of the study and the focus of this report is therefore the assessment of potential impacts on the aquatic ecosystem in relation to this proposed development activity.

The specific aims of the study are to:

- Undertake background research and compile existing information on the aquatic habitats, biota and fisheries of LT Creek;
- Identify legislative requirements and guidelines that are relevant to the effects of the proposed works on aquatic ecology;
- Review current listings of species identified on Schedules to the Threatened *Species Conservation Act 1995* (TSC Act) and the *Fisheries Management Act 1994* (FM Act), and the *Environment Protection and Biodiversity Act 1999* (EPBC Act) and assess the likely presence of protected aquatic species, including a list of such species, populations, communities and processes;
- Assess the relevance of processes as defined in the TSC Act, considering communities, populations and processes that are listed on the relevant TSC Act Schedules;
- Consider potential impacts in relation to Commonwealth requirements and international agreements, including the EPBC Act, wetlands policies and migratory bird agreements;
- Undertake field studies to describe the aquatic habitat provided by, and aquatic species utilising, LT Creek, including the collection of data on water quality, aquatic macroinvertebrates, habitat quality, aquatic macrophytes and fish;
- Assess the potential impact of the proposed works on the aquatic ecology of LT creek and provide recommendations to avoid, minimise and / or mitigate identified potential impacts;
- Identify any permits that may be required; and
- Make recommendations on any further work and further monitoring, if required.

1.3 Background

In 1999 the Newstan Colliery Surface Site, as part of Newstan Colliery, received Development Consent DA 73-11-98 following the submission of the Newstan Colliery Life Extension Area Environmental Assessment (Umwelt 1998). This

development Consent allowed, among other things, the development of coal stockpile areas and the piping of approximately 150 m of LT Creek North Arm between the By-wash Dam and the rail loop and approximately 175 m of LT Creek North Arm within the rail loop. As part of the current Project, Northern Coal Services are planning to extend the approved piping in 2 sections of the creek (approximate addition of 300 m of pipeline in total) to remove the risk of coal entering the creek and being transported downstream from the proposed expansion of the overlying coal stockpile area and associated works. The proposed piping would link the currently approved pipeline sections to create a continuous length of piping approximately 625 m along the north arm of LT Creek as it traverses through the Newstan Colliery Surface Site.

The excavation and disturbance associated with installing the pipelines in the existing channel of the north arm of LT Creek has the potential to result in significant downstream sedimentation. On this basis, it is proposed to install lengths of piping adjacent to the existing creek channel and subsequent diversion of flow through this pipeline. Figure 1-1 shows the two sections of LT Creek North Arm where piping has previously been approved under Development Consent DA 73-11-98 and the two remaining sections of the Creek where Northern Coal Services is seeking approval to extend the pipeline.

1.3.1 Licenced Discharge Points

Newstan Colliery's Environmental Protection Licence (EPL 395) permits the discharge of water from the Newstan Colliery Surface Site through two licenced discharge points on the north arm of LT Creek. Licenced Discharge Point 001 (LDP001) is located at the upper end of the catchment upstream of the By-wash Dam and is licensed to discharge up to 11 ML per day under normal weather conditions. Licenced Discharge Point 002 (LDP002) is located to the south on the downstream side of the Newstan Colliery Surface Site on the Final Pollution Control Dam. LDP002 is only permitted to discharge into LT Creek if the storage capacity of the dam is exceeded during rainfall events. Figure 1-1 shows the locations of the licenced discharge points.

An increase in the volume of water discharged into LT Creek via LDP001 is being sort from the current 11 ML per day limit to 14.5 ML per day. Design of the proposed pipeline through LT Creek will sufficiently accommodate this increase in discharge and will be designed for a 1:100 year storm event (J. Wearne 2013 pers. comm., 11 March).



Figure 1-1: Location of the proposed works and Licenced Discharge Points (LDPs) along LT Creek

1.3.2 LT Creek

LT Creek is a tributary of Lake Macquarie draining a catchment area of some 7.5km², extending north/north-west of the township of Fassifern (Figure 1-2). The catchment is drained by LT Creek and a number of unnamed tributaries, discharging to Fennel Bay, a semi-closed embayment of the broader Lake Macquarie waterway (BMT WBM 2011).

The Newstan Colliery Surface Site lies within the upper catchment of LT Creek and consists of a North Arm and a South Arm that converge within the residential / commercial area of Fassifern (Figure 1-2). The upper catchment of LT Creek North Arm also consists of bushland associated with the Rhondda Colliery owned by Coal and Allied. A power easement and rail corridor runs through the LT Creek catchment downstream of Newstan Colliery. LT Creek was originally an ephemeral system, but the North Arm has been receiving water from the underground mine water for a number of years (GHD 2009).

LT Creek is considered to be a highly valued asset to the local community, particularly the lower estuary where it is interconnected with Lake Macquarie. A 2010 survey of the local community and subsequent report prepared by Lake Macquarie City Council (LMCC), found that residents were most concerned about the water pollution within LT Creek and the sediment deposition into the estuary (LMCC 2010).

Northern Coal Services are in the process of upgrading water treatment at the Newstan Colliery Surface Site by installing a water treatment plant for the LDP001 discharge point. On completion, all water from LDP001 will be treated at the plant prior to discharge. Previously, treatment has involved passive settlement within the By-wash Dam. The planned new water treatment mechanisms combine previous processes with coagulation/flocculation, settlement and filtration in a separate plant. The operation and maintenance of this facility and the existing settlement basins will be an important factor in the protection of the aquatic environment.

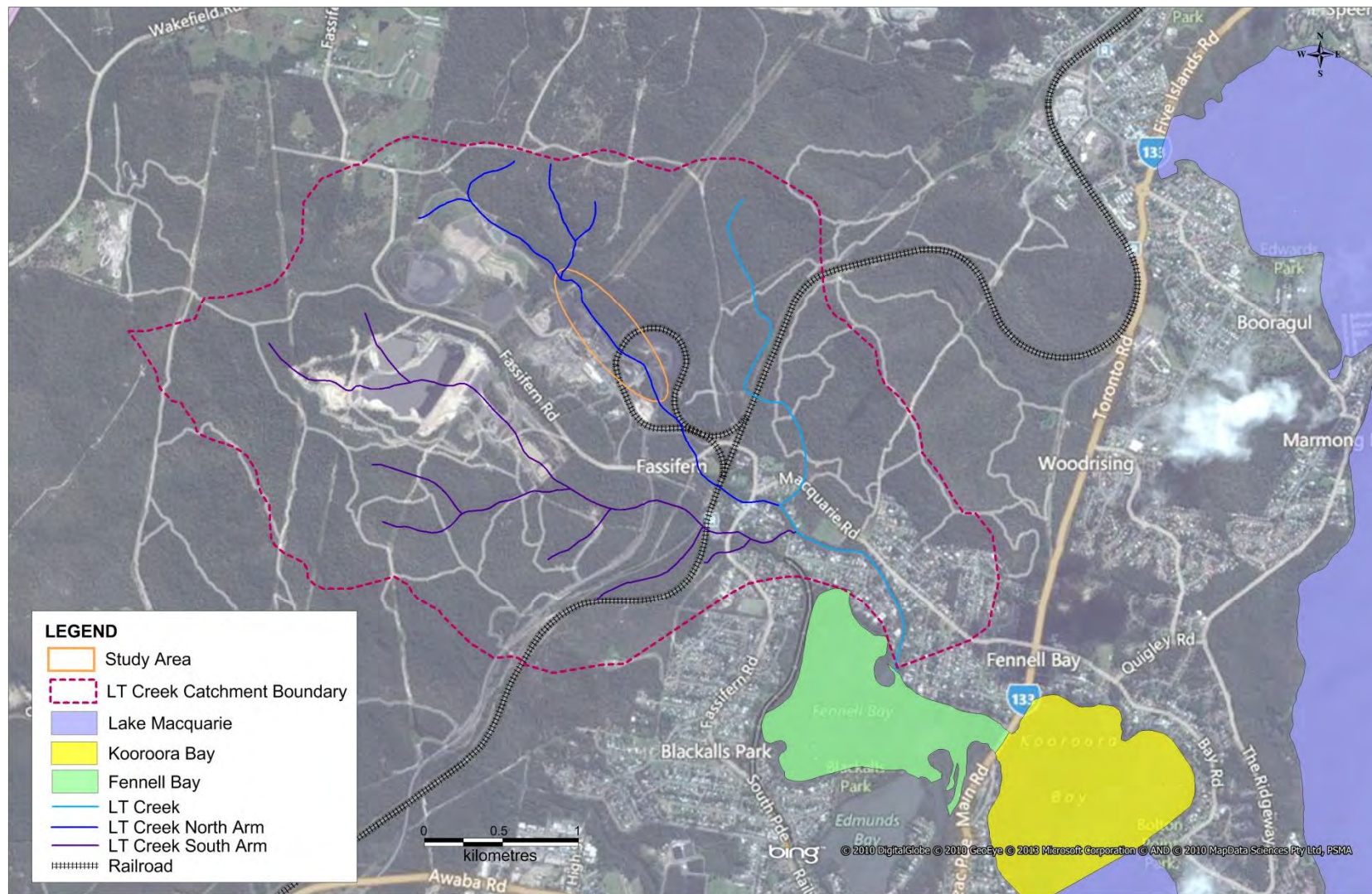


Figure 1-2: LT Creek Catchment boundary and watercourses

2 Legislative Context

2.1 Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act is administered by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC). The aims of the Act are to:

- Provide for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance (NES);
- Promote ecologically sustainable development through conservation and ecologically sustainable use of natural resources;
- Promote conservation of biodiversity;
- Provide the protection and conservation of heritage.

In the aquatic environment, the Act lists the following matters of NES relevant to this study:

- Nationally threatened species, ecological communities, critical habitats and Key Threatening Processes (KTP);
- Migratory species;
- Ramsar wetlands of national significance.

Under the EPBC Act, any action that will have, or is likely to have a significant impact on a matter of NES must be referred to the Australian Government Minister for a decision on whether assessment and approval is required under the EPBC Act. To assist proponents in determining whether an action is likely to have a significant impact on a matter of NES, DSEWPAC's reference Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (DEWHA 2009) is available.

The EPBC Act also provides for the identification and listing of KTPs. A KTP may be identified and listed if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.

To comply with EPBC Act, a survey of the study area needs to be conducted targeting any matters of NES (nationally threatened species, ecological communities, critical habitats, migratory species, Ramsar wetlands). If any of these items are identified within, or are relevant to the study area of this Project, these will need to be assessed under the EPBC Act.

2.2 The Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act is the principal piece of legislation overseeing the assessment and determination of development proposals in NSW. It also establishes the framework under which environmental planning instruments (e.g. State Environmental Planning Policies and Local Environmental Plans) which guide planning decisions are prepared.

The EP&A Act contains several pathways under which development can be assessed and determined.

The Northern Coal Logistics Projects is considered State significant development and, as such, Northern Coal Services is seeking approval under Division 4.1 of Part 4 of the EP&A Act

Under the EP&A Act, any development that will have a significant impact on the environment requires preparation of an environmental impact assessment. This aquatic ecology impact assessment has been prepared to support of the wider Environmental Impact Statement (EIS) for The Project.

As the project is being assessed as a State significant development, preparation of a Species Impact Statement is not required as outlined in Section 78A(8) of the EP&A Act.

2.3 Threatened Species Conservation Act 1995 (TSC Act)

In NSW, the TSC Act, administered by the Office of Environment and Heritage (OEH), formerly the Department for Environment Climate Change and Water (DECCW) includes provisions to declare threatened species, populations, ecological communities and KTPs. Species populations and communities identified as 'endangered' are listed in Schedule 1 of the TSC Act. Species populations and communities identified as 'critically endangered' are listed in Schedule 1A of the TSC Act and species populations and communities identified as 'vulnerable' are listed in Schedule 2 of the TSC Act.

Marine birds, mammals and reptiles are included in Schedules of the TSC Act whereas all fish and marine vegetation and some aquatic invertebrates are listed under the FM Act (see below). In addition, the TSC Act provides for the identification and listing of habitat that is critical to the survival of an endangered species, population or ecological community.

Any organisms found within the study area that are listed in the TSC Act will require specific assessment under this legislation to assess any potential impact by the development.

2.4 Fisheries Management Act 1994 (FM Act)

The FM Act seeks to conserve fish stocks, key fish habitats and threatened species, populations and ecological communities of fish and marine vegetation. Species populations and communities identified as 'endangered' are listed in Schedule 4 of the FM Act. Species populations and communities identified as 'critically endangered' are listed in Schedule 4A of the FM Act and species populations and communities identified as 'vulnerable' are listed in Schedule 5 of the FM Act. The FM Act also lists KTPs that may threaten the survival of those species, populations and ecological communities.

Section 19 of the FM Act allows for the declaration of specified species as protected fish, although not currently declining, these fish must be protected so they do not become threatened in future. Provisions for the protection of aquatic habitats and aquatic reserves are included under Part 7 of the Act. In addition, Division 3 of the FM Act provides for the identification of habitat that is critical to the survival of an endangered species, populations or ecological communities.

Section 218 of the FM Act outlines legislative obligations for fishways to be provided in construction of dams and weirs. The Minister may, by order in writing, require a person (other than a public authority) who constructs, alters or modifies a dam, weir or reservoir on a waterway to carry out, within the period specified in the order, such works as may be so specified to enable fish to pass through or over the dam, weir or reservoir. A person (other than a public authority) must not construct, alter or modify a dam, weir or reservoir on a waterway unless the person ensures that the Minister is given notice in writing of the proposed works at least 28 days before the commencement of the works.

3 Methodology

3.1 Sampling Sites

An initial visit to the study area was made to gain an appreciation of the aquatic habitat, water management practices and proposed development within the site. Four sampling sites were then selected to represent the length of the section of LT Creek (North Arm) below LDP001 and within the area of potential impact. All sites covered a length of approximately 100 m of the creek bank. Site locations, descriptions and GPS coordinates are provided in Table 3-1 and the sampling locations are illustrated in Figure 3-1.

Table 3-1: Site Locations and Descriptions

Site Name	Sampling Site Code	Description	Easting (UTM 56H)	Northing (UTM 56H)
LT Creek 1	LTC 1	Directly above the weir of the Main By-Wash Dam	6350722	0366683
LT Creek 2	LTC 2	Proposed upper piped section downstream of weir	6350567	0366717
LT Creek 3	LTC 3	Proposed lower piped section upstream of railway line	6350342	0366911
LT Creek 4	LTC 4	Below the lower piped section, downstream of the Haul Road	6349999	0367157

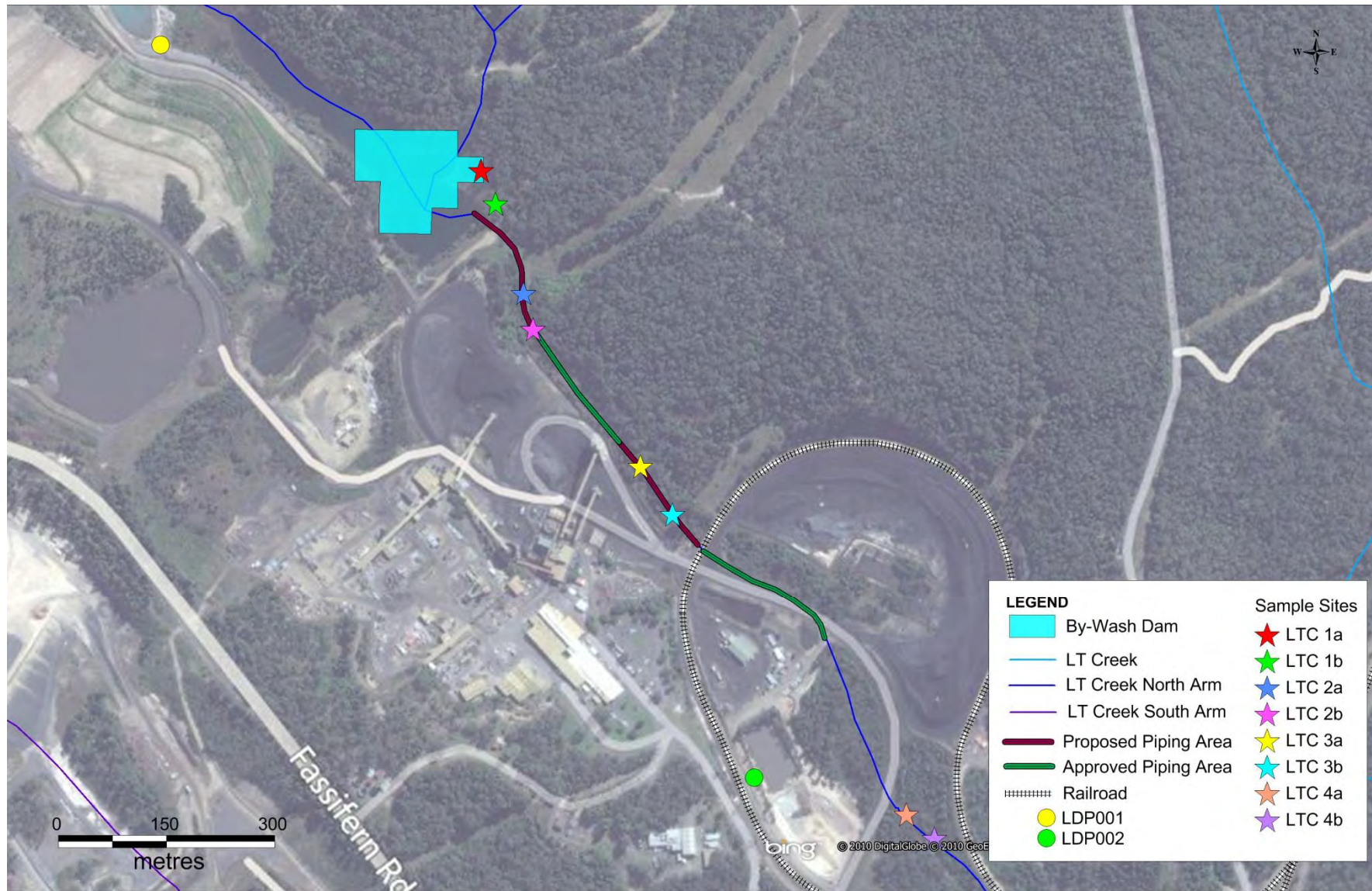


Figure 3-1: Locations of sampling sites

3.2 Sampling Methodology

3.2.1 Aquatic Habitat Assessment

The condition of the aquatic habitat at each site was assessed using a modified version of the Riparian, Channel and Environmental (RCE) Inventory Method (Chessman *et al.* 1997). This assessment involves evaluation and scoring of the characteristics of the adjacent land, the condition of riverbanks, channel and bed of the watercourse, and degree of disturbance evident at each site (Appendix 1). The maximum score (52) indicates a stream with little or no obvious physical disruption and the lowest score (13) indicates a heavily channelled stream without any riparian vegetation. This methodology developed by Peterson (1992), was modified for Australian conditions by Chessman *et al.* (1997) by combining some of the descriptors, modifying some of the associated categories and simplifying the classifications from 1 to 4.

3.2.2 Water Quality

Water quality was measured *in situ* with a YeoKal 611 water quality probe and meter that was calibrated prior to sampling. This was done before aquatic fauna were sampled to avoid disturbance to the waterway. The following variables were recorded:

- Temperature (°C);
- Electrical Conductivity (EC) (µs/cm);
- pH (pH units);
- Dissolved Oxygen (DO) (mg/L and % saturation);
- Oxidation Reduction Potential (ORP) (mV); and,
- Turbidity (NTU).

Two replicate readings of each variable were taken in accordance with Australian Guidelines (ANZECC/ARMCANZ 2000). Six replicate readings were taken for turbidity as this measure tends to be more variable.

3.2.3 Aquatic Macroinvertebrates

Two replicate samples of aquatic macroinvertebrates associated with edge habitats were collected at each site using the AUSRIVAS rapid assessment methodology (RAM) (Turak *et al.* 2004). Riffle habitat was not sampled, because this habitat was not adequately represented at any of the stretches of creek surveyed. Samples were collected with dip nets (250 µm mesh) over a period of 3-5 minutes from a 10 m length of habitat along the creek. The dip net was used to agitate and scoop up material from vegetated river edge sub-habitats including trailing vegetation, submerged macrophytes, rocky substrate, large wordy debris and detritus. Where habitat was discontinuous, patches of habitat with a total length of 10 m were sampled. Each RAM sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps and pipettes. Each tray was picked for a minimum period of forty minutes, after which they were picked at ten minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals in addition to those that were conspicuous or slow. The animals collected at each site were placed into a labelled jar containing 70% alcohol.

In the laboratory, each sample was sorted under a binocular microscope (at 40 X magnification), macroinvertebrates were extracted and identified to family level using standard references and up to ten animals of each family counted, in accordance with the latest AUSRIVAS protocol (Turak *et al.* 2004). Identifications were confirmed using standard references. After confirmation of sample identifications, samples were stored in 70% alcohol in containers appropriate for long-term storage.

The AUSRIVAS model was not used to interpret the macroinvertebrate data collected. This was due to the sampling being conducted well outside the sampling seasons specified by the model. Additionally, high carbonate alkalinity (as opposed to pH) was recorded and this generally results in outputs 'outside the experience of the model'.

The revised SIGNAL2 biotic index (Stream Invertebrate Grade Number Average Level) developed by Chessman (2003) was used to determine the “environmental quality” of sites on the basis of the presence or absence of families of macroinvertebrates. This method assigns grade numbers to each macroinvertebrate family or taxa found, based largely on their responses to chemical pollutants. The sum of all grade numbers for that habitat was divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index. The SIGNAL2 index therefore uses the average sensitivity of macroinvertebrate families to present a snapshot of biotic integrity at a site.

The SIGNAL2 outputs were plotted to display the number of macroinvertebrate taxa and the SIGNAL2 index on separate axis to provide a graphical representation of these data. This diagram is referred to as a SIGNAL2 bi-plot by Chessman (2003) and is usually separated into quadrants representing the level of biological impairment at each sample site (Figure 3-2).

Definition of the biological impairment using these two values (number of taxa and SIGNAL2 index) is somewhat arbitrary and depends on factors such as geographical location and the condition of the aquatic habitat. In general, SIGNAL2 values greater than 6, between 5 and 6, 4 and 5 and less than 4 indicate that the quality of the water is clean, mildly, moderately or severely degraded, respectively. Taxa richness values greater than 20, between 15 and 20, 10 and 15 and less than 10 generally indicate a rich assemblage, moderately degraded, severely degraded and depauperate community respectively. For the purpose of this study, bi-plot boundaries were set at 20 for the number of taxa represented and 4.5 for the SIGNAL2 index to produce a region of ‘high environmental quality’ quadrat above these two values.

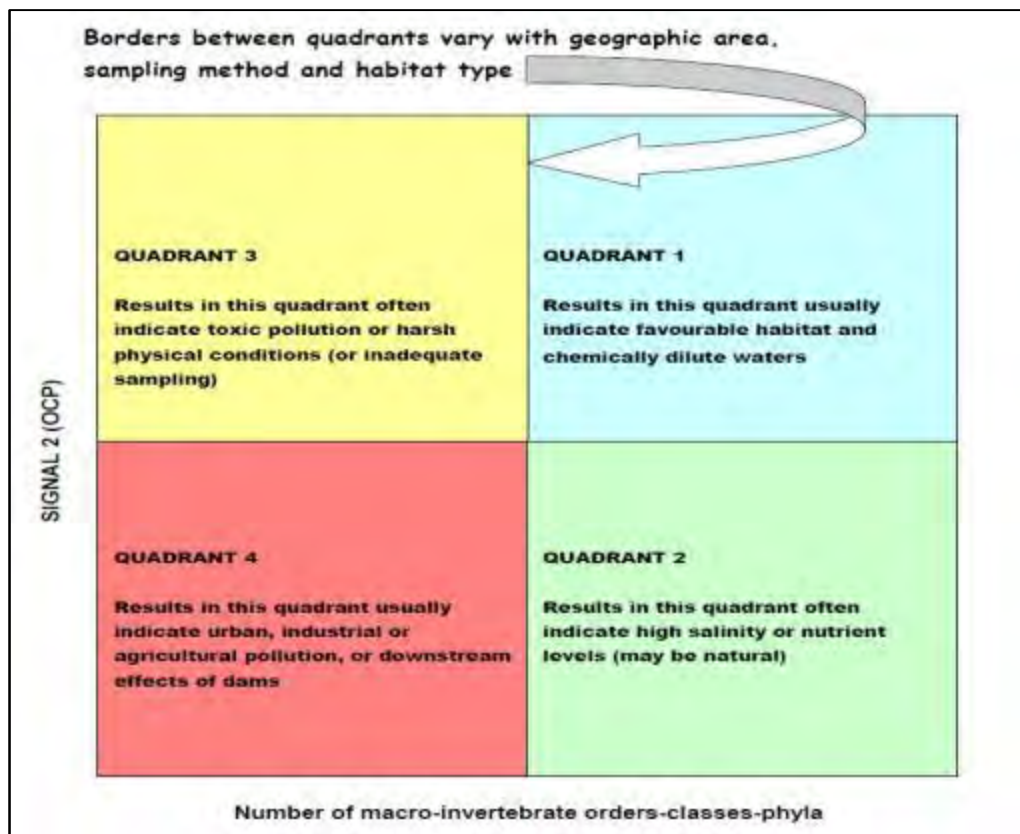


Figure 3-2: SIGNAL2 quadrat descriptions from Chessman (2003).

3.2.4 Fish

At each site, four collapsible bait traps were deployed overnight in discrete locations on the creek bed, amongst vegetation and near submerged logs or within dense vegetation. The traps used were 350 mm long and 200 mm wide, and were constructed of 3 mm wide mesh, with an entrance that tapers in to 15 mm.

Seine netting (using a small 4 m long net with 1 m drop and mesh size 5 mm) was attempted in the shallow margin of the Main By-wash Dam although was unsuccessful due to the sediment and macrophyte density, which prevented acceptable retrieval and therefore catch.

Backpack electrofishing is a non-destructive technique that is restricted to depths of approximately 1 m (hip height) and water bodies with low to moderate salinity. Backpack electrofishing was not used in LT Creek due to high electrical conductivity, which renders the electric pulses generated by the electrofisher ineffective.

All fish caught were placed into a tub containing creek water, identified, counted, checked for abnormalities and then released as quickly as practicably possible. The numbers of each species of fish captured at each site were recorded on data sheets. Non-native species were humanely disposed of, as per DPI guidelines. All fish captured and their fates were reported to the DPI and the Director General's Ethics Committee as per the conditions of our permit to sample fish.

3.2.5 Aquatic Macrophytes

Submerged, emergent and riparian aquatic macrophytes occurring in-stream and within 1m of the wetted bank edge were surveyed at each of the survey sites. This was completed by walking the length of the site along the creek line and identifying and recording all plants within this zone. Most of the plant identifications were completed in the field by an experienced aquatic ecologist. Where identifications were not made in the field, specimens were collected and preserved in a plant press or wet bag (for succulent species) for later identification in the laboratory or by an expert botanist at the Royal Botanic Gardens Herbarium in Sydney. Due to the time of year of the survey, numerous plants were not flowering and were therefore difficult to identify to species level. Where this was not possible, identification was made to the lowest level of taxonomic resolution possible and subsequent checks of the literature were made to eliminate any threatened or endangered species from the identification.

