AMENDMENT MAY 2013

ENVIRONMENTAL IMPACT ASSESSMENT
MARY'S MOUNT BLUE METAL QUARRY

SECTION 4.3 - FLORA & FAUNA

BIOBANKING ASSESSMENT
BIODIVERSITY INVENTORY REPORT &
KOALA PLAN OF MANAGEMENT

PREPARED BY:

Niche Environment and Heritage Pty Ltd

niche
Environment and Heritage

MARY'S MOUNT QUARRY PROJECT

BioBanking Assessment

May 2013

DOCUMENT CONTROL

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Front Cover Photograph: Looking east towards Melville Hill, including the study site

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EXECUTIVE SUMMARY

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Gunnedah Quarry Products Pty Ltd (GQP) to use the NSW BioBanking Assessment Methodology (BBAM) to quantitatively measure the biodiversity offset required for the Marys Mount Quarry Project (the Project). Inputs used to measure these impacts are outlined as follows.

Landscape

The following landscape attributes describe the site prior to development:

- Catchment: Liverpool Plains Part B sub-region of the Namoi Catchment Management Area (CMA);
- Mitchell Landscape: Nombi Plateau and Pinnacles;
- Native vegetation cover:
  - 61% to 70% within the 1,000 hectare assessment circle; and
  - 91% to 100% within the 100 hectare assessment circle.
- There is no primary link as there is no change in connectivity width or condition.

Native Vegetation

- The development site contains 14.60 hectares of native vegetation.
- One endangered ecological community (EEC) listed on the NSW *Threatened Species Conservation Act* 1995 (TSC Act) is present within the development site, being *Semi-evergreen Vine Thicket of the Nandewar and Brigalow Belt South Bioregion*.

Threatened Flora

- Non-ecosystem predicted threatened flora species considered in the assessment include:
  - Finger Panic (*Digitaria porrecta*);
  - Bluegrass (*Dichanthium setosum*);
  - Scant Pomaderris (*Pomaderris queenslandica*); and
  - Austral Toadflax (*Thesium australe*).
- No threatened flora species have been observed within the development site.

Threatened Fauna

- Four threatened animal species listed under the TSC Act have been recorded within the development site, including the Little Lorikeet (*Glossopsitta pusilla*), Koala (*Phascolarctos cinereus*) and Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), with the fourth being a 'possible' recording of the Large-eared Pied Bat (*Chalinolobus dwyeri*).
- Non-ecosystem predicted fauna species considered in the assessment include:

- Brush-tailed Phascogale (*Phascogale tapoatafa*);
- Rufous Bettong (*Aepyprymnus rufescens*);
- Black-striped Wallaby (*Macropus dorsalis*);
- Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*);
- Australian Brush-turkey population in the Nandewar and Brigalow Belt South bioregions (*Alectura lathami*); and
- Little Eagle (*Hieraaetus morphnoides*).

❒ None of the non-ecosystem predicted threatened fauna species were observed within the development site, nor are they considered likely to be impacted by the Project.

Impacts

The Project would result in the following impacts:

❒ Reduce native vegetation cover by 14.60 hectares as follows:
- 11.43 hectares of *White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions* (NA225); and
- 3.17 hectares of *Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147)* (NA199).

❒ No change in connectivity; and

❒ No loss of non-ecosystem predicted threatened flora and fauna species.

Credit Calculations

The BioBanking Credit Calculator (BBCC) Version 2.0 quantified the following biodiversity credits for the Project:

❒ 643 ecosystem credits for NA225; and

❒ 153 ecosystem credits for NA199.

The credit calculation for NA225 was modified by manual adjustment of default Tg scores to reflect the absence of suitable breeding habitat for Barking Owl/Masked Owl and Spotted-tailed Quoll (i.e. 0.33/0.35 to 0.75/1.0). A Tg score of 0.45 was used in credit calculations this reflecting the presence of the Yellow-bellied Sheath-tail Bat.

The Project would impact 'red flag areas' (i.e. endangered ecological communities not in low condition). The impact to red flag areas has been limited to 3.17 hectares. A red flag area variation report has been prepared to assess this impact.

No species credits are required as the Development is unlikely to have an impact on non-ecosystem predicted species.

1 INTRODUCTION

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Gunnedah Quarry Products Pty Ltd (GQP) to quantify the biodiversity impacts of the Marys Mount Quarry Project (the Project) using *The BioBanking Assessment Methodology and Credit Calculator Operational Manual* (DECC 2009), hereafter referred to as BBAM. This assessment has been prepared to satisfy the Project's impact assessment requirements under Part 4 of the *Environmental Planning and Assessment Act* 1979 (EP&A Act). A BioBanking Statement compliant with the NSW *Biodiversity Banking and Offsets Scheme* (BioBanking Scheme) is sought through this assessment.

1.1 Biodiversity Banking and Offsets Scheme (BioBanking)

The BioBanking Scheme, established under Part 7A of the NSW *Threatened Species Conservation Act* 1995 (TSC Act), enables a streamlined method for biodiversity assessment (i.e. the BBAM) accompanied by a rigorous and credible offsetting scheme for the impacts from development. It provides mechanisms for the consideration of impacts on listed threatened species and communities and the criteria for the offsetting of these impacts.

The BBAM incorporates a "maintain and improve" test to determine whether or not there will be a net impact on threatened species or native vegetation. The rules used in the assessment are designed to meet the objectives of the TSC Act. The results of a BioBanking assessment are expressed as the number of biodiversity credits required to be retired by a development site and the number of credits generated and available for retirement at a BioBank site (offset site).

1.2 Definitions and abbreviations

BBAM – BioBanking Assessment Methodology

BBCC – BioBanking Credit Calculator Version 2.0 (on-line version)

EEC – Endangered Ecological Community

ha – Hectare

EEC – Endangered Ecological Community

ha – hectare

OEH – NSW Office of Environment and Heritage (formerly DECCW)

SEWPaC – Commonwealth Department of Sustainability, Environment, Water, Population and Communities (formerly DEWHA)

TSC Act – NSW *Threatened Species Conservation Act* 1995

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

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

1.3 The Project

1.3.1 Location

GGP propose a blue metal quarry on Melville Hill at Marys Mount, which is located approximately 25 km west of Gunnedah in central northern NSW (Figure 1). The Project occurs within an established agricultural landscape and does not occur adjacent to any conservation reserves.

1.3.2 Description

The Project as described in the Environmental Impact Statement (Stewart Surveys, 2012) was for an impact area of 39 hectares. The boundary of the development have since been revised following the findings from recent surveys (Niche, 2013a) to reduce the Project's impact on the habitat of listed threatened species and ecological communities.

The revised boundary for the development site (Figure 2) contains 14.60 hectares of native vegetation representing a 73% reduction in the original Project area. The Project would operate over three successive stages for an estimated 36 year period.

The final landform would be subject to progressive rehabilitation using native species consistent with current native vegetation cover. Additional revegetation works are proposed throughout lands to the north and east of the development site in accordance with an approved site specific Koala Plan of Management (KPoM) (Niche, 2013b).

1.4 Assessment objectives

The primary objective of this assessment is to calculate the Project's biodiversity offset requirement in accordance with the BioBanking Scheme. Biodiversity offsets are quantified in the following units:

- ecosystem credits; and
- species credits.

The BBCC generates a credit profile, this being the basis for a BioBank Statement application. An approved BioBank Statement would formally specify the biodiversity offset requirements for the Project.

1.5 Assessment resources and assessor qualifications

1.5.1 Background resources

This BioBanking assessment has been prepared using the following resources:

- The BBAM (DECC, 2009);
- BioBanking Credit Calculator Version 2.0 (BBCC);

- Site data sourced from 2013 field surveys (Appendix A); and
- Regional datasets (see Section 3.1).

1.5.2 Qualifications

This BioBanking Assessment has been prepared by the following accredited assessors:

- Mark Aitkens: field survey, data management and entry, credit calculations, review of credit calculations and report preparation; and
- Dr Rhidian Harrington: report review and quality assurance.

Other specialist staff involved in preparing the assessment includes:

- Dr Ross Jenkins: GIS analyst and map preparation.

1.6 Assumptions and limitations

1.6.1 BBAM suitability for impact assessment

The Project is a designated development under Part 4 of the EP&A Act. Designated development occurring on rural zoned land is exempt from the *Native Vegetation Act* 2003, thereby permitting the use of the BioBanking Scheme under Part 7A of the TSC Act.

1.6.2 Application of the BBAM

This assessment has been completed using the BioBanking Assessment Methodology and Credit Calculator Operational Manual (DECC, 2009), BioBanking Credit Calculator (BBCC) Version 2.0 (accessed April, 2013) and relevant updates that accompany Version 2.0 of the BBCC.

1.6.3 Survey data

The BioBanking assessment for this Project is based on field survey data collected from the development site, which meets the minimum data requirements specified by the BBAM. A Biodiversity Inventory Report (Appendix A) provides supporting information on vegetation classifications, targeted survey results, threatened species likelihood of occurrence and plot data.

1.6.4 Impacts

It is assumed the impacts of the Project would result in the loss of native vegetation and associated habitat. No benefit derived from proposed progressive rehabilitation and revegetation of the site following completion of quarrying have been quantitatively considered in this assessment.

2 DEVELOPMENT IMPACTS

2.1 Project impacts

The Project's biodiversity impacts were re-evaluated following the assessment of the proposed quarry as presented in the Environmental Impact Statement (Stewart Surveys, 2012). A biodiversity inventory report was prepared (Appendix A) with the findings of that investigation used to minimise the impact of the quarry footprint. A comparison between the revised quarry footprint and the original proposal is provided in Figure 3, with the area shaded showing the extent of impact avoidance.

The direct impact of the revised quarry footprint is 14.60 hectares of native vegetation, including:

- 11.43 hectares of White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (NA225); and
- 3.17 hectares of Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) (NA199). This vegetation type corresponds to the *Semi-evergreen Vine Thicket of the Nandewar and Brigalow Belt South Bioregion* endangered ecological community (EEC) listed on the TSC Act and is also listed on the *Environment Protection and Biodiversity Conservation Act* 1999.

Impacts assessed in this report are restricted to native vegetation contained within the revised quarry footprint and associated management buffer (i.e. development site as shown in Figure 2).

Indirect impacts, such as edge effects, would be limited to the development site by careful quarry staging and through the implementation of an Environmental Management Plan (EMP) and site specific Koala Plan of Management (KPoM). The EMP would detail the management of matters such as weeds, feral animals and fire frequency. Details regarding progressive rehabilitation would also be detailed. The KPoM details the spatial and temporal revegetation specifications relative to the proposed staging of the quarry.

2.2 Impact assessment principles

Current government policy dictates an assessment hierarchy comprising avoid, mitigate and offset (in order of importance). Avoid and mitigate considerations are provided as follows. Impact offsetting is the purpose of this report.

2.2.1 Avoid

The Biodiversity Inventory Report recommended the consideration of impact avoidance as the main method for reducing the Project's impact on the Koala, and its habitat, and the Semi-evergreen Vine Thicket EEC (SEVT). The original quarry design was 39 ha and impacted almost entirely on these matters. The Projects impact has been reduced by 63% to an impact footprint of 14.60 hectares as shown by the shaded area in Figure 3. .

2.2.2 Mitigate

Impact mitigation is proposed to minimise the Projects impact on the Koala and SEVT. An agency/Council approved site specific KPoM would be implemented with this plan provided in Appendix B. This plan includes provisions for the revegetation of existing cleared lands, progressive rehabilitation of the quarry and adaptive management procedures to reduce direct impacts through the operational period of the quarry. The KPoM would apply to specified areas adjacent the development site (Appendix A).

A staged extraction process is proposed to minimise the effects of habitat loss on resident biodiversity. This staged habitat loss would also simultaneously allow for the achievement of ecological benefit expected from the KPoM and site EMP (e.g. weed management). The EMP would apply to the shaded area identified in Figure 3.

Residual areas of SEVT would be managed for weeds and feral fauna (i.e. wild pigs). Edge effects would be minimised containing the development impacts within the site boundary. Threats such as unplanned fire events would also be managed to minimise the potential for adverse impacts on SEVT. Progressive rehabilitation within the quarry area would be outlined in the EMP and would be focused on establishing habitat for Koalas and vegetation similar to SEVT, dependant on its previous vegetation type.

3 SITE ASSESSMENT

Outlined in this section is information sourced from the literature, local and regional studies and site surveys used in the preparation of the assessment for the development site. This information forms the basis for measuring the biodiversity values of the development site in units defined in a BioBanking Statement (i.e. ecosystem and species credits).

3.1 Relevant studies

3.1.1 Regional

The Project is located within the Brigalow Belt South Bioregion, which has been the subject of many regional surveys commissioned by the NSW Government. Relevant studies include:

- *Brigalow Belt South - Stage 1. Vegetation Survey and Mapping* (Beckers and Binns 2000);
- *Brigalow Belt South - Stage 2. Targeted Flora Survey and Mapping* (NPWS 2002a);
- *Brigalow Belt South - Stage 2. Joint Vegetation Mapping Project* (NSW Department of Infrastructure, Planning and Natural Resources [DIPNR] 2004);
- NSW Vegetation Types Database (NSW Office of Environment and Heritage] Updated May 2012);
- *NSW Western Regional Assessments, Nandewar. Biodiversity Surrogates - Vegetation* (Wall 2004);
- *NSW Vegetation Classification and Assessment: Plant communities of the BBS, NAN & West New England Tablelands Bioregions* (Benson *et al*. 2010); and
- *Vegetation Mapping and Survey Data Audit and Gap Analysis for the Namoi and Border Rivers-Gwydir CMAs* (ELA, 2007).

3.1.2 Local

Biodiversity surveys conducted on or near the development site that are relevant to this assessment include:

- Ecological Impact Assessment: Watermark Coal Project (Cumberland Ecology, 2013);
- BioBanking Agreement #43: 'Yarrari' and 'Belah' properties, Wean Road, Kelvin (ELA, 2010; OEH, 2011); and
- Biodiversity Inventory Report – Mt Somner, Gunnedah LGA (Niche, 2012).

These studies have been used in combination with the 2013 field investigations by Niche (Appendix A) to evaluate the biodiversity values of the development site.

3.1.3 Relevant information

Landscape context

CMA, CMA subregion and Mitchell Landscape mapping is integral to a BioBanking assessment as they provide:

- Context for the landscape assessment of native vegetation types (e.g. status such as EECs, over cleared or highly over cleared); and
- Broad filters for threatened species that have the potential to occur within the development site (i.e. Mitchell Landscapes).

Figure 4 identifies the development site as occurring in the Namoi CMA Region: Liverpool Plains Part B Subregion and Nombi Plateau and Pinnacles Mitchell Landscape.

Native Vegetation

Native vegetation mapping (Figure 5) has been used as the basis for defining vegetation zones used in this assessment. BioMetric plot data, plot locations and vegetation descriptions that support the vegetation mapping provided in Figure 5 is detailed in Appendix A.

Threatened species

Three TSC Act-listed threatened fauna species have been confirmed as occurring within the development site, these including:

- Little Lorikeet (*Glossopsitta pusilla*);
- Koala (*Phascolarctos cinereus*); and
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*).

There is a possible recording of a fourth threatened species, the Large-eared Pied Bat (*Chalinolobus dwyeri*), within the development site. Whilst harp trapping did not confirm the presence of this species within the development site, it is considered that there are no suitable roost/breeding sites within the development site for this species (Appendix A).

3.2 Landscape score

Assessment circles of radius 1,784 m (1,000 hectares) and 564 m (100 hectares), as per DECC (2009), were used to calculate the landscape score for the development site. One 1,000 hectare circle and its 100 hectare pair were required for this purpose as shown in Figure 6. Attributes required to measure the landscape score for the development site are detailed in this section and Section 3.1.3. Use of judgement is discussed in Section 3.2.4.

3.2.1 Native vegetation cover

The 'before' and 'after' native vegetation cover estimates for the assessment circles mapped in Figure 6 are detailed in Table 1. The native vegetation cover estimate has taken its condition into consideration (see Section 3.2.4).

Table 1: Native vegetation cover – assessment circles

Assessment Circle Name	Native Vegetation Cover Class (%)			
	Before Development		After Development	
	100 ha	1000 ha	100 ha	1000 ha
1	91-100 (94.49)	61-70 (670.78)	71-80 (79.89)	61-70 (656.18)

3.2.2 Connectivity value

The primary link was selected using the following factors:

- The width of the current and future connecting link; and
- The condition of the current and future connecting link.

It was determined that no primary link exists for the development site as before and after vegetation connectivity is equally connected on all sides. The expected connectivity change arising as a consequence of the Project is described in Table 2.

Table 2: Connectivity value – width and condition

Connectivity Value	Before Development	After Development
Width	100-500m	100-500m
Overstorey Condition	PFC at BM	PFC at BM
Mid storey/ groundcover condition	PFC of mid-storey/ groundcover at BM	PFC of mid-storey/ groundcover at BM

3.2.3 Landscape score calculation

The information presented in Sections 3.1.3, 3.2.1 and 3.2.2 was entered into the BBCC Version 2.0, resulting in a landscape score calculation of 13.0 for the Development (assessment circle 1).

3.2.4 Use of judgement

Native vegetation cover

Vegetation condition was considered when estimating the spatial extent of native vegetation cover within each assessment circle mapped in Figure 6. The area mapped as 'native vegetation – moderate to good condition (50% of benchmark)' exhibits vegetation with overstorey condition below the lower benchmark threshold for the corresponding vegetation types. Vegetation types coincident with this mapped area include:

- Poplar Box - Belah woodland on clay-loam soils of the alluvial plains of north-central NSW (Benson 56);
- White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions; and

- Wilga - Western Rosewood shrubland of the tropical sub-humid climate zone Brigalow Belt South and Darling Riverine Plains Bioregions (Benson 145).

In determining amount of native vegetation cover within each of the assessment circles the spatial extent of 'native vegetation – moderate to good condition (50% of benchmark)' has been discounted by 25% due to the absence of native overstorey cover. The condition of groundcover/midstorey strata for this area is either near or at benchmark condition.

Connectivity

The loss of native vegetation from the development site is in addition to existing vegetation losses for an approved, constructed and operating quarry. It is important to note that the imagery used in this assessment does not accurately show this change in native vegetation cover. Use of judgement was applied to account for this disparity.

Southwest to northeast fauna movements have already been influenced by the above mentioned vegetation losses (i.e. cleared extent represents a hostile gap). After accounting for this vegetation loss it was determined that there would be no expected change in the BBAM connectivity width or condition classes. Notwithstanding, proposed revegetation works specified in the KPoM and progressive rehabilitation would significantly reduce any development related alteration in connectivity through the Projects operational period and, in the medium-term (seven years), are likely to increase connectivity.

3.3 Vegetation zones

Four vegetation zones comprising two separate NSW Vegetation Types have been mapped within the development site (Figure 7). The area for these zones, as detailed in Table 3, was entered into the 'vegetation zone' tab of the BBCC.

Table 3. Vegetation zone - assessment circle 1

Zone	NSW Vegetation type name	Code	Condition	Area (ha)
1	Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147)	NA199	Moderate/Good	3.17
2	White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	NA225	Moderate/Good_high	5.76
3	White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	NA225	Moderate/Good_medium	1.86
4	White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	NA225	Moderate/Good_other	3.81

3.3.1 Threatened species sub-zones

A single threatened species sub zone has been generated for each vegetation zone identified in Section 3.3. No further differentiation of vegetation zones has been included in this assessment.

3.3.2 Adjacent remnant area

The adjacent remnant vegetation area and patch size is consistent for all vegetation zones and their associated threatened species subzones mapped within the development site. The adjacent remnant area and patch size is greater than 500 hectares (i.e. 501 hectares) and has been determined from the area of moderate to good condition native vegetation mapped in Figure 6.

3.4 Geographic and habitat features

The geographic and habitat features tab in the BBCC is designed to further filter threatened species that are likely to be relevant to the habitats present within the development footprint. Table 4 outlines the responses to geographic/ habitat feature questions in the BBCC.

Table 4. Project relevant geographic and habitat questions

Question Does any part of the development impact on:	Answer
coastal headlands, grassland, grassy open forest or woodland on fertile or moderately fertile soils	Yes
land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels	No
land within 100 m of rocky areas	Yes
land north of Gunnedah in Liverpool Plains (Part B) CMA subregion	Yes*
rocky outcrops/cliffs in Pilliga (Part A) CMA subregion	No

* Note – conservatively included

The responses to the geographic and habitat questions generated the following list of non-ecosystem predicted species for consideration:

- Black-striped Wallaby (*Macropus dorsalis*) - land north of Gunnedah in Liverpool Plains (Part B) CMA subregion;
- Austral Toadflax (*Thesium australe*) - coastal headlands, grassland, grassy open forest or woodland on fertile or moderately fertile soils; and
- Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*) - land within 100 m of rocky areas.

3.5 Identified populations

No 'identified populations' as defined by the BBCC are relevant to the development site.

3.6 Site survey details

Sufficient targeted surveys were conducted for threatened species identified by the BBCC as requiring survey for the Project. See Appendix A for the results of these surveys.

3.7 Site values

3.7.1 Transect/ Plot Data

The BBAM requires site data to accurately define vegetation type, condition and threatened species habitat areas. Nine BioBanking plots were completed in four vegetation zones as detailed in Table 5.

Table 5. Vegetation zones plot requirements

Veg Zone	Vegetation type name	Veg Code	Per cent cleared	Area (ha)	Condition	Min. Plot Number[1]	Plots used[2]
1	Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147)	NA199	85	3.17	Moderate/Good	2	2
2	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	NA225	55	5.76	Moderate/Good_high	3	3
3	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	NA225	55	1.86	Moderate/Good_medium	1	1
4	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	NA225	55	3.81	Moderate/Good_other	2	3

Plot locations shown in Figure 8 have sampled each vegetation zone as follows:

- Vegetation Zone 1 (NA199 Moderate/ Good): Plots 10 and 16;
- Vegetation Zone 2 (NA225 Moderate/ Good_high): Plots 5, 13 and 19;
- Vegetation Zone 3 (NA225 Moderate/ Good_medium): Plot 17; and
- Vegetation Zone 4 (NA225 Moderate/ Good_other): Plots 9, 11, 12 and 15.

BioBanking plot data is provided in Appendix A.

[1] Minimum plot requirement for grouped assessment circles

[2] Plots do not necessarily spatially correlate with vegetation zone. See use of judgement.

3.7.2 Conservation status of vegetation zones

The conservation status of the NSW Vegetation Types found within the development site is provided in Table 6 and mapped in Figure 9. Those identified as being EECs or over cleared vegetation types represent 'red flag areas', which require additional assessment.

Table 6. NSW Vegetation Types – conservation status

NSW Vegetation Type	TSC Act status	Over cleared Vegetation	Red flag area
Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147)	EEC	Yes	Yes
White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Not an EEC	No	No

Conservation status under the TSC Act and EPBC Act as at 25th March 2013

SEVT that occurs outside the development site boundary but within a 10 kilometre radius are shown in Figure 9. These occurrences represent the nearest known patches of SEVT that have not been identified or mapped in regional vegetation mapping (ELA 2007). These occurrences have been identified from recent local studies (Niche 2013, Niche 2012, ELA 2010, OEH 2012) and aerial photography interpretation using the visual characteristics of known local occurrences that have been ground-truthed (Niche 2013, Niche 2012).

3.7.3 Management zones

A single management zone was established to match each vegetation zone and its associated threatened species sub-zone. The default decrease in site score allowed by the BBCC was accepted for all management zones.

3.7.4 Use of judgement

Plot data collected from the development site and surrounding area was used to redefine the development site boundary in accordance with the process outlined in Section 2 (i.e. impact avoidance). As a consequence of this process, one of the plots intended for use in this assessment fell outside the redefined development site boundary (i.e. Plot 19).

Plot 19 has been used in this assessment to meet the minimum plot requirements for the corresponding vegetation zone. While this plot is not located within the development site, it is considered that the data is suitable for this BioBanking assessment. Reasons are as follows:

- The plot is close to the development site boundary (i.e. approximately 50 m);
- The site attribute values of this plot are comparable with the mean of other plots used for this vegetation zone; and
- The plot data is generally consistent with benchmark conditions for NA225.

Appendix A exhibits the plot data for the consideration of this use of judgement.

3.8 Threatened species survey results

The BBCC identified the following non-ecosystem predicted threatened species for survey:

- Rufous Bettong (*Aepyprymnus rufescens*);
- Bluegrass (*Dichanthium setosum*);
- Finger Panic Grass (*Digitaria porrecta*);
- Little Eagle (*Hieraaetus morphnoides*);
- Square-tailed Kite (*Lophoictinia isura*);
- Black-striped Wallaby (*Macropus dorsalis*);
- Brush-tailed Phascogale (*Phascogale tapoatafa*);
- Scant Pomaderris (*Pomaderris queenslandica*); and
- Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*).