3.3 Assumptions and Constraints

LT Creek was visually surveyed during an initial site visit on 12 June 2012, between the By-wash Dam weir and the railway crossing downstream. This initial assessment provided a broad description of the aquatic habitat along this section of the creek, around the newly proposed pipe sections. The aquatic habitat along this stretch of the creek was assessed as relatively homogenous, and two study sites were subsequently selected to represent this reach in the detailed field investigation. It is assumed that the two sites selected adequately represent the aquatic ecosystem within this area of the creek. The area in between the two selected sites was not visited during the detailed investigation and is assumed to contain similar aquatic species to those areas assessed.

The field survey completed covered the aquatic and riparian environment within 1m of the creek and did not examine the terrestrial margins of this zone. Riparian zone flora and fauna located away from the creek and the terrestrial environment were not included in the survey.

A targeted search for frogs was completed by RPS (A. Smith 2012 email comm., 5 October) but no searches were undertaken for waterbirds during this investigation. Comments on the presence or absence of waterbirds have therefore been based on available habitat and known distributions.

3.4 Literature Review

A review of available information on the aquatic ecosystem of LT Creek and the proposed Project was undertaken for this assessment. The key documents reviewed are:

- BMT WBM (2011). *LT Creek Flood Study - Final Report*. Prepared for Lake Macquarie City Council.
- Centennial Coal (2009). *Revised Water Management Plan*.
- Centennial Coal (2012). *Newstan Colliery Extension of Mining Project Briefing Paper*.

- GHD (2009). *Centennial Coal – Newstan: Surface Water Quality Baseline Study*. Prepared for Centennial Newstan Pty Ltd.
- GHD (2011). *Centennial Newstan: Report for LT Creek Ecotox Study - Ecotoxicological Assessment and Trigger Values*. Prepared for Centennial Newstan Pty Ltd.
- GHD (2012). *Centennial Newstan: Downstream Assessment of LT Creek Report*. Prepared for Centennial Newstan Pty Ltd.
- GHD (2012). *Centennial Newstan: Report for Treated Discharge Water Ecotoxicology*. Prepared for Centennial Newstan Pty Ltd.
- Umwelt (2009). *LT Creek Catchment Water Quality Management Plan*. Prepared on behalf of Lake Macquarie City Council.

3.5 Database Searches

A search of the Bionet Atlas of NSW Wildlife database was conducted for threatened flora and fauna species recorded since 2000 in a 5km by 5km search area surrounding the site on 6 July 2012. The EPBC Database (Protected Matters Search Tool) was also searched on 4 August 2012 with a 1km search buffer around the study area. The results of the searches are discussed in Section 4.2.1.

4 Existing Environment

4.1 Physical Setting

LT Creek is located on the western side of Lake Macquarie, draining to the northern side of Fennel Bay (Figure 1-2) with a catchment area of approximately 7.5km². Alternate layers of sandstone, coarse pebbly conglomerate and fine grained claystone underlie the ridges and slopes in the catchment. Small cliffs, steep rock slopes and flatter benches form on different rock types. The topography of the catchment area generally consisted of rolling low hills with short side slopes and numerous closely spaced drainage lines, on predominately coarse-grained sediments of the Narrabeen Group and Newcastle Coal Measures. Slope gradients were generally 10 – 25 per cent and local relief was between 20 m and 110 m Australian Height Datum (AHD) (Centennial Coal 2012).

Severe sheet, rill and gully erosion of dispersible soils has occurred in the LT Creek catchment where groundcover vegetation and catchment hydrology have been disturbed by land uses such as mining, urban and infrastructure (power easements, rail and road). Together with runoff from the Newstan Colliery that may be contaminated with fine coal particles as well as sand and clay from the local bedrock and soils, this catchment erosion has resulted in very high sediment concentrations in LT Creek during rainfall events (Umwelt 2009).

4.2 Aquatic Habitat

Detailed descriptions of the aquatic habitat observed during the field investigation on 9 and 10 July 2012 are provided below. Also described are the locations and sub-habitat characteristics at the location of each of the macroinvertebrate sampling points.

4.2.1 LT Creek (North Arm)

At the time of the site inspection (9-10 July 2012), the hydrology and water quality of the North Arm of LT Creek was dominated by the discharge of water from Newstan Colliery's LDP001. Water management structures including dams, weirs, culverts, flow diffusers and a largely modified and unnatural channel form are the most prominent features of the creek.

The channel width ranged from around 1m in the steeper narrow sections (and piped areas around the rail loading facility) to over 100m at the earthen wall of the By-wash Dam. At the time of the inspection, water depth in the thalweg ranged from around 0.5m along the flowing channel to greater than 1m (unmeasured) within the By-wash Dam. Sediment accumulation within the main channel (and assumedly within the By-wash Dam) was severe, with depths of greater than 0.5m recorded in the flowing channel despite moderate flow velocity. The water was brackish in the supra-tidal creek channel, which has been the norm for several decades due to mine water discharges (Stuart C. Gray 2012 pers. comm. 27 September).

The in-stream habitat consisted of some large woody debris and large levels of detritus mixed in amongst a thick bed of blanketing silt substrate. In-stream submerged and emergent macrophytes (including dense macroalgae) were moderately abundant along most of the creek and By-wash Dam. Riparian zone macrophytes were also abundant with some trailing vegetation also present. Erosion controls were in place in the form of modified bank structures. Erosion was observed in some areas where erosion controls were not in place.

4.2.1.1 LT Creek 1 – Directly above the By-wash Dam

This site was located directly upstream of the By-wash Dam (Plate 1) at the south-eastern edge of stored water. The riparian vegetation at this site was dominated by a canopy of *Angophora costata* with a shrub layer of *Melaleuca sp.*, *Acacia sp.*, *Dodonea sp.*, and other native shrubs. A sparse cover of native and exotic grasses was also present. The banks were steep and unnatural around the weir channel becoming gentler around the main stored water area. The eastern banks of the dam were generally less disturbed than the western banks, where mining activity and related vegetation disturbance was more evident.

Macroinvertebrate sample #1 (LTC 1a) was collected around the eastern bank of the By-wash Dam, around 50 m upstream of the main high flow weir (Plate 2). The dam was close to 100m wide at this point and greater than 0.5m deep around the sampled edge. The water here was still and slightly turbid with an exclusively silt and detritus substrate.

that produced large quantities of anoxic gas when disturbed. A dense cover of emergent aquatic macrophytes was present around the sample area (predominantly *Triglochin microtuberosum*, *Bacopa monnieri* and *Schoenoplectus validus*) and large areas of *Typha orientalis* were dominant elsewhere around the periphery of the dam.

Macroinvertebrate sample #2 (LTC 1b) was collected in the channel directly upstream of the main high flow weir (Plate 1). The channel was approximately 3 m wide and reached over 1 m deep in the middle of the channel, close to the weir. The water here was flowing slowly and was slightly turbid. The substratum was predominantly silt with a small amount of sand and gravel which produced moderate quantities of anoxic gas when disturbed. A concrete bank existed on the eastern edge and a submerged concrete structure was present perpendicular to the bank within the channel. Emergent macrophytes present included *Baumea articulata*, *Typha orientalis* and *Bacopa monnieri*, while the submerged macro-algae *Chara* sp. was relatively dense close to the weir.

4.2.1.2 LT Creek 2 – Proposed upper piped section

This site was located approximately 50m downstream of the By-wash Dam Weir, where access was amenable. The riparian vegetation at this site was dominated by a canopy of *Eucalyptus* sp. and a small number of *Syncarpia glomulifera*, with *Glochidion ferdinandi* and various *Melaleuca* sp. dominant closer to and within the creek. Shrubs in the riparian zone included *Dodonaea* sp. and smaller specimens of *Melaleuca* sp. and *Glochidion ferdinandi*. Various ferns, vines and grasses were present in the understorey. The eastern bank was of a gentle slope close to the access road and the western bank was relatively steep and unnaturally covered with riprap to prevent erosion.

Macroinvertebrate sample #1 (LTC 2a) was collected around a series of small, heavily silted pools upstream of the GPS location recorded (Plate 3). The creek here was approximately 6m wide and 0.25 - 0.5m deep. The substratum consisted entirely of silt and detritus and the channel was braided by loose sediment that produced anoxic gas when disturbed. The flow velocity was moderate and the water relatively clear, with few snags or woody debris present. A small riffle like section was present upstream (Plate 4), although this was too small and silty to warrant sampling. Herbaceous emergent macrophytes present included the noxious weed *Ageratina adenophora*, the native sedge *Schoenoplectus validus* and *Typha orientalis*. Submerged macrophytes present around the pools included *Potamogeton* sp. and the macro-algae *Nitella* sp.

Macroinvertebrate sample #2 (LTC 2b) was collected downstream of the GPS position in moderately sized, heavily silted pools, similar to those upstream. The creek became swamplier and was up to 12m wide and around 0.3m deep. The substratum again consisted entirely of loose, anoxic, gaseous silt and detritus. The flow velocity was moderate in the main line of flow and low to still in the wider offline areas. *Melaleuca* sp. and *Glochidion ferdinandi* were dominant shrubs within the channel and *Triglochin* sp., *Gahnia clarkei*, *Typha orientalis* and *Ageratina adenophora* were present in the understorey.

4.2.1.3 LT Creek 3 – Proposed lower piped section

This site was located directly upstream of the rail line and loading facility (Plate 5). The riparian vegetation at this site was similar to that of the site directly upstream with *Eucalyptus* sp., *Glochidion ferdinandi* and *Melaleuca* sp. dominant. Some *Pittosporum undulatum* were also present in the canopy and a large bed of *Nephrolepis cordifolia* was present on the eastern bank. The banks were slightly steeper than further upstream and both sides were unnaturally covered with riprap to prevent erosion, some pieces of which had made their way into the channel. The in-stream habitat was also of a similar character to that described for the LT Creek 2 site.

Macroinvertebrate sample #1 (LTC 3a) was collected at the upstream end of the site below a concrete weir (Plate 6). The creek was reduced to around 1 - 2m wide at this point and close to 1m deep, including a very deep layer of loose, silty, anoxic sediment (approximately 0.5m). A reasonable amount of large woody debris was present in the creek at this point and the flow velocity was moderate. A dense bed of emergent *Schoenoplectus validus* and *Typha orientalis* was present above the weir with far fewer plants present below it.

Macroinvertebrate sample #2 (LTC 3b) was collected upstream of the culvert below the railway line (Plate 5). Here the creek was around 2m wide and the water around 0.5 m deep with loose, silty, anoxic sediment again around 0.5m deep. Some emergent macrophytes were present along the banks and included *Gahnia clarkei*, *Typha orientalis* and *Ageratina adenophora*. Some submerged *Potamogeton* sp. was observed in the channel close to the culvert.

4.2.1.4 LT Creek 4 – Downstream of the Newstan-Eraring Private Haul Road

This site was located downstream of the rail loading facility and private haul road. The riparian vegetation and in-stream habitat at this site were separated into two relatively distinct zones. The area within 30 m of the culvert and flow diffusion structure was swampy and dominated by a canopy of *Melaleuca sp.* and an understorey of *Gahnia clarkei*. Below this, the channel became deep and appeared to have been either artificially cut out or severely eroded and was dominated by *Typha orientalis*.

Macroinvertebrate sample #1 (LTC 4a) was collected closest to the culvert in the upper swampy zone described (Plate 7). The creek was approximately 15m wide and relatively shallow (approximately 0.4m), around half of this depth being loose silty anoxic sediment. A bed of *Typha orientalis* grew closest to the culvert. Downstream some large woody debris was present, mostly in the form of exposed *Melaleuca styphelioides* tree roots. The water velocity was slow and pooling in some areas due to the wideness and spreading nature of the waterway. *Gahnia clarkei*, *Lantana camara* and *Ageratina adenophora* were the dominant plants amongst the *Melaleuca* canopy.

Macroinvertebrate sample #2 (LTC 4b) was collected downstream of the swampy area described above, in a relatively deep channel below a series of small waterfalls (Plate 7) (around 10 cm drop) that transected the creek in an approximately north-south direction. The channel was relatively deep (> 1m in the centre) with very deep, loose, anoxic sediment taking up around half of this depth. The banks of the channel were heavily eroded and appeared to have been unnaturally cut in the past, or scoured out by high flows. The upstream end of the channel was a small pool (Plate 7), relatively devoid of vegetation, before dense bed of *Typha orientalis* and other emergent macrophytes (*Schoenoplectus validus*) and weeds (*Cortaderia selloana*) covered the channel entirely (Plate 8).

4.2.2 Threatened Species

A desktop study and site inspection (9-10 July 2012) were conducted to establish the existing environment with respect to riparian flora and fauna at the site. Ecological databases searched during the desktop study included:

- EPBC Database (with a 1km radial buffer around the proposed piping of LT Creek works);
- NSW FM Act list of threatened, endangered and protected fish species in NSW;
- NSW NPWS Wildlife Atlas (with a 5km x 5km buffer around the proposed piping of LT Creek works); and
- OEH Critical Habitat Register.

Note that these databases are indicative records of flora and fauna species recorded in the locality only and are not the result of a systematic flora and fauna survey.

4.2.2.1 Flora

A search of the Bionet NSW Wildlife Database and the EPBC Protected Matters Search tool identified a total of 30 types of flora species that could occur or have previously occurred within 5km of the works site that are protected under the TSC Act and/or the EPBC Act. No Endangered Ecological Communities (EECs) were identified as having potential to be located within 1km of the study area according to the EPBC Database. The protected, threatened and endangered flora species are listed in Table 4-1 and their locations illustrated in Figure 4-1.

Table 4-1: Threatened Flora Species within 5km of the Study Area

Scientific Name	Common Name	Classification	
		EPBC Act	TSC Act
<i>Acianthus fornicatus</i>	Pixie Caps	-	P
<i>Acacia bynoeana</i>	<i>Bynoe's Wattle</i>	V	E
<i>Angophora inopina</i>	Charmhaven Apple	V	V
<i>Archontophoenix cunninghamiana</i>	Bangalow Palm	-	P
<i>Banksia spinulosa</i>	Hairpin Banksia	-	P
<i>Banksia spinulosa</i> var. <i>collina</i>		-	P
<i>Boronia polygalifolia</i>	Dwarf Boronia	-	P
<i>Caladenia catenata</i>	White Caladenia	-	P

Scientific Name	Common Name	Classification	
		EPBC Act	TSC Act
<i>Caladenia</i> spp.		-	P
<i>Callistemon linearifolius</i>	Netted Bottle Brush	-	V
<i>Calochilus paludosus</i>	Red Beard Orchid	-	P
<i>Cymbidium suave</i>	Snake Orchid	-	P
<i>Dicksonia antarctica</i>	Soft Treefern	-	P
<i>Doryanthes excelsa</i>	Gymea Lily	-	P
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge	-	P
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V
<i>Kunzea ambigua</i>	Tick Bush	-	P
<i>Livistona australis</i>	Cabbage Palm	-	P
<i>Macrozamia communis</i>	Burrawang	-	P
<i>Maudia triglochoides</i>		-	V
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	V	V
<i>Persoonia levis</i>	Broad-leaved Geebung	-	P
<i>Persoonia linearis</i>	Narrow-leaved Geebung	-	P
<i>Prasophyllum</i> spp.		-	P
<i>Pterostylis</i> spp.	Greenhood	-	P
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	V	V
<i>Tetradlea juncea</i>	Black-eyed Susan	V	V
<i>Xanthorrhoea latifolia</i>		-	P
<i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i>		-	P
<i>Xanthorrhoea</i> spp.		-	P

P = Protected; V = Vulnerable; E = Endangered

4.2.2.2 Fauna

A search of the Bionet NSW Wildlife Database and the EPBC Protected Matters Search tool identified 16 types of protected, threatened and endangered fauna species and 3 types of migratory marine birds that could occur or have previously occurred within 5km of the works site that are protected under the TSC Act and/or the EPBC Act. These species are listed in Table 4-2 and their locations illustrated in Figure 4-1.

Table 4-2: Threatened Aquatic Fauna Species and Migratory Marine Birds within 5km of the Study Area

Scientific Name	Common Name	Classification		
		EPBC Act	TSC Act	FM Act
<i>Epinephelus daemeli</i>	Black Rockcod, Black Cod, Saddled Rockcod	V	-	V
<i>Mixophyes balbus</i>	Stuttering Frog	V	-	-
<i>Mixophyes iteratus</i>	Giant Barred Frog	E	E	-
<i>Crinia signifera</i>	Common Eastern Froglet	-	P	-
<i>Limnodynastes peronii</i>	Brown-striped Frog	-	P	-
<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	-	P	-
<i>Litoria aurea</i>	Green and Golden Bell Frog	V	E	-
<i>Litoria chloris</i>	Red-eyed Tree Frog	-	P	-
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	-	P	-
<i>Litoria latopalmata</i>	Broad-palmed Frog	-	P	-
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog, Heath Frog	V	V	-
<i>Litoria peronii</i>	Peron's Tree Frog	-	P	-
<i>Litoria tyleri</i>	Tyler's Tree Frog	-	P	-
<i>Litoria verreauxii</i>	Verreaux's Frog	-	P	-
<i>Pseudophryne coriacea</i>	Red-backed Toadlet	-	P	-
<i>Uperoleia fusca</i>	Dusky Toadlet	-	P	-

Scientific Name	Common Name	Classification		
		EPBC Act	TSC Act	FM Act
<i>Apus pacificus</i>	Fork-tailed Swift	M	-	-
<i>Ardea alba</i>	Great Egret, White Egret	M	-	-
<i>Ardea ibis</i>	Cattle Egret	M	-	-

V = Vulnerable; E = Endangered; M = Migratory

4.2.2.3 Aquatic Species

Most of the protected flora and some of the protected fauna are terrestrial organisms and are therefore not associated with the aquatic environment that is under investigation in this assessment. An assessment of the likelihood of each of these organisms occurring in close proximity to LT Creek is provided in Appendix 9 based on habitat present and environmental requirements of the organisms.

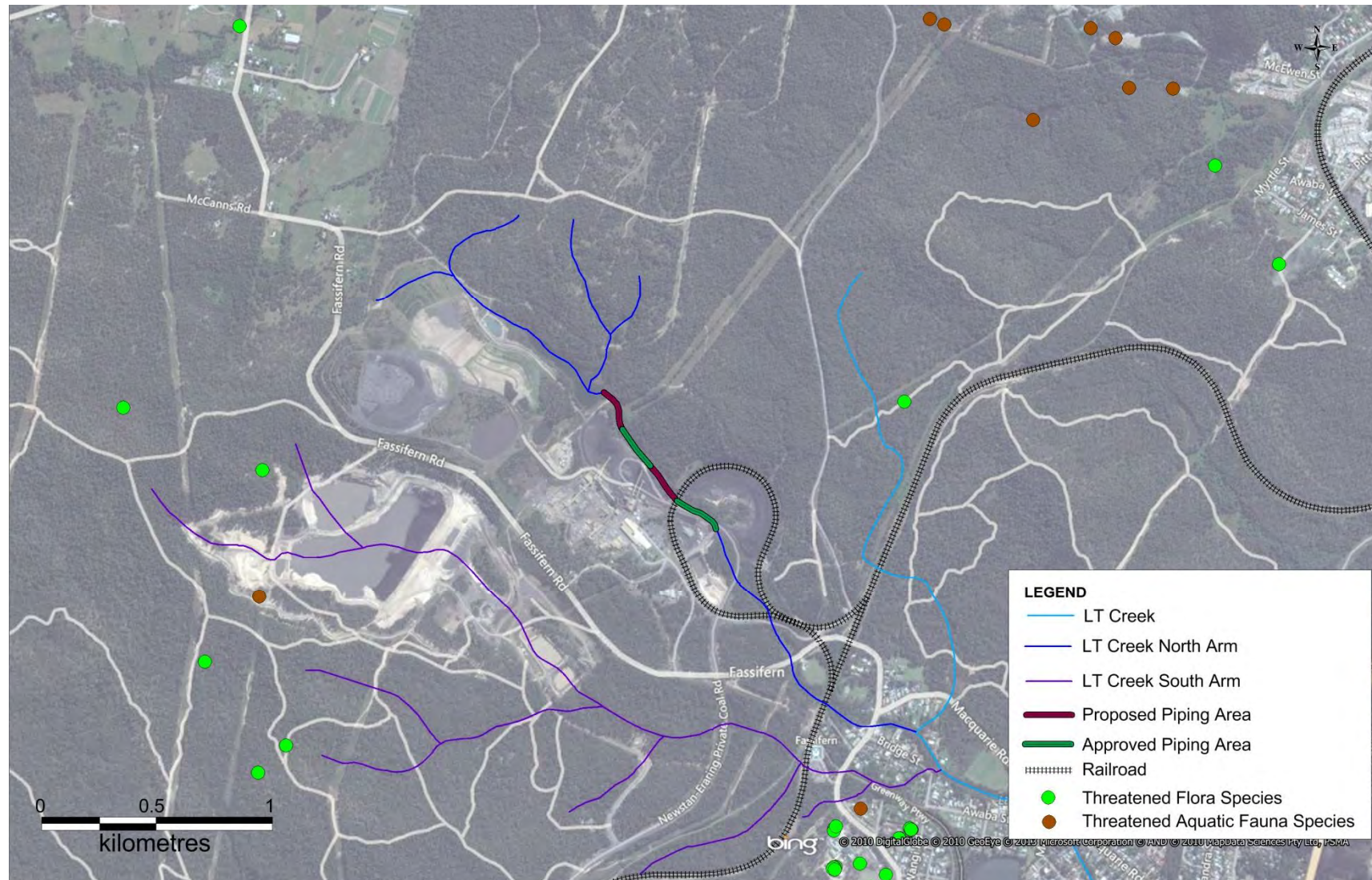


Figure 4-1: Threatened species (listed under the TSC Act) recorded around the LT Creek study area (5km x 5km search area) since 2000.

4.3 Water Management and Monitoring

Water in the LT Creek North Arm is dominated by the discharge from mining operations during dry weather conditions and by rainfall runoff during certain rainfall events. As previously noted, Newstan Colliery's EPL 395 permits the discharge of water from the Newstan Colliery Surface Site via two Licenced Discharge Points, which are identified in Figure 1-1. The figure in Appendix 4, taken from the Northern Coal Logistics Water Balance (GHD 2013), illustrates water movement around the Newstan Colliery Surface Site.

GHD (2011) have described water quality data collected from:

- WMP01 (LT Creek North Arm upstream of LDP001);
- WMP09 (LT Creek South Arm in the upper catchment);
- LDP001 (at the LDP001 discharge point); and
- WMP03 (within the By-wash Dam).

Robust background water quality data was only available from the sampling site WMP09 on the South Arm of LT Creek. Background data for WMP01 was incomplete due to the ephemeral nature of creek upstream of the By-wash Dam and high salinity measurements between January 2002 and March 2013 that were not deemed suitable background information and were therefore excluded. Data collected from WMP03 (Appendix 2), being the most spatially representative site sampled, were used to describe water quality of LT Creek North Arm within the current area of investigation. The location of sampling points WMP01, WMP09, LDP001 and WMP03 are illustrated in Figure 4-2.

4.3.1 Licenced Discharge Points

The current conditions of the licence contain both concentration and volume limits as specified in the Environmental Protection Licence (Appendix 11).

4.3.1.1 LDP001

LDP001 at the Newstan Colliery Surface Site is located in the upper storage of the By-wash Dam and is licenced to discharge up to 11 ML per day under normal weather conditions. If water quality indicates additional settling time is required to reduce suspended solids, water can be pumped through LDP001 to discharge into Graunches Dam, which has a temporary storage capacity of approximately 9 ML (Cells 1 and 2) before controlled overflow into the By-wash Dams. An increase of 3.5 ML per day to 14.5 ML per day is currently being sort for this discharge point as part of this Project.

4.3.1.2 LDP002

LDP002 is located downstream of the Newstan Colliery Surface Site at the Final Pollution Control Dam (FPCD). A recent upgrade of the FPCD increased the storage capacity from 18 ML to around 50 ML. LDP002 is only permitted to discharge into LT Creek if the storage capacity of the FPCD is exceeded during rainfall events.

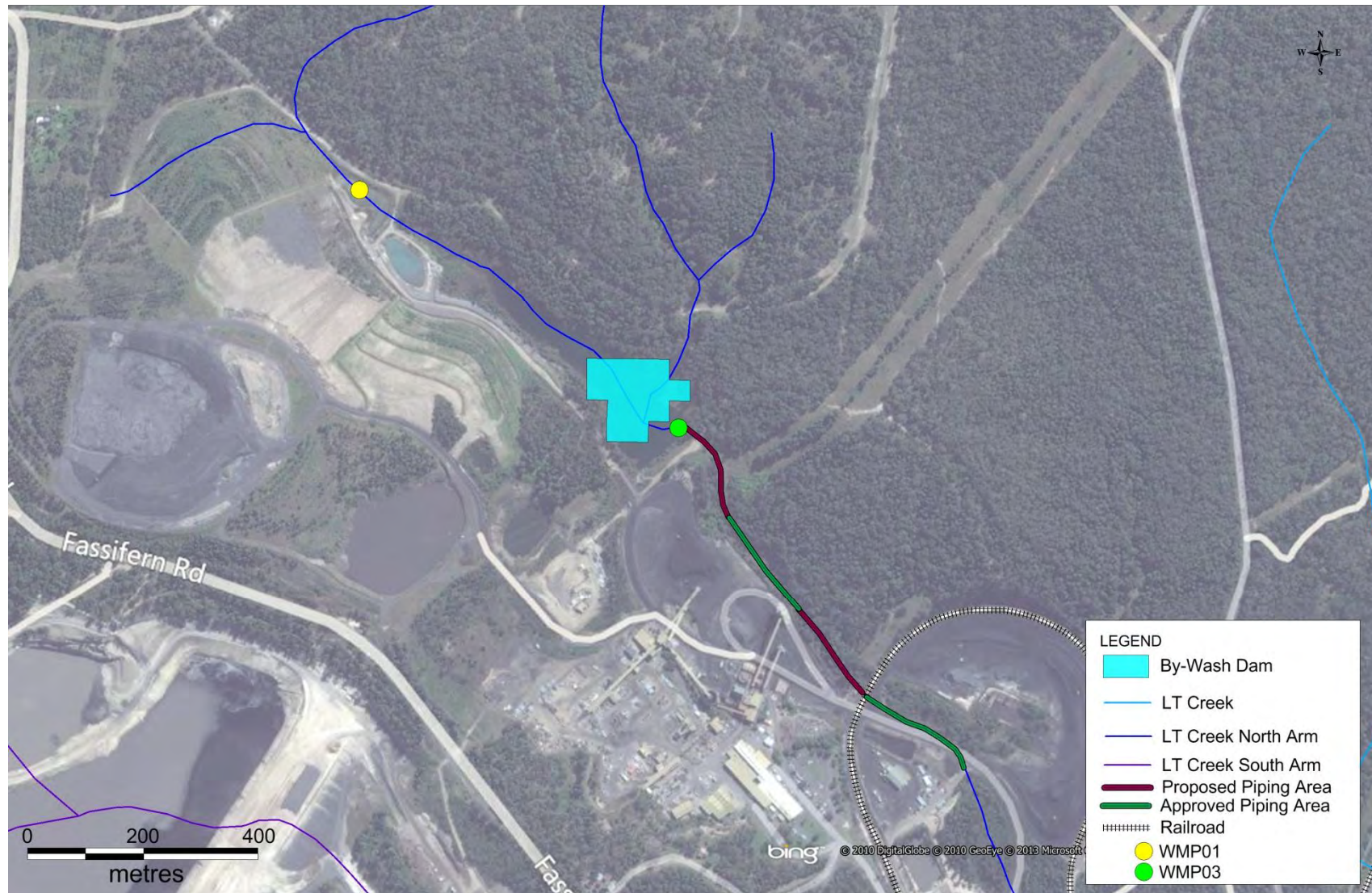


Figure 4-2: GHD (2009) Water Sampling Locations WMP01 and WMP03.

4.3.2 Overview of Water Quality Within LT Creek

GHD (2011) derived site specific trigger values for LT Creek based on background water quality data. Sites selected as appropriate background sites for LT Creek were:

- WMP01 (LT Creek North Arm); and
- WMP09 (LT Creek South Arm).

The 50th percentile concentrations reported at the WMP3 site were compared with the adopted trigger values (either the site specific trigger value or the default ANZECC and ARMCANZ (2000) value) in Appendix 3.

The elevated electrical conductivity is indicative of a high concentration of dissolved ionic constituents, which can be seen from the analysis of water samples from the WMP03 site undertaken for the ecotoxicology investigation conducted by GHD (2011). From the sample taken from WMP03 in May 2011, high bicarbonate (590 mg/L), chloride (437 mg/L), sulphate (128 mg/L) and sodium (599 mg/L) ions were detected (GHD 2011).

Arsenic (0.028 mg/L) and selenium (0.11 mg/L) concentrations were detected above the site specific trigger values for the sample collected in the GHD (2011) investigation, although arsenic concentrations were very low (maximum of 0.003) in the historical dataset summarised by GHD (2009). The ecotoxicology assessment conducted by GHD (2011) for the untreated mine water discharge indicated toxicity effects for some of the organisms tested, with the cladocera and larval fish taxa being most affected.

A subsequent ecotoxicology assessment was conducted using 'treated' mine water discharge and resulted in considerably reduced toxicity (GHD 2012b). The water used for this subsequent ecotoxicology assessment is understood to have been treated using the chemical coagulation/flocculation, settlement and filtration method outlined in Hunter Water (2011). Water quality test results from the water treatment trial were not available from the Hunter Water (2011) report, although the treatment method is likely to have resulted in the removal of total solids and other suspended contaminants. Conditions of the EPL (Appendix 11) also require Northern Coal Services to undertake a detailed sampling regime of the treated mine water following the commissioning of the water treatment plant.

Total contaminant load downstream of the discharge in relation to the aquatic ecosystem have been considered in the surface water assessment report currently being prepared by GHD (L. Hammersly, 2013, *letter comm.* 10 April), in addition to the specific contaminant concentration. If total water volume increases, total mass of contaminants is increased proportionally given unchanged concentration. This increased mass of contaminants, particularly for total and dissolved solids, increases the potential impact on the receiving environment and ecosystem, in terms of potential sedimentation and overall contribution to the stream and estuary. This would be most evident during high flow events such as significant rainfall and is also relevant in relation to increased licenced discharges.

4.4 Sediment

High concentrations of suspended solids have been recorded in LT Creek, particularly after heavy rainfall, and this has been attributed to elevated erosion in the upper catchment, contaminants from mine water discharge and poor historical sediment control within the Newstan Colliery (Umwelt 2009). Significant settling and accumulation of this suspended material has been recorded along the freshwater section of LT Creek, within the estuarine channel and within Fennell Bay. Sediment is evidently mobilised after heavy rainfall, when high volumes of catchment runoff increase vertical mixing and longitudinal velocities within the settlement basins and along the creek. A large increase in the total load of contaminants would be expected during these high flow events.

One of the dominant mechanisms influencing sediment accumulation and transport is settlement within storages and along the creek line, and re-suspension and transport of this material under high flow conditions. Chemical precipitation is also likely to be a significant mechanism in the accumulation of sediment along the creek. This is due to the high ionic concentrations in the mine discharge and moderate historical fluctuations in pH (GHD 2009).

Water management, especially the management of suspended sediment, has therefore been a major issue for the Newstan Colliery and has subsequently been addressed in ongoing optimisation of water management as outlined in the Newstan Colliery Water Management Plan (WMP) (Centennial Coal, 2009). The WMP outlines measures taken to

optimise clean water runoff and to minimise dirty water discharge through the optimised recirculation and treatment mechanisms. Current and proposed water treatment mechanisms are outlined in Section 4.5.

GHD (2012a) reported that all metal concentrations in LT Creek surface and deep sediment samples were below ANZECC/ARMCANZ (2000) low interim sediment quality guidelines (ISQG), with the exception of lead. Copper concentrations were somewhat elevated in the deep sediments being approximately four times higher than the surface sediments, although did not exceed the ISQG in LT Creek North Arm. Due to the high total organic carbon (TOC) and small sediment particle size, lead present in sediments may be bound tightly to the sediment and would be unlikely to be bioavailable. Relatively neutral water pH in historical measurements would not promote the mobilisation and bioavailability of lead. The surface sediment samples showed a decrease in metal concentration with distance from the mine discharge point, with metals decreasing by an average of 90% at a WMP03 sampling site and many metals below detection limit at this site GHD (2012a).

4.5 Water Treatment

The majority of water treatment is currently undertaken through passive methods, mainly through settlement in sedimentation basins. Appendix 4 illustrates the flow pathways through storage and settlement basins before discharge. Improvements to Graunches Dam (receiving water from LDP001) will improve passive treatment from LDP001, while a recent upgrade to the storage (18 ML to 50 ML) of the Final Pollution Dam will increase the capacity of this basin to retain and treat runoff.

Active treatment processes are also employed in the treatment of water within the site. Treatment of water with a high risk of hydrocarbon contamination is separated and treated using an oil/water separator, with the retained oil removed from the site. Additionally, a Sewage Treatment Plan (STP) is operated on the site, which discharges treated water into a sewage maturation pond for further passive treatment.

Northern Coal Services are in the process of upgrading water treatment, specifically installing a new Water Treatment Plant (WTP) at the Newstan Colliery Surface Site to improve the quality of water being discharged into LT Creek via LDP001. All water discharged from LDP001 would be treated at the new WTP (J. Wearne 2013 pers. comm., 1 May). The new WTP will utilise the chemical coagulation/flocculation, settlement and filtration method outlined by Hunter Water (2011). This treatment process is likely to significantly improve the removal of total solids, including suspended contaminants bound to particulates. Commissioning this WTP is expected to significantly improve treatment of the discharge water (Hunter Water 2011) and may benefit the aquatic ecosystem through reduced toxicity of aquatic organisms (GHD 2012b) if specific contaminant concentrations are reduced.

5 Field Survey Results and Discussion

Results of the field survey completed on 9 and 10 July 2012 are outlined below. Conditions at the time of the sampling were fine to overcast. Light rainfall was recorded at the Bureau of Meteorology's (BoM) Lake Macquarie Automated Weather Station (AWS) at Cooranbong in the week prior to the survey (2, 11 and 3 mm on 5, 6 and 7 July 2012 respectively) and heavy rainfall was recorded around a month prior (17, 55 and 13 mm on 11, 12 and 13 June 2012 respectively). A plot of the rainfall in the period preceding sampling is provided in Appendix 5. Ambient daily minimum and maximum temperature measurements in the month prior to sampling ranged from -0.4 °C on 25 June to 21.2 °C on 15 June.

5.1 Aquatic Habitat

Detailed descriptions of the aquatic habitat during the field investigation have been provided in Section 4.2 along with specific information on each of the macroinvertebrate sapling locations. Habitat assessment based on the Riparian, Channel and Environmental Inventory (RCE) scores for each of the aquatic ecology sampling sites on LT Creek are provided in Table 5-1. These values provide a numeric interpretation of the written descriptions.

Table 5-1 - Habitat Description Scores using the Modified RCE Inventory Method

Designation		LT Creek 1	LT Creek 2	LT Creek 3	LT Creek 4
1	Land use pattern beyond the immediate riparian zone	3	3	3	3
2	Width of riparian strip of woody vegetation	4	3	3	4
3	Completeness of riparian strip of woody vegetation	2	2	2	3
4	Vegetation of riparian zone within 10m of channel	4	3	3	3
5	Stream bank structure	3	3	3	3
6	Bank undercutting	4	3	3	2
7	Channel form	1	3	3	3
8	Riffle/pool sequence	1	1	1	1
9	Retention devices in stream	1	2	2	2
10	Channel sediment accumulations	1	1	1	1
11	Stream bottom	1	1	1	1
12	Stream detritus	2	2	2	2
13	Aquatic vegetation	1	1	1	1
Total		28	28	28	29

The RCE index used provides a simplified description of the aquatic habitat and does not fully represent complex nature of the aquatic habitat, for example the change in habitat structure in response to elevated flow. The score also has equal weightings for each of the indices and therefore, certain elements and differences in the habitat of each site may be masked. The scores should therefore be used as a generalised assessment only.

All sites along LT Creek scored similarly for the total RCE index, this being in the poor to average habitat quality range. Site 1 on LT Creek was within the impoundment of the By-wash Dam and as such, scored differently in several indices to the sites further downstream, although the total score remained comparable.

5.2 Water Quality

A summary of the in-situ physicochemical water quality measurements collected at the time of the survey are provided in Appendix 6.

The in-situ physico-chemical measurements collected during the survey (Appendix 6) concur with the historical data for LT Creek in GHD (2009) (Appendix 2 and 3), this being moderately degraded. The main observations from the data collected are that electrical conductivities are in the brackish range (average between 1994 – 2254 $\mu\text{S}/\text{cm}$ at LT Creek Site 3 and Site 1 respectively), high alkalinity measurements (all greater than 500 ppm) and alkaline pH, becoming increasingly so moving downstream (averages of 7.9, 8.1, 8.1 and 8.3 units at LT Creek Site 1, 2, 3, and 4 respectively).

5.3 Aquatic Macroinvertebrates

5.3.1 LT Creek

A total of 35 distinct macroinvertebrate taxa were recorded from the eight samples collected in LT Creek (Appendix 7). The minimum number of taxa represented in an individual sample was seven in the LTC 2a and the maximum was 24 in the LTC 1b sample. SIGNAL2 indexes ranged from 3.4 in the LTC 1a and LTC 1b samples (15 and 23 SIGNAL2 taxa represented respectively) to 4.6 at the LTC 4a sample (12 SIGNAL2 taxa represented). Note that the number of SIGNAL2 taxa can be less than the total number of taxa, as some groups of organisms do not have SIGNAL2 scores assigned.

Four families belonging to the generally more pollution sensitive orders (EPT) of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddis flies) were observed across all sites in LT Creek. These were (SIGNAL2 scores in brackets) the Ephemeroptera Caenidae (4), Trichoptera Hydroptilidae (4), Ecnomidae (4), and Leptoceridae (6). These taxa are all relatively common EPT families and are less sensitive than others within the group. No Plecoptera were observed, with these organisms more common in relatively undisturbed, oxygenated riffle zones. Other families observed in LT Creek with relatively high SIGNAL2 scores were the freshwater mites, Hydracarina (6), the Alderfly family, Corydalidae (7) and the Beetle family, Scirtidae (6).

5.3.2 SIGNAL2 interpretation

A graphical representation of the SIGNAL2 outputs using a biplot with boundaries set at 4.5 for the SIGNAL2 index and 20 for the number of SIGNAL2 taxa represented is provided in Figure 5-1. Most of the sites fell into quadrant 4, indicating water pollution issues or the downstream effects of dams. The sample from LTC 4a is close to, or within quadrant 3 (indicative of harsh pollution or physical conditions) and the sample from LTC 1b was within quadrant 2 (indicating elevated salinity or nutrient levels). As would be expected, no samples fell within quadrant 1 (favourable habitat and chemically dilute water), although sample LTC 4b was closest to this zone in the figure.

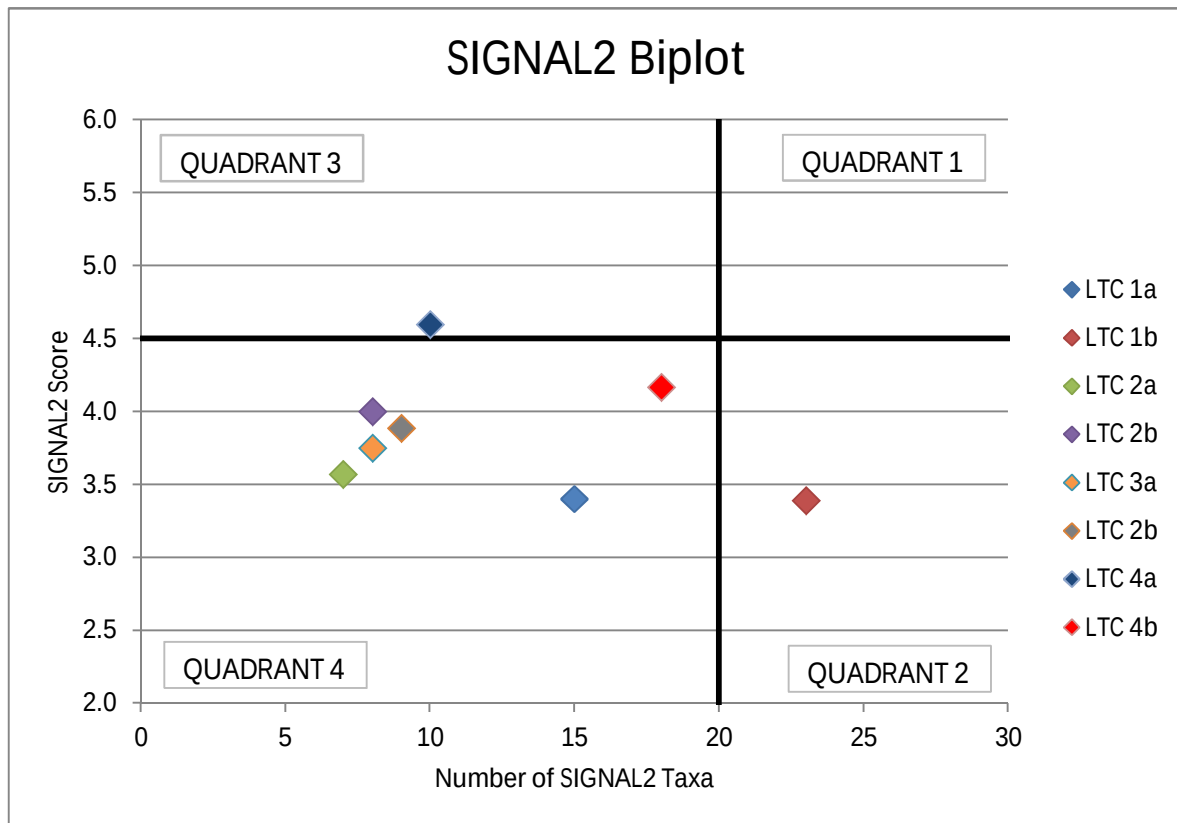


Figure 5-1: SIGNAL2 bi-plot for samples collected from LT Creek and the unnamed Creek

SIGNAL2 values for each taxa were derived from ecotoxicology investigations, and are therefore relevant to water quality sensitivity. Considering that water quality at the time of sampling was similar across the LT Creek sites, other factors, such as habitat characteristics and hydrological effects are likely to be largely influential in the results obtained.

The macroinvertebrate results from LT Creek samples are indicative of a degraded ecosystem, with many pollution tolerant taxa identified. Overall, the macroinvertebrate samples collected from the LT Creek site 1 (above the By-wash Dam) produced better results in terms of taxa diversity than those downstream. This may have been due to more stable conditions at this location above the dam, with those further downstream being more likely to experience high velocity flows and associated water quality disruption following rainfall, as was the case around a month prior to sampling. Different habitat conditions at this site, such as a greater abundance of macrophytes, may also have contributed to increased taxa diversity.

5.4 Aquatic Macrophytes

A list of the macrophyte species recorded along LT Creek during the field investigation is provided in Appendix 8.

Thirty two macrophyte species were recorded across the four LT Creek sites of which the majority were considered emergent (11) and submerged (2) herbaceous fully aquatic macrophytes, macro-algae (2) and hydrophilic trees/shrubs (4). The remaining plants were grasses (6), herbs (2), ferns (3) and vines (2) that were considered more terrestrial, water loving species. The dominant canopy species were *Melaleuca decora* and *Glochidion ferdinandi*, with *Schoenoplectus validus*, *Gahnia clarkei*, and *Ageratina adenophora* being dominant in the understorey. *Potamogeton* spp., *Triglochin* spp. and *Bacopa monnieri* were the most common in-stream macrophytes observed.

Three of the plants recorded are listed as noxious weeds under the NSW Noxious Weeds Act (1993); Crofton's Weed (*Ageratina adenophora*), Pampas Grass (*Cortaderia selloana*) and Lantana (*Lantana camara*). Four plants were not able to be fully identified due being in an early stage of development or due to lack of floristic structures. No plants listed as threatened or endangered were found at the LT Creek sites during the survey. Those that were not fully identified were confirmed as not resembling threatened species within the taxonomic group to which they were identified.

5.5 Fish

Three species of fish were found within LT Creek (Table 5-2); Firetail Gudgeon (*Hypseleotris galii*), Striped Gudgeon (*Gobiomorphus australis*) and Common Jollytail (*Galaxias maculatus*). All three were found in three traps only at site 4, below the proposed piped area. The three out of four bait traps that captured fish at this site were located within the deeper downstream channel area described in the habitat description for LTC 4b above. This area was the deepest area of the site and was below the major existing piped area below the rail loading facility. No fish were captured elsewhere in the upper sections of the creek or in the By-wash Dam.

Table 5-2 - Number of fish and mobile invertebrate species captured in bait traps deployed at each location

Common Name	Scientific Name	LTC 1	LTC 2	LTC 3	LTC 4
Firetail Gudgeon	<i>Hypseleotris galii</i>	0	0	0	3
Striped Gudgeon	<i>Gobiomorphus australis</i>	0	0	0	4
Common Jollytail	<i>Galaxias maculatus</i>	0	0	0	9

*Denotes a noxious species under the NSW Fisheries Management Act 1994

Fish were only found downstream of the railway loading and Newstan-Eraring private haul road already approved to be piped. This indicates that there are already significant barriers in place for fish movement, including the culverts themselves and the flow diffusion area below the railway and haul road. It is therefore possible that the proposed piping of the creek upstream of this will have little additional impact to fish movement compared to what already exists. A significant blockage to fish passage is the large By-wash Dam weir further upstream.

The current investigation is limited in temporal scope and triggers such as rainfall may stimulate fish movement upstream of the existing structures, if navigable. Different species of fish are triggered to migrate by a variety of environmental cues, such as decreased electrical conductivity following rainfall. As the discharge water has a high conductivity, impediments to fish migration cues may already be in place, as well as the more obvious physical barriers.

The fact that no fish were caught upstream during this investigation does not mean that none are present. Some species of fish and certainly larger fish in general, are unlikely to have been captured with the methods used. Freshwater eels and carp are examples of common fish that could potentially be present in the dam that would not have been captured using the baited traps. Additionally, fish migration events may be triggered by environmental cues that were not present around the time of sampling and may result in fish attempting migration further up the creek at some time in the future.

6 Assessment of Impacts

The assessment of impacts has been considered in two phases; construction and operation. For the assessment of operational impacts, the final development is assumed to have been constructed as outlined in the plan provided in Appendix 10. These plans indicate that the existing creek line and riparian zone between the By-wash Dam and the rail loading facility would be covered by the expansion of stockpiles and related conveyance systems. The creek would be piped parallel to its existing route, with approval having already been granted for piping of around a third of its length around the middle of the section between the By-wash Dam and railway loop and another section within the railway loop. No specific plans have been developed for the construction activities at this stage and this assessment has therefore assumed that construction will be completed with appropriate environmental management considerations.

The increase in discharge from LDP001 has not been assessed in this report although all water discharged here would be treated at the new water treatment plant as previously described.

6.1 Construction Phase

6.1.1 Aquatic Habitat Loss

During construction, all functional in-stream and riparian habitat within the proposed development site boundary would be removed. Concrete channels and smooth pipelines do not provide habitat for aquatic flora and fauna and enclosed pipelines prevent light reaching the water. The piped section would therefore serve only to conduct water downstream. The impact on the aquatic flora and fauna in this section of the creek would be significant in that would alter key aspects of the aquatic habitat.

The length of flowing freshwater habitat between the By-wash Dam weir and the point where tidal influence begins (the main northern railway line near Fassifern) is around 1500 m. This reach represents the bulk of relatively undisturbed freshwater riverine habitat along the north arm of LT Creek (different habitat characteristics are present above the By-wash Dam). Assuming an average stream width of 5 m and an additional 1 m on either bank of lower riparian vegetation, the area of aquatic habitat along this reach would be 10500 m². Existing culverts under roads and railways account for approximately 195 m of this reach (length reduced to 1305 m), bringing the current estimated aquatic habitat area to around 9135 m². This estimate does not consider the two sections of LT Creek already approved for piping.

Approval has already been granted for piping of approximately 150 m of the creek between the By-wash Dam and the rail loading facility, and another 175 m of the creek within the rail loading loop (325 m in total and approximately 25% of the aquatic habitat in this reach) (Appendix 10). The proposed pipeline, would add a further 300 m of pipeline to that already approved. The proposed pipeline would also link already approved sections creating a 625 m continuous section of piping along the creek. Using the assumption of a 7 m aquatic habitat width, the total aquatic habitat lost to construct the already approved pipeline is 2275 m². A further 2100 m² of aquatic habitat would then be lost to construct the new pipeline. This equates to approximately 48% (4375 m²) of remaining aquatic habitat (9135 m²) being lost in the construction of all pipeline sections. This represents a significant loss of aquatic habitat within the LT Creek catchment and subsequently a significant impact on resident aquatic flora and fauna in the construction zone.

Riparian zone macrophytes are important habitat for terrestrial and littoral organisms as well as being an integral part of the in-stream habitat, providing habitat structure in the form of woody debris, as well as providing food and shelter in various forms of organic matter. The estimation of riparian habitat loss above is a broad brush approach that accounts for macrophytes in the lower riparian zone only and does not account for land clearing away from the creek. Although potential impacts on terrestrial ecology are covered in a separate report, both aquatic and terrestrial ecosystems are intrinsically linked through a plethora of physicochemical and biological interactions and therefore should not be considered in isolation.

Runoff following rain may result in erosion in areas of earthworks, unprotected spoil or cleared land during construction and this could increase sediment transported into LT Creek and the estuary. Although already a historical issue in the degradation of the aquatic habitat, increased sediment loads resulting from uncontrolled sediment would exacerbate this problem in the receiving environment. This increase in sediment would result in loss of habitat through a reduction in depth of available pools, which serve as refuge areas for aquatic biota, and the smothering of habitat features such as aquatic macrophyte beds, woody debris, riffles and spawning grounds in the estuary.

6.1.2 Water Quality and Flow

During construction, the hydrology within the pipeline area would be changed from the natural turbulent flow pathway to a more laminar flow through the pipeline. Not considering the increase in flow volume from LDP001, this change in hydrology would increase longitudinal water velocity and reduce residence time. Increased water velocity may result in scouring of the bed and increased bank erosion at the outlet of the pipeline if not adequately managed. The lack of substrata and structures available for periphytic growth within the pipeline (such as woody debris and macrophytes) may decrease water treatment enacted by filtration, sorption and ion exchange processes. Decreased residence time within the piped area may also result in reduction in passive settlement through this reach.

As indicated above, ineffective sediment management during construction could result in material entering the creek and smothering habitat. In this scenario, water quality impacts would also be observed in the form of increased suspended solids and turbidity. This would result in a decline in light penetration and a subsequent reduction in primary productivity. This may affect submerged macrophytes, photosynthetic algae and other organisms for which these plant and algae groups provide food or habitat. Increased turbidity and subsequent reduced primary productivity may also impact oxygenation of water provided by photosynthesis in submerged macrophytes and algae. This could also have carry on effects on sediment redox reactions and microbial metabolic processes. Oxygenation of water would also be reduced due to the removal of turbulent flow and light induced photosynthesis in the piped waterway, having similar potential impacts on fauna to those described above and more obvious potential impacts on oxygen respiring organisms.

If released into the water column during construction, nutrient enrichment would increase the risk of algae blooms, while other contaminants may induce toxicity effects on aquatic fauna. Contaminants related to construction activities (oil or chemicals spillage for machinery or construction processes) may be washed into the creek unless adequate control measures are implemented. Depending on the product and quantity involved, this could be toxic to aquatic fauna if allowed to enter the creek. Risk management and appropriate housekeeping would be required to mitigate potential harm.

Additionally, mobilisation of sediments may lead to an increase in nutrients and other contaminants associated with solids. Sediment mobilisation during the construction phase is most likely to occur during periods of rainfall. The likelihood and scale of impacts associated with an increased sediment load would depend on the amount of sediment mobilised into the water and over what period it occurs. Given the conditions at the worksite (i.e. steeply sloping banks, proximity of earthworks to the waterway, potential for high rainfall), a detailed sediment and erosion control plan would be required to ensure that risks of increased sedimentation are adequately addressed.

6.1.3 Aquatic Ecology

In-stream and riparian fauna species will not inhabit an area without adequate aquatic habitat and amenable environmental conditions. As outlined above, suitable habitat conditions will be removed within the construction zone for most aquatic fauna. Upstream of the construction zone, impacts are expected to be negligible assuming that water is not held back within the By-wash Dam. If this was to occur, it may result in riparian vegetation dieback and drowning of terrestrial fauna.

Downstream of the construction zone, impacts on aquatic fauna may include habitat change, potential water quality degradation and changes to the creek hydrology. Excess water and high velocities may result in unfavourable conditions, whereas a lack of water would desiccate habitat. Interrupting water flow, if required during construction, would result in impacts due to the drying of habitat and potential stranding of organisms. Potential water quality degradation as a result of the construction activities has been outlined above and this evidently has the potential to impact on aquatic fauna through toxicity. Any potential toxicity would be dependent on the type of contaminant and its concentration.

Numerous species of threatened and endangered frogs are known to occur in the vicinity of the Newstan Colliery and populations of these organisms may be impacted by construction activities. A targeted frog survey was completed by RPS Australia on the 3rd and 4th of October 2012 using call identification and spotlighting to determine frog species were residing along LT Creek (A. Smith 2012 *email comm.*, 5 October). This investigation detected four frogs, these being the Common Eastern Froglet (*Crinia signifera*), Eastern Dwarf Tree Frog (*Litoria fallax*), Broad Palmed Frog (*Litoria latopalmata*) and Peron's Tree Frog (*Litoria peronii*). None of these species are listed under state or federal threatened species legislation. Habitat and water quality constraints along LT Creek are likely to be the cause of limited frog

observations. Some endangered frogs listed as occurring in the vicinity are unlikely to be present along LT Creek for this reason (e.g. Red-crowned Toadlet) (A. White 2012 *pers. comm.* 2 August).

When flow through the creek is redirected through the pipeline, any larger mobile organisms (fish, turtles, frogs) that are present along the creek may naturally move downstream to the outlet area where water is more plentiful. Smaller organisms such as macroinvertebrates are likely to become stranded when flow ceases and may perish. Some adult insects with the ability to fly (e.g. beetles) are likely to migrate elsewhere if the creek dries sufficiently.