Targeted surveys were conducted in January and March 2013 using methods suitable for the detection of these species (Niche 2013: Appendix A). These surveys resulted in the possible detection of the Large-eared Pied Bat, although no suitable roost/breeding habitat was identified for this species within the development site.

Survey and habitat assessment indicate that the Project is unlikely to have an adverse impact on any of the above listed species. No species polygons or counts have been established for the purposes of calculating species credits in this BioBanking assessment.

4 CREDIT CALCULATIONS

This section summarises the biodiversity credit calculations for the development site and represent the offset component identified in Section 2. These calculations are based on the information presented in Section 3, use of judgement and 'avoid and mitigate' considerations presented in Section 2. Applicable assumptions and limitations are outlined in Section 1.6, Sections 3.2.4 and 3.7.4 (i.e. use of judgement) and Appendix A.

4.1 Ecosystem credits

Ecosystem credits calculated for the vegetation zones impacted by the Project total 796 credits, as specified in Table 7. The credit report for the Project is provided in Appendix B.

Table 7. Ecosystem credit calculation for the development site

Veg Zone	NSW Vegetation Type	Condition	Red Flag	Area (ha)	Credits
1	Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147)	Moderate/ Good	Yes	3.17	153
2	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Moderate/ Good_high	No	5.76	339
3	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Moderate/ Good_medium	No	1.86	98
4	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Moderate/ Good_other	No	3.81	206
Total				**14.60**	**796**

An assessment of the Projects impact on red flag areas is provided in Section 5.

4.1.1 Use of judgement

The ecosystem credit calculation for NA225 was modified by manual adjustment of the default Tg scores. The occurrence of NA225 within the development site is not considered suitable breeding habitat for the Barking Owl (Tg = 0.33), Masked Owl (Tg = 0.33) or Spotted-tailed Quoll (Tg = 0.35) (Niche 2013: Appendix A). Tg scores for these species were altered to either 0.75 or 1.0 to reflect the occurrence of low value foraging habitat only. Arguments supporting these Tg modifications are provided in Section 6.

The lowest Tg score used in credit calculations for NA225 was 0.45. The use of this Tg score reflects the known presence of the Yellow-bellied Sheath-tail Bat within the development site. Breeding and roosting habitat for this ecosystem predicted species is present within NA225.

4.2 Species credits

Species credits have not been calculated for predicted non-ecosystem species considered in this assessment as the Project is unlikely to have an impact on any of these species.

5 RED FLAG AREAS

The Project has been identified as having a direct impact on a red flag area, as indicated in Table 7, for the following reasons:

- Impact on endangered ecological communities not in low condition (Figure 9); and
- Vegetation type that has been cleared by more than 70% and is not in low condition.

The criteria used to determine if the Project's impact on red flag areas can be regarded as improving or maintaining biodiversity values are outlined in the BBAM (DECC, 2009). These criteria are:

- Options to avoid on red flag areas must be considered;
- Highly cleared vegetation types have been considered;
- Contribution to regional biodiversity values must be low;
- Viability must be low or not viable; and
- Consideration of other matters such as approved regional plans, consistency with these plans and the benefits of any extra environmental contributions.

The Director General can only make a determination of a 'maintain or improve' outcome if satisfied that the criteria outlined in Section 2.3 of the BBAM are met (i.e. a 'red flag variation' assessment). A red flag area variation assessment addressing the above criteria is provided in the following sections for the Director Generals' consideration.

5.1 Options to avoid

5.1.1 Avoid averse impacts on the red flag area

Section 2 outlines the process used to avoid impacts from the development by modifying the final quarry footprint (i.e. development site boundary shown in Figure 2). In this respect, the impact area has been revised down from that exhibited in the Environmental Impact Statement (Stewart Surveys, 2012).

The development site boundary has a spatial extent that is approximately 37% of the original proposed quarry (Stewart Surveys, 2012), whilst maintaining a similar bulk cubic metre product output. This has been achieved through the deepening of the quarry pit floor. The revised Project has resulted in a substantial reduction in impact on SEVT. Approximately 4 hectares have been avoided through modification of the development site footprint.

5.1.2 Improve or retain the viability of the red flag area

A biodiversity offset including provisions for the in perpetuity conservation of SEVT is implied by the approval of a BioBank statement for the Project. A like for like SEVT specific

offset of approximately 20 hectares would be a requirement with the sourcing of this offset to be restricted to the Liverpool Plains Part B CMA subregion and adjacent subregions contained within the Namoi CMA. This conservation outcome would represent only the second known occurrence of SEVT in a secure conservation area for the Namoi CMA.

In addition to this offset outcome would be the implementation of an approved site specific EMP and KPoM. The impact mitigation works specified within these plans would be a requirement for any conditioned approval issued for the Project under NSW legislation.

Native vegetation avoided by the Project, as indicated in Figure 3, would be subject to an agency approved EMP. Management actions included in this EMP would aim to prevent indirect impacts on adjacent vegetation. Management actions proposed for inclusion in this EMP would include the following:

- Weed control, particularly for species such as *Zinnia peruviensis*, a weed species that was noted to occur within SEVT;
- Feral animal control, particularly for feral pigs, which were noted to be damaging SEVT; and
- Fire management by proactively excluding fire from areas of SEVT.

Residual areas of SEVT would be managed for weeds and feral fauna (i.e. wild pigs). Edge effects would be minimised through proposed management actions (i.e. weed management) Threats such as unplanned fire events would also be managed to minimise the potential for adverse impacts on SEVT. Progressive rehabilitation within the quarry area would be outlined in the EMP and would be focused on establishing vegetation similar to SEVT.

Progressive rehabilitation of the final landform would also be undertaken as part of a staged development. Details for establishing vegetation cover of similar structure and floristics to SEVT would be defined in the EMP.

5.2 Highly cleared vegetation types

OEH (2012) estimate 85% of the pre-1750 extent of SEVT (i.e. NA199) has been cleared within the Namoi CMA. On this basis NA199 is not classed as a highly cleared vegetation type and, as such, the other criteria (i.e. contributions to regional biodiversity values and viability) can be considered in this red flag area variation assessment.

5.3 Contribution to regional biodiversity values must be low

For the purposes of a red flag area assessment the BBAM defines 'region' as the CMA subregion where the red flag area is located and the adjacent subregions within the respective CMA region. In this case the region for the Project is defined as the Liverpool Plains Part B CMA subregion and the following adjacent CMA subregions:

- Peel;
- Kaputar;
- Northern Basalts;

- Castlereagh – Barwon;
- Pillaga Outwash;
- Pilliga; and
- Liverpool Range.

Combined, the above CMA subregions are commensurate with the area mapped as the Namoi CMA. Discussions provided in the following sections are based on this definition of region.

5.3.1 Relative abundance

SEVT occurring within the development site corresponds to the Benson *et al* (2010) plant community: *Mock Olive - Wilga - Peach Bush - Carissa Semi-evergreen Vine Thicket (dry rainforest) mainly on basalt soils in the BBS bioregion*. ELA (2007) in Benson *et al* (2010) modelled a pre-1750 extent of 12,000 hectares (8,400 – 15,000 hectares) for this plant community within the Brigalow Belt South (30-70%) and Nandewar (<30%) bioregions. An estimated 1,800-2,200 hectares is now predicted to remain in the Brigalow Belt South Bioregion (ELA, 2007 in Benson *et al*, 2010).

According to Benson *et al*. (2010) approximately 3,600 hectares of the pre-1750 SEVT cover estimate is predicted to occur within the Namoi CMA. The current estimate of SEVT cover within the Namoi CMA is 451 hectares (ELA, 2007) or 12 per cent of the pre-1750 modelled occurrence.

Recent site-based biodiversity investigations (ELA 2010, Niche 2012) and aerial photography interpretation of the locality has identified additional SEVT occurrences in the Gunnedah area not previously identified or mapped by ELA (2007). These unmapped occurrences, as shown in Figure 9, indicate that the ELA (2007) pre-1750 modelling is likely to represent an underestimate of the regional extent of SEVT. The area of SEVT for the above mentioned unmapped occurrences is approximately 601 hectares and is estimated as follows:

- Mt Somner – 55 hectares (Niche, 2012);
- BioBanking Agreement #43 – 176 hectares (ELA, 2010; OEH, 2011); and
- Nombi Plateau and Pinnacles (including the development site) – approximately 370 hectares (aerial photography interpretation).

These unmapped SEVT occurrences would alone account for approximately 17 per cent of the Namoi CMA pre-1750 estimate and over 100 per cent of the current estimated extent. In this respect it is considered that SEVT extant mapping for the Namoi CMA, as reported in Benson *et al* (2010), has underestimated both pre-1750 and current SEVT cover.

When considering these additional areas of SEVT, it is considered the Project would not substantially reduce the currently published estimate of SEVT extent in the Gunnedah area or the region. Locally, it is considered that the current relative abundance of SEVT would remain intact.

5.3.2 Per cent remaining is high

Benson *et al* (2010) conservatively estimate the extent of SEVT within the Namoi CMA as 15 per cent of pre-1750 modelled extant, which is not classified as high (i.e. greater than 50% of the pre-1750 distribution). However, as outlined in Section 5.3.1 the Benson *et al* (2010) pre-1750 modelling is likely to have underestimated the regional occurrence of SEVT.

The inclusion of previously unmapped SEVT occurrences in the Gunnedah area would raise the SEVT per cent remaining estimate for the Namoi CMA to between 25 and 30 per cent. While this per cent remaining estimate is not high, it is close to the 70 per cent threshold that differentiates between overcleared vegetation types and those that are not. It is considered that further detailed SEVT mapping and ground truthing in the region would be likely to increase the remaining regional per cent estimates for SEVT.

5.3.3 Per cent native vegetation (by area) remaining high

The remaining native vegetation cover for the region is 1,905,183 hectares or 45 per cent of the pre-1750 extant native vegetation cover (Namoi CMA, 2011a). This estimate is not greater than the 50% threshold used to define 'high' (DEC, 2009). However, for woody vegetation types regional vegetation mapping only takes into account the extent of current woody cover. Native vegetation in a derived grassland state have not been estimated and if included the per cent native vegetation remaining for the Namoi region would be expected to exceed 50 per cent and would thus be classified as high.

5.3.4 Whether the red flag area is in moderate to good condition

The red flag area is in moderate to good condition.

Plot data indicates the condition of SEVT within the development site as highly variable and generally not within benchmark condition as indicated in Appendix A. Site attribute values are above and below benchmark condition for NA199 resulting in a site value score of 51.74 out of a possible score of 100. This implies a condition of approximately 50% of benchmark, and is only 18% above the threshold defining low condition in the Biodiversity Certification Assessment Methodology (DECCW 2011).

5.3.5 Relative abundance of individual threatened species

This criterion is not relevant to the assessment as the red flag area does not pertain to an individual threatened species.

5.4 Viability must be low or not viable

The sub-benchmark condition of the red flag area, as indicated in Section 5.3.4 and Appendix A, is likely to be a consequence of land use related impacts. These include prior clearing (i.e. patch fragmentation and edge effects) and farming (i.e. grazing, altered fire regimes and introduction of pests). The effects of these on the red flag area are discussed as follows:

Land clearing

The development site is surrounded by farmland that has been developed and used for cropping and grazing for over 150 years. Land clearing supporting the development of this farmland has resulted in the isolation of woody vegetation within the area, including that of the development site.

Plot data indicates that this isolation has resulted in the degradation of site attribute scores for the red flag area, notably native plant species richness. Also site attribute scores that measure vegetation structure are mostly outside benchmark condition, which is likely to be a result of reduced plant species richness (i.e. fewer species contributing to vegetation structure) and the simplification/alteration of ecological function (e.g. fire frequency and recovery). The latter effect is common in isolated patches and is well described in the literature (i.e. island biogeography).

Farming

Agricultural practices in the area have introduced various factors that are likely to have had a pronounced effect on isolated patches of native vegetation, such as those occurring within the development site. Weeds, feral pigs and red fox are present within the development site and would collectively have an adverse affect on the red flag area.

These adverse influences are currently uncontrolled and, when considering the site's current land use and isolated nature, would continue to simplify the biodiversity values of the red flag area. This is supported by site observations of feral pig activity and weed occurrence where impacts exerted by these existing threats are directly impacting groundcover conditions.

Conclusions

The analysis of site data indicate that the red flag area has already deteriorated from expected benchmark condition. The observed effect of past and current threats on the red flag area indicate that proactive management is required to prevent further degradation.

While it cannot be argued that the red flag area is not viable, it is considered likely that it will continue to degrade to a low viability condition state without proactive management.

5.5 Consideration of other matters

5.5.1 Regional plans

The Namoi Catchment Action Plan 2010-2020 (Namoi CMA, 2011a) is the most recent regional plan applicable to the Project and this assessment. This plan confirms the threatened status of the red flag area for the Namoi CMA (i.e. endangered ecological community). Among other objectives, the plan aims to increase the remaining native vegetation cover of the Namoi CMA. This is currently estimated to be at 45 per cent of pre-1750 native vegetation cover.

5.5.2 Consistency with plans

The loss of native vegetation is not consistent with the fundamental objectives of the Namoi Catchment Action Plan (Namoi CMA, 2011a). However, the proposed mitigation actions (i.e. revegetation and rehabilitation works) and offsetting (i.e. compliance with a BioBank Statement) are consistent with the 'maintain and improve' outcome that compensates for the native vegetation loss.

The Project is consistent with the aim of increasing remaining native vegetation cover in the Namoi CMA (Namoi CMA, 2011a; Namoi CMA, 2011b) by:

- Ensuring that development results in no net loss of native vegetation in the catchment and would compensate for biodiversity loss. Revegetation works proposed in the KPoM would compensate for the vegetation loss attributed to the Project resulting in a net increase in native vegetation cover;
- Ensuring that development impact avoids crossing critical biodiversity thresholds through staged development. Temporal net changes in vegetation cover would be managed through the timely implementation of proposed mitigation works to minimise habitat displacement;
- Progressive rehabilitation would, in part, limit the Projects impact on native vegetation; and
- Being consistent with the existing NSW Government and Commonwealth legislative requirements through the delivery of a like-for-like offset sourced within the region via the BioBanking Scheme.

The implementation of the KPoM would increase native vegetation cover in the region and would also increase the local availability of suitable foraging habitat for the Koala. Further, these revegetation works would increase patch size and connectivity condition in an already over cleared subregion of the Namoi CMA, thereby redressing existing land use impacts on local vegetation cover and habitat.

Proposed progressive rehabilitation following the staged cessation of quarrying activities provides an opportunity for the re-establishment of native vegetation. Rehabilitation works would form part of the Project EMP and would aim to re-establish native vegetation of similar structure and floristic composition to SEVT.

Namoi CMA Offsets Policy

The following principles must be applied when considering using biodiversity offsets in the Namoi Catchment for any development (Namoi CMA, 2011b):

- Offsets will be used as a last resort, after consideration of alternatives to avoid and/or mitigate impacts;
- Offset areas must be kept within the Namoi Catchment boundaries (either wholly or in part – as a contiguous area of native vegetation);
- Offsets must be of the same vegetation type and be at least the size, equivalent biodiversity value and configuration of the vegetation lost through development and additional to existing native vegetation areas;

- Offsetting must achieve biodiversity benefits in perpetuity and be registered on title;
- Offset conditions must be monitored, enforceable, clearly mapped, recorded and publicly available; and
- An offset area, once designated, cannot be used for further offsetting of subsequent developments in future.

The evolution of the Project and its expected biodiversity offset outcomes, which has involved the principles of avoid and mitigate, is consistent with the above principles.

5.5.3 Environmental contributions

The Project is expected to deliver the following environmental contributions:

- Rehabilitation of SEVT: Progressive rehabilitation works are proposed from year 14. A mix of SEVT and Koala habitat would be established in the mined area.
- Revegetation of cleared lands: As part of the KPoM approximately 45 hectares of adjacent derived grasslands would be revegetated with preferred Koala feed tree species. This would have the effect of improving connectivity and the condition of patch size, with the expected outcomes being a net improvement on existing conditions.
- Weed and feral management in adjacent areas of SEVT: As part of an EMP it is anticipated that the condition of adjacent of areas of avoided SEVT would be improved.

6 MORE APPROPRIATE LOCAL DATA

Three ecosystem predicted species are predicted to use the habitat within the development site for breeding purposes. However, survey results for the development site do not support this prediction (Appendix A). A review of the sites suitability for these species is provided as follows with recommendations supporting the modification of Tg scores used in the calculation of ecosystem credits.

6.1 Spotted-tailed Quoll

6.1.1 Habitat Requirements

The Spotted-tailed Quoll *Dasyurus maculatus* is mainly a forest dwelling species that occupies large, usually exclusive, home ranges (Andrews 2005, Belcher and Darrant 2004). Minimum reported home range size for females is around 88 hectares, but is usually larger, and males occupy substantially larger home ranges. Typical environments where quolls prosper are those with higher productivity and subsequent abundant prey. The prey utilised by Spotted-tailed Quolls is diverse and varies dramatically between sites.

The Spotted-tailed Quoll inhabits a variety of habitats, including dry to moist open forests or closed forests containing rock caves, hollow logs or trees for denning and foraging. Viable populations of the Spotted-tailed Quoll occupy complex overlapping individual home ranges comprising numerous individuals. Females occupy smaller ranges (mean 500 hectares) comprising an abundance of resources, with males occupying larger home ranges (Belcher 2008). Ideal habitat for this species is generally contained in large undisturbed connected tracts of intact native vegetation, which are under threat throughout the range of this species.

Populations of the Spotted-tailed Quoll are very sensitive to changes in the predator-prey relationship of their chosen environment (Catling and Burt 1995). An area containing an abundant source of medium-sized mammals (500 – 5,000 grams) is an important feature of suitable foraging habitat for the Spotted-tailed Quoll (Belcher 1995), with a low abundance of medium-sized mammals likely to increase habitat suitability for competitors such as the European fox (*Vulpes vulpes*) (Catling and Burt 1995). Competition from the European fox serves to inhibit Spotted-tailed Quoll populations (Catling and Burt 1995) as the European fox is more adapted to fragmented landscapes comprising a mosaic of cleared and vegetated lands.

6.1.2 Regional status

The Spotted-tailed Quoll was previously widely distributed from south-east Queensland, eastern NSW, Victoria, south-east South Australia and Tasmania (Jones et al. 2001). The subspecies' mainland range has reduced by 50-90% (Jones et al. 2001). Detailed distribution records and abundance estimates are generally lacking due to the scale and intensity of surveying that is required to detect the species across its entire range (Long & Nelson 2004).

Figures from 2004 suggest that there are 44 known sites in NSW, 16 sites in the ACT, four to five sites in Victoria and possibly none in South Australia (TSSC 2004). Spotted-tailed Quoll records indicate that the species is now confined to within 200 km of the coast and range from the Queensland border to Kosciuszko National Park. Locations include:

- Hunter Valley, Taree, Port Macquarie and Coffs Harbour through to the gorges and escarpments of the New England Tableland;
- Locally abundant populations occur in the south of the state (i.e. Kosciuszko National Park and coastal national parks);
- Isolated records near Hay; and
- Several disjunct populations between the Border Ranges and the Blue Mountains/Illawarra area (Catling & Burt 1997).

6.1.3 Local occurrence

Spotted-tailed Quoll is known to occur within the Liverpool Plains Part B CMA subregion of the Namoi CMA (Namoi CMA 2013). Surveys did not find any evidence to show that this species currently or has previously used the site (Appendix A).

Local records are few and are centred on the Gunnedah township and adjacent areas. The nearest record is approximately 15 km to the east and was reported as a road kill. Nearly all records within a 50 km radius are associated with large woody vegetation remnants exceeding 1,000 hectares in area.

6.1.4 Habitat within the development site

Prima facie the vegetation type identified within the development site has the potential to provide habitat for the Spotted-tailed Quoll for the following reasons:

- The vegetation type is a known habitat surrogate;
- The presence of fertile basalt derived soils may provide the productivity required for this higher order predator; and
- Suitable prey species including the Common Brushtail Possum, hollow and communal roosting birds and small mammals are present.

However, the suitability of this habitat is regarded as low for the following reasons:

- Remnant size (excluding adjacent derived grasslands) is not large enough to support an individual Spotted-tailed Quoll. Derived grasslands that surround the development site are not suitable for the Spotted-tailed Quoll;
- Adjacent areas of habitat to the east (i.e. woody vegetated remnants) are separated from the development site by unsuitable habitat (i.e. derived grasslands and croplands);
- The density of preferred prey species is low and is insufficient to support an individual breeding female Spotted-tailed Quoll;

- Other well known prey such as small macropods, rabbits and smaller arboreal mammals seem to be rare or absent from the development site;
- Suitable denning sites such as hollow fallen logs and medium to large tree hollows are absent; and
- There are European foxes present with the development site, which is known to successfully outcompete the Spotted-tailed Quoll (Catling and Burt 1995).

Based on the above it is considered that the habitat present within the development site is suitable only for opportunistic foraging activity and/or transient movements throughout the region.

6.1.5 Tg score

The Project would impact low value opportunistic foraging habitat for the Spotted-tailed Quoll that would otherwise represent only a small fraction of a much larger home range occupied by this species. For this reason and those stated in Section 6.1.4 it is considered that the use of more appropriate local data is substantiated for this species. It is considered that the default Tg score of 0.35 for the Spotted-tailed Quoll inappropriately characterises the current habitat values of the development site for this species. A Tg score of 1.0 is considered a more accurate account of the current habitat values for this species within the development site.

6.2 Masked Owl

6.2.1 Habitat Requirements

The Masked Owl lives as monogamous, sedentary life-long pairs in large permanent home ranges (Debus 1993 in DEC 2006). It inhabits a diverse range of wooded habitat that provides tall or dense mature trees with hollows suitable for nesting and roosting (DEC 2006). Home range has been estimated as 400-1000 ha according to habitat productivity.

Roosts by day in tree hollows, caves, and dense foliage including exotic trees. Foliage roosts can be highly cryptic. Forages by hunting from perches at or near ground level on the forest edge, in woodland or in open country.

Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (DEC 2006). Nest hollows are usually located within dense forests or woodlands (DEC 2006). Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (DEC 2006).

Mesic microhabitats, such as gullies, may be used preferentially for nesting and roosting, although upper slopes are also used; ecotones within forests and at forest edges appear to be used preferentially for foraging (DEC 2006). Established pairs roost in traditional tree hollows, including tree hollow nest sites; in the non-breeding season they use other roost sites away from the nest patch (DEC 2006).

6.2.2 Regional status

Approximately 90 per cent of NSW represents the extent of occurrence for the Masked Owl within NSW with only the semi-arid parts of north-western NSW being unsuitable for this species (DEC 2006). It is considered that most of the vegetation cover within the Namoi CMA contains habitat for the Masked Owl.

Masked Owls occupy large continuous tracts of drier forests and woodlands with large old tree hollows and high density small mammal populations. However, through vegetation fragmentation and degradation within the Namoi CMA, in particular the Liverpool Plains Part B CMA subregion, it is considered that the suitability of habitat for the Masked Owl has been substantially reduced. This is substantiated by Masked Owl records for the region, which are mostly aligned to large continuous tracts of native forest and woodland.

6.2.3 Local occurrence

The Masked Owl is known to occur within the Liverpool Plains Part B CMA subregion of the Namoi CMA (Namoi CMA 2013c). Surveys did not confirm any signs of this species within the site (Appendix A).

Local records are few and are centred on forests east and west of Boggabri. The nearest record is approximately 20 km to the north-west in Kerringle State Forest. Nearly all records within a 50 km radius are associated with large woody vegetation remnants exceeding 1,000 hectares in area.

6.2.4 Habitat within the development site

Ecological factors required for reproduction include (DEC 2006):

- ❒ Mature forest or woodland stands with large hollow bearing trees;
- ❒ Dense trees or shrubs for fledglings to shelter within; and
- ❒ High density of small terrestrial mammals, only few of which have any strong relationships with old-growth forest or woodland attributes.

Specific habitat requirements include (DEC 2006):

- ❒ Dry eucalypt forests and woodlands on productive sites on gentle terrain;
- ❒ High density of old hollow bearing trees; and
- ❒ Grassy understorey with a mosaic of sparse and dense ground cover.