6.2 Operation Phase

6.2.1 Aquatic Habitat

No additional impacts on aquatic habitat within the piped section of the creek are expected during the operation phase. Impacts downstream of the pipeline outlet are expected to be minimal compared to construction impacts. Unless appropriate controls/mitigation measures are installed, some increase in erosion and bed scouring downstream of the pipeline outlet may accompany the increase in flow velocity and this may reduce and degrade aquatic habitat downstream of the pipeline. GHD have identified this issue in their surface water impact assessment report and support the construction of stabilisation structures downstream of the discharge point around the Fassifern Archery Club (L. Hammersly, 2013, *letter comm.* 10 April). The pipeline discharge area is relatively well vegetated and this likely to decrease the likelihood of major erosion and scouring. Longer term benefits to the aquatic habitat may be observed with improved treatment of water discharging into LT Creek via LDP001 and reduced volume of coal particles entering the creek from the stockpile areas, although the extent of this benefit is unknown.

6.2.2 Water Quality and Flow

The potential impact of large flood events may be exacerbated by the proposed pipeline if not adequately assessed and managed. This is outside the scope of work for this report, although potential impacts on the aquatic habitat and surrounding environment may be serious if the pipeline flow increased flooding risk. In the event of flood waters washing through stockpile areas due to flow constriction within the pipeline, adverse impacts on the aquatic ecosystem would occur. In relation to the large flood event of 2007, which was modelled by BMT WBM (2011), a rough approximation of the average flow in the 24 hour peak flow period was 10m³/sec (864 ML/day), with a maximum peak instantaneous flow of 28 m³/sec. These are very large potential flows compared with the base flow volumes normally being discharged from LDP001 and indicate the potentially serious implications of flood events on the creek, particularly if water flow is restricted through pipelines. Although there is a risk of negative impacts, Northern Coal Services will design the proposed pipeline to accommodate a 1:100 year rainfall event to ensure this risk is mitigated, as outlined previously.

Large volumes of sediment currently exist in the By-wash Dam and have the potential to be mobilised after heavy rainfall along with material mobilised through erosion within the upper catchment. Any sediment washing over the By-wash Dam during high flow events is likely to be transported effectively through the pipeline, but may become concentrated around the outlet point, pools or estuary downstream, where water velocity is reduced and settling rate increased. Potential sediment mobilisation is likely to be an infrequent occurrence, but may increase through time if sediment influx from the catchment increases and siltation of the By-wash dam increases.

Improvements in water quality are expected to result from operation of the new WTP and maintenance of Graunches Dam around the LDP001. Additionally, the increase in the Final Pollution Control Dam at the LDP002 will improve water quality through increased retention. Water quality within LT Creek will vary over time dependant on factors including flow rate, storage and treatment processes in operation. Although not examined in detail in this report, it is expected that the aquatic ecosystem downstream of the pipeline would benefit from improvements in water quality resulting from improvements to water management and treatment on site.

6.2.3 Aquatic Ecology

Impacts on the aquatic ecosystem following construction are expected to be minor compared with those produced during the construction phase. Macroinvertebrate, water quality and habitat data collected within and downstream of the area of the proposed piping indicated that the aquatic ecosystem is relatively degraded and under stress. Changes to the composition of macroinvertebrate, macrophyte and other groups of aquatic organisms may be observed through water quality changes, habitat changes and/or flow alteration as a result of the pipeline. If realised, improved water quality at

the licenced discharge points is likely to provide an overall benefit to aquatic organisms downstream of the pipeline discharge.

Restricted fish passage following construction of the pipeline has been raised as a potential impact. Barriers to fish movement can be physical (e.g. dams and weirs) or indirect (e.g. interruption of continuous habitat, water quality and light) or a combination of these, the latter often being harder to detect (Koehn 1999). Fish migration for spawning can be triggered by various environmental cues such as season and reduced conductivity after rainfall (Mallen-Cooper 1999). These cues vary between species and are often poorly understood. In reference to vertical slot fishways, Mallen-Cooper (1996) noted that some species only migrated upstream during daylight and if their ascent of the fishway was not completed in daylight, fish moved back down the fishway. This observation may be relevant to the construction of extended pipelines with little light penetration.

Physical barriers to fish migration already exist within LT Creek and include the flow dissipation structure below the rail facility and the By-wash Dam Weir. Indirect barriers also exist, including culverts below the railway line and roads downstream of the proposed piped area. Additionally any fish movement triggered by conductivity changes may already be disrupted due to the consistently brackish water quality of the mine water discharge.

Fish catch data collected during this investigation did not indicate that fish had moved upstream beyond the rail loading facility. It is expected that, although fish passage may be further restricted due to the piping of the creek, this is unlikely to have any further impact than the barriers already in place within the creek. The By-wash-Dam appears to be the most physically restrictive barrier in place for fish movement and is unlikely to allow in-stream fish passage past this point for most species (eels may have bypassed this barrier overland and other species may have been historically released or stocked in the dam).

6.3 Summary of Potential Impacts

The condition of the existing aquatic ecosystem within and downstream of the proposed development area was identified as moderately degraded based on the interpretation of flora, fauna, water quality and habitat data collected in this and previous investigations. Key findings included:

- Aquatic habitat alteration through the presence of deep sediment deposits, unnaturally high flow and unnatural bank and channel form;
- The presence of numerous exotic and invasive macrophytes, some of which are listed as noxious species;
- A macroinvertebrate community assemblage with fewer taxa represented than would be expected in an otherwise undisturbed system;
- A lack of any fish found in the upper catchment and the presence of numerous barriers to fish passage.

The works and activities proposed under this project would take place within an aquatic ecosystem that can be summarised as moderately degraded and under stress, largely, but not entirely due to current and historical land use and water management. Despite the already degraded condition, LT Creek provides valuable aquatic habitat for resident organisms and is part of an interconnected ecosystem stretching from ephemeral creeks in the upper catchment through to the Lake Macquarie estuary.

Further degradation of this ecosystem can be minimised by implementing effective controls to minimise impacts on water quality, hydrology and the aquatic habitat. Key potential impacts identified for the proposed development include:

- Removal of approximately 2100 m² of aquatic habitat in addition to the 2275 m² of habitat already approved for removal during the construction phase;
- Removal of terrestrial habitat adjacent to the creek line to clear land for stockpiles;
- Potential increased sediment and other contaminants entering the creek during construction activities and subsequent transport of this material downstream to the estuary resulting in habitat simplification and aesthetic issues. However, this risk will be significantly reduced during operational activities;
- Potential erosion and bank scouring downstream of the pipeline outlet due to increased water velocity;
- Increased sediment accumulation at the outlet point of the proposed pipeline;
- Drying of aquatic habitat and stranding of organisms in the event of water retention and diversion through the pipeline during construction;
- Further restriction of fish passage through the already highly modified and restricted creek line.

Potential benefits arising from the development may include:

- Decrease in the volume of coal particles being washed into the creek from the stockpile area;
- Improvements to the aquatic ecology through a targeted weed management programme of the sections of LT Creek immediately upstream and downstream of the proposed piped sections; and
- Potential improvements in water quality provided by an active WTP and other improved water management actions.

7 Recommendations

7.1 Aquatic Habitat

While mitigation of impacts caused by the loss in aquatic habitat along the length of the pipeline will be difficult to achieve, improvement of aquatic habitat elsewhere in the catchment will be implemented by Northern Coal Services through bush regeneration and weed control. Northern Coal Services will commit to improving aquatic habitat by undertaking bush regeneration works and weed control upstream and immediately downstream of the construction zone. Beneficial actions may include weed removal, re-planting with native species and improving bank structure and stability in problem areas. Weed removal would optimally start in the upper catchment to minimise rapid weed re-colonisation from seeds dispersed by water.

7.2 Water Quality and Flow

A construction management plan for the development site would be formulated to assist in mitigating any potential negative consequences and would be adhered to during the construction. Appropriate erosion control and water management practices during construction would be implemented through this plan. Erosion control measures are likely to include the construction of sediment control fences and work being undertaken only during appropriate weather conditions.

Capture and treatment of contaminated runoff from new development and stockpile areas would need to be incorporated into management plans to prevent contaminated discharge directly to the creek from newly disturbed areas. The existing water management plan for the site should therefore be updated to reflect changes in site water management post construction of the pipeline.

Hydrological modelling for the construction of the pipeline and related structures will be undertaken to ensure that this infrastructure is appropriate for purpose and does not increase the risk of flooding. Baffles will be incorporated within the piped section near the discharge point which would serve to reduce scouring around the outlet. This would further decrease the potential for sediment to reach the estuary.

7.3 Aquatic Ecology

Effective hydrological and water quality management are required to reduce impacts on the aquatic ecosystem, which may occur as a result of the construction and operation of the Project. Steps are being taken at the Newstan Colliery to improve hydrological management and to improve water quality include increased pollution control dam storage and construction of a new water treatment facility. These actions will help to mitigate impacts on the aquatic ecosystem resulting from the proposed Project construction area. Ongoing environmental monitoring coupled with diligent and active management will be required throughout and following the construction process to ensure that harm to the aquatic ecosystem is minimised. Northern Coal Services will prepare a construction Management Plan that will incorporate erosion and sediment control measures for this purpose. These actions will assist to mitigate harm to the aquatic ecosystem and provide potential benefits to aquatic habitat downstream of the newly piped sections, following the completion of construction.

All action taken to minimise the loss and degradation of aquatic and terrestrial habitat will be beneficial to the remaining aquatic ecosystem within and around the construction zone. Minimising aquatic habitat degradation downstream of the construction area will also be required through proactive management of construction activities, including sediment control, and ongoing diligence in water management practices, both during and post-construction. Targeted bush regeneration and weed management will assist with protection and rehabilitation of riparian habitat for organisms displaced by the construction.

No threatened or endangered aquatic flora or fauna were identified as occurring within this investigation or through the subsequent targeted searches for amphibians. Loss of aquatic flora and fauna from the construction work is therefore not anticipated to directly impact on organisms with legislative protection. Losses of individuals are expected to be common species along with a reduction of available creek habitat.

An ongoing aquatic ecology monitoring program using quantitative or semi-quantitative measurement techniques and a robust experimental design should be developed to help understand how the aquatic ecosystem responds to changes over time. This monitoring program should include the establishment of replicate sites for sampling aquatic flora and fauna in 'impact' and 'control' locations through standardised sampling methods, conducted routinely on an annual or bi-annual basis.

8 Acknowledgements

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10 Plates



Plate 1: LT Creek Site 1 (LTC 1b) looking upstream from the Main By-wash Dam weir



Plate 2: LT Creek Site 1 (LTC 1a) looking east from the south eastern corner of the Main By-wash Dam storage.



Plate 3: LT Creek Site 2 (LTC 1a) looking downstream from near the centre of the site



Plate 4: LT Creek Site 2 looking at the small riffle area near the top of the site



Plate 5: LT Creek Site 3 (LTC 3b) looking upstream from near the railway line culvert



Plate 6: LT Creek Site 3 (LTC 3a) looking upstream from the old weir near the top of the site



Plate 7: LT Creek Site 4 looking upstream from the deep channel (LTC 4b) into the Melaleuca swamp



Plate 8: LT Creek Site 4 looking downstream through the deeply incised channel

11 Appendices

Appendix 1: Riparian, Channel and Environment (RCE) scores modified from Chessman (1997)

	Descriptor and category	Value		Descriptor and category	Value
1	Land use pattern beyond the immediate riparian zone		8	Riffle / pool sequence	
	Undisturbed native vegetation	4		Frequent alternation of riffles and pools	4
	Mixed native vegetation and pasture/exotics	3		Long pools with infrequent short riffles	3
	Mainly pasture, crops or pine plantation	2		Natural channel without riffle / pool sequence	2
	Urban	1		Artificial channel; no riffle / pool sequence	1
2	Width of riparian strip of woody vegetation		9	Retention devices in stream	
	More than 30 m	4		Many large boulders and/or debris dams	4
	Between 5 and 30 m	3		Rocks / logs present; limited damming effect	3
	Less than 5 m	2		Rocks / logs present, but unstable, no damming	2
	No woody vegetation	1		Stream with few or no rocks / logs	1
3	Completeness of riparian strip of woody vegetation		10	Channel sediment accumulations	
	Riparian strip without breaks in vegetation	4		Little or no accumulation of loose sediments	4
	Breaks at intervals of more than 50 m	3		Some gravel bars but little sand or silt	3
	Breaks at intervals of 10 - 50 m	2		Bars of sand and silt common	2
	Breaks at intervals of less than 10 m	1		Braiding by loose sediment	1
4	Vegetation of riparian zone within 10 m of channel		11	Stream bottom	
	Native tree and shrub species	4		Mainly clean stones with obvious interstices	4
	Mixed native and exotic trees and shrubs	3		Mainly stones with some cover of algae / silt	3
	Exotic trees and shrubs	2		Bottom heavily silted but stable	2
	Exotic grasses / weeds only	1		Bottom mainly loose and mobile sediment	1
5	Stream bank structure		12	Stream detritus	
	Banks fully stabilised by trees, shrubs etc	4		Mainly unsilted wood, bark, leaves	4
	Banks firm but held mainly by grass and herbs	3		Some wood, leaves etc. with much fine detritus	3
	Banks loose, partly held by sparse grass etc	2		Mainly fine detritus mixed with sediment	2
	Banks unstable, mainly loose sand or soil	1		Little or no organic detritus	1
6	Bank undercutting		13	Aquatic vegetation	
	None, or restricted by tree roots	4		Little or no macrophyte or algal growth	4
	Only on curves and at constrictions	3		Substantial algal growth; few macrophytes	3
	Frequent along all parts of stream	2		Substantial macrophyte growth; little algae	2
	Severe, bank collapses common	1		Substantial macrophyte and algal growth	1
7	Channel form			TOTAL	
	Deep: width / depth ratio less than 7:1	4			
	Medium: width / depth ratio 8:1 to 15:1	3			
	Shallow: width / depth ratio greater than 15:1	2			
	Artificial: concrete or excavated channel	1			

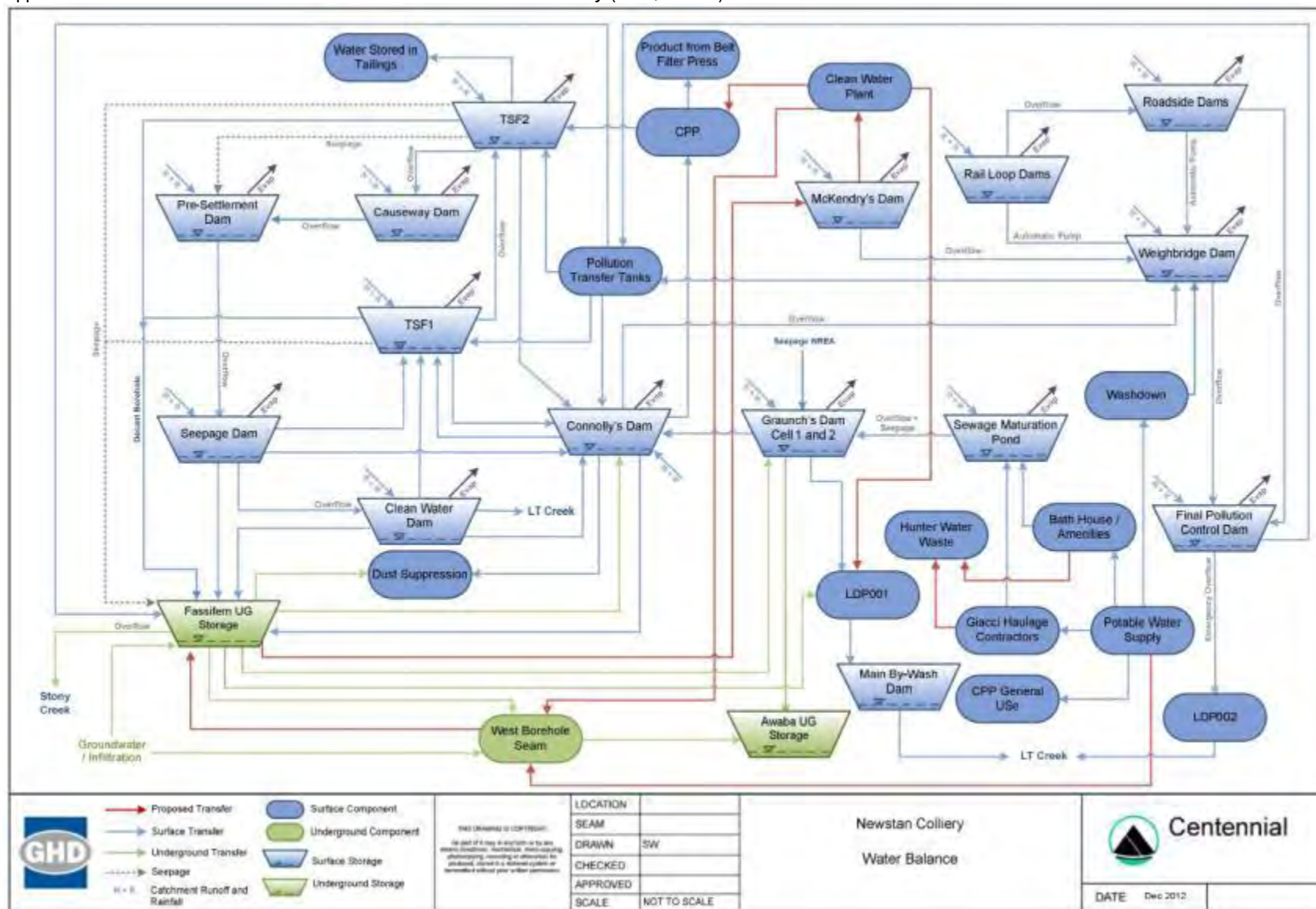
Appendix 2: Statistical Summary of water quality at the LDP001 and WMP03 sites between January 2009 and February 2011 derived from GHD (2009)

Analyte	Units	Ambient (50th%) Statistical Summary LDP001	Ambient (50th%) Statistical Summary WMP03	Trigger Value		Comments
				ANZECC (2000)	SSTV Derived for LT Creek	
pH		7.7	8.3	6.5-8.0	6.5-8.5 ⁽¹⁾	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.2
Turbidity	NTU	3	-	6 – 50	50	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.3
Oil & Grease	mg/L	2	2	-	10	EPL395
EC	µS/cm	2430	2535	125 – 2200	2200	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.3
TSS	mg/L	5	5	6 - 50	50	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 8.2.12
Ammonia as N	mg/L			0.9	0.9	ANZECC & ARMCANZ Freshwater Trigger Value for 95% Species Protection
Total Nitrogen as N	mg/L			0.5	0.5	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.2
Total Phosphorous	mg/L	0.1	-	0.05	0.05	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.2
Aluminium	mg/L	0.3	0.2	0.055	0.68	80 th percentile of upstream WMP09
Arsenic	mg/L	0.01	0.01	0.024	0.024	95% ANZECC (2000) Trigger Value: Table 3.4.1
Boron	mg/L	0.01	0.01	0.37	0.37	95% ANZECC (2000) Trigger Value: Table 3.4.1
Cadmium	mg/L	0.001	0.001	0.0002	0.00054	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Chromium	mg/L	0.22	0.22	0.001	0.0025	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Copper	mg/L	0.0001	-	0.0014	0.0035	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Iron	mg/L	0.001	-	-	0.30	Canadian Guideline as recommended by ANZECC (2000) Ch.8.3.7.1
Lead	mg/L	0.001	0.001	0.0034	0.0136	95% ANZECC (2000)

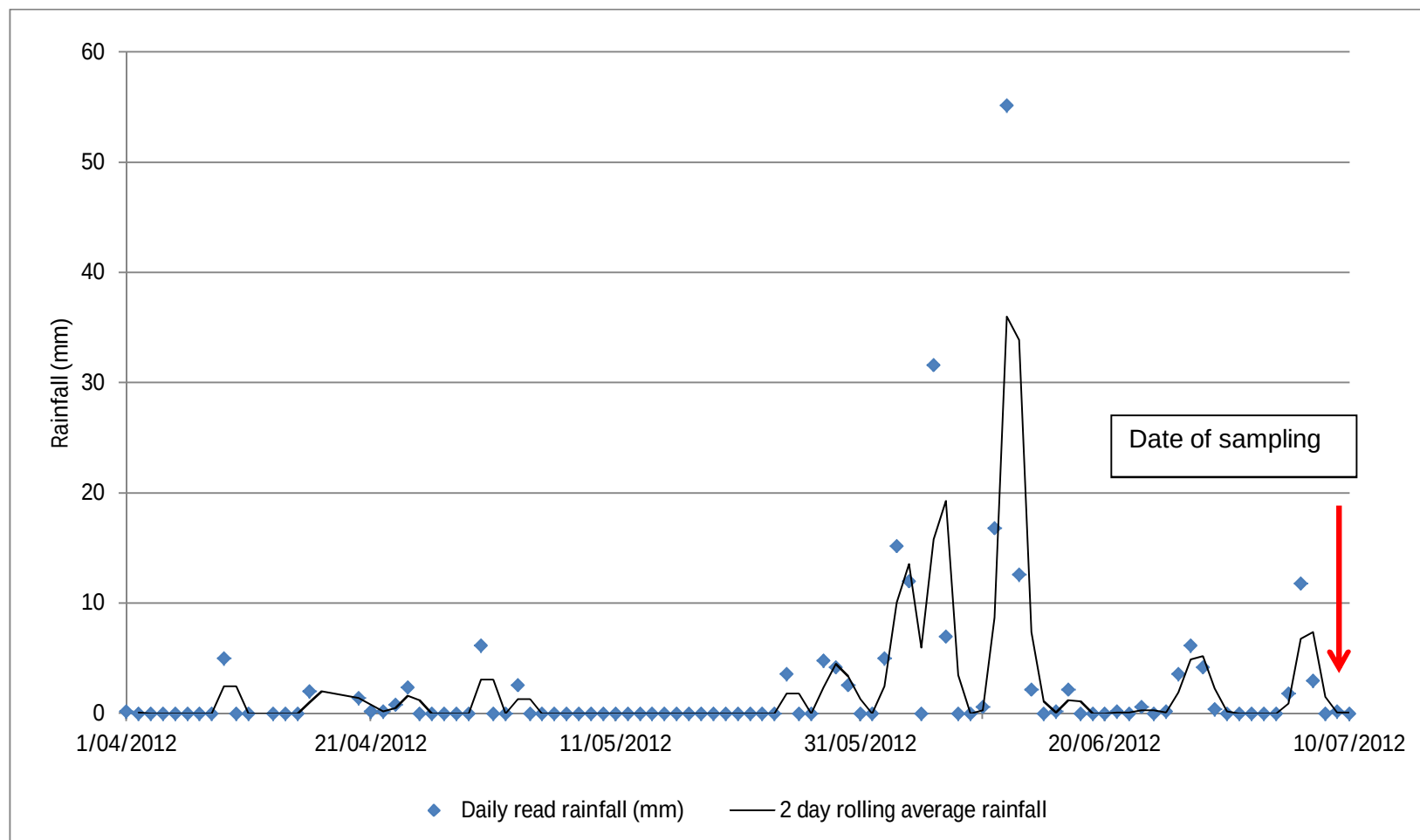
Analyte	Units	Ambient (50th%) Statistical Summary LDP001	Ambient (50th%) Statistical Summary WMP03	Trigger Value		Comments
				ANZECC (2000)	SSTV Derived for LT Creek	
						Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Manganese	mg/L	0.05	0.05	1.9	1.9	95% ANZECC (2000) Trigger Value: Table 3.4.1
Mercury	mg/L	0.006	0.002	0.0006	0.0006	95% ANZECC (2000) Trigger Value: Table 3.4.1
Nickel	mg/L	0.126	0.004	0.011	0.0275	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Selenium	mg/L	0.0001	-	0.011	0.03	Site specific ecotoxicological testing July 2011
Silver	mg/L	0.0165	-	0.00005	0.00005	95% ANZECC (2000) Trigger Value: Table 3.4.1
Zinc	mg/L	0.01	-	0.008	0.02	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4

Summary by S Grey 2012, *email comm.* 20 Sept

Appendix 4: Water movement around the Centennial Newstan Colliery (GHD, 20130)



Appendix 5: Rainfall data for the three months prior to sampling taken from the Lake Macquarie AWS (BOM, 2012)



Appendix 6: Mean water quality data for sites sampled on 9 and 10 July 2011

Variable	Units	DTV	LT Creek 1		LT Creek 2		LT Creek 3		LT Creek 4		UN Creek 1		UN Creek 2	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Temperature	°C		13.5	0.2	15.3	0.0	14.0	0.5	12.8	0.0	10.5	0.1	18.1	0.0
Conductivity	µS/cm	125-2200	2254	190	2130	2	1994	129	2114	0	157	1	4096	35
pH	units	6.5-8	7.9	0.0	8.1	0.0	8.1	0.0	8.3	0.0	7.0	0.2	7.3	0.0
DO	% Sat	85-110	74.3	0.8	88.0	0.5	91.4	2.2	82.9	0.1	56.6	0.3	67.6	1.4
DO	mg/L	-	7.7	0.0	8.8	0.1	9.3	0.1	8.7	0.0	6.5	0.2	6.4	0.2
Turbidity	NTU	6-50	13.7	2.8	11.2	0.4	15.0	0.1	6.8	0.1	63.6	5.5	35.6	1.9
Alkalinity	ppm	-	> 500	-	> 500	-	> 500	-	> 500	-	20	-	> 500	-

(SE = Standard Error, n = 2, except for turbidity where n = 6). Default Trigger Values (DTV) taken from ANZECC/ARMCANZ (2000) guidelines for slightly disturbed lowland rivers in southeast Australia. Grey shading indicates value outside of DTV.

Appendix 7: Aquatic macroinvertebrates collected at each of the two replicate samples at sites on LT Creek (LTC) and the Unnamed Creek (UNC).

Order or Family	LTC 1a	LTC 1b	LTC 2a	LTC 2b	LTC 3a	LTC 3b	LTC 4a	LTC 4b
Aeshnidae	1	6			1		1	1
Araneae				1		2	7	1
Atyidae								
Baetidae								
Caenidae	1	2					4	5
Ceratopogonidae	1	1		1				1
Chironominae	10	9	1	10	5	4	5	10
Tanypodinae	10	3		10	6	1	6	10
Coenagrionidae	4	9	1	2				
Corydalidae							1	
Culicidae								
Dytiscidae	1	1						
Ecnomidae	1	3	1					1
Empididae								1
Entomobryidae		1					2	
Gelastocoridae					1			1
Gerridae		1					1	4
Gyrinidae		1						
Haliplidae	2	1						
Hemicorduliidae	2	3	5	2	1	2	1	1
Hydracarina		3					1	
Hydrobiidae	5				1	2		3
Hydrometridae								2
Hydrophilidae								
Hydroptilidae								6
Leptoceridae	2	1						5
Megapodagrionidae								1
Nepidae		1	1					
Notonectidae		2						
Ostracoda		1						
Parastacidae								
Planorbidae	2	1	1					
Pleidae	4	2						
Pyalidae						2		
Scirtidae		1	1	1		3	1	4
Simuliidae						1		
Spongillidae								
Stratiomyidae		2			1	1		2
Tabanidae	1	1						
Tipulidae				1				
Veliidae		3		2	3	1	2	3
No. taxa	15	24	7	9	8	10	12	19
No. SIGNAL2 taxa	15	23	7	8	8	9	10	18
No. EPT Taxa	3	3	1	0	0	0	1	4
SIGNAL2 Index	3.4	3.4	3.6	4.0	3.8	3.9	4.6	4.2

Appendix 8: Macrophytes collected at each of the sample sites on LT Creek (LTC) and the Unnamed Creek (UNC).

Common Name	Scientific Name	LTC 1	LTC 2	LTC 3	LTC 4	UNC 1	UNC 2	Native / Introduced
Acacia longifolia	Coastal Wattle						x	N
Ageratina adenophora	Crofton's Weed	x	x	x	x		x	I *
Alternanthera denticulata	Lesser Joyweed					x		N
Bacopa monnieri	Bacopa	x	x	x				N
Baumea articulata	Jointed Twig-rush	x						N
Bidens pilosa	Cobblers Pegs			x				I
Carex appressa	Tall Sedge			x	x			N
Cassytha glabella	Slender Devils Twine		x	x	x			N
Chara sp.	Chara	x			x			N
Chloris gayana	Rhodes Grass			x	x			I
Christella dentata	Binung			x				N
Cortaderia selloana	Pampas Grass				x			I *
Cyperus eragrostis	Umbrella Sedge					x		I
Dianella sp.	Flax Lilly					x		N
Doodia caudata	Small Rasp Fern						x	N
Echinochloa colona	Awnless Barnyard Grass			x				N
Eucalyptus robusta	Swamp Mahogany					x		N
Gahnia clarkei	Tall Saw-edge	x	x	x	x	x		N
Glochidion ferdinandi	Cheese Tree		x	x	x		x	N
Isolepis prolifera	Proliferating Isolepis					x		I
Juncus usitatus	Common Rush					x	x	N
Lantana camara	Lantana		x	x	x		x	I *
Leptospermum sp.	Tea Tree					x		N
Ligustrum sinense	Small Leafed Privet						x	I *
Melaleuca decora	Paperbark	x	x	x	x	x		N
Melaleuca styphelioides	Prickly Paperbark		x		x			N
Nephrolepis cordifolia	Fishbone Fern			x				N
Nitella sp.	Nitella		x					N
Paspalum urvillei	Vasey Grass	x		x				I
Persicaria decipiens	Slender Knotweed					x		N
Phragmites australis	Common Reed						x	N
Potamogeton ochreatus	Blunt Pondweed		x					N
Potamogeton pectinatus	Sago Pondweed	x	x	x			x	N
Pteridium esculentum	Bracken Fern				x			N
Pteris tremula	Tender Brake						x	N
Ranunculus repens	Creeping Buttercup					x		N
Rubus fruticosus	Blackberry						x	I *
Schoenoplectus validus	River Clubrush	x	x	x	x			N
Setaria gracilis	Slender Pigeon Grass	x			x			N
Setaria sphacelata	Giant Pigeon Grass				x	x	x	I
Triglochin Microtuberosa	Small Water Ribbons	x	x	x	x			N
Triglochin procerum	Water Ribbons		x					N
Typha orientalis	Cumbungi	x	x	x	x		x	N
Unidentified Fern	Cyanthea sp.						x	N
Unidentified Forb	Xanthorrhoea sp.					x		N

Unidentified Grass	Oplismenus sp.					x		N
Unidentified Grass	Paspalum sp.						x	N or I
Unidentified Macrophyte	Cyperaceae				x			N or I
Unidentified Myrtaceae	Melaleuca/Leptospermum					x		N
Unidentified Myrtaceae	Melaleuca/Callistemon		x					N
Unidentified Sedge	Cyperus sp.	x	x					N or I
Unidentified Sedge	Juncus sp.			x	x	x		N or I
Verbena bonariensis	Purpletop						x	I

* Denotes a species listed as a Noxious Weed under the NSW Noxious Weeds Act (1993)

Appendix 9: Protected species recorded on the Bionet Database within 5km of the Works Site and their likelihood of occurrence within the LT Creek aquatic environment

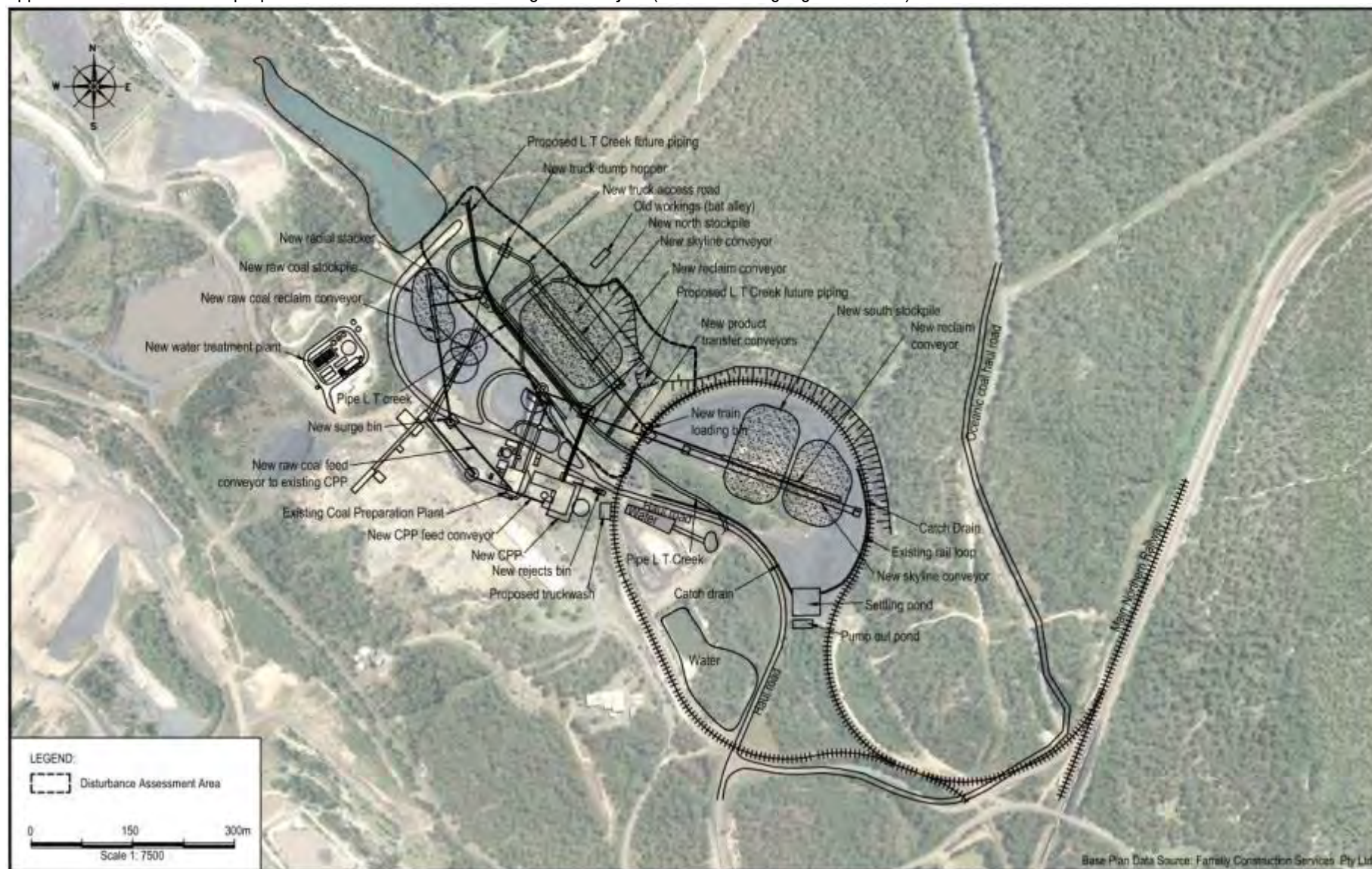
Scientific Name	Common Name	Likelihood of Occurrence
<i>Acianthus fornicatus</i>	Pixie Caps	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Acacia bynoeana</i>	<i>Bynoe's Wattle</i>	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Angophora inopina</i>	Charmhaven Apple	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm, however this species distribution range includes Lake Macquarie and have been recorded south of the study area in Toronto (Centennial Coal, 2006). (Terrestrial)
<i>Archontophoenix cunninghamiana</i>	Bangalow Palm	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat may be present in the study area. (Terrestrial)
<i>Banksia spinulosa</i>	Hairpin Banksia	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Banksia spinulosa</i> var. <i>collina</i>		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Boronia polygalifolia</i>	Dwarf Boronia	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Caladenia catenata</i>	White Caladenia	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Caladenia</i> spp.		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Callistemon linearifolius</i>	Netted Bottle Brush	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Calochilus paludosus</i>	Red Beard Orchid	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Cymbidium suave</i>	Snake Orchid	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Dicksonia antarctica</i>	Soft Treefern	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat may be present in the study area. (Terrestrial)
<i>Doryanthes excelsa</i>	Gynea Lily	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat is present in the study area. (Semi-Aquatic species)

Scientific Name	Common Name	Likelihood of Occurrence
<i>Grevillea parviflora</i> <i>subsp. parviflora</i>	Small-flower Grevillea	Possible – No sightings have been recorded within the vicinity of LT Creek North Arm, however GSS Environmental (2011) recorded species within the Newstan Mine property south of LT Creek North Arm. (Terrestrial)
<i>Kunzea ambigua</i>	Tick Bush	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Livistona australis</i>	Cabbage Palm	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Macrozamia communis</i>	Burrawang	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Maundia triglochinoides</i>		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat is present in the study area. (Aquatic Macrophyte)
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat is present in the study area. (Semi-Aquatic species)
<i>Persoonia levis</i>	Broad-leaved Geebung	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Persoonia linearis</i>	Narrow-leaved Geebung	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Prasophyllum spp.</i>		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Pterostylis spp.</i>	Greenhood	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat may be present in the study area. (Terrestrial)
<i>Tetraloche juncea</i>	Black-eyed Susan	Moderate probability – No sightings have been recorded within the vicinity of LT Creek North Arm, however GSS Environmental (2011) recorded several near the study area. (Terrestrial)
<i>Xanthorrhoea latifolia</i>		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Xanthorrhoea latifolia</i> <i>subsp. latifolia</i>		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Xanthorrhoea spp.</i>		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
<i>Epinephelus daemeli</i>	Black Rockcod, Black Cod, Saddled Rockcod	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Marine/estuarine species)

Scientific Name	Common Name	Likelihood of Occurrence
<i>Mixophyes balbus</i>	Stuttering Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Mixophyes iteratus</i>	Giant Barred Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Crinia signifera</i>	Common Eastern Froglet	Moderate Probability – Found during targeted survey. Common frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Limnodynastes peronii</i>	Brown-striped Frog	Moderate Probability – Common Frog, tolerant to pollution. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Limnodynastes tasmaniensis</i>	Striped Grass Frog	Moderate Probability – Common Frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Litoria aurea</i>	Green and Golden Bell Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Litoria chloris</i>	Red-eyed Tree Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	Moderate Probability – Found during targeted survey. Common frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Litoria latopalmata</i>	Broad-palmed Frog	Moderate Probability – Found during targeted survey. Common frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog, Heath Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Litoria peronii</i>	Peron's Tree Frog	Moderate Probability – Found during targeted survey. Common frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Litoria tyleri</i>	Tyler's Tree Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Litoria verreauxii</i>	Verreaux's Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Pseudophryne coriacea</i>	Red-backed Toadlet	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
<i>Uperoleia fusca</i>	Dusky Toadlet	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)

Scientific Name	Common Name	Likelihood of Occurrence
<i>Apus pacificus</i>	Fork-tailed Swift	Low Probability – Migratory species unlikely inhabit the study area. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Migratory bird)
<i>Ardea alba</i>	Great Egret, White Egret	Low Probability – Migratory species unlikely inhabit the study area. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Migratory bird)
<i>Ardea ibis</i>	Cattle Egret	Low Probability – Migratory species unlikely inhabit the study area. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Migratory bird)

Appendix 10. Plans for the proposed Northern Coal Services Logistics Project (modified to highlight LT Creek)



Appendix 11. Environmental Protection Licence

Licence Number 395

Centennial Newstan Pty Ltd

Premises: 100 Miller Road, Fassifern NSW 2283

Appendix 9

Cooranbong-Awaba Haul Road Threatened Flora Translocation Reports



Centennial Coal

Cooranbong-Awaba Haul Road
Threatened Flora Translocation Report

January 2010



Centennial Coal Cooranbong-Awaba Haul Road Threatened Flora Translocation Report January 2010

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HUNTER ECO



Colin Driscoll
Environmental Biologist
NPWS Scientific Licence S10565
Exp 31 January 2011

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Centennial Coal Cooranbong-Awaba Haul Road Threatened Flora Translocation Report January 2010

1 Introduction

Centennial Coal received NSW Department of Planning approval in 1998 (DA 97/800) for the construction of a haul road to move coal from the Cooranbong mine near Dora Creek, connecting into the existing Eraring – Newstan haul road near Awaba. At the time of the preparation of this report, the haul road was close to completion.

A condition attached to the original approval required that a survey be conducted to locate any threatened plant species within and around the proposed haul road. A report was prepared (Driscoll 2008) that showed that there were three threatened flora species *Acacia bynoeana*, *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* present. Investigation of the wider area showed that the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* found in and near the haul road were parts of much larger continuous populations. While it was possible to relocate the haul road to avoid the *Acacia bynoeana* populations it was clear that no matter where the haul road was located, some *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* would be lost.

The original consent provided for the translocation of any threatened flora species that could not be planned around and a translocation proposal was approved for the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* (Driscoll 2009).

2 The translocation procedure

2.1 *Grevillea parviflora*

An excavator was first used to prepare the recipient site by clearing any fallen timber and scarifying the surface. At the donor sites, excavation outlines were marked on the ground with survey paint and the excavator was used to scoop the plants out and each bucketful was placed into the prepared recipient site. When a recipient area was filled, the translocated plants were thoroughly watered.

2.2 *Tetratheca juncea*

Plants were moved using two methods:

- Excavator bucket moving groups of clumps in bulk

This method was similar to that described above for *Grevillea parviflora* subsp. *parviflora* with the exception that at the recipient site individual holes were dug in which the translocated bucketful of clumps was placed.

Two sites were used, one at the southern end of the haul road and the other at about the centre of the haul road in an area beside a powerline easement that had been used to burn timber from the original clearing; this area was selected as a rehabilitation trial using the translocated clumps.

- Shovel and pots moving single clumps.

This method was originally used at Gwandalan (Driscoll & Bell 2008). As per the translocation proposal (Driscoll 2009) an experimental grid of holes was prepared in which the translocated clumps were placed. The grid was a 2 metre, 9 x 9 array of 81 holes. Clumps to be translocated were marked with flagging tape and these

clumps were carefully removed using a curved post-hole shovel. The soil bolus containing the clump was placed in a plastic pot for transport to the recipient site. Approximately 20 litres of water was supplied to each clump following translocation.

3 Results

Translocation was carried out between 27 April 2009 and 6 May 2009 inclusive. A cursory inspection of all sites was conducted on 3 November 2009 and detailed monitoring was carried out on 12 January 2010.

There was one recipient site for *Grevillea parviflora* subsp *parviflora* and three sites for *Tetralthea juncea* (**Table 1** and **Figure 1**).

Table 1 **Summary of the translocation results**

Site Number	Species	Method	Amount translocated
1	<i>Grevillea parviflora</i>	Excavator	An area of about 10mx10m
2	<i>Tetralthea juncea</i>	Individual clumps	81 clumps
3	<i>Tetralthea juncea</i>	Excavator	21 buckets placed together
4	<i>Tetralthea juncea</i>	Excavator	13 individual buckets



Figure 1 The haul road disturbance area and the recipient sites

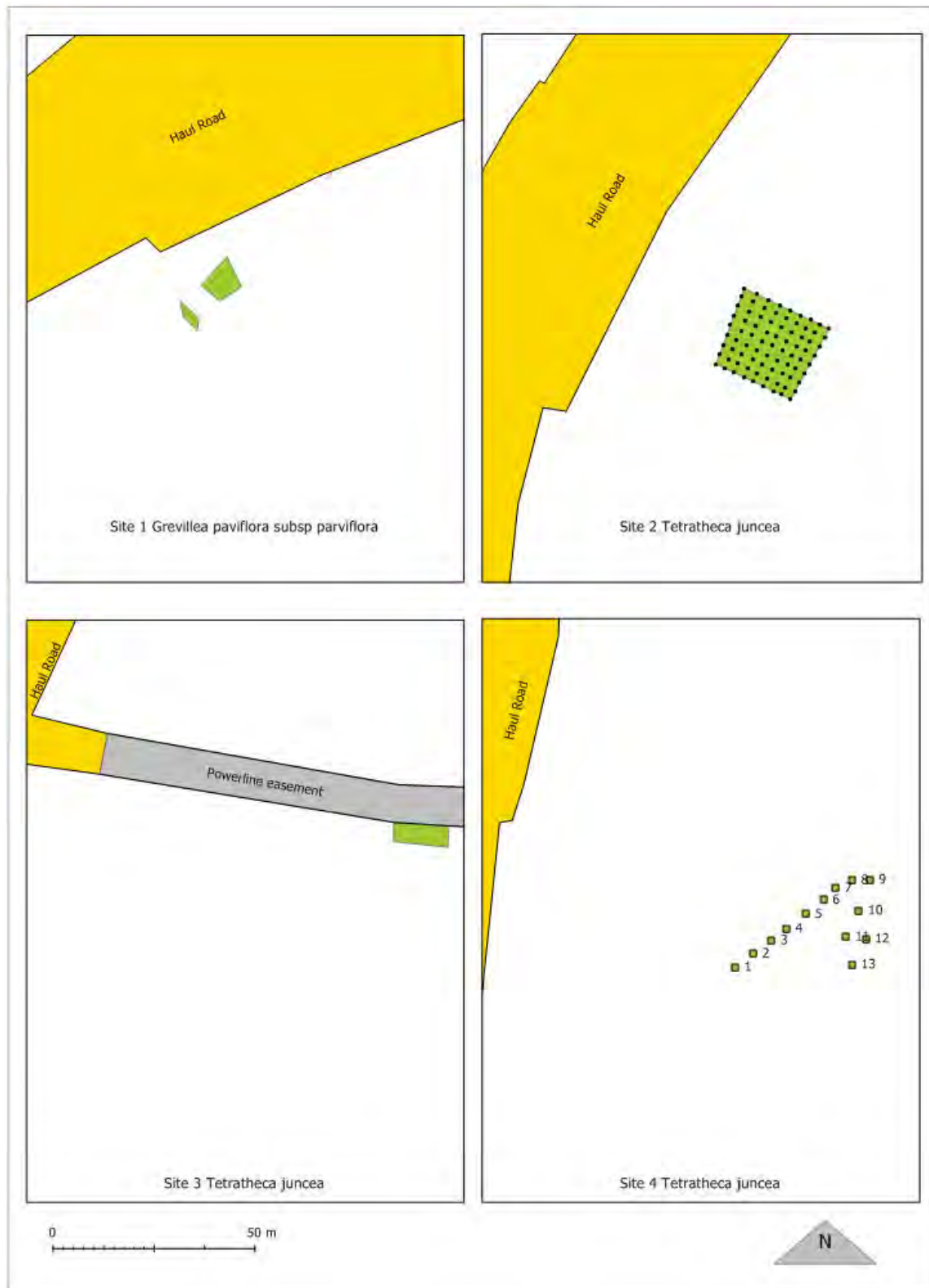


Figure 2 Recipient site location details

3.1 Site 1 *Grevillea parviflora* subsp *parviflora*

Approximately 70m² of *Grevillea parviflora* subsp *parviflora* was translocated (**Figure 3**). Individual stems were not counted at the translocation stage. At 12 January 2010 there were 75 live stems along with a number of dead plants.



Figure 3 A bucketful of *Grevillea parviflora* subsp *parviflora*

3.2 Site 2 *Tetratheca juncea*

Figure 4 shows *Tetratheca juncea* clumps in pots ready for planting in the prepared holes.



Figure 4 Potted *Tetratheca juncea* clumps ready for planting

On 3 November 2009 a general inspection found that several of the translocated clumps were flowering.

Details of the monitoring results from 12 January 2010 can be found in **Table 2**. In summary, of the 81 clumps, 5 clumps were no longer visible in any form (No Plant), all of the stems of 8 clumps were dead (Dead) but still present and the remaining 68 clumps were alive and in varying condition. Of the living clumps, 51 had vigorous new stem growth, 17 had green stems but no new growth and 12 of the 68 clumps had been grazed heavily. **Figure 5** provides a graphical description of the condition of the 91 clumps.

An experimental component of this site was to loosen the soil around the planting hole to facilitate the spread of the clump away from the hole. Using the rand() function in Microsoft Excel, 34 of the surviving clumps were randomly selected and the soil around the holes was loosened using a pick.

Table 2 **Details of the condition of Site 2 clumps**

Clump	Size1	Size2	Condition	Grazed		Clump	Size1	Size2	Condition	Grazed
1	<10	<10	OK			42	<10	<10	OK	yes
2	<10		No plant			43	<10	<10	OK	
3	>10	>10	New growth	yes		44	<10	<10	Dead	
4	>10	>10	Dead			45	>10	<10	New growth	
5	<10	<10	New growth			46	<10	<10	New growth	
6	<10	<10	New growth			47	<10	<10	New growth	
7	<10	<10	New growth			48	<10	<10	New growth	
8	<10	<10	New growth			49	<10	<10	New growth	
9	<10	<10	Dead			50	<10	<10	OK	
10	>10	>10	New growth	yes		51	<10	<10	New growth	
11	<10	<10	OK			52	<10	<10	New growth	
12	<10	<10	New growth			53	<10	<10	OK	
13	>10	>10	New growth			54	<10	<10	New growth	
14	>10	>10	New growth			55	<10	<10	OK	
15	<10	<10	New growth			56	<10	<10	New growth	
16	>10	>10	New growth	yes		57	<10	<10	New growth	
17	<10	<10	New growth	yes		58	<10	<10	New growth	
18	<10	<10	New growth	yes		59	<10	<10	New growth	
19	<10	<10	New growth			60	<10	<10	OK	
20	>10	>10	Dead			61	<10	<10	New growth	
21	<10	<10	New growth			62	<10	<10	New growth	
22	<10	<10	New growth			63	>10	>10	Dead	
23	<10	<10	New growth			64	<10	<10	New growth	
24	<10	<10	New growth			65	<10	<10	New growth	
25	<10	<10	OK			66	<10	<10	New growth	
26	<10	<10	OK			67	<10	<10	New growth	
27	<10	<10	New growth			68	>10	>10	OK	yes
28	>10	>10	New growth			69	>10	<10	OK	
29	<10	<10	New growth			70	<10	<10	OK	yes
30	<10	<10	Dead			71	<10		No plant	
31	<10	<10	New growth			72	>10	>10	New growth	yes
32	<10	<10	New growth			73	<10		No plant	
33	>10	<10	New growth			74	<10	<10	OK	
34	<10	<10	Dead			75	<10		No plant	
35	>10	>10	New growth			76	>10	<10	New growth	
36	<10	<10	New growth			77	>10	>10	OK	yes
37	<10	<10	New growth			78	<10	<10	OK	yes
38	<10		No plant			79	>10	>10	New growth	yes
39	<10	<10	Dead			80	>10	>10	New growth	
40	<10	<10	New growth			81	>10	>10	OK	
41	>10	>10	New growth							

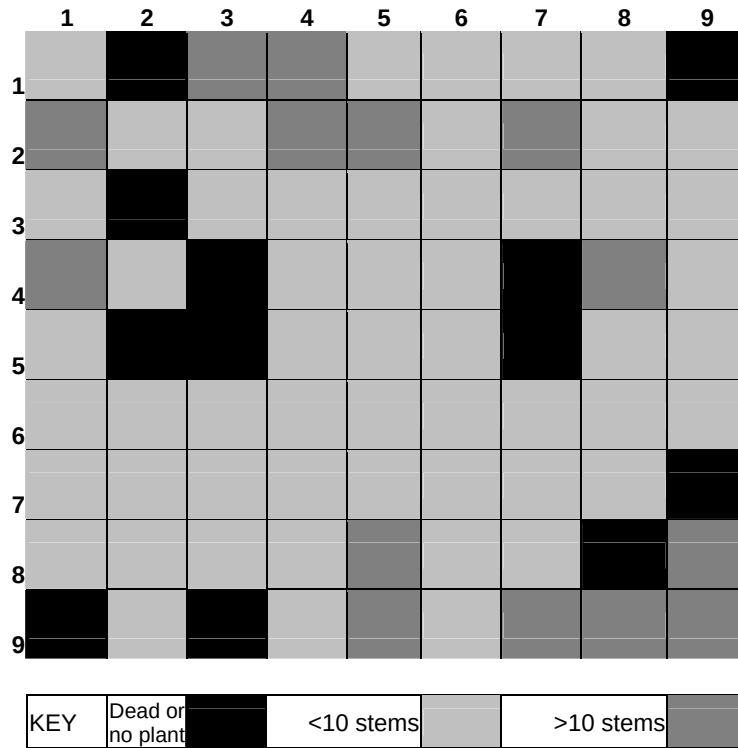


Figure 5 Showing the condition of the clumps in the grid as of January 2010

3.3 Site 3 *Tetratheca juncea*

This site was an experimental attempt at using the bulk translocation of *Tetratheca juncea* to rehabilitate a small area. The area was approximately 180 m² located beside a powerline easement and where logs from the clearing of that easement had been burned. The area had no ground vegetation. **Figures 6 & 7** show the site before and after translocation. Twenty one excavator buckets containing *Tetratheca juncea* and other vegetation were translocated to the site.



Figure 6 Site 3 before translocation



Figure 7 Site 3 after translocation

Figure 8 shows the site at 12 January 2010. A number of the large shrubs translocated along with the *Tetratheca juncea*, particularly *Lambertia formosa*, had died. Twelve large clumps of *Tetratheca juncea* were visible and those at the eastern end (left hand side of the images) where the tree shade was deepest, seemed to be in better condition than the rest.



Figure 8 **Site 3 January 2010**

3.4 Site 4 *Tetratheca juncea*

Thirteen excavator buckets containing *Tetratheca juncea* were translocated to this site which was located in undisturbed vegetation beside an old track (**Figure 9**).



Figure 9 Placing a bucket of *Tetratheca juncea* at Site 4

At 12 January 2010 only one of the 13 plots had no visible *Tetradleca juncea*, four had at least one flower and one had a seed capsule (**Table 3**).

Table 3 **Site 4 clumps condition at 12 January 2010**

Plot Number	Condition	Flowers	Seed capsules
1	Good with new growth	1	
2	Good with new growth	1	
3	Good with new growth	2	1
4	Good with new growth	1	
5	Good with new growth		
6	Single stem		
7	No visible plant		
8	Good but grazed		
9	Good		
10	Good		
11	Good		
12	Good		
13	Poor		

4 Discussion

A successful translocation would be one where a functional population unit has been established showing normal growth, reproduction and propagation cycles. It is too early to assess the success of the Haul Road translocation project.

Some issues are evident following the translocation process and the January 2010 monitoring:

Site 1

While the site was prepared well it was a flat site on which buckets of vegetation were deposited. The intention was to scoop out relatively flat slabs of even thickness however this did not appear to be possible using an excavator. The end result was that the buckets of soil were not well surrounded by the base soil and the resulting air cavities would have led to excess drying and the death of plants at the perimeter of each load. It would have been better to scoop individual holes at the recipient site as was done later at Site 4 for *Tetradleca juncea*.

Site 2

Watering the individual clumps was difficult and could not be done with the hose from the water truck because the dragging hose would get caught in all the vegetation and also had the potential to damage the newly placed clumps. This meant manual watering which was a difficult task with each clump needing at least 20 litres of water. A better method would be to set up a monsoon-type sprinkler in the centre of the site and run that by pump to supply water to the entire site.