In relation to the above factors it is considered that the development site contains only suitable foraging habitat due to the absence of large and/or old hollow bearing trees. These foraging values are also considered less than ideal for the Masked Owl due to the species need for a large home range comprising woodlands and forests with high densities of small terrestrial mammals. These conclusions are supported by the literature where it has been reported that habitat reduction by clearing for agriculture has resulted in widespread local extinctions in the inland regions (DEC 2006). Its decline in western regions has also been attributed to the collapse of native mammal populations in the inland (DEC 2006).

6.2.5 Tg score

The Project would impact low value opportunistic foraging habitat for the Masked Owl that would otherwise represent only a small fraction of a much larger home range occupied by this species. For this reason and those stated in Section 6.2.4 it is considered that the use of more appropriate local data is substantiated for this species. It is considered that the default Tg score of 0.33 for the Masked Owl inappropriately characterises the current habitat values of the development site for this species. A Tg score of 0.75 is considered a more accurate account of the current habitat values for this species within the development site.

6.3 Barking Owl

6.3.1 Habitat Requirements

The Barking Owl lives in forests and woodlands of tropical, temperate and semi-arid zones. The habitat is typically dominated by eucalypts, often red gum species, and in the tropics, paperbark Melaleuca species. It usually roosts in or under dense foliage in large trees including rainforest species of streamside gallery forests, River She-oak *Casuarina cunninghamiana*, other *Casuarina* and *Allocasuarina* species, eucalypts, *Angophora* or *Acacia* species. Roost sites are often near watercourses or wetlands. It typically breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands. Barking Owls have been recorded in remnants of forest and woodland and in clumps of trees at farms, towns and golf courses (NPWS 2003).

6.3.2 Regional status

In NSW, it is widespread on the coastal plain and foothills and the inland slopes and plains. It is sparse on the higher parts of the tablelands and in the arid zone west of the Darling River and rare or absent in the dense, wet forests of the eastern fall of the Great Dividing Range (NPWS 2003).

Surveys of the north-western slopes of NSW detected a total of eight Barking Owls at only five of the 110 locations surveyed (NPWS 2003). The only known stronghold of the species in NSW occurs in Pilliga West State Forest where there are at least 30 pairs (NPWS 2003).

6.3.3 Local occurrence

The Barking Owl is known to occur within the Liverpool Plains Part B CMA subregion of the Namoi CMA (Namoi CMA 2013). Local records are few and are centred on the Pilliga forests (OEH 2013, NPWS 2003). Surveys did not confirm any signs of this species within the site (Appendix A).

The nearest record is approximately 20 km to the north-west in Kerringle State Forest. Nearly all records within a 50 km radius are associated with very large woody vegetation remnants in association with major watercourses and rivers.

6.3.4 Habitat within the development site

Key habitat requirements for the Barking Owl, including large or old hollow trees, preferred foliage roost trees, forests and woodlands adjacent major drainages and rivers, and preferred foraging resources are absent from the site and adjacent areas. It is considered that the habitat suitability of the site for the Barking Owl is considered very low and restricted to opportunistic foraging only.

6.3.5 Tg score

The Project would impact very low value opportunistic foraging habitat for the Barking Owl that would otherwise represent only a small fraction of a much larger home range occupied by this species. For this reason and those stated in Section 6.3.4 it is considered that the use of more appropriate local data is substantiated for this species. It is considered that the default Tg score of 0.33 for the Barking Owl inappropriately characterises the current habitat values of the development site for this species. A Tg score of 1.0 is considered a more accurate account of the current habitat values for this species within the development site.

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FIGURES

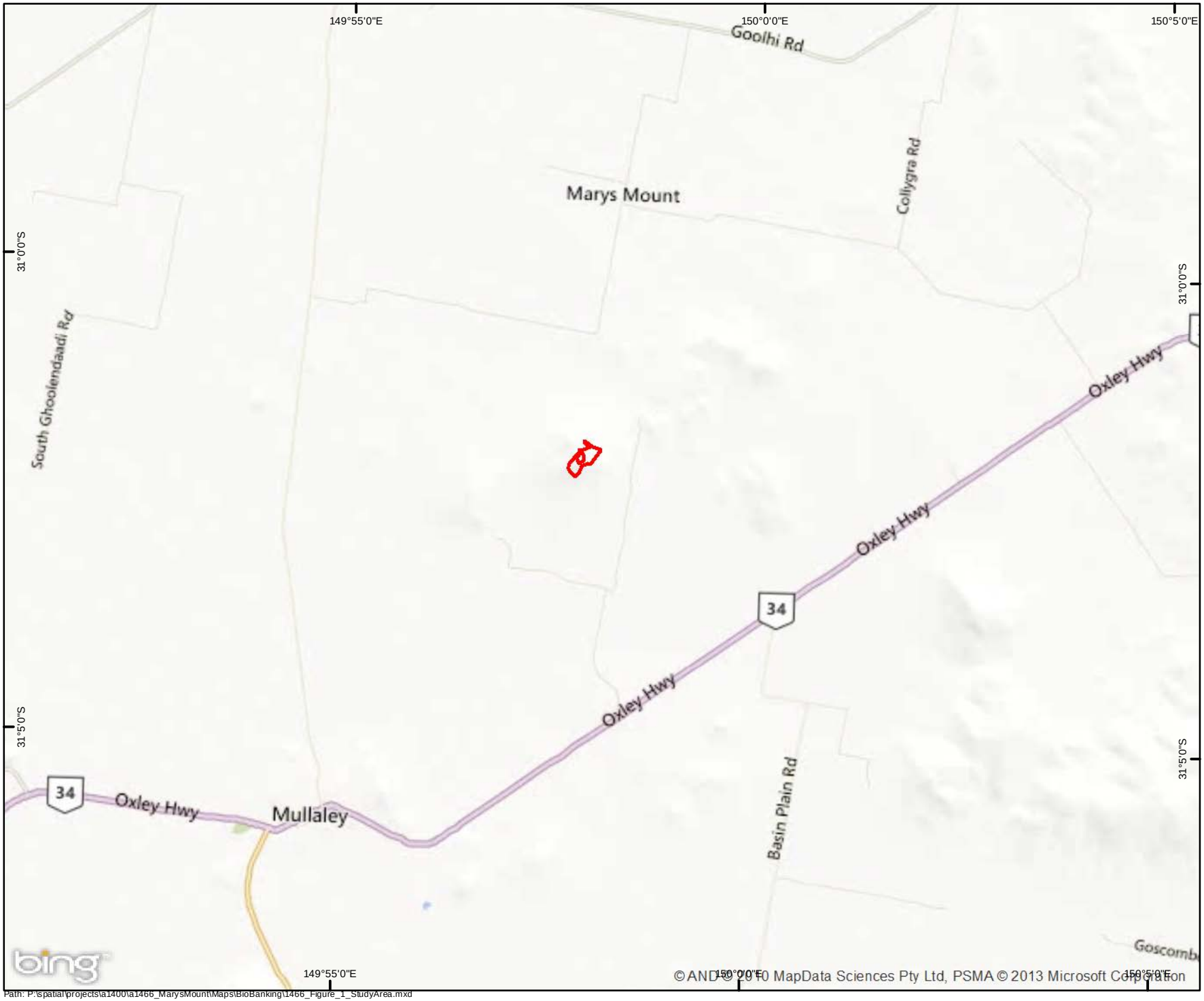

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Figure 1: Project location

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

Development Site

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niche
Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

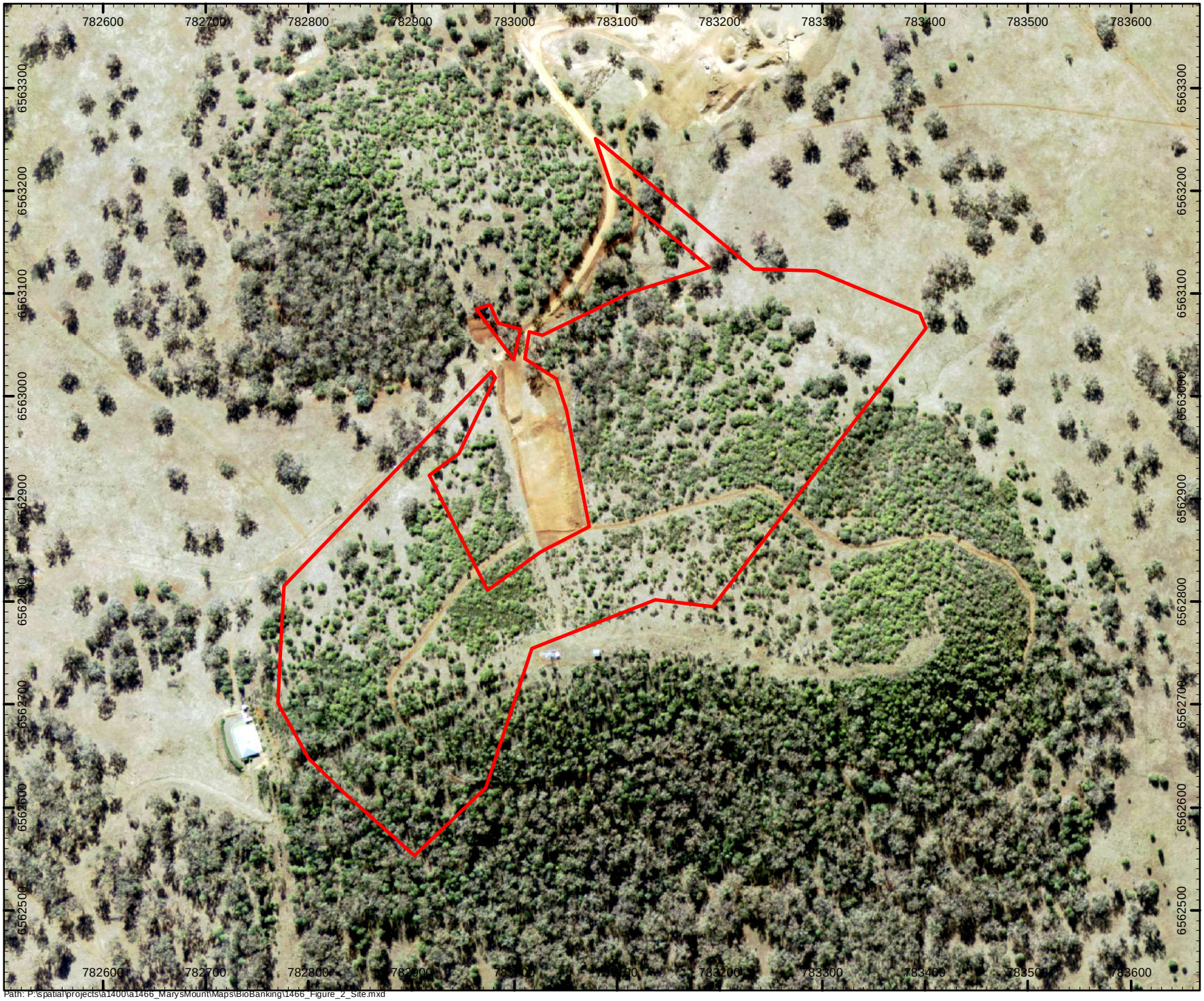

Figure 2: Development Site

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

Development Site

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Metres
0 50 100 150

niche
Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

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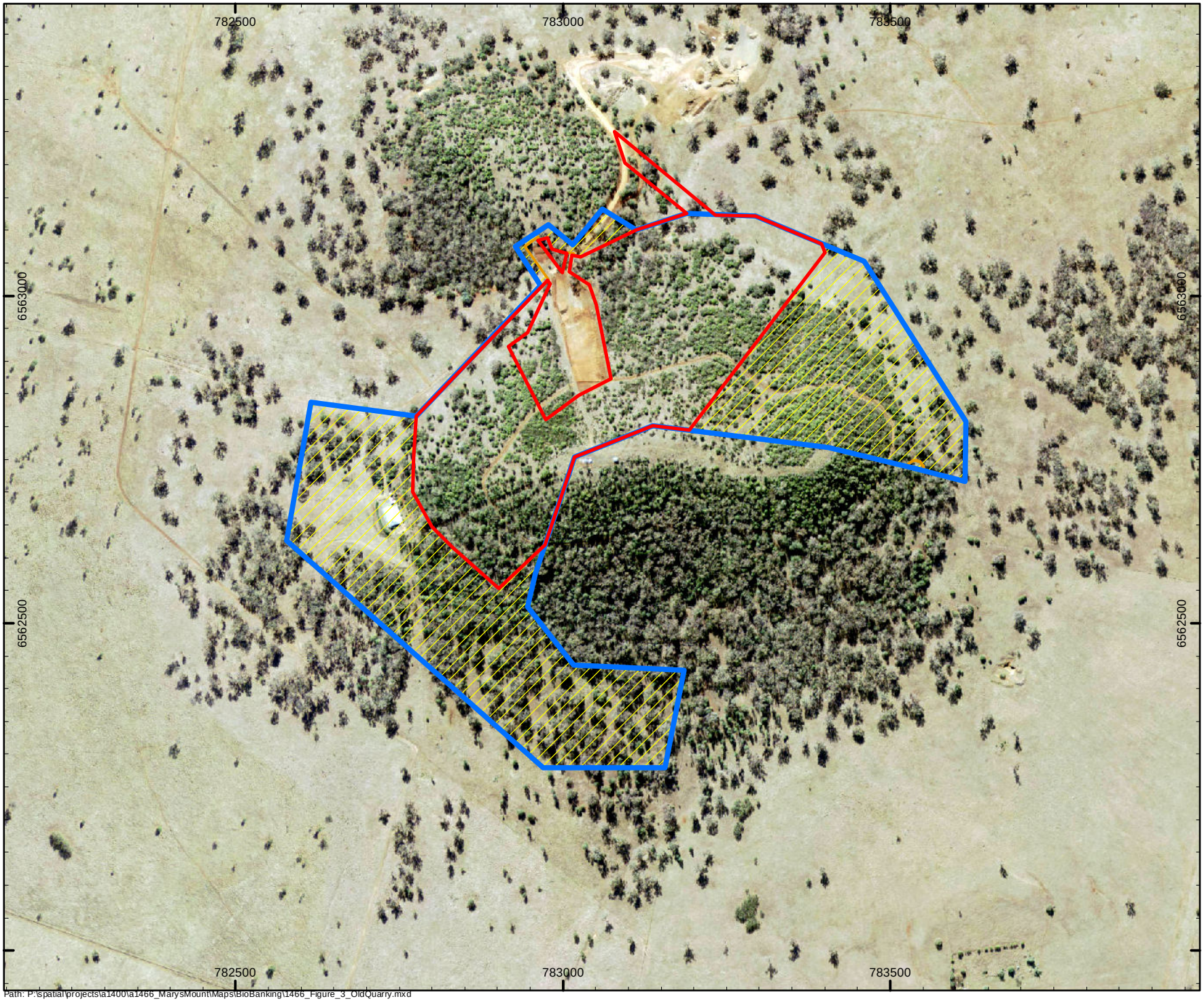

Figure 3: Site Plan

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

Development Site
Original Quarry Proposal
Avoided Vegetation

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Metres
0 50 100 150 200 250 300

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Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

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Figure 4: CMA Region-Subregion and Mitchell Landscapes

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

Development Site
CMA Region: Subregion
Mitchell Landscapes

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Metres
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Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

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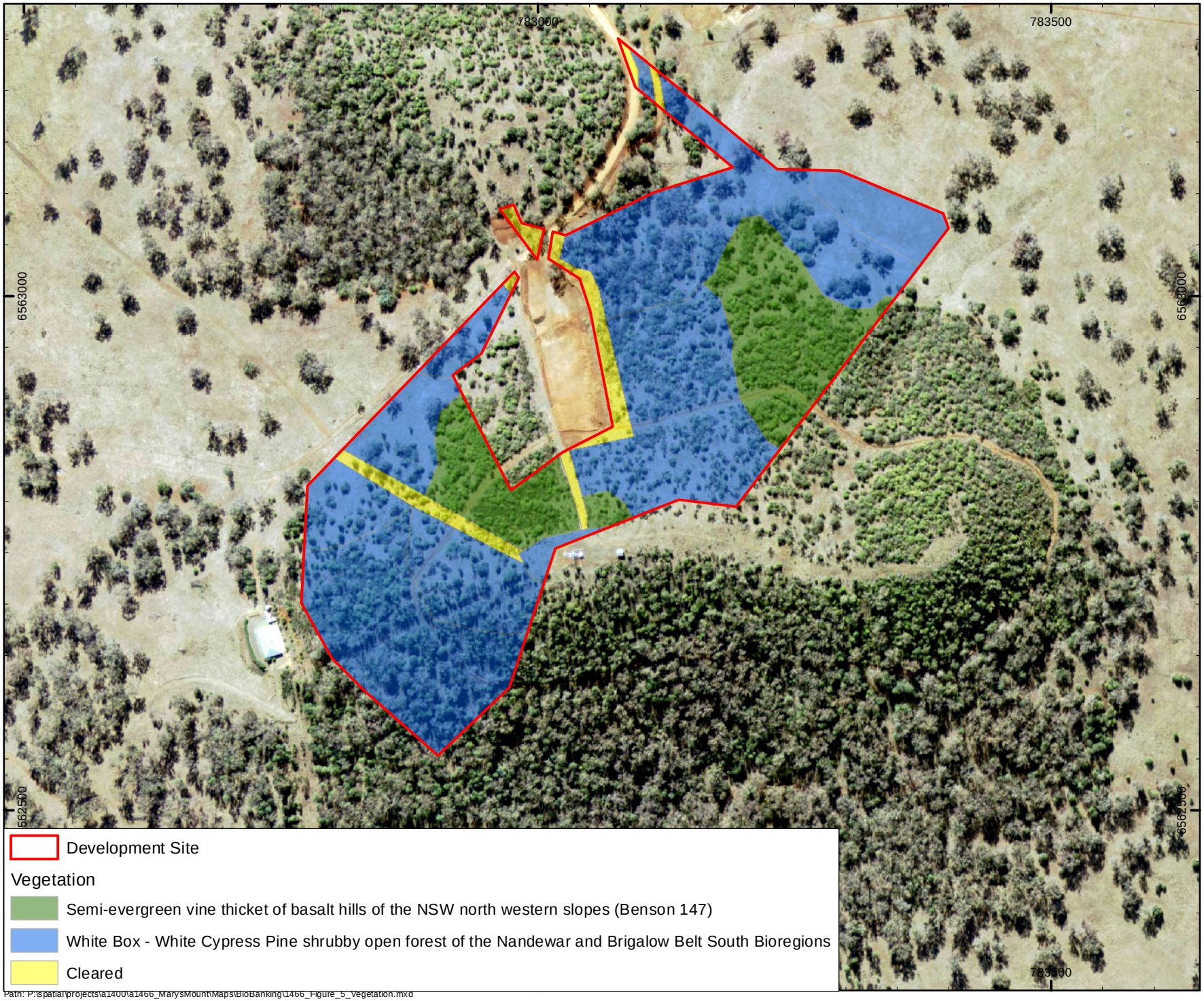

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Figure 5: Native Vegetation

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

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Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

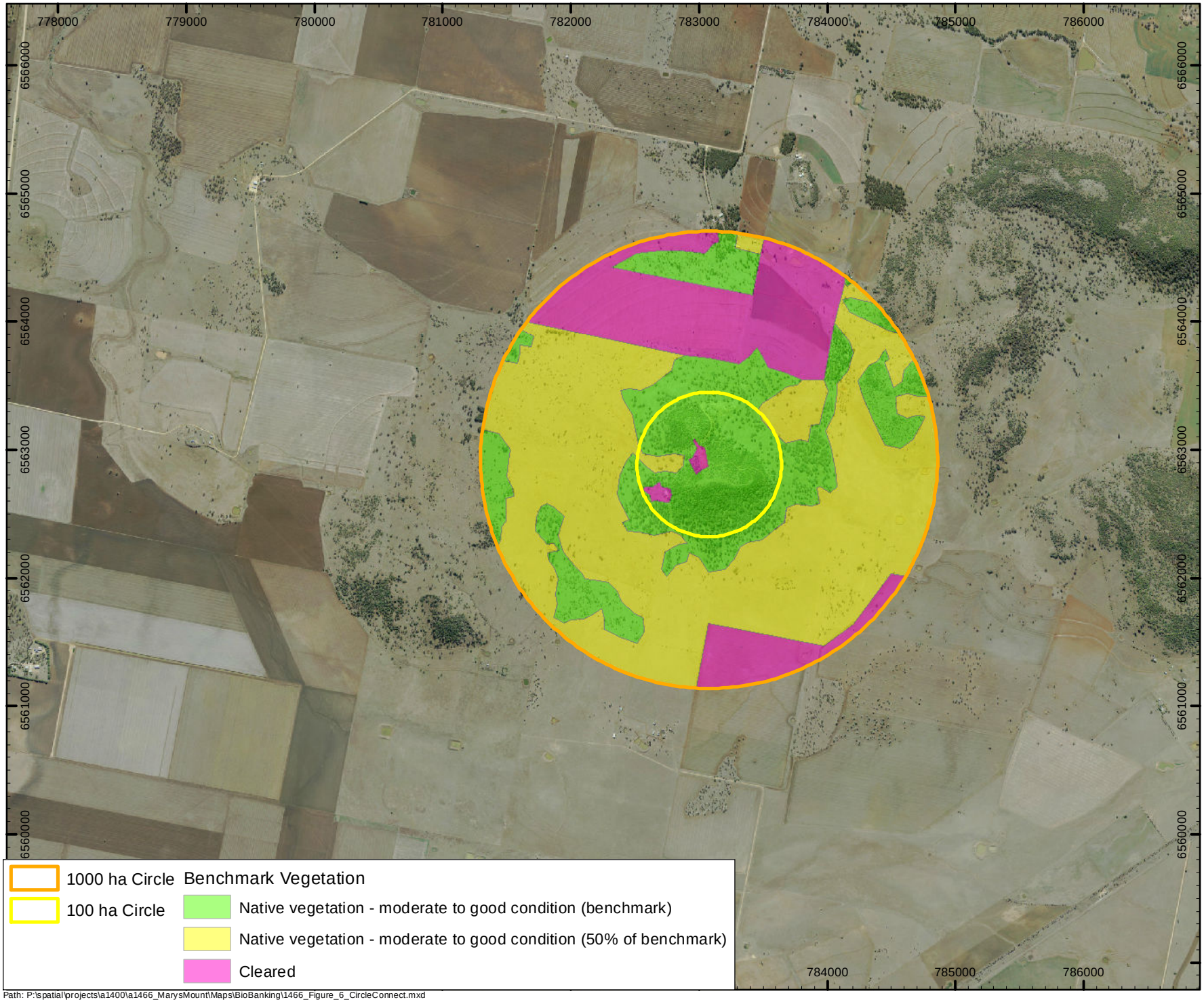

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Figure 6: Assessment Circles and Connectivity

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

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Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

Figure 7: Vegetation Zones

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

N
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Metres
0 50 100 150 200 250

niche Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

Path: P:\spatial\projects\a1400\a1466_MarysMount\Maps\BioBanking\1466_Figure_7_VegetationZones.mxd

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Figure 8: Plot Locations

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

N
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Metres
0 50 100 150 200

niche Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

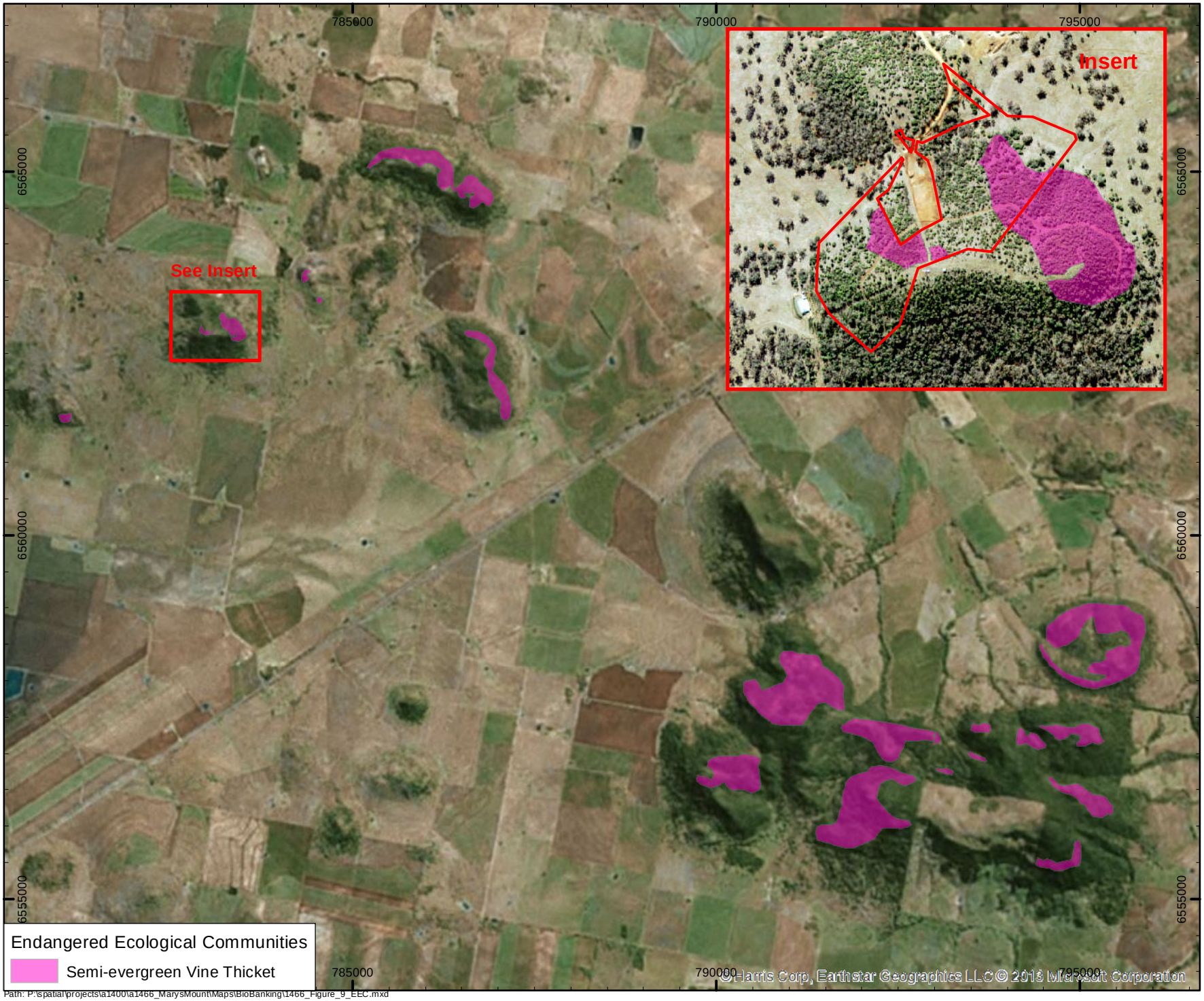

Figure 9: Endangered Ecological Communities

1466 Marys Mount Gravel Quarry
Lot 161 DP 755508

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

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Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI; Microsoft 2010

Path: P:\spatial\projects\a1400\a1466_MarysMount\Maps\BioBanking\1466_Figure_9_EEC.mxd

APPENDICIES

Appendix A: Biodiversity Inventory Report

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Environment and Heritage

BIODIVERSITY INVENTORY REPORT

Mary's Mount Blue Metal Gravel Quarry

April 2013

DOCUMENT CONTROL

Business unit	Niche Environment and Heritage, /Hunter Office		
Project no.	1415		
Document description	Biodiversity Inventory Report		
	Name	**Signed**	**Date**
Supervising manager(s)	Frank Lemckert		

Person managing this document	**Person(s) writing this document**
Mark Aitkens	Mark Aitkens and Matthew Stanton

Document revision no.	**Date prepared**	**Reviewed by**	**Date**
Rev0	18/04/2013	Rhidian Harrington	19/04/2013

Prepared for:	**Organisation**
	Gunnedah Quarry Products Pty Ltd PO Box 259 Gunnedah NSW 2380

Front cover photograph: Thick-tailed Gecko (*Underwoodisaurus milii*)

EXECUTIVE SUMMARY

Context

Niche Environment and Heritage Pty Ltd was commissioned by Gunnedah Quarry Products to conduct a targeted biodiversity survey of the proposed Marys Mount Blue Metal Quarry (the Project) to support additional assessments for this Project.