Site3

Being beside a cleared easement meant that this site was quite exposed. The condition of all of the translocated vegetation appears indicative of insufficient water. However there may well be sufficient seedbank and established plants for the overall vegetation to recover over time.

Site 4

The translocation procedure at this site was probably as successful as could be expected. Each load of soil and vegetation sat well in the prepared holes and watering access was easy.

5 References

Driscoll, C. (2009) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora translocation proposal*. Report by Hunter Eco for Centennial Coal. March 2009.

Driscoll, C. (2008) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora investigation*. Report by Hunter Eco for Centennial Coal. November 2008.

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Centennial Coal

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Threatened Flora Translocation Report**

November 2010

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A condition attached to the original approval required that a survey be conducted to locate any threatened plant species within and around the proposed haul road. A report was prepared (Driscoll 2008) that showed that there were three threatened flora species *Acacia bynoeana*, *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* present. Investigation of the wider area showed that the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* found in and near the haul road were parts of much larger continuous populations. While it was possible to relocate the haul road to avoid the *Acacia bynoeana* populations it was clear that no matter where the haul road was located, some *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* would be lost.

The original consent provided for the translocation of any threatened flora species that could not be planned around and a translocation proposal was approved for the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* (Driscoll 2009).

Translocation was carried out between 27 April 2009 and 6 May 2009 inclusive. There was one recipient site for *Grevillea parviflora* subsp. *parviflora* and three sites for *Tetratheca juncea* (**Table 1** and **Figure 1**).

Table 1 Summary of the translocation results

Site Number	Species	Method	Amount translocated
1	<i>Grevillea parviflora</i>	Excavator	An area of about 10mx10m
2	<i>Tetratheca juncea</i>	Individual clumps	81 clumps
3	<i>Tetratheca juncea</i>	Excavator	21 buckets placed together
4	<i>Tetratheca juncea</i>	Excavator	13 individual buckets

Figure 2 provides details of each of the four recipient sites.

The translocated plants are to be monitored annually for five years. A cursory inspection of all sites was conducted on 3 November 2009 and the first detailed monitoring was carried out on 12 January 2010. This is the report of the results from a monitoring inspection conducted on 16 November 2010.



Figure 1 The haul road disturbance area and the recipient sites

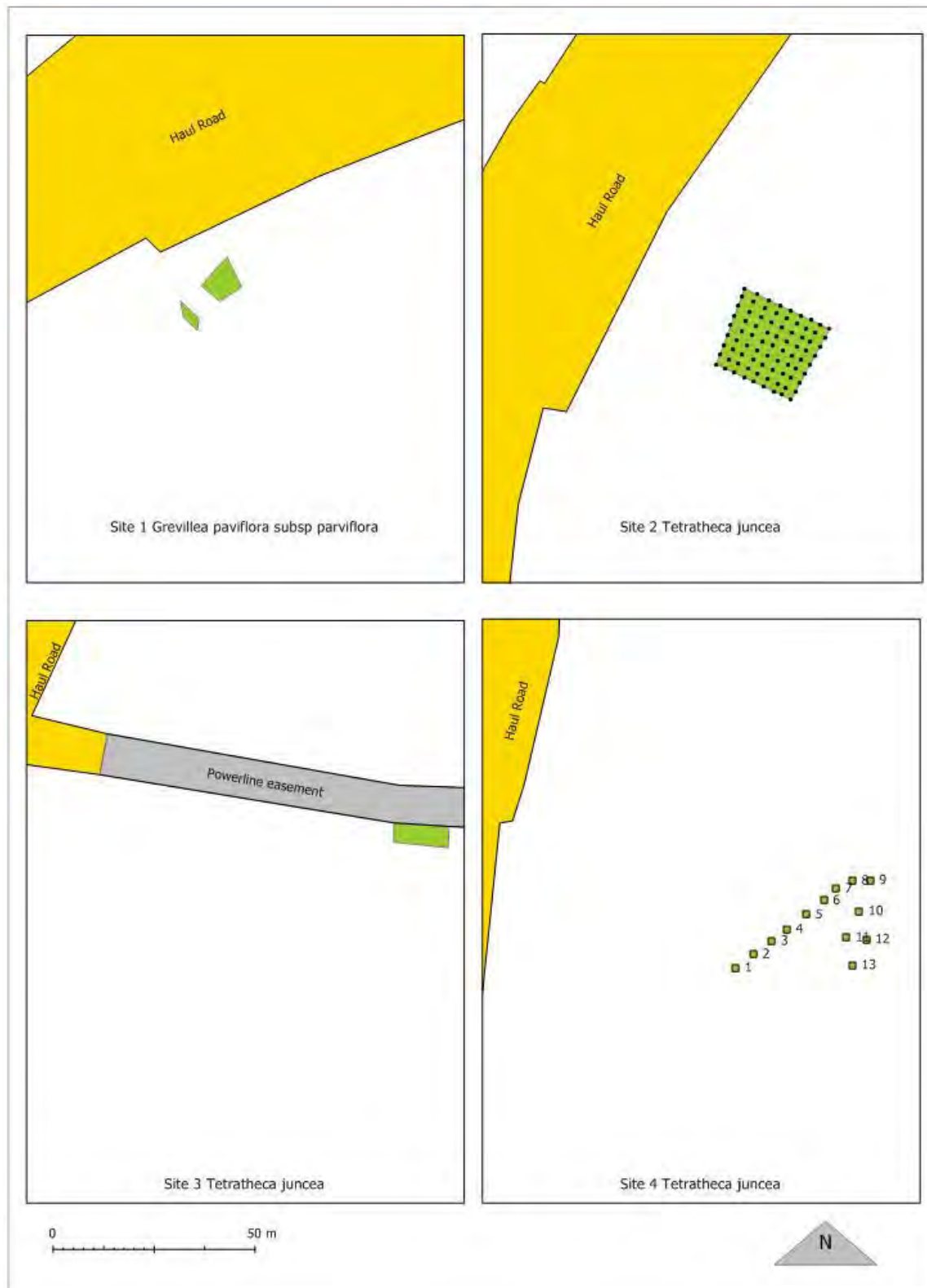


Figure 2 Recipient site location details

2 Results

2.1 Site 1 *Grevillea parviflora* subsp *parviflora*

In January 2010 there were 75 live and a number of dead plants. Since then the plants have started to grow back and there were a number of small (about 10 cm tall) plants scattered throughout. There were 128 *Grevillea* plants present, a 70% increase. A few of the mature plants were flowering (**Figure 3**).



Figure 3 Translocated *Grevillea parviflora* subsp *parviflora* flowering at Site 1

2.2 Site 2 *Tetratheca juncea*

At this site, 81 clumps had been individually translocated by hand. The first observation was that clumps 1, 2 and 3 had been driven over. There is no obvious explanation for this because the site is about 25 m into the bush from the haul road clearing.

As was noted in the January 2010 report, the clumps had been fairly heavily grazed, presumably by wallabies, and this has continued with more clumps grazed. Table 2 provides the details of the condition of each clump and Figure 3 shows a summary of the main condition indices over time. Figure 4 is a graphical representation of the overall grid and the condition of each clump.

Table 2 Details of the condition of Site 2 clumps

Clump	Size1	Size3	Condition	Grazed	Clump	Size1	Size3	Condition	Grazed
1	<10	<10	Poor		42	<10	<10	OK	yes
2	<10		No plant		43	<10		No plant	
3	>10	<10	New growth	yes	44	<10		No plant	
4	>10		No plant		45	>10	<10	New growth	
5	<10	<10	New growth		46	<10	<10	New growth	
6	<10	<10	New growth		47	<10	<10	New growth	yes
7	<10	<10	New growth		48	<10	<10	New growth	
8	<10		No plant		49	<10	<10	New growth	yes
9	<10		No plant		50	<10	<10	OK	
10	>10	>10	New growth	yes	51	<10	<10	New growth	
11	<10	<10	New growth		52	<10		No plant	
12	<10		No plant		53	<10		No plant	
13	>10	<10	New growth	yes	54	<10	<10	New growth	
14	>10	<10	New growth	yes	55	<10	<10	New growth	
15	<10	>10	New growth	yes	56	<10	<10	New growth	
16	>10	<10	New growth	yes	57	<10	<10	New growth	yes
17	<10	<10	New growth	yes	58	<10	<10	New growth	
18	<10	<10	New growth	yes	59	<10		No plant	
19	<10	<10	New growth		60	<10	<10	New growth	
20	>10		No plant		61	<10	<10	New growth	
21	<10	<10	New growth		62	<10		No plant	
22	<10	<10	New growth		63	>10		No plant	
23	<10	<10	New growth	yes	64	<10		No plant	
24	<10	<10	New growth	yes	65	<10		No plant	
25	<10	<10	New growth		66	<10	<10	New growth	yes
26	<10	<10	New growth		67	<10	<10	New growth	yes
27	<10		No plant		68	>10	<10	New growth	yes
28	>10	<10	New growth		69	>10		No plant	
29	<10		No plant		70	<10	<10	New growth	yes
30	<10	<10	No plant		71	<10		No plant	
31	<10	<10	New growth		72	>10	>10	New growth	yes
32	<10		No plant		73	<10		New growth	
33	>10	<10	New growth		74	<10		No plant	
34	<10		No plant		75	<10		No plant	
35	>10		No plant		76	>10		No plant	
36	<10	<10	New growth		77	>10	<10	New growth	yes
37	<10	<10	New growth		78	<10	<10	New growth	yes
38	<10		No plant		79	>10	>10	New growth	yes
39	<10		No plant		80	>10	<10	New growth	yes
40	<10	<10	New growth		81	>10		No plant	
41	>10	<10	New growth	yes					

Size1=clumps size when translocated Size3=clumps size at November 2010

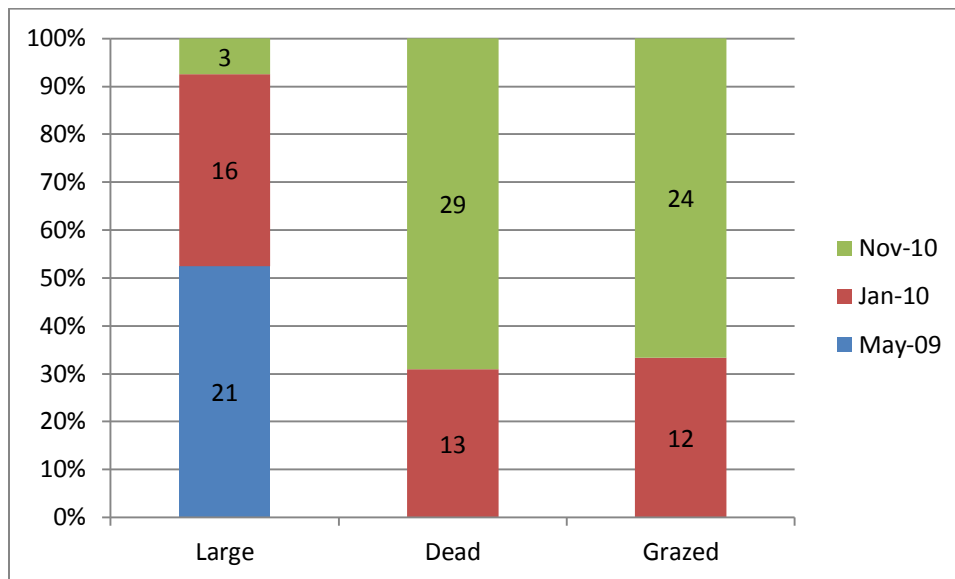


Figure 4 A graph of the indices used for monitoring the 81 translocated clumps showing changes over time.

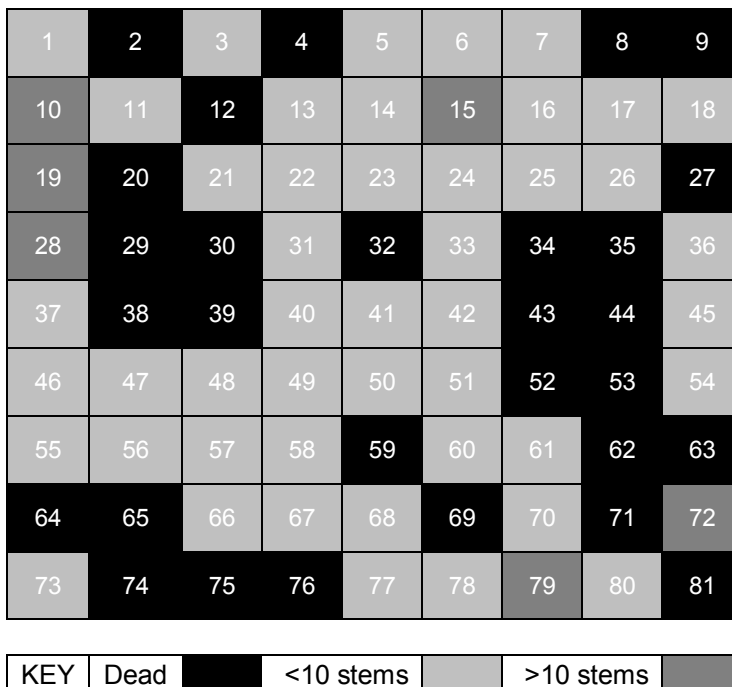


Figure 5 Showing the condition of the clumps in the grid as of November 2010

2.3 Site 3 *Tetratheca juncea*

This site was an experimental attempt at using the bulk translocation of *Tetratheca juncea* to rehabilitate a small area of disturbance. The area was approximately 180 m² located beside a powerline easement and where logs from the clearing of that easement had been burned. The area had no ground vegetation. **Figures 6 & 7** show the site before and after translocation. Twenty one excavator buckets containing *Tetratheca juncea* and other vegetation were translocated to the site.



Figure 6 Site 3 before translocation



Figure 7 Site 3 after translocation

Figure 8 shows the site at 16 November 2010. A number of the large shrubs translocated along with the *Tetratheca juncea*, particularly *Lambertia formosa*, had died. Fifteen large clumps of *Tetratheca juncea* were visible and those at the eastern end (left hand side of the images) where the tree shade was deepest, seemed to be in better condition than the rest.



Figure 8 **Site 3 November 2010**

Table 3 provides details of the condition of the fifteen identifiable clumps.

Table 3 **Site 3 *Tetratheca juncea* condition**

Clump	Flowers	Overall condition
1	-	No visible plant.
2	1	Abundant new growth.
3	-	Small amount of new growth.
4	-	Small amount of new growth. Clump heavily grazed.
5	1	No new growth.
6	-	One small clump. No new growth. Clump heavily grazed.
7	-	Abundant new growth.
8	-	Good new growth. Clump grazed.
9	-	Good new growth. Clump grazed.
10	6	Good new growth. Clump grazed.
11	-	No new growth. Clump heavily grazed.
12	-	Small amount of new growth. Clump heavily grazed.
13	-	Small amount of new growth.
14	5	Abundant new growth.
15	62	Very large spreading clump. Abundant new growth.

2.4 Site 4 *Tetradthea juncea*

In January 2010 only one of the 13 plots had no visible *Tetradthea juncea*, four had at least one flower (5 flowers in total) and one had a seed capsule. In November 2010 there were 41 flowers and one seed capsule and the Plot 7 plant (not visible in January 2010) had recovered (**Table 4**).

Table 4 Site 4 clumps condition at 16 November 2010

Plot Number	Condition	Flowers	Seed capsules
1	Good with abundant new growth	6	-
2	Good with abundant new growth	3	-
3	Good with abundant new growth. Appears to be spreading.	2	-
4	Good with abundant new growth	2	-
5	Good with new growth. Appears to be spreading.	2	-
6	Small clump, some new growth.	4	-
7	Small clump, some new growth	1	-
8	Good with abundant new growth. Grazed.	2	-
9	Good. Small amount of new growth.	11	1
10	Good with abundant new growth	-	-
11	Good. Small amount of new growth.	8	-
12	Good. Small amount of new growth. Grazed.	-	-
13	Good. Small amount of new growth.	-	-

2.4.1 Collateral translocation

When using a large excavator bucket, other species are translocated along with the target species. The success of these collateral species may be important to the success of the target *Tetradthea juncea*. For example *Tetradthea juncea* has a symbiotic root association with a soil fungus known as *Mycorrhiza* which facilitates root absorption of soil nutrients. This fungus might be associated with other plants.

Table 5 shows that 28 species were translocated along with the *Tetradthea juncea*.

Table 5 Collateral species growing well in the Group 4 translocation plots.

Family Name	Scientific Name	1	2	3	4	5	6	7	8	9	10	11	12	13
Anthericaceae	<i>Tricoryne elatior</i>		*											
Apiaceae	<i>Platysace linearifolia</i>	*	*	*	*					*		*		*
Cyperaceae	<i>Cyathochaeta diandra</i>		*	*			*							
Cyperaceae	<i>Lepidosperma concavum</i>		*		*		*	*	*					
Cyperaceae	<i>Ptilothrix deusta</i>	*		*		*		*		*	*	*	*	*
Dennstaedtiaceae	<i>Pteridium esculentum</i>							*	*					
Epacridaceae	<i>Epacris pulchella</i>	*	*	*	*	*	*	*		*			*	*
Euphorbiaceae	<i>Phyllanthus hirtellus</i>						*	*	*					
Fabaceae (Faboideae)	<i>Bossiaea obcordata</i>							*	*					
Fabaceae (Faboideae)	<i>Bossiaea stephensonii</i>				*									
Fabaceae (Faboideae)	<i>Dillwynia retorta</i>		*			*	*		*					
Fabaceae (Faboideae)	<i>Mirbelia rubiifolia</i>							*						
Fabaceae (Mimosoideae)	<i>Acacia suaveolens</i>									*				
Goodeniaceae	<i>Dampiera stricta</i>			*			*							
Lauraceae	<i>Cassythia glabella forma glabella</i>									*				
Lindsaeaceae	<i>Lindsaea linearis</i>				*	*					*	*	*	*
Lomandraceae	<i>Lomandra obliqua</i>						*							
Myrtaceae	<i>Leptospermum polygalifolium subsp. polygalifolium</i>										*		*	*
Myrtaceae	<i>Leptospermum trinervium</i>			*	*	*			*					
Pittosporaceae	<i>Billardiera scandens var. scandens</i>						*							
Poaceae	<i>Anisopogon avenaceus</i>	*	*	*			*				*		*	*
Poaceae	<i>Entolasia stricta</i>		*		*			*			*	*	*	*
Poaceae	<i>Themeda australis</i>						*							
Proteaceae	<i>Banksia oblongifolia</i>		*		*	*	*					*	*	
Proteaceae	<i>Banksia spinulosa var. collina</i>										*		*	
Proteaceae	<i>Hakea dactyloides</i>			*										
Proteaceae	<i>Isopogon anemonifolius</i>			*	*									
Proteaceae	<i>Lambertia formosa</i>	*	*		*					*				
Totals	28	5	10	9	10	6	11	8	6	6	6	5	8	7

3 Discussion

Site 1 *Grevillea parviflora* subsp *parviflora*

The plants appear to be recovering from the move with a lot of new growth and a few mature plants in flower.

Site 2 *Tetradthea juncea*

So far the plants at this site are struggling to get ahead of the wallabies grazing them. This site was intended to provide experimental data on the effect of physically loosening the soil around some of the clumps as an aid to the plants spreading outside of the hole in which they were planted. With just over a third of the plants dead that experimental opportunity could be lost. An option now would be to fence out the wallabies and this should be considered.

Site 3 *Tetradthea juncea*

This site is very dry and exposed to the sun and it would appear that all species including *Tetradthea juncea* have not responded well to the translocation process, particularly when compared with the results at Site 4. The plot that is growing and flowering prolifically is located at the eastern end where it is shaded by the surrounding vegetation. There is also a problem with wallabies grazing the fairly exposed clumps and fencing should again be considered for this site.

Site 4 *Tetradthea juncea*

The 13 plots at this site are all progressing very well. The species that were translocated along with the *Tetradthea juncea* are providing them with physical protection with very little evidence of grazing. The site is also quite moist being on a lower slope and this will have facilitated the survival of all of the translocated species.

4 References

Driscoll, C. (2009) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora translocation proposal*. Report by Hunter Eco for Centennial Coal. March 2009.

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Translocation was carried out between 27 April 2009 and 6 May 2009 inclusive. There was one recipient site for *Grevillea parviflora* subsp. *parviflora* and three sites for *Tetradlea juncea* (**Table 1** and **Figure 1**).

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Figure 2 provides details of each of the four recipient sites.

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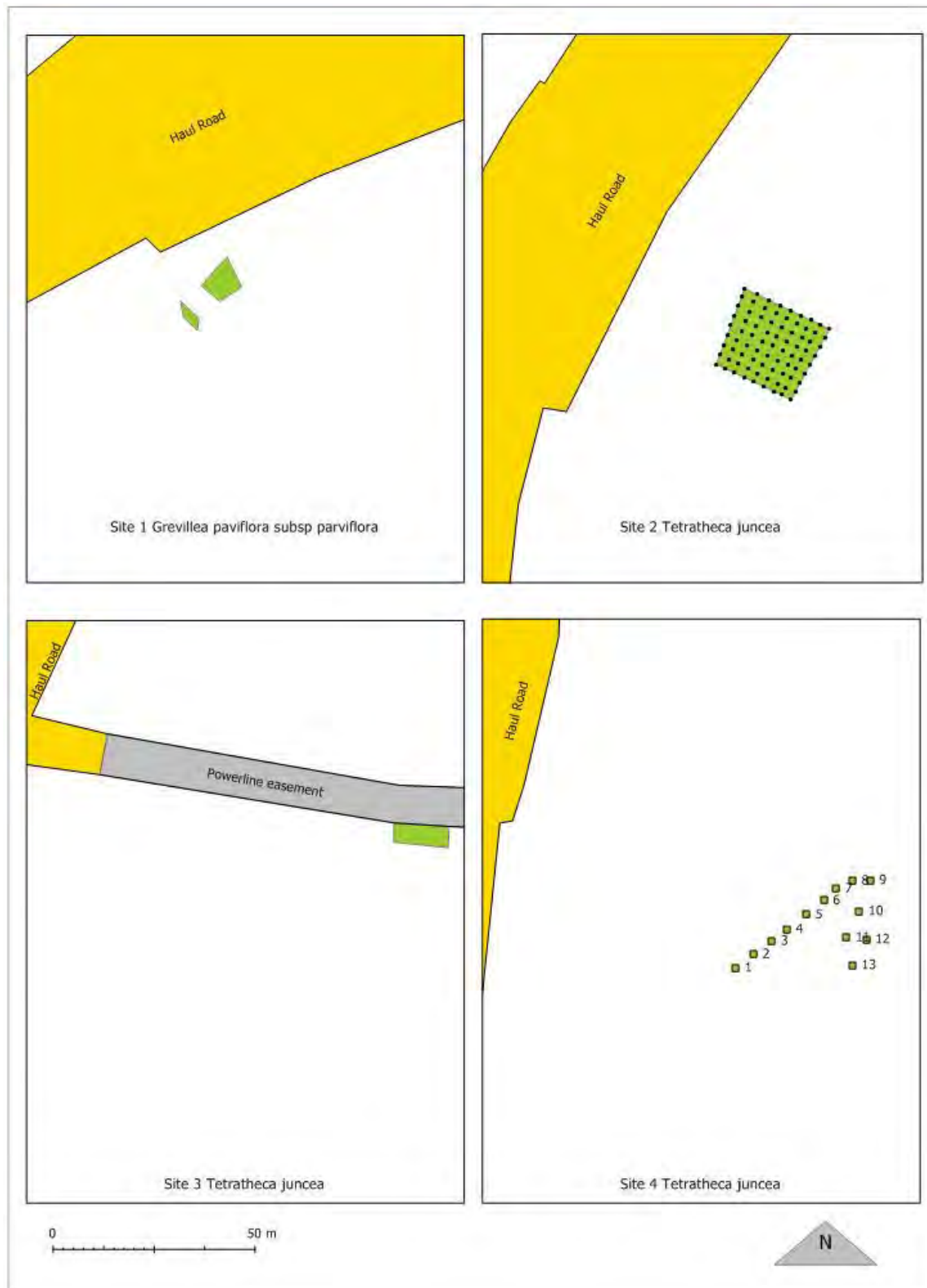


Figure 2 Recipient site location details

2 Results

2.1 Site 1 *Grevillea parviflora* subsp *parviflora*

In January 2010 there were 75 live and a number of dead plants. There were 128 plants present in November 2010, a 70% increase, with these plants being around 10 cm tall. In November 2011 there were 147 plants, just under double the number recorded in January 2010. The plants were around 20 cm tall. As in 2010 several of the mature plants were flowering (**Figure 3**).



Figure 3 Translocated *Grevillea parviflora* subsp *parviflora* flowering at Site 1 25/11/2011

2.2 Site 2 *Tetratheca juncea*

At this site, 81 clumps had been individually translocated by hand.

Table 2 provides details of the condition of each clump as at November 2011 and **Figure 4** shows a plot of percentage of surviving clumps. **Figure 5** is a graphical representation of the overall grid and the condition of each clump.

Table 2 Details of the condition of Site 2 clumps

Clumps with condition shown in bold were recorded as 'no plant' in November 2010

Clump	Size1	Size4	Condition	Grazed	Clump	Size1	Size4	Condition	Grazed
1	<10		No plant		42	<10		No plant	
2	<10		No plant		43	<10		No plant	
3	>10		No plant		44	<10		No plant	
4	>10		No plant		45	>10	<10	New growth	
5	<10	<10	New growth		46	<10		No plant	
6	<10	<10	New growth		47	<10		No plant	
7	<10	<10	New growth		48	<10		No plant	
8	<10		No plant		49	<10		No plant	
9	<10		No plant		50	<10	<10	New growth	
10	>10	>10			51	<10	<10	No plant	
11	<10		No plant		52	<10		New growth	
12	<10		No plant		53	<10		No plant	
13	>10	<10	New growth		54	<10	<10	New growth	
14	>10	<10	New growth		55	<10		No plant	
15	<10	>10	New growth		56	<10		No plant	
16	>10		No plant		57	<10		No plant	
17	<10	<10	New growth		58	<10		No plant	
18	<10	<10	New growth		59	<10		No plant	
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26	<10	<10	New growth		67	<10		No plant	
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28	>10	<10	New growth		69	>10		No plant	
29	<10		No plant		70	<10		No plant	
30	<10		No plant		71	<10		No plant	
31	<10		No plant		72	>10		No plant	
32	<10		New growth		73	<10		No plant	
33	>10		No plant		74	<10		No plant	
34	<10		No plant		75	<10		No plant	
35	>10		No plant		76	>10		No plant	
36	<10	<10	New growth		77	>10		No plant	
37	<10		No plant		78	<10		No plant	
38	<10		No plant		79	>10	>10	New growth	
39	<10		No plant		80	>10	<10	New growth	
40	<10		No plant		81	>10		No plant	
41	>10		No plant						

Size1=clumps size when translocated Size4=clumps size at November 2011

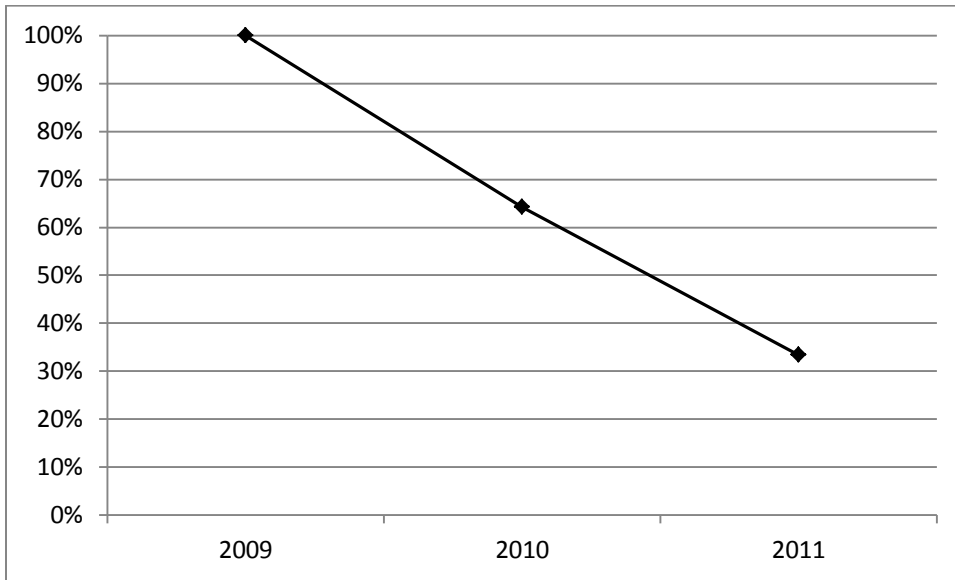


Figure 4 Percentage of clumps surviving at Site 2 over time

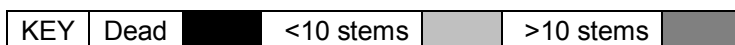
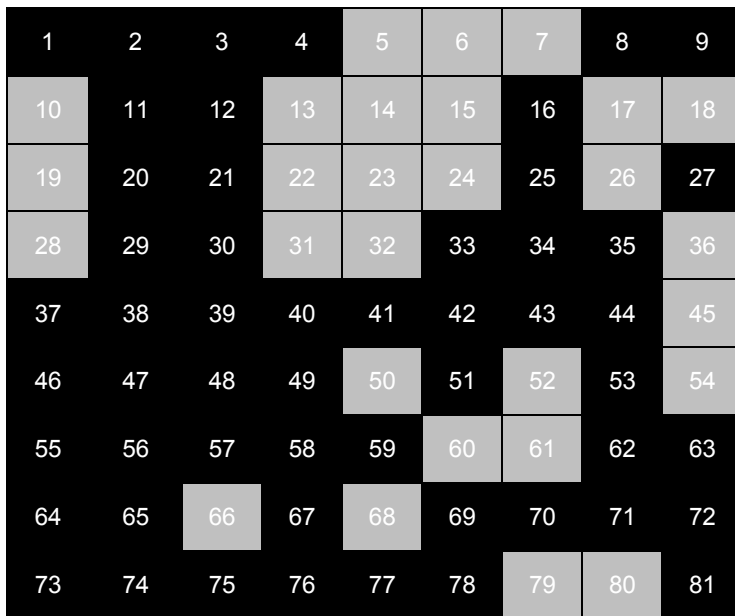


Figure 5 Showing the condition of the clumps in the grid as of November 2011

2.3 Site 3 *Tetratheca juncea*

This site was an experimental attempt at using the bulk translocation of *Tetratheca juncea* to rehabilitate a small area of disturbance. The area was approximately 180 m² located beside a powerline easement and where logs from the clearing of that easement had been burned. The area had no ground vegetation. **Figures 6 & 7** show the site before and after translocation. Twenty one excavator buckets containing *Tetratheca juncea* and other vegetation were translocated to the site.



Figure 6 Site 3 before translocation



Figure 7 Site 3 after translocation

Figure 8 shows the site at 16 November 2010 and **Figure 9** shows the site at 25 November 2011.



Figure 8 Site 3 November 2010



Figure 9 Site 3 November 2011

In November 2010 15 clumps in varying condition were recorded and in November 2011 there were 19 clumps recorded. Herbivore grazing continues to be a problem.

2.4 Site 4 *Tetradlea juncea*

In January 2010 only one of the 13 plots had no visible *Tetradlea juncea*, four had at least one flower (5 flowers in total) and one had a seed capsule. In November 2010 there were 41 flowers and one seed capsule and the Plot 7 plant (not visible in January 2010) had recovered (**Table 4**). In November 2011 there were 12 flowers and no seed capsules. No clumps were present at Plot 9 while the previously recovered Plot 7 had 2 clumps and new growth.

Table 4 Site 4 clumps condition at 16 November 2011

Plot Number	Condition	Flowers	Seed capsules
1	>10 stems heavily grazed	-	-
2	3 clumps, >10 stems, some new growth, heavily grazed	2	-
3	2 clumps, >10 stems, some new growth, moderate grazing	3	-
4	1 clump, >10 stems, some new growth, heavily grazed		-
5	1 clump, >10 stems, some new growth, moderate grazing		-
6	2 clumps, > and < 10 stems, some new growth, moderate grazing	3	-
7	2 clumps, <10 stems, some new growth, moderate grazing		-
8	2 clumps, >10 stems, heavily grazed	2	-
9	No clumps		-
10	2 clumps, <10 stems, some new growth	-	-
11	1 clump, >10 stems, some new growth, moderate grazing	2	-
12	1 clump, >10 stems, heavily grazed	-	-
13	1 clump, < 10 stems, heavily grazed	-	-

Herbivore grazing of *Tetratheca juncea* was now widespread with a grazed clump shown in **Figure 10**.



Figure 10 Grazed *Tetratheca juncea* clump at Plot 8

2.4.1 Collateral translocation

When using a large excavator bucket, other species are translocated along with the target species. The success of these collateral species may be important to the success of the target *Tetradlea juncea*. For example *Tetradlea juncea* has a symbiotic root association with a soil fungus known as *Mycorrhiza* which facilitates root absorption of soil nutrients. This fungus might be associated with other plants.

The total number of species translocated along with *Tetradlea juncea* has increased from 28 recorded in November 2010 to 34 in November 2011 (**Table 5**).

Table 5 Collateral species growing in the Site 4 translocation plots.

Family Name	Scientific Name	1	2	3	4	5	6	7	8	9	10	11	12	13
Fabaceae (Mimosoideae)	<i>Acacia suaveolens</i>									✓				
Poaceae	<i>Anisopogon avenaceus</i>	x	✓	x			✓			☑	✓		✓	✓
Proteaceae	<i>Banksia oblongifolia</i>		✓	☑	✓	✓	x					✓	✓	
Proteaceae	<i>Banksia spinulosa</i> var. <i>collina</i>										✓		✓	
Pittosporaceae	<i>Billardiera scandens</i> var. <i>scandens</i>						✓							
Fabaceae (Faboideae)	<i>Bossiaea obcordata</i>							✓	✓					
Fabaceae (Faboideae)	<i>Bossiaea stephensonii</i>				✓									
Lauraceae	<i>Cassytha glabella</i> forma <i>glabella</i>			☑	☑			☑		✓				
Cyperaceae	<i>Cyathochaeta diandra</i>	☑	✓	✓	☑		x			☑	☑	☑		
Goodeniaceae	<i>Dampiera stricta</i>		☑	✓			✓					☑		
Fabaceae (Faboideae)	<i>Dillwynia retorta</i>	☑	✓			x	x		✓	☑				
Poaceae	<i>Entolasia stricta</i>		✓	☑	✓	☑	☑	✓	☑	☑	✓	✓	✓	✓
Epacridaceae	<i>Epacris pulchella</i>	✓	✓	✓	✓	✓	✓	x		✓	☑		✓	✓
Fabaceae (Faboideae)	<i>Gompholobium minus</i>									☑				
Proteaceae	<i>Hakea dactyloides</i>			✓										
Dilleniaceae	<i>Hibbertia vestita</i>			☑										
Proteaceae	<i>Isopogon anemonifolius</i>			✓	✓									
Proteaceae	<i>Lambertia formosa</i>	✓	✓		✓					✓		☑		
Cyperaceae	<i>Lepidosperma concavum</i>		✓	☑	✓		✓	✓	✓					
Cyperaceae	<i>Lepidosperma laterale</i>							☑						☑
Myrtaceae	<i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i>										✓		✓	✓
Myrtaceae	<i>Leptospermum trinervium</i>	☑		✓	✓	✓			x		☑			
Lindsaeaceae	<i>Lindsaea linearis</i>				✓	✓					x	✓	x	✓
Loganiaceae	<i>Logania pusilla</i>												☑	
Lomandraceae	<i>Lomandra obliqua</i>						✓							
Fabaceae (Faboideae)	<i>Mirbelia rubiifolia</i>							✓						☑
Iridaceae	<i>Patersonia sericea</i>											☑		
Euphorbiaceae	<i>Phyllanthus hirtellus</i>						✓	x	x					
Apiaceae	<i>Platysace linearifolia</i>	x	✓	✓	✓	☑				✓	☑	✓	☑	✓
Dennstaedtiaceae	<i>Pteridium esculentum</i>							✓	✓					
Cyperaceae	<i>Ptilothrix deusta</i>	✓	☑	✓	☑	✓		x		✓	x	x	✓	✓
Fabaceae (Faboideae)	<i>Pultenaea tuberculata</i>				☑									
Poaceae	<i>Themeda australis</i>						✓	☑						
Anthericaceae	<i>Tricoryne elatior</i>		✓											
Totals	34	6	12	13	14	7	9	8	5	11	8	8	9	9

KEY: x = previously present, now absent ✓ = present previously and now ☑ = previously absent, now present.

3 Discussion

Site 1 *Grevillea parviflora* subsp *parviflora*

The plants appear to be recovering from the move with a lot of new growth and a few mature plants in flower. The plants had approximately doubled in size.

Site 2 *Tetratheca juncea*

This group is now down to one third of the originally translocated clumps and each of the survivors only have a few stems. Previously it was reported that the clumps were being heavily grazed and this may have contributed to the steady decline. Two clumps that recorded as missing in November 2010 had regrown.

Site 3 *Tetratheca juncea*

Grazing by herbivores was again evident. The number of clumps was up from 15 to 19 and overall growth in the translocated sites has increased.

Site 4 *Tetratheca juncea*

Previously there was no evidence of grazing but unfortunately the herbivores have discovered the site and most clumps had been grazed by varying amounts. No *Tetratheca juncea* was visible at 9. The number of collaterally translocated species has increased although changes have occurred in the species content at each site.

So far the most significant problem for the translocated *Tetratheca juncea* has been grazing by herbivores, most likely wallabies. *Grevillea parviflora* subsp *parviflora* appear to be responding well to translocation.

4 References

Driscoll, C. (2009) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora translocation proposal*. Report by Hunter Eco for Centennial Coal. March 2009.

Driscoll, C. (2008) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora investigation*. Report by Hunter Eco for Centennial Coal. November 2008.

Driscoll, C., & Bell, S.A.J. (2008) *The Experimental Translocation of Tetratheca juncea Sm. (Elaeocarpaceae) at Gwandalan, Wyong Shire*. Report to Crighton Properties Pty Ltd, Wyong Shire Council, NSW Department of Environment & Climate Change. December 2008.



Centennial Coal



Cooranbong-Awaba Haul Road

Threatened Flora Translocation Monitoring

Mandalong

November 2012



**Centennial Coal Cooranbong-Awaba Haul Road
Threatened Flora Translocation Monitoring Report
November 2012**

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Centennial Coal Cooranbong-Awaba Haul Road Threatened Flora Translocation Monitoring Report November 2012

1 Introduction

Centennial Coal received NSW Department of Planning approval in 1998 (DA 97/800) for the construction of a haul road to move coal from the Cooranbong mine near Dora Creek, connecting into the existing Eraring – Newstan haul road near Awaba.

A condition attached to the original approval required that a survey be conducted to locate any threatened plant species within and around the proposed haul road. A report was prepared (Driscoll 2008) that showed that there were three threatened flora species *Acacia bynoeana*, *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* present. Investigation of the wider area showed that the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* found in and near the haul road were parts of much larger continuous populations. While it was possible to relocate the haul road to avoid the *Acacia bynoeana* populations it was clear that no matter where the haul road was located, some *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* would be lost.

The original consent provided for the translocation of any threatened flora species that could not be planned around and a translocation proposal was approved for the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* (Driscoll 2009).

Translocation was carried out between 27 April 2009 and 6 May 2009 inclusive. There was one recipient site for *Grevillea parviflora* subsp. *parviflora* and three sites for *Tetratheca juncea* (**Table 1** and **Figure 1**).

Table 1 Summary of the translocation results

Site Number	Species	Method	Amount translocated
1	<i>Grevillea parviflora</i>	Excavator	An area of about 10mx10m
2	<i>Tetratheca juncea</i>	Individual clumps	81 clumps
3	<i>Tetratheca juncea</i>	Excavator	21 buckets placed together
4	<i>Tetratheca juncea</i>	Excavator	13 individual buckets

Figure 2 provides details of each of the four recipient sites.

The translocated plants are to be monitored annually for five years. A cursory inspection of all sites was conducted on 3 November 2009 and the first detailed monitoring was carried out on 12 January 2010. This is the report of the results from the fourth annual monitoring inspection conducted on 26th November 2012.



Figure 1 The haul road disturbance area and the recipient sites

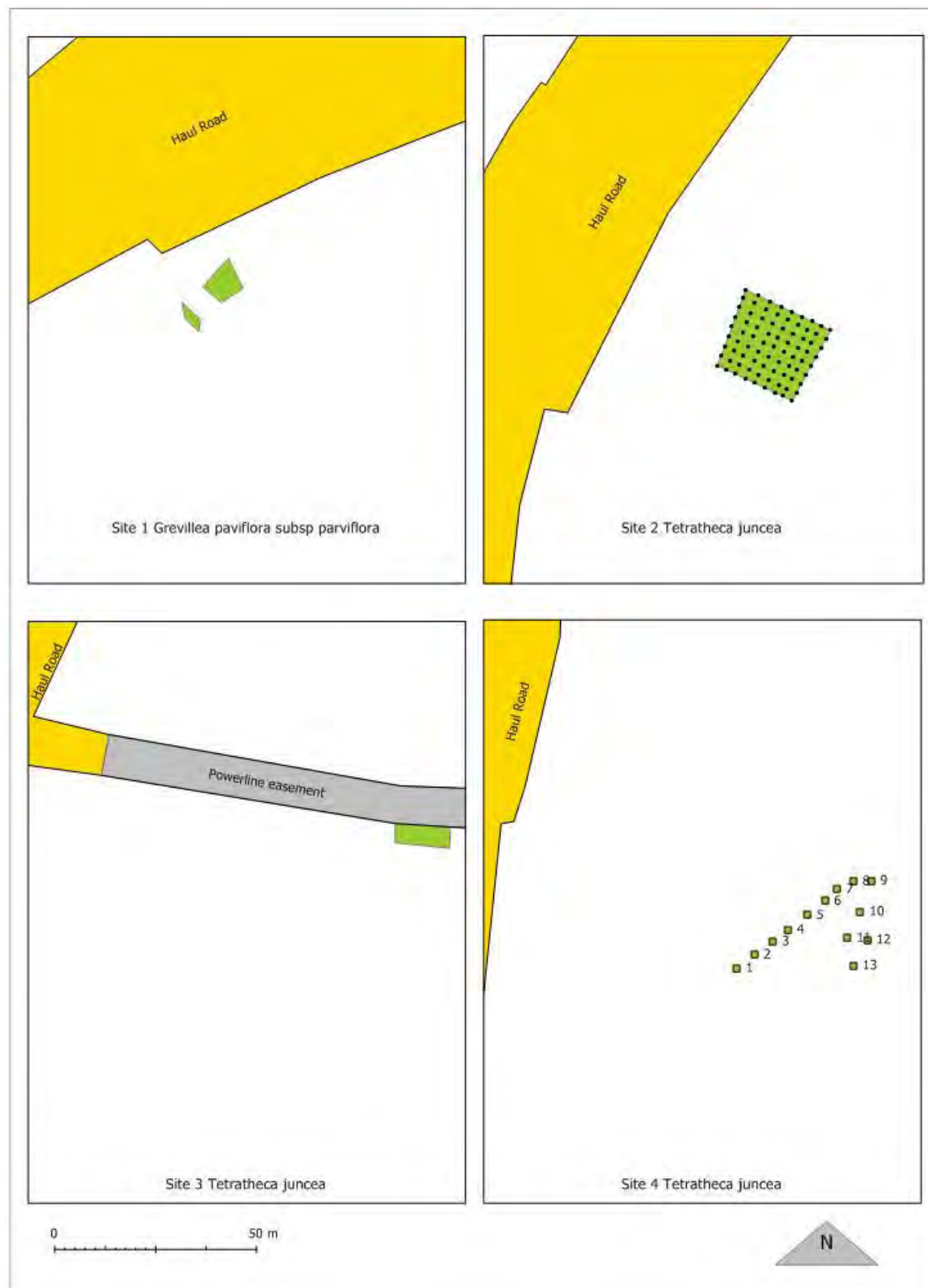


Figure 2 Recipient site location details

2 Results

2.1 Site 1 *Grevillea parviflora* subsp *parviflora*

In January 2010 there were 75 live and a number of dead plants. There were 128 plants present in November 2010, a 70% increase, with these plants being around 10 cm tall. In November 2011 there were 147 plants, just under double the number recorded in January 2010. The plants were around 20 cm tall. In November 2012 there were 136 plants with several flowering (**Figure 3**). The tallest plants were 65 cm with the average around 40 cm. Thus total plants were slightly down compared with 2010 but plants had approximately doubled in size.



Figure 3 Translocated *Grevillea parviflora* subsp *parviflora* flowering at Site 1 November 2012

2.2 Site 2 *Tetratheca juncea*

At this site, 81 clumps had been individually translocated by hand. As of November 2012 only nine clumps had survived. **Table 2** provides details of the condition of each clump and **Figure 4** shows a plot of percentage of surviving clumps. **Figure 5** is a graphical representation of the overall grid and the condition of each clump.

Table 2 Details of the condition of Site 2 clumps, November 2012

Clumps with condition shown in bold were recorded as 'no plant' in November 2011

Clump	Size1	Size4	Condition	Grazed	Clump	Size1	Size4	Condition	Grazed
1	<10		No plant		42	<10		No plant	
2	<10		No plant		43	<10		No plant	
3	>10		No plant		44	<10		No plant	
4	>10		No plant		45	>10	<10	New growth	No
5	<10	<10	New growth	No	46	<10		No plant	
6	<10	<10	New growth	No	47	<10		No plant	
7	<10		No plant		48	<10		No plant	
8	<10		No plant		49	<10		No plant	
9	<10		No plant		50	<10		No plant	
10	>10	>10	New growth	No	51	<10		No plant	
11	<10		No plant		52	<10		No plant	
12	<10		No plant		53	<10		No plant	
13	>10		No plant		54	<10		No plant	
14	>10	<10	New growth	No	55	<10		No plant	
15	<10		No plant		56	<10		No plant	
16	>10		No plant		57	<10		No plant	
17	<10		No plant		58	<10		No plant	
18	<10	<10	New growth	No	59	<10		No plant	
19	<10		No plant		60	<10		No plant	
20	>10		No plant		61	<10		No plant	
21	<10		No plant		62	<10		No plant	
22	<10		No plant		63	>10		No plant	
23	<10		No plant		64	<10		No plant	
24	<10		No plant		65	<10		No plant	
25	<10	<10	New growth	No	66	<10		No plant	
26	<10		No plant		67	<10		No plant	
27	<10		No plant		68	>10		No plant	
28	>10		No plant		69	>10		No plant	
29	<10		No plant		70	<10		No plant	
30	<10		No plant		71	<10		No plant	
31	<10		No plant		72	>10		No plant	
32	<10		No plant		73	<10		No plant	
33	>10		No plant		74	<10		No plant	
34	<10		No plant		75	<10		No plant	
35	>10		No plant		76	>10		No plant	
36	<10	<10	New growth	No	77	>10		No plant	
37	<10		No plant		78	<10		No plant	
38	<10		No plant		79	>10		No plant	
39	<10		No plant		80	>10		No plant	
40	<10	<10	New growth	No	81	>10		No plant	
41	>10		No plant						

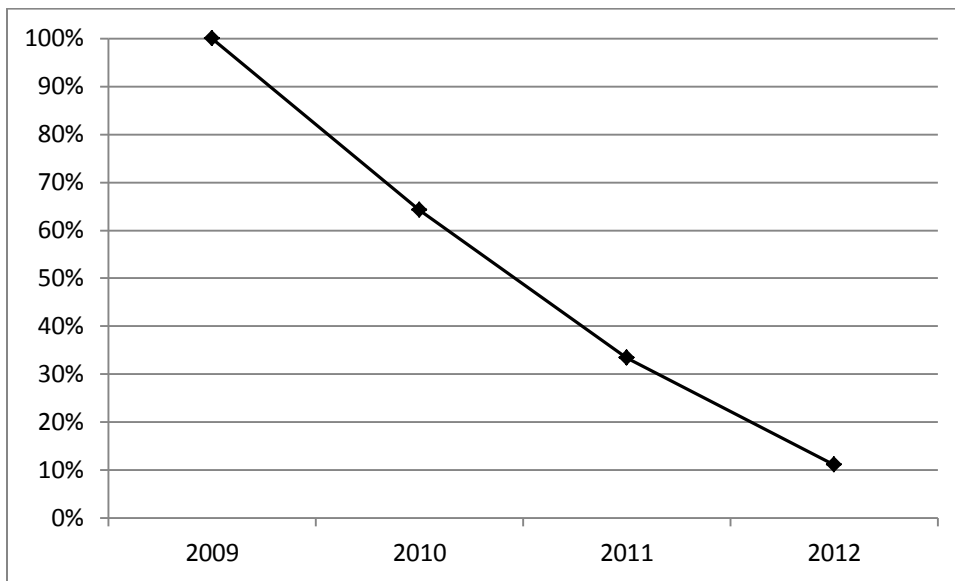


Figure 4 Percentage of clumps surviving at Site 2 over time

1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27
28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54
55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81

KEY	Dead	<10 stems	>10 stems
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Figure 5 Showing the condition of the clumps in the grid as of November 2012

2.3 Site 3 *Tetratheca juncea*

This site was an experimental attempt at using the bulk translocation of *Tetratheca juncea* to rehabilitate a small area of disturbance. The area was approximately 180 m² located beside a powerline easement and where logs from the clearing of that easement had been burned. The area had no ground vegetation. **Figures 6 & 7** show the site before and after translocation. Twenty one excavator buckets containing *Tetratheca juncea* and other vegetation were translocated to the site.



Figure 6 Site 3 before translocation



Figure 7 Site 3 after translocation

Figures 8, 9 and 10 show the site at each monitoring occasion. In November 2010 15 clumps in varying condition were recorded and in November 2011 there were 19 clumps recorded. Nineteen clumps were again recorded in November 2012. Herbivore grazing continues to be a problem which is unfortunate because the clumps are generally robust and multi-stemmed.



Figure 8 Site 3 November 2010



Figure 9 Site 3 November 2011



Figure 10 Site 3 November 2012

2.4 Site 4 *Tetratheca juncea*

Changes over time for the 13 plots are as follows:

- January 2010, only one of the 13 plots had no visible *Tetratheca juncea*, four had at least one flower (5 flowers in total) and one had a seed capsule;
- November 2010, there were 41 flowers and one seed capsule and the Plot 7 clump (not visible in January 2010) had recovered;
- November 2011, there were 12 flowers and no seed capsules. No clumps were present at Plot 9 while the previously recovered Plot 7 had 2 clumps and new growth; and
- November 2012, (**Table 3**) only two clumps had flowers (Plots 3 and 6) with a total of seven flowers. Plot 3 had five seed capsules indicating active pollinators. Four plots had no visible clumps.

Table 3 Site 4 clumps condition, November 2012

Plot Number	Condition	Flowers	Seed capsules
1	2 clumps, >10 stems	-	-
2	5 clumps, >10 stems, some new growth	-	-
3	1 clump, >10 stems, some new growth	6	5
4	1 clump, <10 stems, some new growth, heavily grazed	-	-
5	3 clumps, <10 stems, some new growth, moderate grazing	-	-
6	2 clumps, > and < 10 stems, some new growth	1	-
7	1 clump, <10 stems, some new growth	-	-
8	5 clumps, >10 stems, heavily grazed	-	-
9	No clumps	-	-
10	No clumps	-	-
11	1 clump, <10 stems	-	-
12	No clumps	-	-
13	No clumps	-	-

2.4.1 Collateral translocation

When using a large excavator bucket, other species are translocated along with the target species. The success of these collateral species may be important to the success of the target *Tetralthea juncea*. For example *Tetralthea juncea* has a symbiotic root association with a soil fungus known as *Mycorrhiza* which facilitates root absorption of soil nutrients. This fungus might be associated with other plants.

The total number of species translocated along with *Tetralthea juncea* has increased from 28 recorded in November 2010 to 35 in November 2012 (**Table 5**).

Table 4 Collateral species growing in the Site 4 translocation plots

Family Name	Scientific Name	1	2	3	4	5	6	7	8	9	10	11	12	13
Anthericaceae	<i>Tricoryne elatior</i>		x											
Apiaceae	<i>Platysace linearifolia</i>	x	✓	✓	✓	✓				✓	x	✓	✓	✓
Cyperaceae	<i>Cyathochaeta diandra</i>	✓	✓	✓	✓	☑	x		x	✓	✓	✓		
Cyperaceae	<i>Lepidosperma concavum</i>		✓	✓	✓		x	✓	✓			☑		
Cyperaceae	<i>Lepidosperma laterale</i>							x						x
Cyperaceae	<i>Ptilothrix deusta</i>	✓	✓	✓	✓	✓		x		✓	☑	☑	☑	✓
Dennstaedtiaceae	<i>Pteridium esculentum</i>							✓	x					
Dilleniaceae	<i>Hibbertia vestita</i>			x										
Epacridaceae	<i>Epacris pulchella</i>	✓	✓	✓	x	x	✓	x		✓	✓		✓	x
Euphorbiaceae	<i>Phyllanthus hirtellus</i>						✓	x	x					
Fabaceae (Faboideae)	<i>Bossiaea obcordata</i>							✓	x	☑				
Fabaceae (Faboideae)	<i>Bossiaea stephensonii</i>				x									
Fabaceae (Faboideae)	<i>Dillwynia retorta</i>	x	✓			x	x		✓	x				
Fabaceae (Faboideae)	<i>Gompholobium minus</i>									x				
Fabaceae (Faboideae)	<i>Mirbelia rubiifolia</i>						☑	x						✓
Fabaceae (Faboideae)	<i>Pultenaea tuberculata</i>			☑	x									
Fabaceae (Mimosoideae)	<i>Acacia suaveolens</i>									x				
Goodeniaceae	<i>Dampiera stricta</i>		✓	✓			☑					x		
Iridaceae	<i>Patersonia sericea</i>											✓		
Lauraceae	<i>Cassytha glabella</i> forma <i>glabella</i>			✓	✓			x		✓				
Lindsaeaceae	<i>Lindsaea linearis</i>				✓	✓					☑	✓	☑	✓
Loganiaceae	<i>Logania pusilla</i>												x	
Lomandraceae	<i>Lomandra obliqua</i>						✓							
Myrtaceae	<i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i>										x		✓	✓
Myrtaceae	<i>Leptospermum trinervium</i>	✓		✓	✓	✓	✓		☑		x		☑	
Pittosporaceae	<i>Billardiera scandens</i> var. <i>scandens</i>						x							
Poaceae	<i>Anisopogon avenaceus</i>	☑	✓	x	☑		✓		☑	☑	✓		x	✓
Poaceae	<i>Entolasia stricta</i>	☑	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Poaceae	<i>Themeda australis</i>						✓	x						
Proteaceae	<i>Banksia oblongifolia</i>		✓	☑	✓	✓	✓					✓	✓	
Proteaceae	<i>Banksia spinulosa</i> var. <i>collina</i>										✓		✓	
Proteaceae	<i>Hakea dactyloides</i>			✓										
Proteaceae	<i>Isopogon anemonifolius</i>			✓	✓									
Proteaceae	<i>Lambertia formosa</i>	✓	✓		✓					✓	☑	x		
Restionaceae	<i>Leptocarpus tenax</i>					☑								☑
Totals	35	7	11	10	12	8	10	4	5	9	8	8	9	8

KEY: x = previously present, now absent ✓ = present previously and now ☑ = previously absent, now present.