Aims

This survey aims to provide additional information on threatened biodiversity including those listed on the *Threatened Species Conservation Act* 1995 (TSC Act), as well as specified matters of national environmental significance (MNES) identified in Section 1 of the Department of Sustainability Environment Water Population and Communities (SEWPaC) letter dated 4/12/2012.

Methods

Targeted flora and fauna surveys were completed on 16-18 January 2013 and 4-8 March 2013. Methods included the use of BioMetric (Gibbons *et al*, 2009) to identify and analyse vegetation communities, condition and habitat quality. Systematic fauna survey methods were completed including spotlighting, habitat searches, camera traps, scat surveys, harp trapping and observation points. Methods and survey design followed the DEC (2004) survey guidelines.

Key Results – flora

One Commonwealth listed threatened grass species, Bi-lobed Bluegrass (*Bothriochloa biloba*), was observed within the study area outside the site boundary. Semi-evergreen Vine Thicket of the Brigalow (north and south) and Nandewar Bioregions endangered ecological community (EEC) was found within the site, with its extent quantified for the study area.

Key Results - fauna

The Koala (*Phascolarctos cinereus*), a threatened species listed as vulnerable under the NSW TSC Act and Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act), was common within the study area. An additional two TSC Act-listed species were recorded, including the Little Lorikeet (*Glossopsitta pusilla*) and Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*).

A fourth species, the Large-eared Pied Bat (*Chalinolobus dwyeri*), has possibly been recorded within the study area, although this recording was not verified by harp trapping results and there is no apparent roost habitat (caves) within the study area. The Rainbow Bee-eater (*Merops ornatus*) and Black-faced Monarch (*Monarcha melanopsis*), common migratory bird species listed under the EPBC Act, were also recorded.

Other target species such as the Superb Parrot (*Polytelis swainsonii*), Malleefowl (*Leipoa ocellata*) and Brush-tailed Rock Wallaby (*Petrogale penicillata*) were not found within the study area. These species are highly unlikely to occur within the study area as habitat suitability is considered very low to nil.

CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Gunnedah Quarry Products to conduct targeted surveys for threatened biodiversity for a study area located at Marys Mount, NSW. The targeted survey is to support the preparation of impact assessments for the Marys Mount Blue Metal Gravel Quarry (the Project).

1.1 Project location

The Project is located approximately 28 km west south west of Gunnedah, NSW (Figure 1). The Project comprises areas referred to as the 'site' and 'study area', as shown in Figure 2. These are described as follows:

- The Site is the area where direct impacts from the quarry are expected;
- The Study Area is the area including direct and indirect impacts and lands where mitigation/offsetting are proposed.

A summary of the major geographical features of the study area is presented in Table 1.

Table 1: Geographical context of the study area

Geographical Feature	Description
Bioregion	Brigalow Belt South
Catchment management authority	Namoi
Sub-catchment	Liverpool Plains Part B
Mitchell Landscape	Nombi Plateau and Pinnacles
Local government area	Gunnedah local government area
Watercourses	n/a
Nearby conservation areas	Pilliga Nature Reserve

The site is 14.6 hectares within a study area of approximately 367 hectares. The land is used primarily for agriculture (i.e. grazing) and extractive industries (i.e. gravel quarry). It is bounded by open grazing land with light timber cover in all directions (Figure 2).

The landscapes of the study area include open eucalypt woodlands dominated primarily by white box with varying understorey structure and plant composition. The steeper rocky slopes of east and south-east aspect, or other slopes with sheltered aspects, are characterised by closed shrublands grading to open shrublands comprising red gum mallee woodland on northern aspects of the exposed hilltops.

1.2 Legislative context

The following legislative context has been used to investigate and report on the biodiversity values of the study area:

- NSW *Threatened Species Conservation Act* 1995 (TSC Act);

- NSW State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44); and
- Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

This legislative context is outlined in the following sections.

1.2.1 TSC Act

The TSC Act provides legal status for biota of conservation significance in NSW. The Act aims to, *inter alia*, 'conserve biological diversity and promote ecologically sustainable development'. It provides for:

- The listing of 'threatened species, populations and ecological communities', with endangered species, populations and communities listed under Schedule 1, 'critically endangered' species and communities listed under Schedule 1A, and vulnerable species and communities listed under Schedule 2;
- The listing of 'Key Threatening Processes' (under Schedule 3);
- The preparation and implementation of Recovery Plans and Threat Abatement Plans; and
- Requirements, or otherwise, for the preparation of a Species Impact Statement (SIS).

Threatened species, populations and ecological communities listings are relevant to this report.

1.2.2 SEPP 44

SEPP 44 aims to encourage the 'proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline'. SEPP 44 contains matters for consent authorities to consider in the assessment of impacts on koalas for development proposals subject to Part 4 of the *Environmental Planning and Assessment Act* 1979 (EP&A Act).

The results of the targeted surveys and analysis from this study would be used in the preparation of a site specific Koala Plan of Management, as the site contains core Koala habitat.

1.2.3 EPBC Act

The purpose of the EPBC Act is to ensure that actions likely to cause a significant impact on 'matters of national environmental significance' undergo an assessment and approval process. Under the EPBC Act, an action includes a project, undertaking, development or activity. An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities (SEWPaC).

The EPBC Act identifies matters of national environmental significance (MNES) as:

- World heritage properties;

- National heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

The Project is deemed a controlled action (ref: 2012/ 6603) under Section 75 and Section 87 of the EPBC Act, with the relevant controlling provisions being *listed threatened species and communities* (sections 18 & 18A). The decision on the assessment approach is preliminary documentation. A request for additional information is provided in the Department of Sustainability, Environment, Water, Population and Communities' (SEWPaC) letter dated 4/12/2012, which states:

> 1. Detailed, on ground, flora and fauna surveys targeting EPBC Act listed threatened species and ecological communities, especially:
>
> 1.1 Assessment of the vegetation within and around the proposed quarry site, including proposed new road alignment, against the condition criteria and species lists for the EPBC Act listed ecological communities with specific reference to White Box – Yellow Box – Blakely's Red Gum Woodland and derived Native Grasslands.
>
> 1.2 Habitat and population surveys for the Koala (*Phascolarctos cinereus*) (combined populations of Qld, NSW and the ACT) in and around the proposed quarry site.
>
> 1.3 Habitat surveys and a robust assessment of the likely presence of the following threatened species:
>
> - Malleefowl (*Leipoa ocellata*) – Vulnerable
>
> - Superb Parrot (*Polytelis swainsonii*) – Vulnerable
>
> - Brush-tailed Rock Wallaby (*Petrogale pencillata*) – Vulnerable

1.3 Purpose of this report

This report has focused on the reporting of field survey results and data analysis for threatened species, populations and ecological communities listed on the TSC and/ or EPBC Act. No assessments pursuant to these Acts are provided. The findings presented in this report are to support the preparation of impact assessments and management plans for the Project, namely:

- BioBanking assessment;
- Koala Plan of Management; and
- EPBC Act controlled action.

Surveys have targeted threatened biodiversity listed on the TSC Act and matters of national environmental significance (MNES) listed under the EPBC Act.

1.4 Investigation scope

The targeted field survey was to provide information for matters identified in Section 1.3. This involved the completion of the following tasks:

- Review of relevant data and reports;
- Completion of targeted field surveys by experienced and recognised ecologists;
- Data analysis to examine the extent of habitat for listed threatened species, populations and ecological communities, if present;
- Preparation of an inventory report describing the biodiversity characteristics of the study area (this document); and
- Robust assessment of the likely presence of State and Commonwealth listed threatened species, populations and ecological communities.

2 METHODS

2.1 Survey guidelines

Survey methods used in this investigation were based on the following:

- ❒ OEH Draft Threatened Biodiversity Survey and Assessment Guidelines (DEC 2004); and
- ❒ An operational method to assess impacts of land clearing on terrestrial biodiversity (BioMetric) (Gibbons *et al*, 2009).

Some methods have been varied, where necessary, to suit species, populations and communities identified as relevant to the Project.

2.2 Literature and database review

2.2.1 Databases

Relevant databases were reviewed prior to field survey to identify data gaps and inform survey design. Database searches for a 10 km radius around the study area were conducted in January 2013 to identify threatened biodiversity and migratory species with known occurrences in the locality. The following databases were used for this purpose:

- ❒ OEH Atlas of NSW Wildlife (OEH, 2013); and
- ❒ EPBC Act Protected Matters Search Tool (SEWPaC, 2013).

2.2.2 Regional vegetation mapping

Native vegetation mapping of the region was reviewed to provide broad context for the vegetation type(s) that may be expected to occur within the study area. The vegetation types mapped by ELA (2007) for the study area are provided in Table 2.

Table 2: Regional vegetation communities within the study area (ELA, 2007)

Regional Vegetation Community (ELA, 2007)	TECs[1]
White Cypress Pine - White Box - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion	no
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	yes
Derived grasslands, Brigalow Belt South and Nandewar	no

1. Threatened ecological communities (TECs): critically endangered ecological Community (CEEC); endangered ecological community (EEC) listed under the TSC Act and/or EPBC Act

2.3 Survey stratification

Survey stratification units were derived from aerial photography interpretation, regional vegetation mapping and site inspection and used to aid survey design and effort. Survey stratification units were digitised into a GIS and codified with notional descriptors such as:

- Overstorey dominants (e.g. white box);
- Overstorey structure (e.g. woodland, open woodland, shrubland).

Flora and fauna survey effort, which is described in the following sections, biased the investigation of vegetation cover contained within the site.

2.4 Vegetation survey methods

A combination of survey methods including flora plots, BioMetric plots (Gibbons *et al* 2009) and random meanders were used to sample the native vegetation of the study area. These are discussed as follows.

2.4.1 Flora plots

Flora plots measuring 400 m^2 (i.e. 20 x 20 metre quadrat) were used to aid vegetation classification and descriptions for vegetation mapped within the study area. Data collections in accord with the a modified Braun-Blanquet cover abundance scale; a scale designed to measure plant species relative abundance. The modified Braun-Blanquet cover abundance scale was used in this survey, as follows:

1. 1-5% rare.
2. 1-5% common.
3. 6-25% cover.
4. 26-50% cover.
5. 51-75% cover.
6. 76-100% cover.

Modified Braun-Blanquet scores were estimated for each observed plant species within the flora plot, which was nested within the larger BioMetric plot (see below).

2.4.2 BioMetric plots

BioMetric plots measuring 1000 m^2 (i.e. 20 x 50 metres) were used to sample vegetation structure and habitat in accordance with the method described by Gibbons *et al* (2009). The BioMetric plot provides an objective standardised approach to the characterisation of bio-condition and is a method compatible with the NSW BioBanking Methodology.

Bio-condition is assessed by comparing measured site attribute scores (see below) against published 'vegetation benchmarks' for each vegetation type:

- Native plant species richness (NPS);
- Native overstorey cover (NOC);
- Native mid-storey cover (NMS);
- Native groundcover stratum grasses (NGSG);
- Native groundcover stratum shrubs (NGSS);
- Native groundcover other (NGSO);
- Exotic plant cover (EPC);
- Number of trees with hollows (NTH);
- Overstorey regeneration (OR); and
- Total length of fallen logs (FL).

Vegetation benchmarks are quantitative measures of the expected variability in vegetation condition that once occurred prior to habitat modification by humans since European settlement (post 1750).

2.4.3 Random meander

A random meander survey following DEC (2004) was conducted targeting threatened plant species within habitat areas deemed suitable for those species to determine presence and abundance. A random meander allows optimal coverage of the study area and target species. Observed threatened plants were marked by GPS and a population count conducted.

2.5 Fauna survey methods

2.5.1 Review of existing information

Aerial photography and available vegetation mapping was examined prior to survey to identify potential vegetation communities, habitat types for fauna and determine stratification units for survey design. Five dominant habitat classes were found to occur within the study area comprising open grassy White Box woodland, shrubby White Box woodland, White Box with well developed dry rainforest midstorey, red gum mallee/woodland and semi-evergreen vine thicket.

2.5.2 Threatened fauna

Field surveys were undertaken on 16-18 January 2013 and 4-8 March 2013.

The survey design for the January visit targeted four threatened species previously found within 30 km of the study area and identified by SEWPaC as having a reasonable chance of occurring. Field surveys incorporated targeted survey using established survey techniques, opportunistic observations and habitat assessment. Survey procedures are presented in Table 3 and were based upon the OEH *Draft Threatened Biodiversity Survey and Assessment Guidelines* (DEC 2004).

The surveys in March were targeted at a wider suite of threatened fauna, including all those scheduled under the TSC Act and known to occur within 10 km of the site or that were known to occur in similar habitat from further afield.

Table 3: Targeted fauna survey methods

Method	Details
Spotlighting	Spotlighting surveys for Koalas, other mammals, birds, reptiles and frogs were performed mostly on foot or opportunistically from a vehicle along roads and tracks.
Koala scat searches	45 minute (minimum), two hectare (minimum) searches were conducted at seven locations within identified Koala habitat as judged by the presence of known feed tree species (mostly *Eucalyptus nandewarica*, other red gums, *E. albens* and *E. populnea*) and trees suitable for shelter (*Callitris glaucophylla* and tall dense shrubs such as *Geijera parviflora*). At least 30 trees were searched. Each tree was examined for scratches and a scat search was performed for at least one minute around the base and under the tree canopy.
Rock Wallaby scat and habitat search	The presence of likely rock wallaby habitat was assessed by walking over the site and searching for potential shelter sites and forage areas. Areas with suitable habitat were searched for signs of rock wallaby presence, particularly for their distinctive scats and suitable shelter sites.
Infra-red and daylight-light camera traps	20 motion sensing camera traps were deployed using the following strategies: Target species – Brush-tailed Rock Wallaby. Cameras placed knee high along identified macropod trackways in suitable rocky habitat. Target species – Black striped Wallaby, Rufous Bettong. Cameras placed knee high along identified macropod trackways leading from cover to well grassed areas and near holes through fences. Target species – Tiger or Spotted-tailed Quoll, Brush-tailed Phascogale. Cameras were baited with a poultry-based lure. Squirrel Glider. Cameras were baited with a honey-based lure placed on tree trunks within frame. Upon recovery, the pictures were individually analysed and animals were identified to species level.
Diurnal bird surveys	Timed (20 minute) point surveys for birds within each stratification unit were completed in the January survey. Diurnal birds were opportunistically observed and noted throughout the eight survey days.
Herpetological surveys	Herpetological surveys were included opportunistically during spotlighting and diurnal survey activities.
Bat Harp Trap survey	Insectivorous bats were targeted at five trap locations over four nights in March. This method is ideal for bat species that cannot be differentiated by acoustic survey methods.
Acoustic Bat survey	Insectivorous bats were recorded at five locations over four nights in March. 'SongMeter 2 Bat' recorders (Wildlife Acoustics, USA) were used to record at 192 kHz sample rate. The audio files were then post processed using 'Kaleidoscope' software (Wildlife Acoustics, USA) to generate zero crossings files compatible with ANALOOK software (Chris Corben). Individual calls were parsed in ANALOOKW to find calls with characteristic frequencies of threatened bats.

2.5.3 Habitat assessment

Habitat assessments were conducted along each transect and wherever vegetation structure or floristic qualities were unique within the study area. Habitat characteristics and parameters that were assessed included:

- Aspect/slope of the site;
- Dominant vegetation, floristic composition and structure;
- Composition of ground layer (bare earth, litter etc.);
- Presence and relative abundance of key habitat features (e.g. tree hollows, large logs, exfoliating rock, flowering resources, aquatic features);
- Condition and disturbance factors; and
- Vegetation age structure.

2.6 Nomenclature

2.6.1 Plant taxonomy

Plant taxonomy used was consistent with the nomenclature of the *Flora of NSW* (Harden 1990-1993; 2002), except where more recent revisions have been published in recognised

scientific journals and accepted by the National Herbarium of New South Wales (as per their PlantNet web site http://plantnet.rbgsyd.nsw.gov.au/).

2.6.2 Vegetation types

The assigning of NSW Vegetation Types to vegetation cover mapped within the study area was in accordance with the NSW Vegetation Types Database (OEH, 2012). Published scientific literature, where available, was used to aid in the interpretation of this database (e.g. referenced source documents).

2.6.3 Fauna taxonomy

Taxonomy and common names of fauna in this report were from the following sources.

Mammals: Menkhorst and Knight (2010), A Field Guide to the Mammals of Australia; Churchill (2008), Australian Bats; and Pennay *et al*. (2004), Bat calls of New South Wales: Region based guide to the ecolocation calls of Microchiroteran bats).

Birds: Christidis and Boles (2008), Systematics and Taxonomy of Australian Birds.

Reptiles: Wilson and Swan (2010), A Complete Guide to Reptiles of Australia.

Frogs: Tyler and Knight (2009), Field Guide to the Frogs of Australia.

2.7 Survey effort

2.7.1 Vegetation surveys

Table 4 details the flora survey effort expended in this investigation. Survey locations are shown in Figure 4 including reference to survey stratification units.

Table 4: Flora and BioMetric plots per stratification unit

Stratification Unit	Area (ha)	Plots Completed
White box woodland	56.59	7
White box open woodland	101.86	3
White box derived grassland	229.24	0
Red gum open woodland	20.92	3
Red gum derived grassland	1.44	1
Open shrubland	6.29	2
Closed shrubland	9.08	2
Poplar Box Open Woodland	2.61	1

A minimum 2 hour random meander was expended in each stratification unit contained within the site to investigate suitable habitat for threatened flora species (i.e. targeted surveys).

2.7.2 Fauna surveys

Table 5 details the fauna survey effort expended in this investigation. Survey locations are shown against vegetation type in Figure 5.

Table 5: Fauna survey effort within the study area

Date	Bat Harp Traps	Spotlight (hours)	Koala Scat Search (hours)	Rock Wallaby Scat Search (hours)	Infra Red Camera Traps (cameras/night)
16/01/2013		8		2	4
17/01/2013		8	5		4
18/01/2013			2	1	
04/03/2013	Site 1, 2, 3	8			16
05/03/2013	Site 1, 2, 3	16	4		16
06/03/2013	Site 2, 4, 5	12	4		16
07/03/2013	Site 2, 4, 5	1	4		16
08/03/2013	Trapping concluded		4		Trapping concluded

Spotlighting effort was directed based on vegetation types with all of the sites and the majority of the woody parts of the study area being covered.

2.8 Data analysis

2.8.1 Vegetation typing

A standardised classification for the vegetation cover of stratification units sampled within the study area was based on comparisons with published descriptions provided in the NSW Vegetation Types database (OEH, 2012). This database was developed for each of the 13 catchment management authority (CMA) areas with most of the vegetation types comprising original vegetation types (i.e. pre-1750).

Each vegetation type is defined for field identification purposes on the basis of the following attributes, where relevant:

- Dominant canopy species;
- Main associated species;
- Landscape position;
- Characteristic mid-storey species;
- Characteristic groundcover species; and
- Other diagnostic features.

Published local and regional vegetation mapping was used where appropriate to assist the classification of native vegetation cover within the study area.

2.8.2 Vegetation benchmarks

Site attribute scores, as collected from the BioMetric plots sampled from within the study area, were compared with relevant published vegetation benchmarks for the CMA that the study area occurs within. Terms such as 'within benchmark' or below benchmark may be used to qualify these comparisons and may be used to understand bio-condition relative to pre-European settlement.

Where appropriate vegetation benchmark comparisons were also used to validate vegetation type classifications. This validation process may be useful in circumstances

where disturbance, for example, has substantially altered vegetation structure and relative cover abundance of characteristic plant species.

2.8.3 Identification of threatened ecological communities

The following documents were used to assess for the presence of listed threatened ecological communities (TECs) within the study area:

- Commonwealth listing advice and conservation advice on White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (TSSC, 2006a);
- EPBC Act policy statement 3.5 - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (TSSC, 2006b);
- Species list for the EPBC Act policy statement 3.5 - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (TSSC, 2006c);
- Commonwealth listing advice on Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions; and
- National Recovery Plan for the Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions ecological community.

2.8.4 Threatened species likelihood of occurrence

The appropriate level of assessment that is likely to apply to the specified species and communities has been determined by analysing their likelihood of occurrence within the study area. Five categories for 'likelihood of occurrence' may be attributed to the specified species and communities after considering the following:

- Number and proximity of known records;
- Presence or absence of important habitat features;
- Mobility of the species;
- Results of field surveys; and
- Professional judgement.

The categories for 'likelihood of occurrence' are outlined in Table 6.

Table 6: Likelihood of occurrence criteria

Likelihood rating	Threatened Flora/EEC Criteria	Threatened and Migratory Fauna Criteria
Known	The species/EEC was recorded within the study area during the field surveys.	The species was observed within the study area.
High	It is likely that a species/EEC inhabits or utilises habitat within the study area for one or more of the following reasons: ❒ preferred habitat present and is in good condition ❒ there is a high number of records of the species within the locality.	It is likely that a species inhabits or utilises habitat within the study area for one or more of the following reasons: ❒ preferred habitat present and is in good condition ❒ breeding or limiting foraging habitat is present in the study area ❒ species is dependant on habitat within the study area on a permanent or seasonal basis ❒ there is a high number of records of the species within the locality.
Moderate	It is possible that a species/EEC inhabits or utilises habitat within the study area for one or more of the following reasons: ❒ habitat for a species/EEC occurs on the site but is in a disturbed condition ❒ some records for the species occur within the locality ❒ species is cryptic and was not seasonally targeted.	It is possible that a species inhabits or utilises habitat within the study area for one or more of the following reasons: ❒ habitat for a species occurs on the site and the species may occasionally utilise that habitat ❒ species unlikely to be wholly dependent on habitat present within the study area ❒ species was not seasonally targeted and surveys were limited to opportunistic observations and habitat assessment ❒ some records for the species occur within the locality.
Low	It is unlikely that the species/EEC inhabits the study area for one or more of the following reasons: ❒ preferred habitat for the species is not present ❒ there are limited records of the species in the locality ❒ non-cryptic species that was not recorded during targeted field surveys.	It is unlikely that the species inhabits the study area for one or more of the following reasons: ❒ preferred habitat for the species is not present ❒ if present within the study area the species would likely be a transient visitor ❒ the study area contains only very common habitat for this species which the species does not rely on for its ongoing local existence ❒ there are limited records of the species in the locality.
None	The species/EEC is not considered to be present within the study area for one or more of the following reasons: ❒ the habitat within the study area is unsuitable for the species/EEC ❒ the species/EEC has not been recorded previously in the locality ❒ The study area is beyond the known limit of the species distribution.	The species is not considered to be present within the study area for one or more of the following reasons: ❒ the habitat within the study area is unsuitable for the species ❒ the species has not been recorded previously in the locality ❒ The study area is beyond the known limit of the species distribution.

Species identified as having a 'moderate' to 'known' likelihood of occurrence are considered relevant to the Project.

2.9 Limitations

2.9.1 Survey methods

Survey methods prescribed in the OEH *Draft Threatened Biodiversity Survey and Assessment Guidelines* (DEC 2004) were not used for some species groups, when threatened species or their habitats from that group are unlikely to occur within the site or study area.

2.9.2 Survey stratification

'Survey stratification units' represent a preliminary mapping scheme based on available and relevant desktop information. This information has been used to aid the design of detailed field survey investigations, including the selection of survey methods and proportioning of survey effort. A site inspection is conducted, where possible, to increase the accuracy of survey stratification mapping that may otherwise be limited by the available spatial datasets (e.g. small scale regional mapping and imagery resolution/age).

2.9.3 Plant and animal detection

Numerous threatened plant and animal species are cryptic or difficult to detect. Consequently negative survey results, no matter how extensive the survey design and effort, do not necessarily indicate species absence. For instance, some cryptic plant species are more easily detected at certain times of the year, such as during flowering events. Some fauna can only be detected during certain seasons (e.g. migration patterns or intra-torpor periods).

Species that are difficult to detect have been targeted, where possible, using appropriate survey methods, effort and timing. These species have also been considered on the basis of habitat suitability. Habitat assessments are conservative and default to *assumed presence* where there is insufficient scientific knowledge to determine otherwise. Assumed presence of a species dictates inclusion within the assessment process.

2.9.4 Taxonomy

Red gum variation was observed within the study area with at least one taxa identified (i.e. Tumbledown Red Gum *Eucalyptus dealbata*). Eucalypt variation is not unusual as many species are known to hybridise or show introgression (i.e. repeated backcrossing of an interspecific hybrid and one of its parent species). Consequently, there is the possibility that similar red gum taxon such as *Eucalyptus dwyeri* and/or *Eucalyptus nandewarica* could occur within the study area or, at the very least, have genetic influence in the red gums observed within the study area.

Due to survey timing it was not possible to determine if this variation could be ascribed to more than one species (i.e. flowering material required to differentiate between red gum species). Surveys designed to examine red gum variation in accordance with prescribed taxonomic keys have not been undertaken and are not warranted for the following reasons:

- None of the potential alternative taxa are listed as threatened; and
- Vegetation typing in accordance with OEH (2012) would not be influenced by further taxonomic differentiation.

Notwithstanding, taxonomic differentiation may be of interest when considering Koala habitat. In this respect it is noted that none of the above listed species are listed as feed tree species on schedule 2 of SEPP 44. However, all are listed as secondary Koala food trees for NSW (DECC, 2007). Accordingly, in this assessment all references to tumbledown red gum include the observed red gum variation, which may implicate occurrences of *Eucalyptus dwyeri*, *Eucalyptus nandewarica* and/or genetic influence from these species with known tumbledown red gum occurrence within the study area.

3 RESULTS

3.1 Weather conditions

Field surveys were conducted during 16-18 January 2013 and 4-8 March 2013. Weather conditions during the January survey period were hot with some windy periods, while the March survey experienced milder conditions. The survey period followed a moderately dry spring/summer period. Bureau of Meteorology records from Gunnedah, NSW are presented in Table 7.

Table 7: Weather conditions at Gunnedah

Date	Day	Temperature		Rain	9:00 AM					3:00 PM				
		Min	Max		Temp	Humidity	Cld	Dir	Spd	Temp	RH	Cld	Dir	Spd
		°C	°C	mm	°C	%	8th	km/h		°C	%	8th	km/h	
Jan-16	We	-	35.2	0	-	-	-	-	-	33.5	29	0	W	11
Jan-17	Th	20.9	38.3	0	29.4	36	0	NNW	6	36.4	23	0	NNW	15
Jan-18	Fr	21.2	41.9	0	31.8	31	0	NNW	19	41.0	17	0	NNW	19
Mar-04	Mo	18.0	28.6	0	21.4	68	3	SSE	28	27.4	46	0	SE	22
Mar-05	Tu	16.3	28.4	0	20.6	71	5	SSE	20	27.3	43	0	E	22
Mar-06	We	14.6	28.6	0	19.5	72	2	SE	19	27.6	39	0	ESE	13
Mar-07	Th	14.9	28.3	0	20.8	67	1	ESE	13	27.3	42	0	ESE	15
Mar-08	Fr	15.3	29.0	0	20.1	69	4	SE	15	27.7	36	0	E	9

The January hot weather conditions were considered suboptimal for the detection of bird and amphibian species. Conditions were appropriate for the detection of reptiles, mammals and some frog species (i.e. nocturnal foraging activity).

3.2 Survey Stratification

Survey stratification units delineated for this investigation are mapped in Figure 3 and are as follows:

- White box woodland;
- White box open woodland;
- White box derived grassland;
- Red gum open woodland;
- Red gum derived grassland;
- Open shrubland;
- Closed shrubland;
- Poplar box open woodland; and
- Western rosewood open shrubland.

3.3 Database searches

The following threatened species have previously been recorded within the Marys Mount locality (OEH, 2013):

- Lobed Bluegrass (*Bothriochloa biloba*) Vulnerable Species or species habitat known to occur;
- Ooline (*Cadellia pentastylis*) Vulnerable Species or species habitat likely to occur;
- *Dichanthium setosum* Vulnerable Species or species habitat likely to occur;
- Finger Panic Grass (*Digitaria porrecta*) Endangered Species or species habitat may occur;
- *Euphrasia arguta* Critically Endangered Species or species habitat may occur;
- *Hakea pulvinifera* Endangered Species or species habitat known to occur;
- *Homopholis belsonii* Vulnerable Species or species habitat may occur;
- *Philotheca ericifolia* Vulnerable Species or species habitat likely to occur;
- a leek-orchid (*Prasophyllum* sp. Wybong (C.Phelps ORG 5269)) Critically Endangered Species or species habitat likely to occur;
- Cobar Greenhood Orchid (*Pterostylis cobarensis*) Vulnerable Species or species habitat likely to occur;
- *Rulingia procumbens* Vulnerable Species or species habitat likely to occur;
- Slender Darling-pea (*Swainsona murrayana*) Vulnerable Species or species habitat likely to occur;
- Austral Toadflax (*Thesium australe*) Vulnerable Species or species habitat likely to occur; and
- *Tylophora linearis* Endangered Species or species habitat known to occur.

3.4 Vegetation communities

Plot data was used to prepare a vegetation map (Figure 6) and descriptions including floristic composition and condition. Equivalent NSW Vegetation Types were identified from the NSW Vegetation Types Database (OEH, 2012) as outlined in Table 8.

Table 8: Equivalent NSW Vegetation Types

Stratification Unit	NSW Vegetation Type (OEH, 2012)
White box woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]
White box open woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]
White box derived grassland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]
Red gum open woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225] – red gum variant
Red gum derived grassland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225] – red gum variant
Open shrubland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225] – red gum variant
Closed shrubland	Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) [NA199]
Poplar Box Open Woodland	Poplar Box grassy woodland on alluvial heavy clay soils in the Brigalow Belt South Bioregion (Benson 101) [NA185]
Western rosewood open shrubland	Wilga - Western Rosewood shrubland of the tropical sub-humid climate zone Brigalow Belt South and Darling Riverine Plains Bioregions (Benson 145) [NA235]

Floristic descriptions are provided in Section 3.4.1 for vegetation types occurring within the site:

- White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]; and
- Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) [NA199].

Two mapped vegetation types not described in this report, as they occur outside the site, include:

- Wilga - Western Rosewood shrubland of the tropical sub-humid climate zone Brigalow Belt South and Darling Riverine Plains Bioregions (Benson 145) [NA235]; and
- Poplar Box grassy woodland on alluvial heavy clay soils in the Brigalow Belt South Bioregion (Benson 101) [NA185].

The occurrence of *White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions* [NA226] has not been investigated in this report as it has not been found to occur within the site. The occurrence of threatened ecological communities within the site is discussed in Section 4.

3.4.1 NSW Vegetation Types

The spatial extents of the NSW Vegetation Types identified within the study area are provided in Table 9. Spatial extents for NA225 and NA199 within the site, according to structural and floristic differences, are provided in Table 10.

Table 9: Spatial extent of NSW Vegetation Types within the study area

NSW Vegetation Type (OEH, 2012)	Grassland (ha)	Shrubland (ha)	Open woodland (ha)	Woodland (ha)	Total (ha)
White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]	73.06	0	83.40	62.96	**220.83**
White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225] red gum variant	1.08	0	22.68	0	**22.36**
Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) [NA199]	0	9.92	0	0	**9.92**
Poplar Box grassy woodland on alluvial heavy clay soils in the Brigalow Belt South Bioregion (Benson 101) [NA185]	11.34	0	2.62	0	**13.96**
Wilga - Western Rosewood shrubland of the tropical sub-humid climate zone Brigalow Belt South and Darling Riverine Plains Bioregions (Benson 145) [NA235]	0	93.40	0	0	**93.40**
Total	**85.48**	**103.32**	**108.7**	**62.96**	**360.46**

Table 10: NSW Vegetation Types, structure and floristics within the site

NSW Vegetation Type (OEH, 2012)	Grassland (ha)	Shrubland (ha)	Open woodland (ha)	Woodland (ha)	Total (ha)
White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]	0	0	1.86	5.76	**7.62**
White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225] red gum variant	0	0	3.81	0	**3.81**
Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) [NA199]	0	3.17	0	0	**3.17**

The following descriptions are for NSW Vegetation Types mapped within the site.

White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]

(plots: 1,2,3,4,5,6,13,17,18,19)

Woodlands almost solely dominated by white box occur throughout the site and study area with 'shrubby' and 'grassy' variants observed. Vegetation with a shrubby understorey was found on the steeper slopes of Melville Hill where exposed basalt and shallow weathered basalt soils prevail. The shrubby variant contains white cypress pine (*Callitris glaucophylla*) as a canopy associate and understory comprising sticky hopbush (*Dodonaea viscosa*), blackthorn (*Bursaria spinosa*) and mock olive (*Notelaea microcarpa)*. Grassy tussocks characterise the groundcover stratum including

snow grass (*Poa sieberiana*), barbed wire grass (*Cymbopogon refractus*) and wallaby grass (*Rytidoperma* spp.).

The shrubbier woodlands abruptly transition into a grassy variant on the lower gentler slopes where less exposed basalt rock and increased soil depth was observed. The abrupt transition, as shown in the photograph opposite, coincides with increased agricultural suitability which may in part be responsible for the abruptness of the observed change in vegetation structure. Flora plot data show limited change in plant species composition between shrubby and grassy variants, although there were clear differences in the relative cover abundance between shrub and grass species. Despite agricultural activity, plot data indicates a weed cover consistently below 2%. Table 11 provides details on the character of this vegetation type within the study area.

Table 11: Structure and composition of white box dominated woodlands

Strata	Form	Height Range (m)	% Cover	Dominant Species
Over-storey	Trees	12-18	5-10	*Eucalyptus albens, Callitris glaucophylla*
Mid	Shrubs	4 - 6	5-10	*Eucalyptus albens* (juvenile), *Alectryon oleifolius, Notelaea microcarpa, Geijera parviflora, Dodonaea viscosa* (per cent cover higher in shrubby variant where the latter three species are dominant)
Groundcover	Shrubs	0 - 1	0-10	*Jasminum lineare, Abutilon oxycarpum, Solanum parvifolium*
Groundcover	Herbs/Grasses	0 - 0.5	5-70	*Aristida vagans, Boehavia dominii, Rumex brownii, Glycine tabacina, Einadia nutans, Dichondra repens, Chloris ventricosa, Austrostipa scabra*

White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions – Red Gum variant [NA225]

(plots: 9, 11, 12, 14, 15)

Scattered occurrences of white cypress pine and tumbledown red gum (*Eucalyptus dealbata*) form an open woodland structure on the upper slopes and crest of Melville Hill. The occurrence of this vegetation is restricted to north and west facing slopes where these canopy species emerge above an open shrubland structure. Structural and floristic variation was observed throughout this vegetation suggesting a broad transition between adjacent white box woodlands and SEVT. Weeds were present throughout, particularly near disturbed edges, and included *Zinnia peruviana* and Cobblers Pegs (*Bidens pilosa*). Table 12 provides details on the character of this vegetation type within the study area.

Table 12: Structure and composition of red gum dominated woodlands

Strata	Form	Height Range (m)	% Cover	Dominant Species
Over-storey	Trees	12-18	5-10	*Eucalyptus dealbata, Callitris glaucophylla*
Mid	Shrubs	4 - 6	5-10	*Notelaea microcarpa, Geijera parviflora, Dodonaea viscosa*
Groundcover	Shrubs	0 - 1	0-10	*Jasminum lineare, Abutilon oxycarpum, Solanum parvifolium*
Groundcover	Herbs/Grasses	0 - 0.5	5-70	*Aristida vagans, Boehavia dominii, Rumex brownii, Glycine tabacina, Einadia nutans, Dichondra repens, Chloris ventricosa, Austrostipa scabra*

Vegetation dominated by tumbledown red gum within the study area has been merged with the *White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]* vegetation type for the following reasons:

- ❒ No equivalent NSW Vegetation Type currently exists for this vegetation; and
- ❒ NA225 is the closest description for this vegetation.

A future proposed plant community type known as *Cypress Pine - Tumbledown Red Gum - Red Ash low open woodland on rocky hills in the Nandewar and Brigalow Belt South Bioregions* (Benson *et al*, 2010) closely resembles the above description. This plant community is described as occurring on the 'jump up hills' of the Mullaley district (i.e. Garawilla volcanics), which the study area is located within.

Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) (SEVT) [NA199]

(plots: 7, 10, 16)

Shrublands dominated by mock olive and peach bush (*Ehretia membranifolia*) occur on the north and east facing rocky basalt scree slopes with skeletal red soils. A closed shrub canopy cover was found on the sheltered east facing slopes, differing substantially to the scattered shrub canopies observed on the exposed north facing slopes. The occurrence of dense vine growth of wonga vine (*Pandorea pandorea*) and gargaloo (*Parsonsia eucalyptophylla*) that extend into the overstorey canopy are restricted to this vegetation.

Table 13 provides details on the character of this vegetation type within the study area.

Table 13: Structure and composition of SEVT

Strata	Form	Height Range (m)	% Cover	Dominant Species
Over-storey	Shrubs	4 - 6	60	*Ehretia membranifolia, Notelaea microcarpa, Alphitonia excela, Geijera parviflora*
Mid	Vines	1 - 6	< 5	*Parsonsia eucalytophylla, Pandorea pandorana.*
Groundcover	Shrubs	0 - 2	< 5	*Breynea oblongifolia, Beyeria viscosa, Solanum parvifolium, Einadia hastata, Capparis mitchelii*
Groundcover	Herbs/Grasses	0 - 0.5	25	*Cymbopogon refractus, Boerhavia dominii,, Austrostipa verticillata*

3.4.2 Vegetation condition

White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions [NA225]

Table 14 details the site attribute scores for BioMetric plots in mapped areas of NA225. Benchmark data for NA225 is provided for comparative purposes, as is benchmark data for NA226 (White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions).

Table 14: BioMetric plot data for NA225 – white box woodlands

Plot	NSW Vegetation Type	Site Attribute Score										Easting	Northing
		NPS	NOC (%)	NMS (%)	NGSG (%)	NGSS (%)	NGSO (%)	EPC (%)	NTH	OR	FL (m)		
1	NA225 'grassy'	18	7.5	0	62	2	10	0	8	0	11	782474	6562901
2	NA225 'grassy'	23	7	0.1	58	2	8	0	2	0	10	782718	6563414
3	NA225 'shrubby'	17	5.5	4.7	6	2	2	0	3	0	12	782778	6563116
4	NA225 'grassy'	24	5	8.5	34	2	12	0	0	0	0	783570	6562850
5	NA225 'shrubby'	20	9	32	2	2	0	0	2	0	22	783131	6563051
6	NA225 'grassy'	27	9	0.5	76	8	12	2	1	0	6	783533	6562908
13	NA225 'shrubby'	21	6.5	13.5	62	2	16	0	1	0.5	12	782977	6562651
17	NA225 'grassy'	22	7.5	12	58	2	2	24	0	0	2	782872	6562859
18	NA225 'shrub/grass'	32	13	16.5	34	12	22	2	1	1	18	782811	6562500
19	NA225 'shrub/grass'	38	9.5	10	40	4	10	0	1	0	16	782875	6562554
-	NA225[1] Benchmark	26	6-25	6-25	20-30	3-10	3-5	0	1	1	15	-	-
-	NA226[2] Benchmark	23	6-25	0-5	30-40	0	3-5	0	1	1	30	-	-

BioMetric plot data for both grassy and shrubby variants is consistently near or within benchmark condition[2] for the following site attribute scores:

- ❒ Native over storey cover;
- ❒ Native ground stratum – shrubs;

[1] White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions

[2] White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions

- ❒ Exotic plant cover;
- ❒ Number of tree hollows; and
- ❒ Fallen log length.

Substantial variation in vegetation structure was observed between the 'shrubby' and 'grassy' white box woodland variants. BioMetric plot data is consistently outside benchmark condition for the site attribute scores:

- ❒ Native plant species richness;
- ❒ Native mid storey stratum;
- ❒ Native groundcover stratum – grasses; and
- ❒ Native groundcover stratum – other.

Land use practices and local environmental conditions (e.g. rockiness, soil depth, aspect, slope and soil moisture) are factors that could explain this variation.

White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions – Red Gum variant [NA225]

Table 15 details the site attribute scores for BioMetric plots collected within open woodlands dominated by tumbledown red gum. Benchmark data describing NA225 is provided for comparative purposes.

Table 15: BioMetric plot data for NA225 - red gum variant

Plot	NSW Vegetation Type	Site Attribute Score										Easting	Northing
		NPS	NOC (%)	NMS (%)	NGSG (%)	NGSS (%)	NGSO (%)	EPC (%)	NTH	OR	FL (m)		
9	NA225 'red gum'	37	6	18	64	8	8	0	2	0	25	783110	6562959
11	NA225 'red gum'	36	3	8	74	2	10	2	6	0	21	782718	6563414
12	NA225 'red gum'	26	5	7.5	74	4	26	22	3	0	4	782913	6562723
14	NA225 'red gum'	22	0	0	84	16	14	28	0	0	0	783050	6562761
15	NA225 'red gum'	26	5.5	4.5	78	2	6	16	8	0	20	783087	6562814
-	NA225[3] Benchmark	26	6-25	6-25	20-30	3-10	3-5	0	1	1	15	-	-

Site attribute scores are mostly consistent with vegetation in benchmark condition. A notable exception is plot 14, which sampled a derived grassland. Also the NGSG site attribute scores are consistently above benchmark for all plots, which is likely to be linked to soil fertility and the open woodland structure.

Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) (SEVT) [NA199]

Site attribute scores for BioMetric plots placed within the SEVT are provided in Table 16. Benchmark data describing NA199 is provided for comparative purposes.

[3] White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions

Table 16: BioMetric plot data for NA199 - SEVT

Plot	NSW Vegetation Type	Site Attribute Score										Easting	Northing
		NPS	NOC (%)	NMS (%)	NGSG (%)	NGSS (%)	NGSO (%)	EPC (%)	NTH	OR	FL (m)		
7	NA199	22	61	4.6	8	4	24	0	0	1	0	783466	6562823
10	NA199	24	49	5.5	20	2	14	12	0	1	24	783260	6562952
16	NA199	28	7.5	42	38	8	28	20	0	1	4	782973	6562799
-	NA199[4] Benchmark	35	15-25	25-40	3-20	5-15	3-15	0	0	1	15	-	-

Site attribute scores vary considerably within and outside benchmark condition for SEVT. Reasons for this are unknown, although local variation in soil depth, aspect, rockiness, fire histories, transitions with adjacent vegetation types and land use could be influential factors.

3.5 Flora

A total of 102 species were recorded, including 12 exotic species. The species list from the flora plots and random meander surveys is provided in Appendix 1.

3.5.1 Threatened flora

The study area contains habitat that may be suitable for the following threatened plant species:

- Lobed Bluegrass *Bothriochloa biloba*;
- Ooline;
- *Dichanthium setosum*;
- Finger Panic Grass *Digitaria porrecta*; and
- Austral Toadflax *Thesium australe*.

The Lobed Bluegrass was observed at two locations within the study area as shown in Figure 7. Both recorded occurrences are located outside the site boundary. Habitat suitability for these species is discussed in Section 4.

3.6 Fauna habitats

Habitat assessments confirmed the habitat types identified prior to survey and provided additional information regarding habitat characteristics and the quality of habitats available within and around the study area.

3.6.1 Terrestrial habitat features

The predominant vegetation formation/class found within the study area were:

- Formation - Dry Sclerophyll Forests (Shrub/grass subformation); and

[4] *Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147)*

- Class - North-west Slopes Dry Sclerophyll Woodlands.

Descriptions of the fauna habitat found within the study are described below.

Tree hollows and stags

Hollows occurred at moderate densities throughout most of the study area. The majority of white box on the site was mature and thus had at least small hollows or other stem defects that might shelter small vertebrate fauna species. Hollows of a suitable size for Superb Parrot were present in white box growing at lower elevations. The majority of red gums had small (less than 30 mm) hollows, including those growing in mallee form. Larger hollows were generally absent from red gums unless they held larger dead branches.

Overstorey composition

Much of the study site has a limited diversity of overstorey trees. White box is frequently the only overstorey species. In the most exposed areas the tumbledown red gum was the only substantial tree (or sometimes mallee). Between these areas were patches with a mix of both species. Parts of the eastern and southern faces of Melville Hill had no eucalyptus species present, nor any other tall trees. Semi-evergreen vine thickets occurred in those areas. The only other eucalyptus present in the study area was poplar box and this only occurred outside the site in a small patch on the north-eastern boundary of the study area.

Surface and exfoliating rock

Rocky habitat throughout the study area was predominantly on steeper slopes, particularly on the northern and southern faces of the higher hill. Deep basalt scree covers large portions of the steeper slopes. Large exfoliating slabs of rock were rare. However loose rock and deep cracks into the bedrock are very common over much of the site, particularly on the steepest slopes. Because of the fragmented nature of the bedrock, cliffs, overhangs and caves (which might make shelter for larger fauna) appear to be absent on the site.

Water availability

There are no permanent natural water features on the site, although water was noted to be available for fauna from two sources. There are water tanks maintained in the current quarry operation and there are two bores on the southern and northern side of the site which were leaking water during the surveys.

3.7 Fauna

A total of 113 vertebrate species were recorded during the field surveys, comprising 82 birds, 21 mammals, seven reptiles and three frogs (Appendix 2).