3 Discussion

Site 1 *Grevillea parviflora* subsp *parviflora*

The plants appear to have established as a population. Once again, the plants had approximately doubled in size over the previous year.

Site 2 *Tetradthea juncea*

This group continues to decline and is now down to nine of the originally translocated 81 clumps, and each of the survivors only have a few stems. Previously it was reported that the clumps were being heavily grazed and this may have contributed to the steady decline. Two clumps that were recorded as missing in November 2011 had resprouted.

Site 3 *Tetradthea juncea*

Total clumps remains at 19 and while the clumps are healthy in appearance they are regularly grazed to about 10 cm from ground level.

Site 4 *Tetradthea juncea*

Grazing was not as evident as previously, however there were fewer clumps and there were few flowers. The number of collaterally translocated species has increased by one, although again, changes have occurred in the species content at each site.

A feature of the current flowering season has been the lack of rain compared with 2011 and this will have had an impact on all of the translocated plants. So far the most significant problem for the translocated *Tetradthea juncea* has been grazing by herbivores, most likely wallabies. *Grevillea parviflora* subsp *parviflora* appear to be now be established as a population.

4 References

Driscoll, C. (2009) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora translocation proposal*. Report by Hunter Eco for Centennial Coal. March 2009.

Driscoll, C. (2008) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora investigation*. Report by Hunter Eco for Centennial Coal. November 2008.

Driscoll, C., & Bell, S.A.J. (2008) *The Experimental Translocation of Tetratheca juncea Sm. (Elaeocarpaceae) at Gwandalan, Wyong Shire*. Report to Crighton Properties Pty Ltd, Wyong Shire Council, NSW Department of Environment & Climate Change. December 2008.



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Cooranbong-Awaba Haul Road

Threatened Flora Translocation Monitoring

Mandalong

November 2013



**Centennial Coal Cooranbong-Awaba Haul Road
Threatened Flora Translocation Monitoring Report
November 2013**

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HUNTER ECO



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Centennial Coal Cooranbong-Awaba Haul Road Threatened Flora Translocation Monitoring Report November 2013

1 Introduction

Centennial Coal received NSW Department of Planning approval in 1998 (DA 97/800) for the construction of a haul road to move coal from the Cooranbong mine near Dora Creek, connecting into the existing Eraring – Newstan haul road near Awaba.

A condition attached to the original approval required that a survey be conducted to locate any threatened plant species within and around the proposed haul road. A report was prepared (Driscoll 2008) that showed that there were three threatened flora species *Acacia bynoeana*, *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* present. Investigation of the wider area showed that the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* found in and near the haul road were parts of much larger continuous populations. While it was possible to relocate the haul road to avoid the *Acacia bynoeana* populations it was clear that no matter where the haul road was located, some *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* would be lost.

The original consent provided for the translocation of any threatened flora species that could not be planned around and a translocation proposal was approved for the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* (Driscoll 2009).

Translocation was carried out between 27 April 2009 and 6 May 2009 inclusive. There was one recipient site for *Grevillea parviflora* subsp. *parviflora* and three sites for *Tetratheca juncea* (**Table 1** and **Figure 1**).

Table 1 Summary of the translocation results

Site Number	Species	Method	Amount translocated
1	<i>Grevillea parviflora</i>	Excavator	An area of about 10mx10m
2	<i>Tetratheca juncea</i>	Individual clumps	81 clumps
3	<i>Tetratheca juncea</i>	Excavator	21 buckets placed together
4	<i>Tetratheca juncea</i>	Excavator	13 individual buckets

Figure 2 provides details of each of the four recipient sites.

The translocated plants were to be monitored annually for five years. A cursory inspection of all sites was conducted on 3 November 2009 and the first detailed monitoring was carried out on 12 January 2010. This is the report of the results from the fifth and final annual monitoring inspection conducted on 4th November 2013.



Figure 1 The haul road disturbance area and the recipient sites

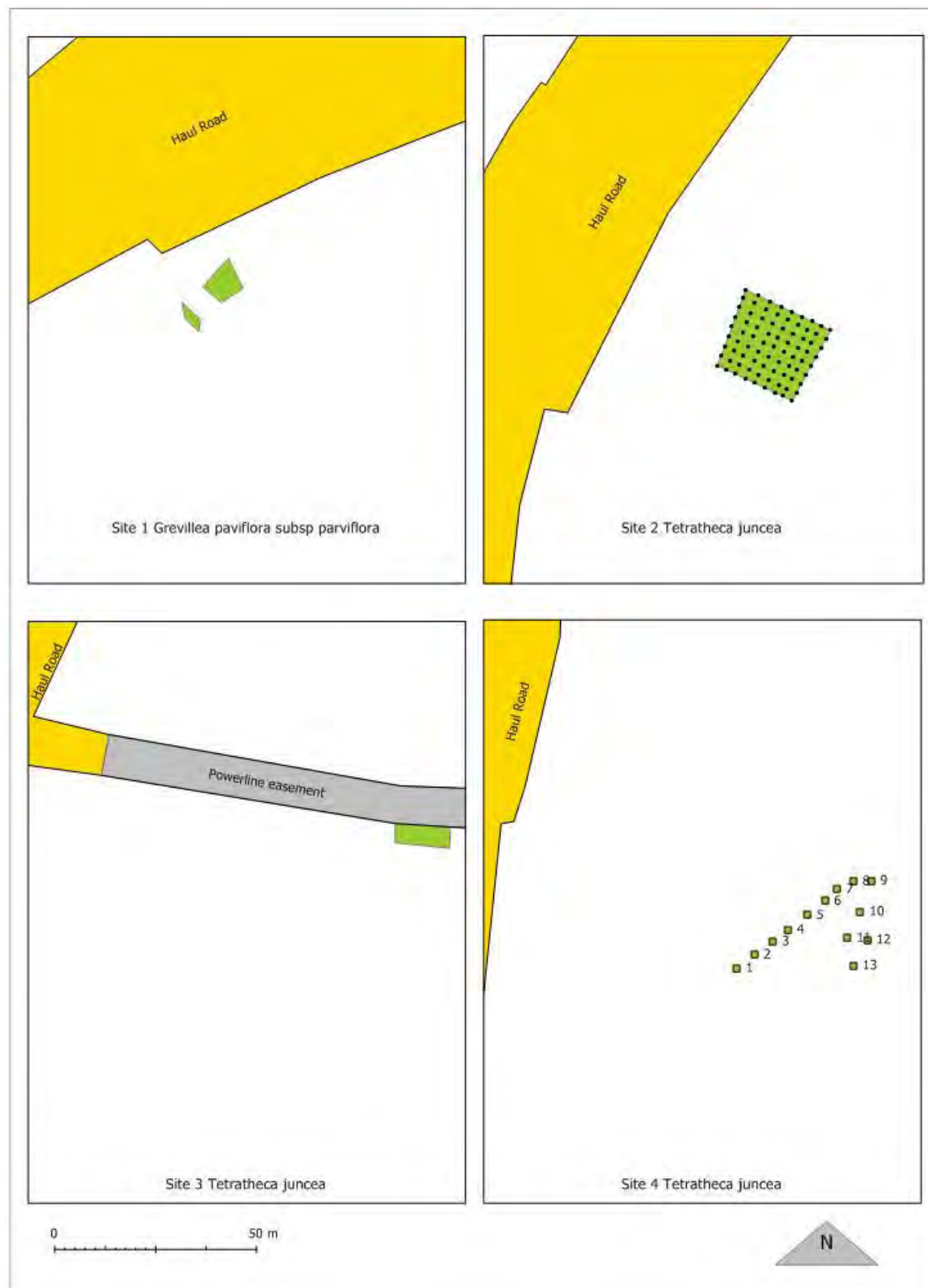


Figure 2 Recipient site location details

2 Results

2.1 Site 1 *Grevillea parviflora* subsp *parviflora*

Figure 3 shows the progress of the *Grevillea parviflora* subsp. *parviflora* plants over the five years since translocation.

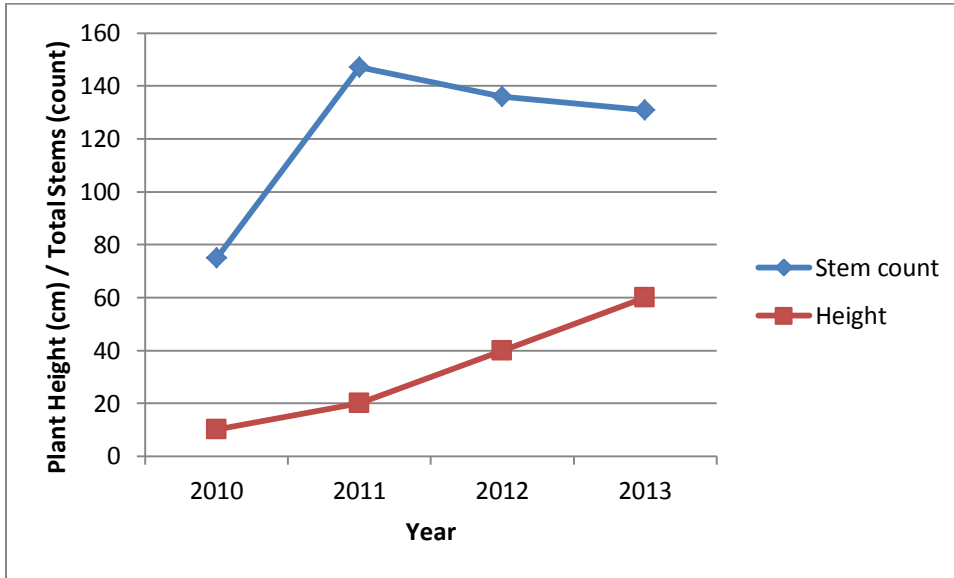


Figure 3 Progress of the translocated *Grevillea parviflora* subsp. *parviflora*

2.2 Site 2 *Tetratheca juncea*

At this site, 81 clumps had been individually translocated by hand. As of November 2013 only seven clumps had survived. **Table 2** provides details of the condition of each clump and **Figure 4** shows a plot of percentage of surviving clumps. **Figure 5** is a graphical representation of the overall grid and the condition of each clump.

Table 2 Details of the condition of Site 2 clumps, November 2013

Clumps with condition shown in bold were recorded as 'no plant' in November 2011

Clump	Size1	Size5	Condition	Grazed	Clump	Size1	Size5	Condition	Grazed
1	<10		No plant		42	<10		No plant	
2	<10		No plant		43	<10		No plant	
3	>10		No plant		44	<10		No plant	
4	>10		No plant		45	>10		No plant	
5	<10		No plant		46	<10		No plant	
6	<10	<10	New growth	No	47	<10		No plant	
7	<10		No plant		48	<10		No plant	
8	<10		No plant		49	<10		No plant	
9	<10		No plant		50	<10		No plant	
10	>10		No plant		51	<10		No plant	
11	<10		No plant		52	<10		No plant	
12	<10		No plant		53	<10		No plant	
13	>10		No plant		54	<10		No plant	
14	>10	<10	New growth	Yes	55	<10		No plant	
15	<10		No plant		56	<10		No plant	
16	>10		No plant		57	<10		No plant	
17	<10		No plant		58	<10		No plant	
18	<10		No plant		59	<10		No plant	
19	<10		No plant		60	<10		No plant	
20	>10		No plant		61	<10	<10	New growth	No
21	<10		No plant		62	<10		No plant	
22	<10		No plant		63	>10		No plant	
23	<10	<10	New growth	No	64	<10		No plant	
24	<10		No plant		65	<10		No plant	
25	<10	<10	New growth	No	66	<10		No plant	
26	<10		No plant		67	<10		No plant	
27	<10		No plant		68	>10	<10	New growth	No
28	>10		No plant		69	>10		No plant	
29	<10		No plant		70	<10		No plant	
30	<10		No plant		71	<10		No plant	
31	<10		No plant		72	>10		No plant	
32	<10		No plant		73	<10		No plant	
33	>10		No plant		74	<10		No plant	
34	<10		No plant		75	<10		No plant	
35	>10		No plant		76	>10		No plant	
36	<10		No plant		77	>10		No plant	
37	<10		No plant		78	<10		No plant	
38	<10		No plant		79	>10	<10	New growth	No
39	<10		No plant		80	>10		No plant	
40	<10		No plant		81	>10		No plant	
41	>10		No plant						

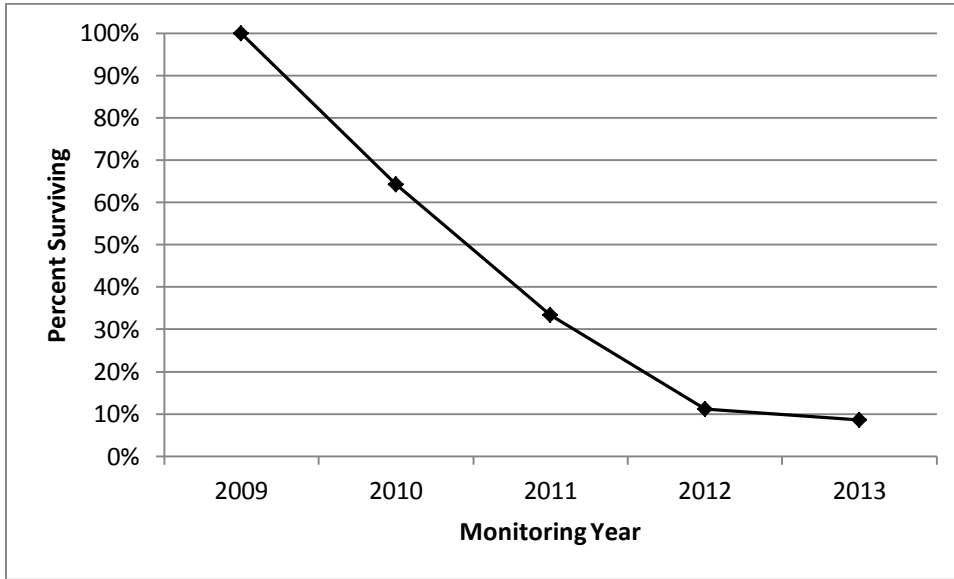


Figure 4 Percentage of clumps surviving at Site 2 over time

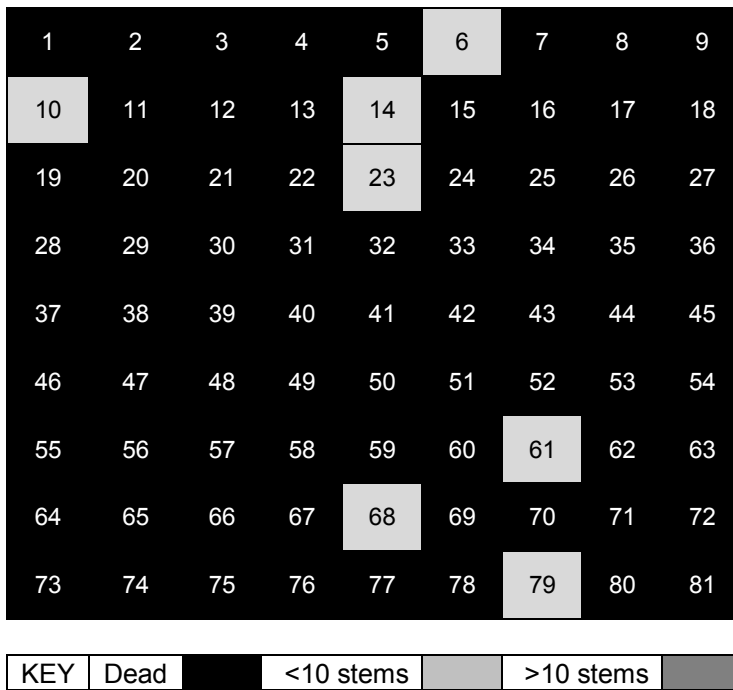


Figure 5 Showing the condition of the clumps in the grid as of November 2012

After five years, only clumps 6, 10 and 14 were present in each year. Clumps 23, 61, 68 and 79 were present in 2013 after being absent in 2012. Over the five years, several clumps that had no visible presence in one year re-appeared in the following year. However, none of these remained established in subsequent years. Thus it is likely that of the 81 clumps translocated only three have survived.

2.3 Site 3 *Tetratheca juncea*

This site was an experimental attempt at using the bulk translocation of *Tetratheca juncea* to rehabilitate a small area of disturbance. The area was approximately 180 m² located beside a powerline easement and where logs from the clearing of that easement had been burned. The area had no ground vegetation. Twenty one excavator buckets containing *Tetratheca juncea* and other vegetation were translocated to the site.

Photographs of Site 3 prior to and following translocation can be found in **Appendix 1**. In November 2010 15 clumps in varying condition were recorded and in November 2011 there were 19 clumps recorded. Nineteen clumps were again recorded in November 2012. Only nine clumps were visible in November 2013. Herbivore grazing continues to be a problem (**Figure 6**) which is unfortunate because the clumps are generally robust and multi-stemmed.



Figure 6 An example of browsed stems at Site 3

Tetratheca juncea stems are vertical dark green in the centre of the photograph

2.4 Site 4 *Tetratheca juncea*

Changes over time for the 13 plots are as follows:

- January 2010, only one of the 13 plots had no visible *Tetratheca juncea*, four had at least one flower (5 flowers in total) and one had a seed capsule;
- November 2010, there were 41 flowers and one seed capsule and the Plot 7 clump (not visible in January 2010) had recovered;
- November 2011, there were 12 flowers and no seed capsules. No clumps were present at Plot 9 while the previously recovered Plot 7 had 2 clumps and new growth; and
- November 2012, only two clumps had flowers (Plots 3 and 6) with a total of seven flowers. Plot 3 had five seed capsules indicating active pollinators. Four plots had no visible clumps.
- November 2013 (**Table 3**), clumps were present in only four plots with Plot 3 having one open flower, three buds and five seed capsules.

Table 3 Site 4 clumps condition, November 2012

Plot Number	Condition	Flowers	Seed capsules
1		-	-
2	3 clumps, >10 stems, some new growth	-	-
3	1 clump, >10 stems, some new growth	1	5
4		-	-
5	1 clump, <10 stems, some new growth, moderate grazing	-	-
6		-	-
7		-	-
8		-	-
9		-	-
10		-	-
11	1 clump, <10 stems, some new growth, moderate grazing	-	-
12		-	-
13		-	-

As for Site 3, grazing was prevalent.

2.4.1 Collateral translocation

When using a large excavator bucket, other species are translocated along with the target species. The success of these collateral species may be important to the success of the target *Tetratheca juncea*. For example *Tetratheca juncea* has a symbiotic root association with a soil fungus known as *Mycorrhiza* which facilitates root absorption of soil nutrients. This fungus might be associated with other plants.

The total number of species translocated along with *Tetratheca juncea* has increased from 28 recorded in November 2010 to 36 in November 2013 (**Appendix 2**).

3 Discussion

3.1 *Grevillea parviflora* subsp. *parviflora*

Translocation of this taxon appears to have been a success with the population established, consisting of robust mature plants along with a range of early successional plants. There was no evidence of fruit production despite consistent flowering so it is likely that the smaller plants are clones sprouting from underground rhizomes.

3.2 *Tetratheca juncea*

There were three aims of this translocation experiment:

1. To compare translocating individual clumps (Site 2) with using an excavator to move large groups of clumps (Sites 3 and 4);
2. At Site 2, to determine whether loosening of soil around the recipient hole facilitated vegetative spread compared with unloosened soil;
3. At Site 3, to determine whether translocating *Tetratheca juncea* using an excavator could assist in rehabilitating a highly disturbed area.

Unfortunately these aims were thwarted by heavy grazing of the translocated *Tetratheca juncea* by herbivores at all three sites. Grazing pressure was such that the translocated clumps were not able to establish themselves. In this regard, comparison can be made with the *Tetratheca juncea* translocation experiment conducted at Gwandalan (Driscoll and Bell 2008) where herbivory was not a problem. That experiment was subdivided into ten groups of ten clumps each, all located in a variety of habitat types. In favourable habitat survival was as high as 90% after five years.

4 References

Driscoll, C. (2009) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora translocation proposal*. Report by Hunter Eco for Centennial Coal. March 2009.

Driscoll, C. (2008) *Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora investigation*. Report by Hunter Eco for Centennial Coal. November 2008.

Driscoll, C., and Bell, S.A.J. (2008) *The Experimental Translocation of Tetratheca juncea Sm. (Elaeocarpaceae) at Gwandalan, Wyong Shire*. Report to Crighton Properties Pty Ltd, Wyong Shire Council, NSW Department of Environment & Climate Change. December 2008.

Appendix 1 Site 3 photographs



Site 3 before translocation



Site 3 after translocation



Site 3 November 2010



Site 3 November 2011



Site 3 November 2012



Site 3 November 2013

Appendix 2 Site 4 collateral species translocated

Family Name	Scientific Name	1	2	3	4	5	6	7	8	9	10	11	12	13
Anthericaceae	<i>Tricoryne elatior</i>													
Apiaceae	<i>Platysace linearifolia</i>	✓	✓	✓	✓					✓		✓	✓	✓
Cyperaceae	<i>Cyathochaeta diandra</i>	✓	✓	✓	✓					✓		✓		
Cyperaceae	<i>Lepidosperma concavum</i>		✓	✓	✓	✓	✓		✓			✓		
Cyperaceae	<i>Lepidosperma laterale</i>													
Cyperaceae	<i>Ptilothrix deusta</i>	✓	✓	✓	✓	✓				✓	✓	✓		✓
Dennstaedtiaceae	<i>Pteridium esculentum</i>							✓						
Dilleniaceae	<i>Hibbertia vestita</i>													
Epacridaceae	<i>Epacris pulchella</i>	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	
Euphorbiaceae	<i>Phyllanthus hirtellus</i>							✓						
Fabaceae (Faboideae)	<i>Bossiaea obcordata</i>							✓						
Fabaceae (Faboideae)	<i>Bossiaea stephensonii</i>													
Fabaceae (Faboideae)	<i>Dillwynia retorta</i>		✓			✓								
Fabaceae (Faboideae)	<i>Gompholobium minus</i>													
Fabaceae (Faboideae)	<i>Mirbelia rubiifolia</i>						✓	✓						
Fabaceae (Faboideae)	<i>Pultenaea tuberculata</i>			✓										
Fabaceae (Mimosoideae)	<i>Acacia suaveolens</i>									✓				
Goodeniaceae	<i>Dampiera stricta</i>		✓	✓										
Iridaceae	<i>Patersonia sericea</i>											✓		
Lauraceae	<i>Cassytha glabella forma glabella</i>			✓	✓		✓					✓		
Lindsaeaceae	<i>Lindsaea linearis</i>				✓	✓					✓	✓	✓	✓
Loganiaceae	<i>Logania pusilla</i>													
Lomandraceae	<i>Lomandra glauca</i>						✓							
Lomandraceae	<i>Lomandra obliqua</i>													
Myrtaceae	<i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i>										✓		✓	✓
Myrtaceae	<i>Leptospermum trinervium</i>	✓		✓	✓	✓	✓		✓		✓			
Pittosporaceae	<i>Billardiera scandens</i> var. <i>scandens</i>						✓							
Poaceae	<i>Anisopogon avenaceus</i>	✓	✓		✓		✓		✓	✓	✓			
Poaceae	<i>Entolasia stricta</i>		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Poaceae	<i>Themeda australis</i>						✓	✓						
Proteaceae	<i>Banksia oblongifolia</i>		✓	✓	✓	✓						✓	✓	
Proteaceae	<i>Banksia spinulosa</i> var. <i>collina</i>										✓			
Proteaceae	<i>Hakea dactyloides</i>			✓										
Proteaceae	<i>Isopogon anemonifolius</i>			✓	✓									
Proteaceae	<i>Lambertia formosa</i>	✓	✓		✓					✓	✓	✓		
Restionaceae	<i>Leptocarpus tenax</i>					✓								
Totals	36	7	11	13	13	8	10	6	4	8	9	11	6	5



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Appendix 2

Site I – Biobanking Credit Report

Biodiversity credit report



This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 19/06/2015

Time: 12:53:49PM

Calculator version: v4.0

Major Project details

Proposal ID:	9999/2015/1918MP
Proposal name:	Northern Coal Logistics - Site 1
Proposal address:	100 Miller Road Fassifern NSW 2283
Proponent name:	Centennial Coal - Newstan
Proponent address:	100 Miller Road Fassifern NSW
Proponent phone:	02 4935 8944
Assessor name:	Arne Bishop
Assessor address:	49 Estelle St Maryville NSW 2293
Assessor phone:	0401 630 465
Assessor accreditation:	999999

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	1.22	55.00
Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	3.50	213.00
Total	4.72	268

Credit profiles

1. Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803)

Number of ecosystem credits created	213
IBRA sub-region	Wyong

Offset options - Plant Community types	Offset options - IBRA sub-regions
Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803)	Wyong and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833)

Number of ecosystem credits created	55
IBRA sub-region	Wyong

Offset options - Plant Community types	Offset options - IBRA sub-regions
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833) Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast, (HU850)	Wyong and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Black-eyed Susan	Tetraloche juncea	376.00	5,640
Little Bentwing-bat	Miniopterus australis	4.72	61
Large-eared Pied Bat	Chalinolobus dwyeri	4.72	61

Appendix 3

Site 2 – Biobanking Credit Report

Biodiversity credit report



This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 19/06/2015

Time: 12:52:05PM

Calculator version: v4.0

Major Project details

Proposal ID:	9999/2015/1908MP
Proposal name:	Northern Coal Logistics - Site 2
Proposal address:	100 Miller Rd Fassifern NSW 2283
Proponent name:	Centennial Coal - Newstan
Proponent address:	PO Box 1000 Toronto NSW 2283
Proponent phone:	4935 8944
Assessor name:	Arne Bishop
Assessor address:	49 Estelle St Maryville NSW 2293
Assessor phone:	0401 630 465
Assessor accreditation:	999999

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	3.93	181.00
White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	0.10	4.00
Total	4.03	185

Credit profiles

1. White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley, (HU798)

Number of ecosystem credits created	4
IBRA sub-region	Wyong

Offset options - Plant Community types	Offset options - IBRA sub-regions
White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley, (HU798)	Wyong and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833)

Number of ecosystem credits created	181
IBRA sub-region	Wyong

Offset options - Plant Community types	Offset options - IBRA sub-regions
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833) Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast, (HU850)	Wyong and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Small-flower Grevillea	Grevillea parviflora subsp. parviflora	1.00	14