3.7.1 Spotlighting

Spotlight sessions covered 72 ha through all habitats on the study area. There was low diversity (two species) of arboreal mammals recorded. However, Koalas were recorded frequently with 41 spot lit during 22 stratified searches. Koalas were seen by spotlight in all vegetation types that contained *Eucalyptus* (Figure 8, Table 17) with the exception of most of the white box open woodland. A juvenile Koala was found accompanying its mother in

the red gum woodland and another in the small patch of poplar box woodland. A female Koala exhibited "wet bottom", a condition associated with infection by chlamydia.

Table 17 Results of Spotlighting for Koalas

Biometric Code	Vegetation Stratification Unit	Koala Records	Area searched	Density	Available hectares	Predicted total Koalas
NA225	Red Gum Open Woodland (high)	25	22	1.14	11.13	12.6
NA225	Red Gum Open Woodland (low)	0	4	0.00	11.55	0.0
NA225	White Box Shrubby Woodland	11	16	0.69	20.96	14.4
NA225	White Box Woodland	3	12	0.25	42	10.5
NA225	White Box Open Woodland	0	8	0.00	83.4	0.0
NA199	Semi-evergreen Vine Thicket	0	4	0.00	9.92	0.0
NA235	Western Rosewood Open Shrubland	0	4	0.00	93.4	0.0
NA185	Poplar Box Open woodland	2	2.3	0.87	2.3	2.0
	Total	**41**	**72**	**0.54**	**275**	**40**

Spotlighting also recorded Common Brushtail Possum, several species of Macropods, feral mammals, geckos and frogs (Appendix 2).

3.7.2 Koala scat searches

Koalas were detected during spotlight and diurnal activities predominantly in red gum and to a lesser extent white box. Field survey results indicate a foraging preference for red gum as indicated by the high Koala faecal pellet counts under red gums (see Table 16).

The use of koala scratch marks to determine tree use was limited in this study due to the inconsistent nature of the bark between the two eucalyptus types present. Claw marks are difficult to detect and quantify on the trunks of white box because the soft bark hides such marks, unless the koala has slipped. Red gum appears to hold its bark sufficiently long to reliably show Koala climbing activity. However, as can be seen in Table 16, bark markings were not required to establish usage in red gums.

The third *Eucalyptus* species found in the study area, poplar box, was examined for Koala occupation. Koala were found to occupy this vegetation both through scat surveys and visual observations.

Table 18 Results of Koala faecal pellet searches. Data presented as tree counts faecal pellet count categories.

Vegetation Type	Vegetation Stratification Unit	Sample plots	Sampled Trees	Percentage of trees used	Hectares available
NA185	Poplar Box Open Woodland	1	35	60%	2.3
NA225	Redgum Open Woodland (high)	6	193	83%	11.13
NA225	Redgum Open Woodland (low)	1	31	16%	11.55
NA225	White Box Open Woodland	3	80	9%	83.4
NA225	White Box Shrubby Woodland	3	87	28%	20.96
NA225	White Box Woodland	3	60	13%	42
All Counts		**17**	**486**	**46%**	**~171**

3.7.3 Rock Wallaby scat searches

Scat searches failed to find evidence of rock wallabies. There was abundant evidence of Common Wallaroo, Swamp Wallaby, Grey Kangaroo, Red-necked Wallabies, Echidna and Pig. Fox and Cat scats as well as domestic stock scats were also recorded.

3.7.4 Camera traps

Over 1,000 photographs of fauna were taken across the 20 camera trap locations. Photographs of Eastern Grey Kangaroo, Common Wallaroo, Red-necked Wallaby and Swamp Wallaby were obtained. Common Brushtail Possums were seen responding to the honey lures. The Common Wallaroo appears to be the most abundant macropod on the steep portions of the study area. Swamp Wallabies were detected by the majority of the cameras. No images of threatened fauna were recorded with the camera traps. Feral foxes and pigs were detected at four camera traps each. No small mammals were detected by the camera traps.

3.7.5 Diurnal bird observations

Eighty-eight species of diurnal bird were detected during survey activity (Appendix 2). Superb Parrots or Malleefowl were not detected in the study area. The Little Lorikeet was detected flying over the current gravel pit operation (3 individuals). They were not seen to stop, which may be explained by the absence of flowering eucalyptus on the site during the survey periods.

3.7.6 Nocturnal bird observations

Five species of common nocturnal bird were detected in the study area (Appendix 2). There was no response to call-playback by threatened owls and it seems unlikely that any of these reside on site.

3.7.7 Insectivorous bat observations

Nine species (40 individuals) of insectivorous bat were captured in harp traps. An additional three species were recorded with ultrasonic detectors from over 4000 'zero-crossing' files. Only one of these species was a threatened species (Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*: Vulnerable TSC Act). Recordings of Yellow-bellied Sheathtail Bat were numerous on the recorders. Recordings started approximately 15 minutes after the earliest bat activity each evening indicating that the bats are roosting in the local area.

A single bat call sequence resembled the call of another threatened species, the Large-eared Pied Bat (*Chalinolobus dwyeri*), but the call identification was inconclusive.

3.7.8 Other habitat observations for threatened fauna

Many of the white box trees on the study area are mature and contain hollows. Most of the hollow-bearing trees occur outside the site boundary within the white box open woodland. There are a reasonable number of hollows of a size suitable for a mid-sized parrot, such as the Superb Parrot, with at least one in four white box appearing to support such hollows. There are numerous small hollows available for smaller species such as the Little Lorikeet and insectivorous bats.

Soils on the study area are typically stony and seemingly shallow due to the high gradients. The soils are not typical of the closest known Malleefowl habitats which are low relief and sandy.

4 DISCUSSION

4.1 Threatened ecological communities

4.1.1 Box gum woodland

EPBC Act

The flora and BioMetric plot data were examined against the published identification material for Box – Gum Woodland to determine whether any of the native vegetation within the site corresponded to the EPBC Act listed White Box – Yellow Box – Blakely's Red Gum Woodland TEC.

All sampled sites contained the following features diagnostic of Box – Gum Woodland:

- Site occurs within the natural range for Box – Gum Woodland;
- A characteristic canopy dominant is present (i.e. white box);
- The understorey is predominantly native;
- Patches are greater than 2 hectares;
- Presence of a woodland structure; and
- Presence of a native grassy understory in both the grassy and shrubby variants.

For vegetation of the site to qualify as part of the threatened Box – Gum Woodland community the floristic composition of the understory must also contain at least 12 of the listed native understory species (excluding grasses) linked to the policy statement (TSSC, 2006c). At least one important species must also be present. Analysis of the flora plot data relative to these criteria is provided in Table 19.

This identification measure indicates that none of the plots sampled within the site qualify as belonging to the listed Box – Gum Woodland TEC. These white box dominated woodlands belong to the locally occurring 'shrubby' vegetation type known as *White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions*, and is not a TEC. Corroborating this observation is the mapped occurrence of the above named 'shrubby' white box woodland vegetation type within the site (ELA, 2007).

Plots identified as meeting the plant species richness criterion include plots 6, 18 and 19. These plots occur outside the site and are restricted to the change in slope located immediately below the outcropping steep basalt slopes. Colluvium from upslope sources is likely to have locally enriched the soil conditions at this elevation thereby elevating soil fertility. This observation is supported by a return to reduced plant species richness in plots located further downslope of the slope change (i.e. plots 1, 2, 3 and 4) where the effects of localised colluvium enrichment are likely to be substantially less.

Notwithstanding the above assessment, it is possible that prior land uses have sufficiently degraded the floristic composition of white box woodlands of the study area to a condition that falls below the minimum degraded status for Box Woodland (TSSC, 2006a). In these circumstances, patches exceeding 2 hectares with 20 or more mature characteristic trees per hectare are included. In this respect it is considered that white box dominated vegetation in woodland condition within the site has not been the subject of a prior

Table 19 EPBC Act box gum woodland analysis: plot data for white box dominated vegetation

Assessed feature	Plot number														
	1	2	3	4	5	6	9	11	12	13	14	15	17	18	19
Characteristic Box Gum canopy dominant present	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes
Understorey appearance	Grassy	Grassy	Shrubby	Shrub Grass	Shrub Grass	Grassy	Shrub Grass	Grassy	Grassy	Shrub Grass	Grassy	Grassy	Shrub Grass	Shrub Grass	Shrub Grass
Grass cover (%)	62	58	6	34	32	74	64	74	74	62	84	78	58	34	40
Shrub cover (%)	0	0.1	4.7	8.5	9	0.5	18	8	7.5	13.5	0	4.5	12	16.5	10
Total native species richness	20	24	17	24	20	29	39	38	28	21	21	26	23	32	37
Total BGW listed native species (non-grass understorey)	3	6	6	8	5	10	6	6	6	6	4	5	2	8	10
Total BGW listed important species (non-grass understorey)	2	2	1	2	3	3	4	4	4	4	1	2	2	4	6
Total non-grass understorey species	5	8	7	10	8	13	10	10	10	10	5	7	4	12	16
Potential Box Gum Woodland?	No	No	No	No	No	**Yes**	No	No	No	No	No	No	No	**Yes**	**Yes**
Inside site boundary	Out	Out	Out	Out	In	Out	In	Out	In	In	In	In	In	Out	Out

disturbance history that would otherwise explain the observed shrubby structure and reduced native plant species richness. The condition of these woodlands within the site is considered to be commensurate with the pre-1750 condition of naturally occurring shrubby woodlands that occur within the region (i.e. NA225).

Some white box stands in the east of the study area (outside of the site) are noted to exceed the '2 hectares with 20 or more mature characteristic trees per hectare' criterion. Land uses disturbances in these areas are noted and are the likely reason for the grassy understory and apparent absence of shrubs (i.e. prior land clearing and cattle grazing). Accordingly, this vegetation may qualify under this criterion.

The results of this analysis indicate that Box – Gum Woodland does not occur within the site. Rather, it has been determined that the white box dominated vegetation of the site belongs to a 'shrubby' vegetation formation (i.e. NA225) that does not form part of the Commonwealth listed Box – Gum Woodland TEC. Although it is possible that white box woodlands within the study area may correspond to the TEC, these possible occurrences occur outside the site.

TSC Act

Woodlands and open woodlands that occur within the site that contain, or once contained, white box as a characteristic overstorey canopy species have been identified by regional mapping (ELA, 2007) as belonging to *White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions* [NA225]. Site surveys confirm the ELA (2007) vegetation typing for NA225 within the site on the basis of:

- Floristics (OEH, 2012); and
- Structure (consistently shrubby understory).

NA225 does not form part of the TSC Act listed Box – Gum Woodland EEC (OEH, 2012).

Notwithstanding, the state listing for Box – Gum Woodland does include shrubby patches of white box woodland where disturbance factors are evident. However, it is considered that the current site does not contain such disturbances (e.g. regrowth following land clearing). The occurrence of the shrubby white box woodlands within the study area are coincident with steep terrain, which is unlikely to have been subject to key disturbance factors such as clearing for agricultural land uses.

4.1.2 Semi-evergreen Vine thicket

Plot data shows that the floristic composition of vegetation mapped as SEVT within the study area is consistent with the NSW Vegetation Type *Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147)*; a threatened ecological community listed on the:

- EPBC Act as *Semi-evergreen Vine Thicket of the Brigalow (north and south) and Nandewar Bioregions endangered ecological community* (EEC); and
- TSC Act as *Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions EEC*.

Structural and floristic condition, as discussed in Section 3.4.2, is not consistent with reported benchmark conditions for SEVT. Notable differences include:

- Native plant species richness (below benchmark);
- Native overstorey cover (below and above benchmark);
- Native midstorey cover (below benchmark); and
- Fallen logs (below benchmark).

It is considered that the condition of SEVT within the site and study area is below that reported for benchmark conditions of pre-1750 stands. Reasons for the reduced condition are likely to be linked to patch isolation resulting from widespread historical land clearing events, effects of feral animals and weeds, altered fire regimes and adjacent agricultural land uses.

4.2 Threatened flora

Suitable habitat for the following flora species has been identified as occurring within the study area:

- Ooline *Cadellia pentastylis*;
- *Dichanthium setosum*;
- Finger Panic Grass *Digitaria porrecta*; and
- Austral Toadflax *Thesium australe*.

Lobed bluegrass *Bothriochloa biloba* (listed as Vulnerable on the EPBC Act) has been observed within the study area (Figure 7). A discussion on the likelihood of occurrence of the above listed species is provided as follows.

4.2.1 Lobed Bluegrass *Bothriochloa biloba*

Lobed bluegrass (listed as Vulnerable on the EPBC Act) occurs on the mid colluviual slopes of Melville Hill (Figure 7). The depth of surface basalt flows in this part of the study area is substantially less than upslope areas as the topographic contour of observed specimens is roughly coincident with observed outcropping of the underlying Permian geology.

Habitat within the study area is likely to be associated with increased soil fertility derived from weathered basalt soils and localised elevated soil moisture. The latter habitat factor substantially limits the potential occurrence of this species within the site as the soils of this part of the study area are comparatively dry.

4.2.2 Ooline *Cadellia pentastylis*

Ooline *Cadellia pentastylis* (listed as Vulnerable on the TSC and EPBC Acts) is a tall shrub species known to occur on lithic sandstones or conglomerate substrates, and sometimes occurs adjacent to Semi-evergreen Vine Thicket of the Brigalow (north and south) and Nandewar Bioregions where basalt occurs. The natural southern distribution limit for this species is Gunnedah (Black Jack Mountain) where it has been found growing adjacent, but not within, Semi-evergreen Vine Thicket. However, the study area is characterised only by tertiary basalt with no evidence of suitable geological substrate for this species. On this basis it is considered that Ooline is unlikely to occur within the study area.

4.2.3 Dicanthium setosum

Dichanthium setosum (listed as Vulnerable on the EPBC Act) is associated with heavy basaltic black soils and stony red-brown hardsetting loam with clay subsoil. Potential habitat for this species occurs within the site for the following reasons:

- The site is located within the prescribed distribution of the species; and
- Stony red-brown hardsetting loam with clay subsoil occurs in parts of the site.

The autumn survey failed to detect this species within the study area, or site. This species is unlikely to occur within the site as it was not recorded, despite the March survey conditions being optimal for detecting this species.

4.2.4 Finger Panic Grass *Digitaria porrecta*

Finger Panic Grass *Digitaria porrecta* (listed as Endangered on the TSC and EPBC Acts) occurs within the region with high population counts in the Premer locality, approximately 40 km south of the site. This species prefers dark fine textured soils, generally with self cracking properties. These habitat attributes do not occur within the site. This species is unlikely to occur within the site as it was not recorded, despite the March survey conditions being optimal for detecting this species.

4.2.5 Austral Toadflax *Thesium australe*

Austral Toadflax *Thesium australe* (listed as Vulnerable on the TSC and EPBC Acts) prefers grassy woodlands, east and west of the Great Dividing Range. Associations with Kangaroo Grass (*Themeda australis*) are reported for this species, however, this association does not preclude occurrence on sites that do not have this grass species.

Austral Toadflax is a cryptic species and is difficult to detect, particularly in grassy landscapes where the grass cover is dense. Surveys conducted in January were not considered definitive in determining whether this species was present on the site. However, the March survey conditions were considered optimal, with survey results indicating this species is absent from the site.

4.3 Threatened fauna

4.3.1 Koala habitat

There is sufficient information to indicate that Koala density at Marys Mount is high (Table 15 and 16). The population density is similar to other high value Koala habitats in the Liverpool Plains region (Lunney *et al*. 2012, Kavanagh and Stanton 2012) and is higher than the density apparent in the Pilliga Forests (Kavanagh and Barrott 2001, Kavanagh *et al*. 2007).

The preferred Koala feed tree at Marys Mount is the red gum (*Eucalyptus dealbata*) growing on basalt in elevated positions with the majority of specimens examined during this survey showing signs of use. Many red gums show signs of over browsing in the form of denuded

branches and minimal leaf loads. However, most specimens showed good recovery during the March visit. Red gum within the site typically grows in locations most strongly exposed to solar radiation and strong winds. On the tops of the two hills on site and on the northern hill faces, red gum is usually the only eucalyptus present.

In the north east portion of the study area there was an 11 hectare stand of red gums growing as open woodland. This stand was on lower gradients and seemingly different geology than the hill top red gum stands. The ground cover was denser in this stand making pellet searches more difficult (similar to the white box open woodlands). Pellet counts were low (Table 18). Spotlighting also failed to detect Koalas. However, four Koalas were seen in this patch during another daylight examination and some trees were noted to have Koala claw marks indicating that this area has potential to support Koalas.

Koalas persist with browsing red gums when those trees are showing poor condition.

The main secondary Koala feed tree on site is the white box. White box was patchily used by Koalas, and although some individual white box experienced high use, the majority showed no signs of use. There was also a trend for white box to be used when growing closer to the elevated red gum patches. Koala scat counts were possibly reduced in white box areas due to greater amounts of litter and herbage in that environment.

Little sign of Koala habitation was seen in areas without eucalypt trees, such as the semi-evergreen vine thicket. However, where the eucalypt species and vine thicket species overlapped, there was some evidence of Koalas utilising the shade of the midstorey as shelter, with two daytime records in Wilga (*Geijera parviflora*).

A more detailed study would be required to determine the effects of further eucalypt removal around the site. However, it is clear that the Koala population depends on the red gum food resource and the supplementary food provided by the white box and poplar box. The heavy shade provided by the mid-storey plants may also be important to their survival

at this location. The low eucalyptus diversity on the study site does not appear to limit the Koala population, probably because the red gum constitutes a primary food tree, while the white box and poplar box are secondary feed trees. The lack of non-feed trees in the woodland canopy qualifies this site as "Habitat critical to the survival of the koala" as defined in *Interim koala referral advice for proponents* (SEWPaC 2012).

Recent studies have shown that Koalas are capable of negotiating considerable spatial barriers to access new food and shelter resources (Lunney *et al*. 2012, Kavanagh and Stanton 2012). The spatial barriers inherent in the study area should be negotiable by Koalas, allowing gene flow and avenues of repopulation should the local population decline for any reason.

4.3.2 Brush-tailed Rock Wallaby

The site contains potential Brush-tailed Rock Wallaby (*Petrogale penicillata*) habitat. Steep basalt scree slopes covered with semi-evergreen vine thicket are utilised by rock wallabies in locations further north in Queensland. Several factors count against the presence of Brush-tailed Rock Wallaby at this site:

- It is isolated from any extensive area of suitable habitat and is more than 25 km from the nearest record;
- It is well populated with at least three native competitors, two feral competitors and an exotic predator; and
- It does not have the rocky refuges (cliffs, caves, overhangs) required to ensure long term survival against fox predation.

In addition, searches and cameras failed to reveal any rock wallaby scats, sightings or photographic evidence.

4.3.3 Superb Parrot

No Superb Parrots were detected on site during this study. The white box and poplar box woodland on site would constitute marginal habitats for this species due to the low diversity of tree species and low suitable tree hollow density. Tree hollows suitable as nest trees are present in the white box woodlands at lower elevations of the study area. However, other parrot species already occupying the area would also be competing for those hollows (Baker-Gabb 2011).

During the shifts in range shown by this species in the last drought, Superb Parrots were found utilising similarly fragmented box woodlands in the Namoi Valley, but none of those records were within 30 km of this site. Therefore, although possible, it is unlikely that Superb Parrot utilise the study area.

4.3.4 Malleefowl

The closest records of Malleefowl are approximately 15 km to the northwest in (or near) Kerringle State Forest, although no recent records exist from that area. Malleefowl typically inhabit flat areas with sandy or loose soils which are suitable for their breeding mounds. This was the case in Kerringle State Forest.

Loose moundable soils are absent from the vegetated portion of the study area, where basalt scree slopes or basalt derived black soils with abundant parent material are dominant. We consider it unlikely that Malleefowl reside on the study area.

4.3.5 South-eastern Long-eared Bat (Greater Long-eared Bat)

Turbill and Ellis (2006) reviewed the records for *Nyctophilus timoriensis* before redescription by Parnaby (2009) as *N. corbeni*. Turbil and Ellis (2006) found a correlation of records with extensive patches of Box Ironbark woodland. Bat trapping studies in fragmented woodland habitat had very low return rates for this species.

Harp traps were used specifically in this study to attempt to locate this species. Two other *Nyctophilus* species (18 captures of *N. geoffroyi* and one capture of *N. gouldi)* were captured, along with 21 captures of seven other bat species. It is considered that the trapping effort was sufficient to capture this species, should a significant population be present. However, there is still a possibility that low numbers of *N. corbeni* may inhabit the study area.

4.3.6 Large-eared Pied Bat

The Large-eared Pied Bat was not positively detected during this study, although a single call sequence recorded in the study area had some of the characteristics of this species. That call sequence was more likely a low call of a Southern Freetail Bat (*Mormopterus sp 4.*), a bat that was commonly detected by its slightly higher frequency calls on site. Low calls can be generated from fast flying bat species such as *Mormopterus* because of the Doppler Effect. In this case the bat would have been flying away from the microphone and modifying its usual search pattern because of a cluttered flying environment (*pers. comm.* Brad Law).

Large-eared Pied Bats usually roost in caves, tunnels and abandoned mines. There are none of these roosting features in the study area and the closest potential location with roost habitat is more than 10 km away. It is unlikely that Large-eared Pied Bats are present on site.

4.3.7 Yellow-bellied Sheathtail Bat

The Yellow-bellied Sheathtail Bat is the largest insectivorous bat in NSW and individuals are frequently detected by their powerful calls. The Yellow-bellied Sheathtail Bat was detected in this study by spotlighting and by call detection. Calls were detected in the study area early enough in the evening to indicate that individuals are roosting in the locality (within 2km of the site). Roost sites are typically in large hollow trees (Churchill 2008) and some of the large white box and dead trees around the study area would make appropriate roosts.

4.3.8 Masked Owl

Masked Owls (*Tyto novaehollandiae*) occupy large home ranges in Australian forests. Typical requirements for Masked Owls are a steady supply of small to medium-sized mammalian

prey, large tree hollows used for nesting/roosting and vegetation structure that suits their hunting methods. Although all of these features are present in the study area, there is insufficient good quality habitat to support even a single Masked Owl home range. No response was made by Masked Owls to call-playback surveys and no other evidence existed to suggest that they occupied the site.

4.3.9 Barking Owl

The nearest populations of Barking Owls to the study area are situated along the northern and western portion of the Pilliga forests and in an area of the Namoi catchment to the northeast of the site (Soderquist 2009). Barking Owl records on the Liverpool Plains are inexplicably rare (OEH 2013), which is probably due to high habitat fragmentation and other effects of agricultural practices (Stanton 2011). In the Pilliga Forest, Barking Owl pairs typically occupy home ranges of around 2,000 ha (Kavanagh and Stanton, 2009). There are not 2,000 ha of suitable habitat around the study site. Barking Owls were not detected on site despite appropriate owl call-playback and extensive nocturnal surveys.

4.3.10 Brush-tailed Phascogale

There are no recent records of Brush-tailed Phascogale (*Phascogale tapoatafa*) in this region (OEH 2013). Although the habitat available on the site is potentially suitable for this cryptic dasyurid, the study site is probably too isolated to afford a suitable area of habitat to sustain a population.

Typically, Brush-tailed Phascogale have been found to occupy large home ranges. For example, Soderquist (1995) found females used 41 ha and males 104 ha. Such large female home ranges would exclude the use of the site by Brush-tailed Phascogale. van der Ree *et al*. (2001) presented a case where female Brush-tailed Phascogale were able to maintain small territories of around 5 ha in constrained habitat along roadside reserves. Such small home ranges might permit the persistence of Brush-tailed Phascogale in the study area. However, in the van der Ree *et al*. (2001) study the roadside reserves were protecting good quality habitat and they were well connected across the landscape.

Although the woodland growing on the basalt soils may be productive enough to support small home ranges for Brush-tailed Phascogale, the vegetation cover of the study area does not have the same connectivity as in van der Ree's study. Thus, there is a low likelihood that the study area supports a population of Brush-tailed Phascogale population.

4.3.11 Black-striped Wallaby

This study specifically targeted Black-striped Wallaby (*Macropus dorsalis*) using 20 remote camera locations over the study area. These cameras took over 900 photos of four other species of macropod, but no record of Black-striped Wallaby was made. The nearest known population of this species is the north-eastern portion of the extensive Pilliga forests (OEH 2013). Any records at the study site would have been a range extension of known records. Therefore, it is highly unlikely that Black-striped Wallabies are present in the study area.

4.3.12 Rufous Bettong

Recent Rufous Bettong records in NSW are almost entirely contained within extensive areas of forest or woodland (OEH 2013). While the habitat in the study area could feasibly support a small population of bettongs, no signs of their presence were found. Given the high number of predators and the studies areas isolation from other areas of suitable habitat the survival of a Rufous Bettong population is unlikely.

4.3.13 Border Thick-tailed Gecko

The Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*) inhabits areas with exfoliating granite, typically at higher altitudes along the New England Tablelands (Wilson and Swan 2010). This site has basalt rock forms and does not have the cool wet environment typically preferred by this species (Wilson and Swan 2010). Instead, this site is occupied by *Underwoodisaurus milii,* a widespread close relative. Border Thick-tailed Gecko is unlikely to occur at this site.

4.3.14 Australian Brush-turkey population in the Nandewar and Brigalow Belt South bioregions

No Australian Brush-turkeys were observed during our surveys, nor were any nesting mounds. There is insufficient soil/litter depth on the study site for mound nesters to construct nest mounds. In any case, it is unlikely that this species could have escaped attention. A population of this species is unlikely to occur on the site.

4.3.15 Little Eagle

There is suitable habitat for Little Eagle to forage and nest in the study area and although no Little Eagles were recorded during this survey, recent records exist from the locality. Relatively tall white box woodland on the southern slopes of the hill contains good nest locations. There is evidence of old stick nests constructed by mid-sized raptors in that area. The nests were too dilapidated to determine the species of origin. If Little Eagles do make seasonal use of the study area, the mature white box woodland on the south side of the hill would be their most important resource for breeding and foraging.

4.3.16 Square-tailed Kite

The nearest known record for the Square-tailed Kite is at Lake Goran, approximately 30 km south of the site. There is suitable habitat for Square-tailed Kite to forage within the study area. Bird and reptile prey species are present in sufficient numbers. However, it would seem unlikely that Square-tailed Kite could breed at this site as the open nature of the surrounding landscape is unlikely to suit them and the woodland of the study area may be too limited to supply all their feeding requirements. However, it cannot be ruled out that disused stick nests in the woodland on the southern side of the hill were built by this species.

4.3.17 Spotted-tailed Quoll

Dasyurus maculatus is mainly a forest dwelling species that occupies large, usually exclusive, home ranges (Andrews 2005, Belcher and Darrant 2004). Minimum reported home range size for females is around 88 hectares, but is usually larger and males occupy substantially larger home ranges. Typical environments where quolls prosper are those with higher productivity and subsequent abundant prey. The prey utilised by quolls is diverse and varies dramatically between sites.

The Spotted-tailed Quoll inhabits a variety of habitats, including dry to moist open forests or closed forests containing rock caves, hollow logs or trees for denning and foraging. Viable populations of the Spotted-tailed Quoll occupy complex overlapping individual home ranges comprising numerous individuals. Females occupy smaller ranges (mean 500 hectares) comprising an abundance of resources with males occupying larger home ranges (Belcher, 2008). Ideal habitat for this species is generally represented by large undisturbed connected tracts of intact native vegetation, which are under threat throughout the range of this species.

Populations of the Spotted-tailed Quoll are very sensitive to changes in the predator-prey relationship of their chosen environment (Catling and Burt 1995). An area containing an abundant source of medium-sized mammals (500 – 5,000 grams) is an important feature of suitable foraging habitat for the Spotted-tail Quoll (Belcher 1995), with a low abundance of medium-sized mammals likely to increase habitat suitability for competitors such as the European fox (*Vulpes vulpes*) (Catling and Burt 1995). Competition from the European fox serves to inhibit Spotted-tail Quoll populations (Catling and Burt 1995), with the fox more adapted to fragmented landscapes comprising a mosaic of cleared and vegetated lands.

Superficially, the habitat in the study area is suitable for the Spotted-tailed Quoll. The fertile basaltic soils might provide the productivity required. The suitable prey species present are Common Brushtail Possum, hollow and communal roosting birds and any small mammals present. Other well known prey such as small macropods, rabbits and smaller arboreal mammals seem to be rare or absent from this site.

The habitat within the study area is not large enough to support a sustainable population of Spotted-tailed Quolls and there would be a need for a population to utilise suitable adjacent habitat as well. Other high quality habitat is not in close proximity to the study area and the open grassland and open grassy woodlands that surround the study area have not been documented to support Spotted-tailed Quoll populations. Therefore, it is highly unlikely that the study area supports Spotted-tailed Quolls and certainly doesn't support a breeding population.

4.3.18 Little Lorikeet

The Little Lorikeet (*Glossopsitta pusilla*) was observed flying over the site without landing. At the time of survey there were no eucalyptus trees in flower. Nectar from eucalyptus trees is a vital component of the diet of Little Lorikeet and in this region during winter they probably rely on flowering white box as a food source. Courtney and Debus (2006) found that in this region, the Little Lorikeet nests in small hollows found in red gums, including some of the red gum species found on this site. The hollows typically have an entrance

diameter of around 30 mm and may be as low as 2 m from the ground. As a winter/spring breeder, Little Lorikeet may utilise this site to breed during white box flowering events. Site observations and habitat analysis indicate that Little Lorikeet breeding and foraging is likely to occur within the site. Further observations during a flowering event would be required to confirm this.

4.3.19 Swift Parrot

As the Swift Parrot (*Lathamus discolor*) is a winter visitor to mainland Australia, the survey timing was not suitable for detecting this species. However, Swift Parrot are known to visit the Liverpool Plains in some years with apparent gaps between visits of many years (OEH 2013). The winter flowering white box in the study area is a known feed tree and would provide a foraging resource for Swift Parrots.

4.3.20 Brown Treecreeper (eastern subspecies)

The eastern subspecies of the Brown Treecreeper (*Climacteris picumnus victoriae*) is potentially at the western edge of its range in the vicinity of the study area. The habitat on site appears suitable with the exception of the patch size. Brown Treecreeper populations are not normally viable in remnants less then 200 ha (Barrett et al. 1994). Brown Treecreeper was not recorded on site. It is normally a highly detectable species and on this basis it is considered that Brown Treecreeper is unlikely to occur within the study area.

4.3.21 Migratory birds (international)

Two migratory birds listed under the EPBC Act were detected on site: Rainbow Bee-eater (*Merops ornatus*) and Black-faced Monarch (*Monarcha melanopsis*). It is probable that both these common species do not breed on site, but instead use it as a stop over point as part of their migration. The Rainbow Bee-eater would not be able to breed here as the soils are too rocky to allow nest burrow excavation. The Black-faced Monarch detected during the survey was a juvenile. This species would most likely have been migrating northwards at the time of the survey and using the study area as a staging point. This record is unusually far west for this species.

4.4 Conclusions

The single greatest fauna constraint on the site is the presence of core Koala habitat. This habitat supports individuals of the Gunnedah important population. The red gum woodlands are clearly important as a primary food source for koalas on the site, and represents core Koala habitat. Areas of white box have been observed to be of lesser importance and are considered secondary Koala habitat with in the study area.

Of secondary importance is the retention of hollow bearing trees which may currently be providing shelter for Yellow-bellied Sheathtail Bats. They potentially also provide habitat for a range of other fauna. Hollow bearing trees are not replaceable in the short or medium-term so their conservation is important for the continuation of a range of fauna that utilise hollows for breeding and/or roosting.

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FIGURES

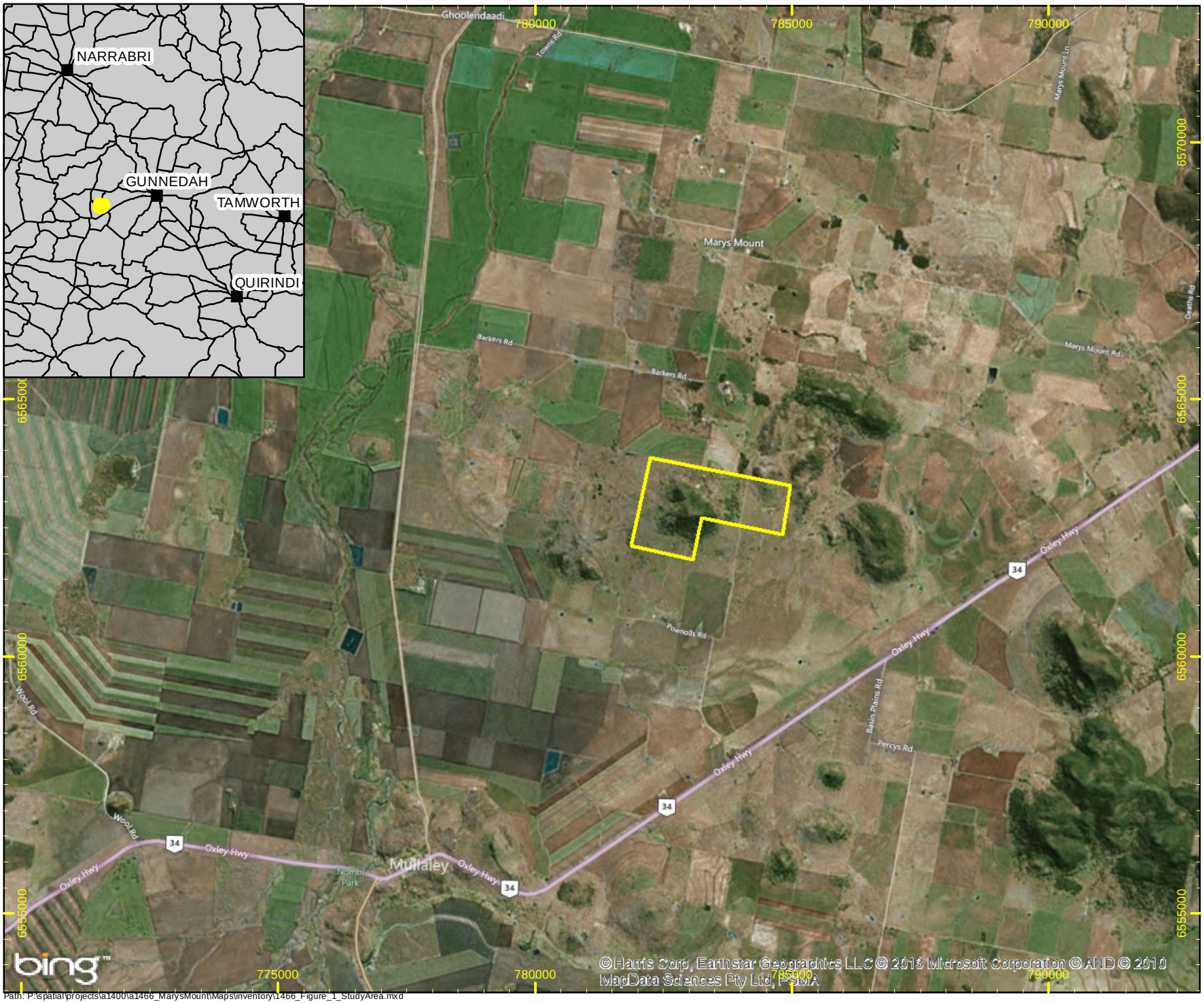

Figure 1: Project location

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 3/04/2013

Study Area

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Environment and Heritage

Horizontal Datum:
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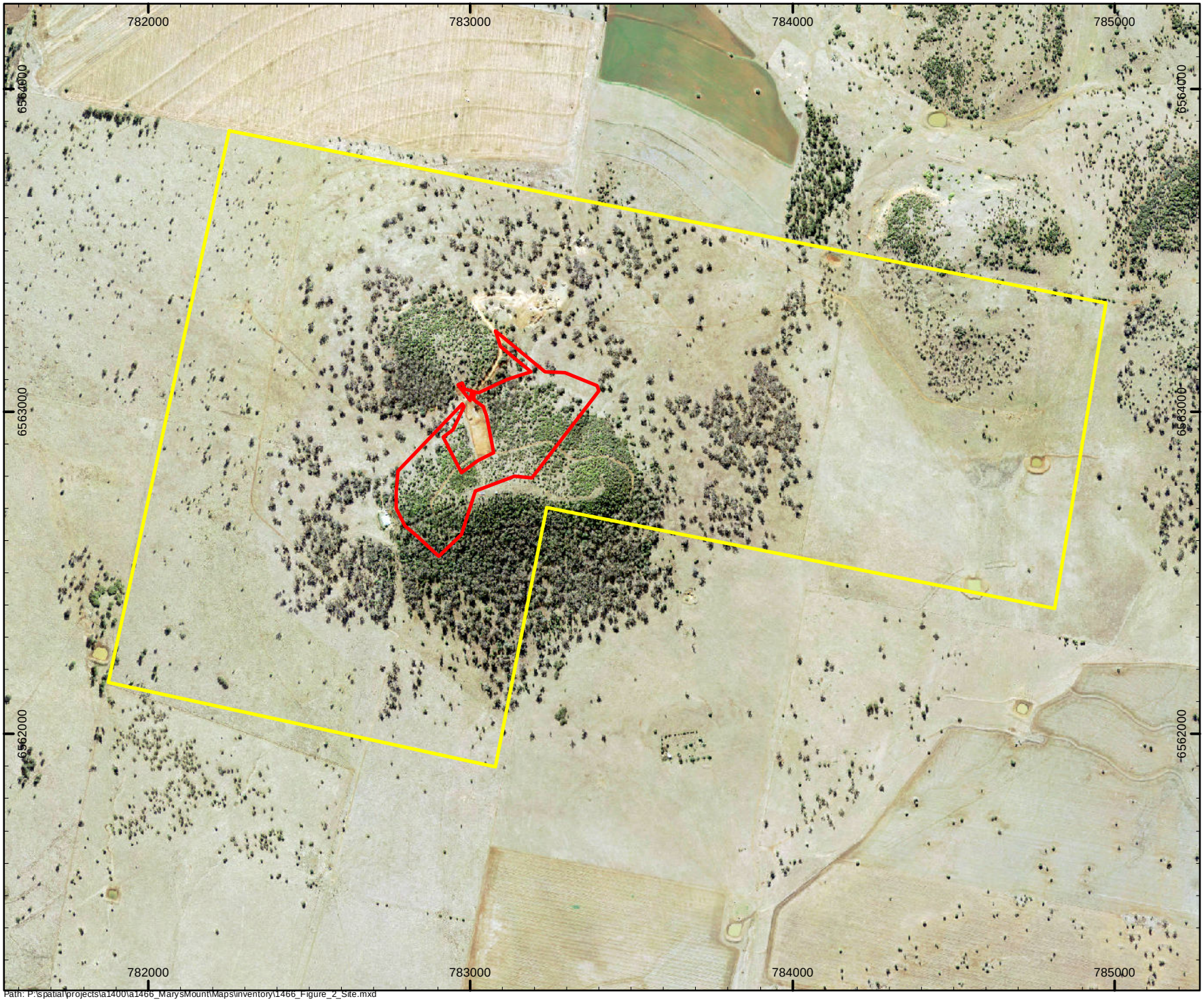

Figure 2: The site and study area

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 3/04/2013

Study Area
Development Site

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Metres
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Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

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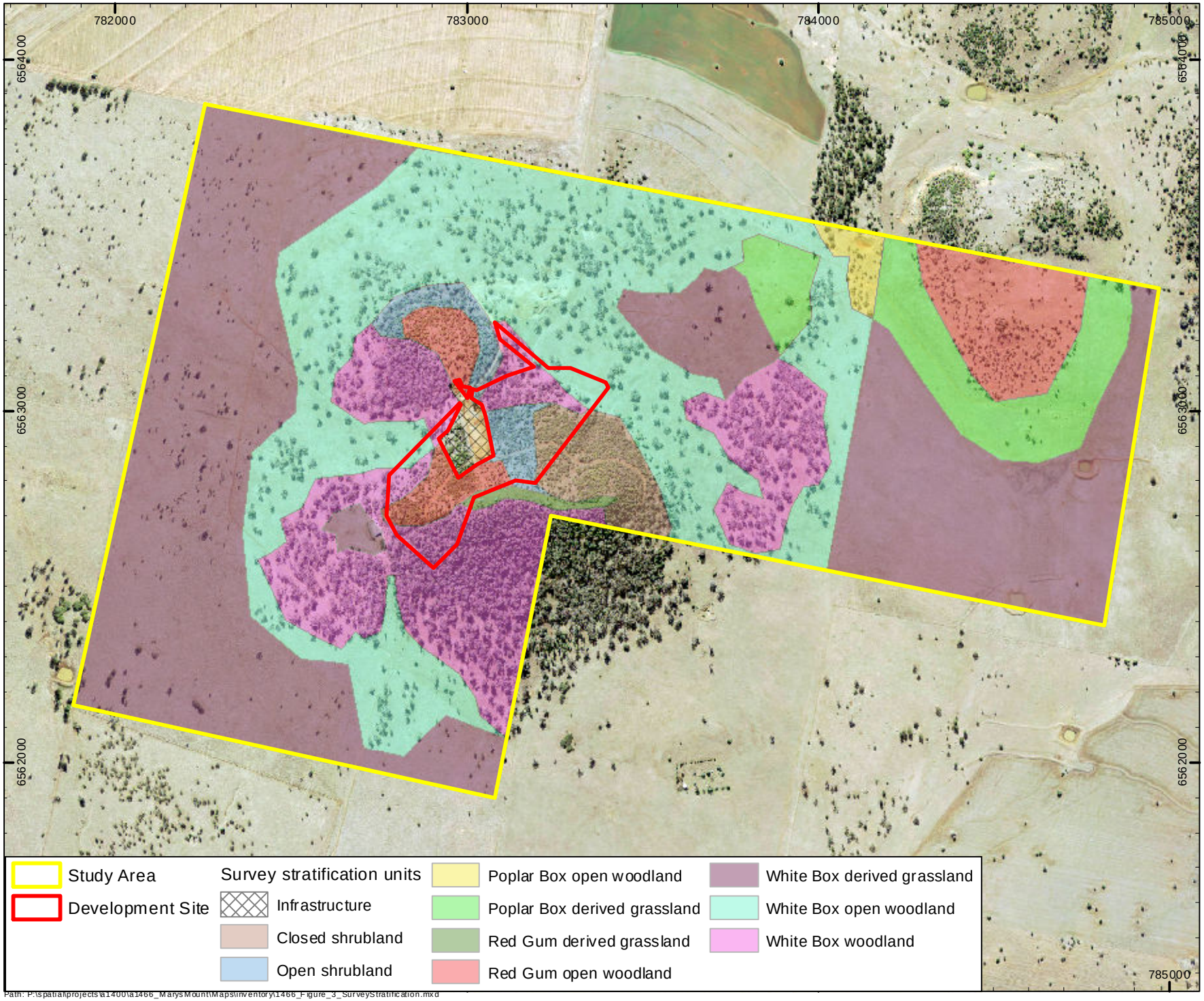

Figure 3: Survey stratification units

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 18/04/2013

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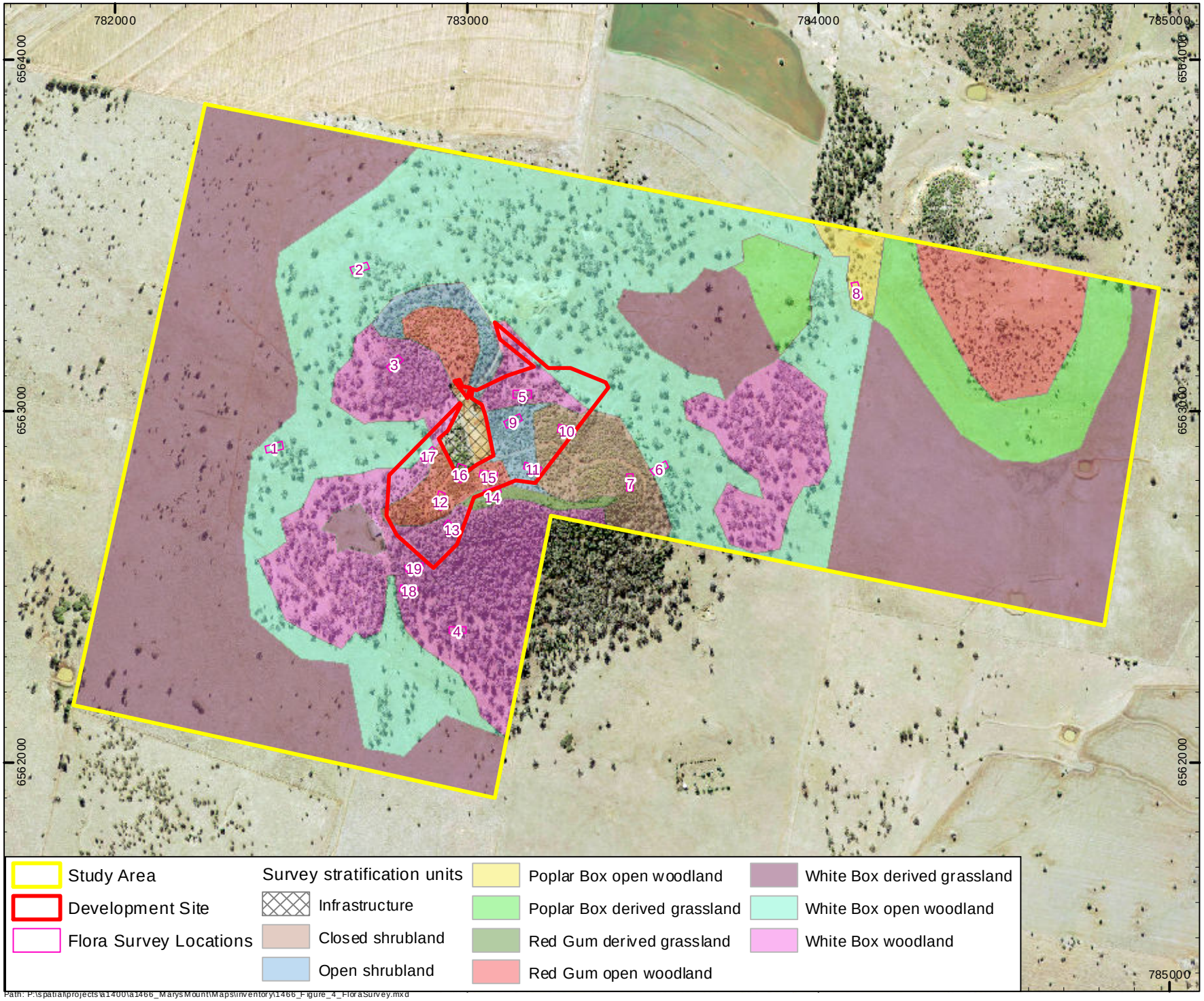

Figure 4: Flora survey locations

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 18/04/2013

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(c) 2007 LPI

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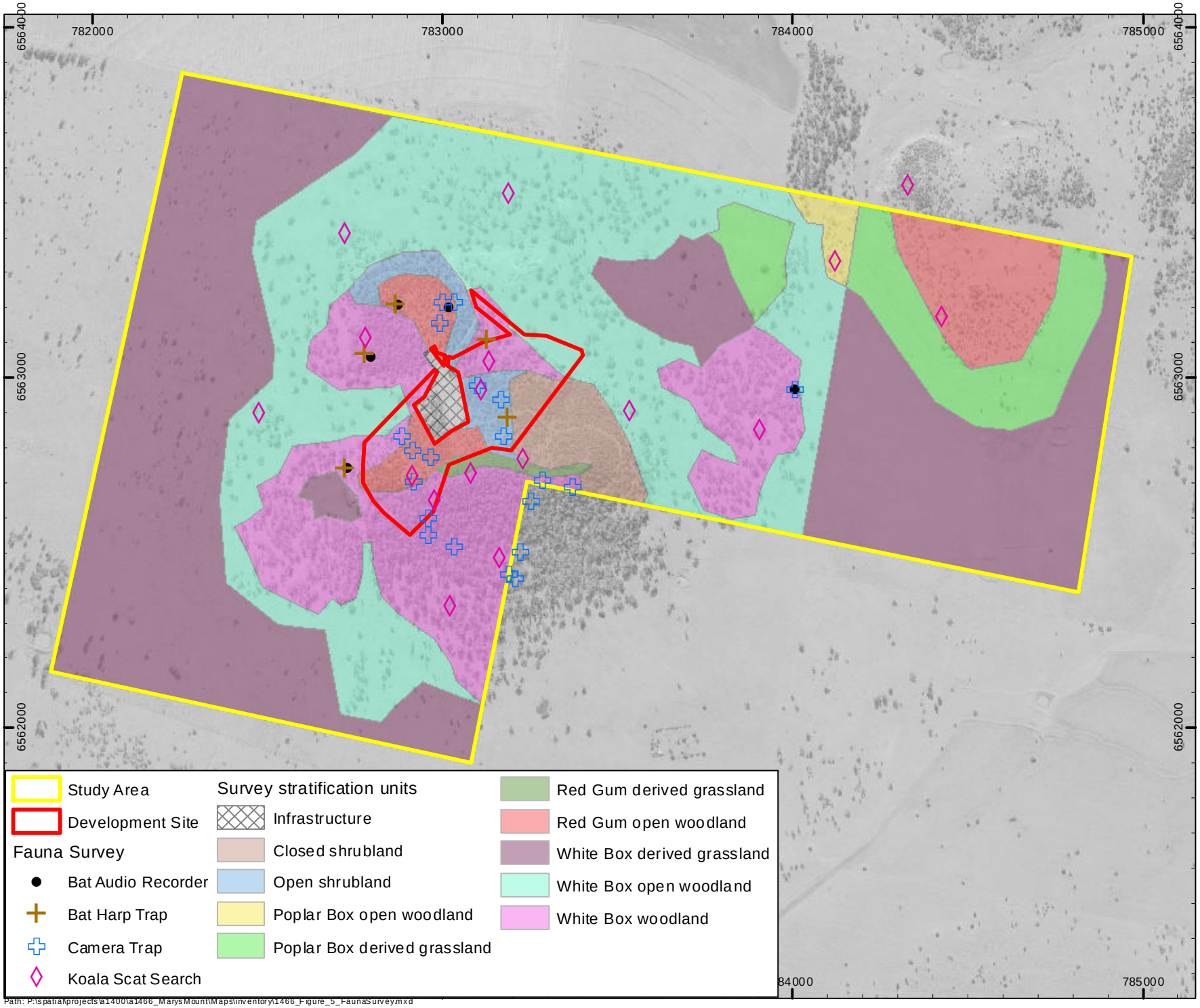

Figure 5: Fauna survey locations

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 18/04/2013

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

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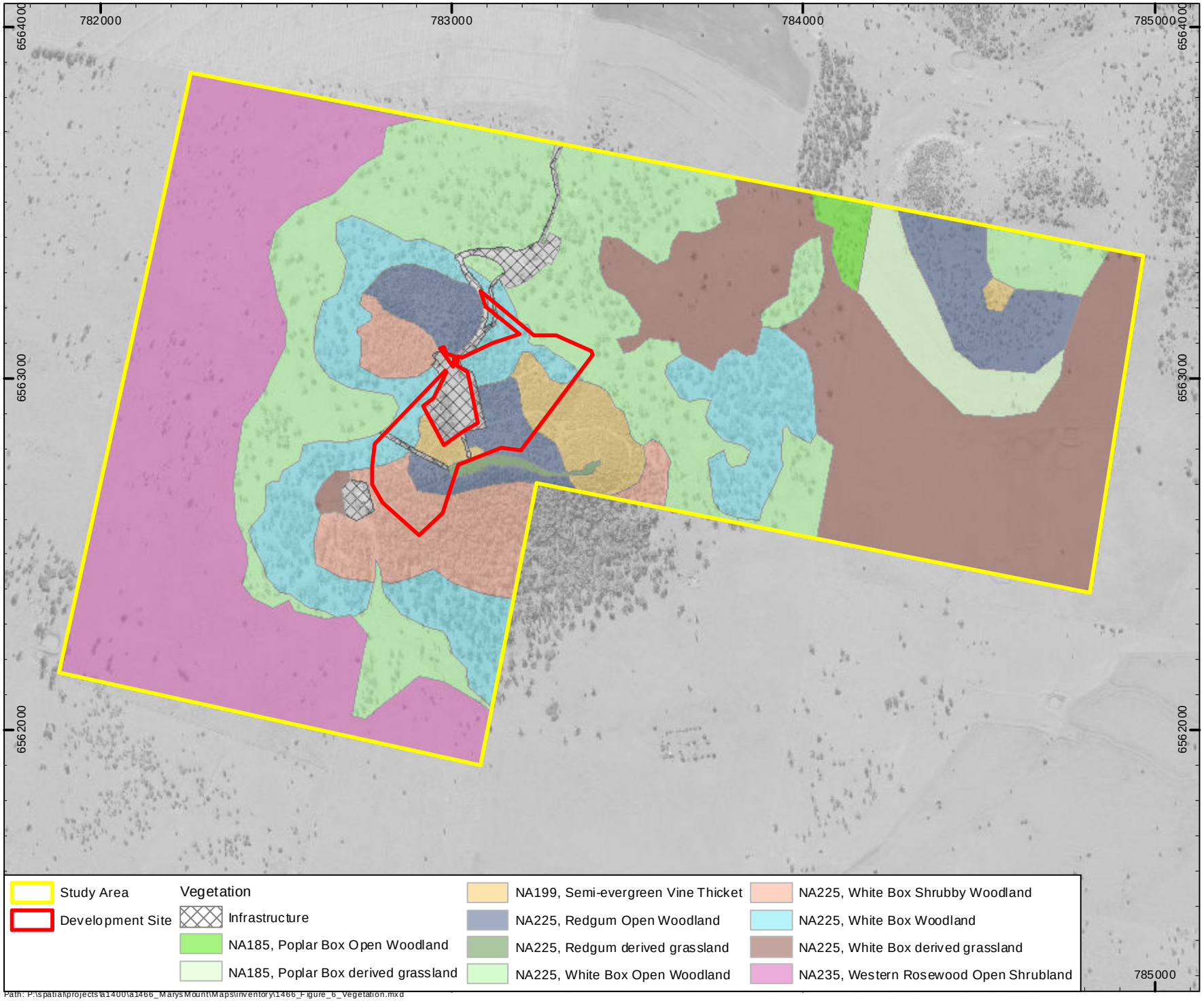

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Figure 6: Native vegetation of the study area

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 18/04/2013

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Horizontal Datum:
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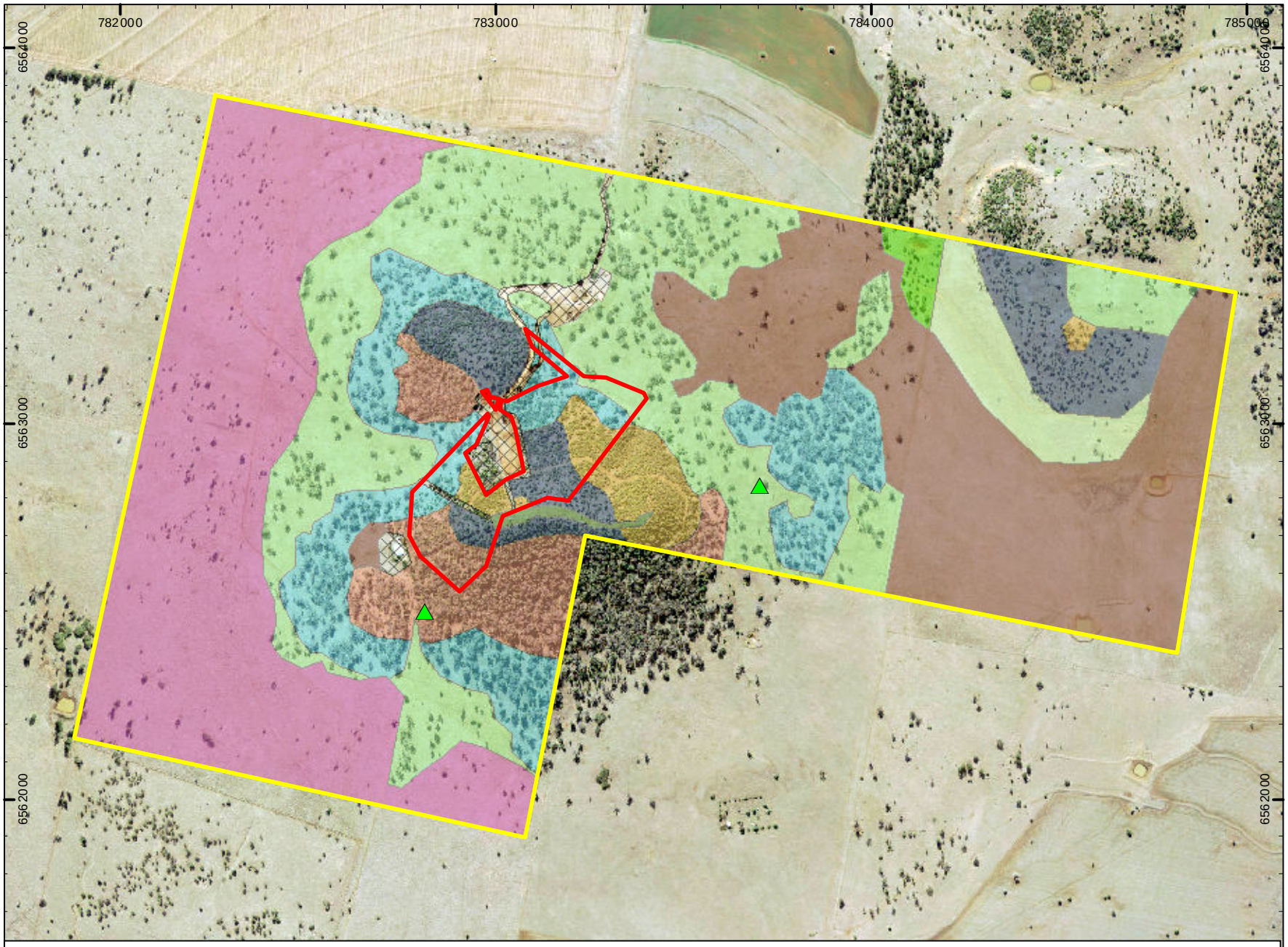

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Figure 7: Threatened flora observations

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 18/04/2013

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Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

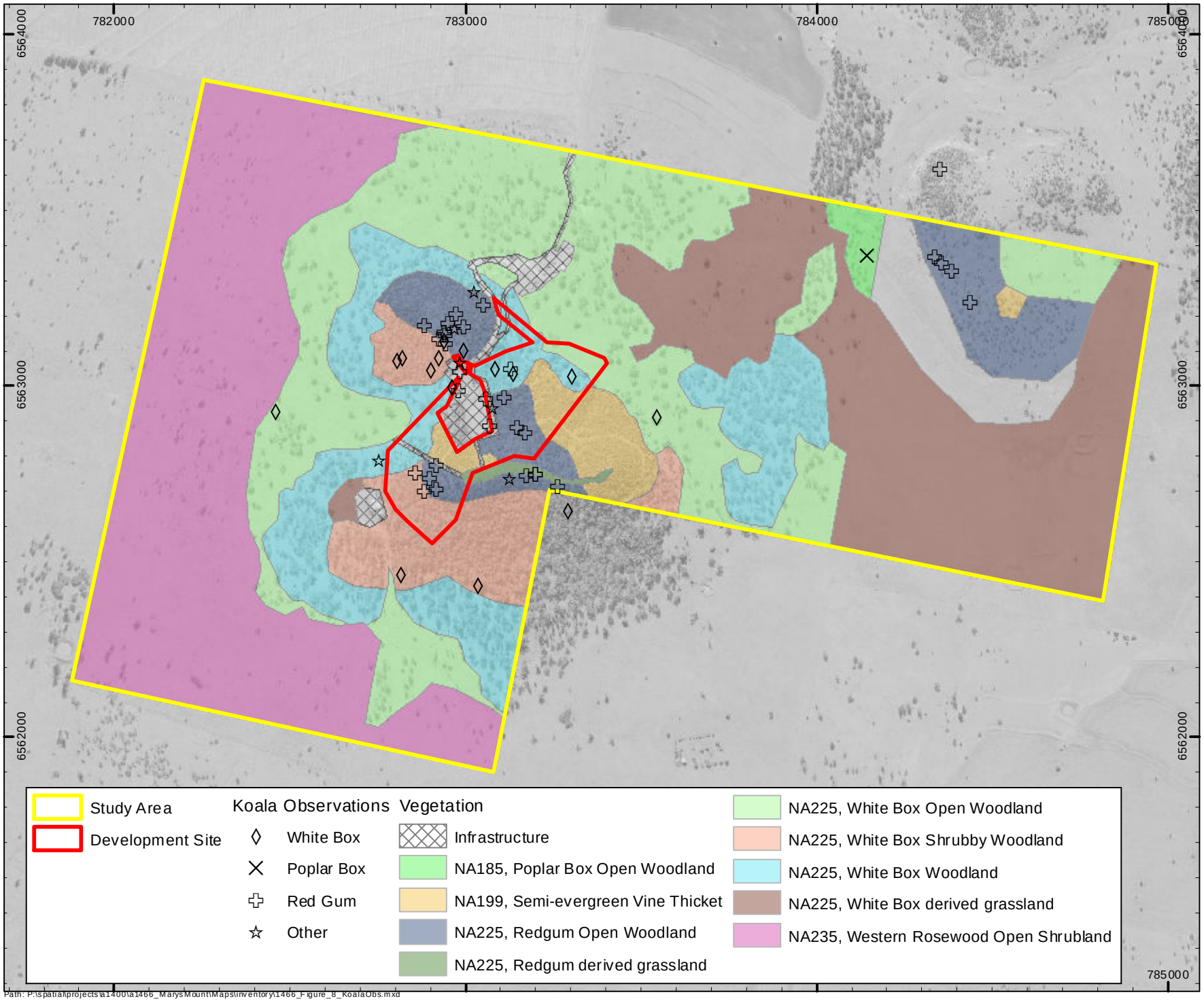

Figure 8: Koala observations

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 18/04/2013

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Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

Path: P:\spatial\projects\a1400\a1466_MarysMount\Maps\Inventory\1466_Figure_8_KoalaObs.mxd

APPENDICIES

Appendix 1: Flora recorded from the study area

Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
Abutilon oxycarpum				2	1						1								1
Acacia implexa												1							
Acacia cheelii				1	1				1							1			1
Ajuga australis						1					2								2
Alectryon oleifolius	1	1		2															
Alphitonia excelsa		1							2							1	1		
Alternanthera pungens								2											
Aristida leptopoda								2										1	
Aristida caput medusae									2	2	2	1		5	4	3			
Aristida ramosa							2	1	2	2	3	2	2		2		4	2	2
Aristida vagans	2	3	2		2	4													
Austrodanthonia bipartita							1	2				2							2
Austrodanthonia racemosa				3									1						1
Austrostipa aristiglumis	1							2										1	
Austrostipa verticillata	4			1		2	1		2		2			2		1			
Austrostipa scabra		2		2	2	2		2			2	2		2				2	2
Beyeria viscosa							2		1							5			
Bidens pilosa	2					2	2		1	1	2	2	1	2	3		2	2	1
Boerhavia dominii	2	1	2	2	2	2	1	3	2	1	2	2		2	2	2	2	2	
Bothriochloa biloba																		2	
Bothriochloa macra								6	2		3	3	1	4	3		3	2	2
Brachychiton populneus													1						
Breynia oblongifolia							1		1	1	1								
Bursaria spinosa											1		2						
Callitris glaucophylla				1	1						3	2	3		3		1		3
Calotis lappulacea		2	1		1	2		2	1		2	2		2	2	1	2	1	2

Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
Capparis mitchelli		1					1		2	2									
Carex inversa					2														
Cenchus caliculatus								2											
Chamaesyce drummondii		1													1			2	2
Cheilanthes distans											2	2							
Cheilanthes sieberi												1	2		1				1
Chloris ventricosa	2	3	2			3					2				2				
Clematis microphylla									1										
Convolvulus erubescens						1													
Cymbopogon refractus					2	1	1		2	2	4	4	2	3	3	2	3	2	1
Cyperus gunnii								2		1									1
Desmodium brachypodum				1	2			2	1				2			1	2	2	1
Desmodium varians													2					2	2
Dichanthium sericeum		2				4											2	3	2
Dichelachne crinita									1										
Dichondra repens	2	2	2	2		2		1		2	2	1	3	2	2			2	2
Digitaria brownii									1		1								
Digitaria breviglumis								2	2	2					2	2			2
Dodonaea viscosa				2	2	1	1		2		2	2	3			1		1	1
Ehretia membranifolia							3		1	2	1					1	2		
Einadia hastata						1	2		2	2						2			
Einadia nutans	2	1	1	2	1	1	1												
Einadia polyginoides							2	2							1			1	1
Einadia trigonos								2			2	2		1	2				
Enneapogon lindleyanus					1						2						2		
Enteropogon ramosus								3										1	
Eucalyptus albens	3	4	3	3	3	4			1				2				1	4	3
Eucalyptus dealbata									3		3	2	1		2				

Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
Eucalyptus populnea								3											
Gallium leptogonium									1										
Geijera parviflora			2	3	3	1	2		3	3	3		1		2	2	2	3	2
Geranium solanderi									1									1	
Glycine canescens								1					2			2			2
Glycine tabacina	2	2		1		2	1		2		2	2	2		2				
Hybanthus filiformis						1													
Indigofera adesmiifolia													3					2	2
Jasminum lineare		2	1	2		2			2	2	1			3		2	2	2	2
Lepidium bonariensis	1	1				1		2											
Lycium ferocissimum		1				1		1											
Marrubium vulgare	1																		
Marsdenia viridiflora	1						1		1	1	1				1		1	1	1
Marsdenia rostrata																1			
Maytenus cunninghamii			2	1															
Mentha satureioides		1	1			2												1	1
Modiola caroliniana								2											
Notelaea microcarpa	1	2	2	2	3	2	5	1	3	5	2	2	2	2	3	2	2	3	3
Opuntia aurantiaca		2	1																
Opuntia stricta	1		1		1	2	1		1	1		1	1		1		2	1	1
Oxalis perrenans	2	1				1	1	2	2	1				1		1		1	2
Pandorea pandorana					1	2	2		2	2	1								
Parsonsia eucalyptophylla								2								2			
Paspalidium gracile	1	2	1	2		2		3	2	2	2	2			2	2	2	2	
Poa sieberiana											2	2	4			2		2	4
Podolepis jaceoides	1																		
Portulaca oleracea								2				1							
Pydrax odorata																2			

Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
Ragodia parabolica									1		1					2			
Rostellularia adscendens				2															1
Rumex brownii	1	2	1	1		2		1						1				1	2
Salvia reflexa								1											
Sclerolaena muricata	1							2											
Senna artemisioides subsp zygophylla		1												1	1				
Sida corrugata					2			2	1			2							
Sida hackettiana								2			2			2	1		1		
Solanum parvifolium	1	2	2	1	1	2	2		2	2	2	1		2	2	1	2	1	1
Solanum sp			1						1										
Spartothamnella juncea							1		2	2	1			1		2	1		
Stackhousia monogyna																			1
Swainsona galegifolia														1				1	
Tragopogon porrifolius		2																	
Tribulus micrococcus	2											2							
Tribulus terrestris								2			2	2		3	2		2		
Vittadinia cuneata		2	1	2	1	1	1				2	2		1					2
Wahlenbergia stricta				1		2		2	1		1	2	1	2	2		2	2	2
Zinnia peruviana	1					1			1	2	2	2		3	3		2		

Appendix 2: Fauna recorded from the study area

Common Name	Scientific Name	Diurnal	Nocturnal	Camera/Audio recordings	Captures
Mammals					
Short-beaked Echidna	*Tachyglossus aculeatus*	1	1		
Common Dunnart	*Sminthopsis murina*	In owl pellet			
Koala (v)	***Phascolarctos cinereus***	**15**	**39**		
Common Brushtail Possum	*Trichosurus vulpecula*		3		
Eastern Grey Kangaroo	*Macropus giganteus*		2	301	
Common Wallaroo	*Macropus robustus*	P	3	129	
Red-necked Wallaby	*Macropus rufogriseus*	P	1	6	
Swamp Wallaby	*Wallabia bicolor*	P	1	464	
Gould's Wattled bat	*Chalinolobus gouldii*			>100	6
Chocholate Wattled bat	*Chalinolobus morio*			>20	2
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			P	18
Gould's Long-eared Bat	*Nyctophilus gouldi*			P	1
Inland Broad-nosed bat	*Scotorepens balstoni*			>50	4
Little Broad-nosed Bat	*Scotorepens greyii*			>100	6
Undescribed Broadnosed Bat	*Scotorepens sp.*			P	2
Little Forest Bat	*Vespadelus vulturnus*			>20	2
Yellow-bellied Sheathtail Bat	***Saccolaimus flaviventris***		**1**	**>100**	
Inland Freetail Bat	*Mormopterus sp3*			>20	
Southern Freetail Bat	*Mormopterus sp4*			>100	1
White-striped Freetail Bat	*Tadarida australis*			>2	
Feral Cat*	*Felis catus*		1		
Red Fox*	*Vulpes vulpes*	P	P	5	
Feral Pig*	*Sus scrofa*	P	6	3	
Birds					
Emu	*Dromaius novaehollandiae*	P			
Stubble Quail	*Coturnix pectoralis*	P			
Brown Quail	*Coturnix ypsilophora*	P			
Australian Wood Duck	*Chenonetta jubata*	P			
Common Bronzewing	*Phaps chalcoptera*	P		26	
Crested Pigeon	*Ocyphaps lophotes*	P			
Peaceful Dove	*Geopelia striata*	P			
Tawny Frogmouth	*Podargus strigoides*	P	2		
Spotted Nightjar	*Eurostopodus argus*		1		
Australian Owlet-nightjar	*Aegotheles cristatus*		2		
Black-shouldered Kite	*Elanus axillaris*	P			
Brown Goshawk	*Accipiter fasciatus*	P			
Nankeen Kestrel	*Falco cenchroides*	P			
Brown Falcon	*Falco berigora*	P			
Masked Lapwing	*Vanellus miles*	P			
Painted Button-quail	*Turnix varius*	P			

Common Name	Scientific Name	Diurnal	Nocturnal	Camera/Audio recordings	Captures
Galah	*Eolophus roseicapillus*	P			
Little Corella	*Cacatua sanguinea*	P			
Sulphur-crested Cockatoo	*Cacatua galerita*	P			
Cockatiel	*Nymphicus hollandicus*	P			
Musk Lorikeet	*Glossopsitta concinna*	P			
Little Lorikeet	*Glossopsitta pusilla*	P			
Australian King-Parrot	*Alisterus scapularis*	P			
Red-winged Parrot	*Aprosmictus erythropterus*	P			
Eastern Rosella	*Platycercus eximius*	P			
Australian Ringneck	*Barnardius zonarius*	P			
Blue Bonnet	*Northiella haematogaster*	P			
Red-rumped Parrot	*Psephotus haematonotus*	P			
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	P			
Pallid Cuckoo	*Cacomantis pallidus*	P			
Eastern Barn Owl	*Tyto javanica*	P	2		
Sacred Kingfisher	*Todiramphus sanctus*	P			
Rainbow Bee-eater (M)	*Merops ornatus*	P			
Dollarbird	*Eurystomus orientalis*	P			
White-throated Treecreeper	*Cormobates leucophaea*	P			
Satin Bowerbird	*Ptilonorhynchus violaceus*	P			
Spotted Bowerbird	*Ptilonorhynchus maculatus*	P			
Superb Fairy-wren	*Malurus cyaneus*	P			
Variegated Fairy-wren	*Malurus lamberti*	P			
Weebill	*Smicrornis brevirostris*	P			
Western Gerygone	*Gerygone fusca*	P			
Yellow Thornbill	*Acanthiza nana*	P			
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	P			
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	P			
Inland Thornbill	*Acanthiza apicalis*	P			
Spotted Pardalote	*Pardalotus punctatus*	P			
Striated Pardalote	*Pardalotus striatus*	P			
Eastern Spinebill	*Acanthorhynchus tenuirostris*	P			
Yellow-faced Honeyeater	*Lichenostomus chrysops*	P			
White-eared Honeyeater	*Lichenostomus leucotis*	P			
Fuscous Honeyeater	*Lichenostomus fuscus*	P			
White-plumed Honeyeater	*Lichenostomus penicillatus*	P			
Noisy Miner	*Manorina melanocephala*	P			
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	P			
Blue-faced Honeyeater	*Entomyzon cyanotis*	P			

Common Name	Scientific Name	Diurnal	Nocturnal	Camera/Audio recordings	Captures
Noisy Friarbird	*Philemon corniculatus*	P			
Little Friarbird	*Philemon citreogularis*	P			
Striped Honeyeater	*Plectorhyncha lanceolata*	P			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	P			
White-bellied Cuckoo-shrike	*Coracina papuensis*	P			
Cicadabird	*Coracina tenuirostris*	P			
White-winged Triller	*Lalage sueurii*	P			
Rufous Whistler	*Pachycephala rufiventris*	P			
Grey Shrike-thrush	*Colluricincla harmonica*	P			
Olive-backed Oriole	*Oriolus sagittatus*	P			
Masked Woodswallow	*Artamus personatus*	P			
White-browed Woodswallow	*Artamus superciliosus*	P			
Grey Butcherbird	*Cracticus torquatus*	P			
Pied Butcherbird	*Cracticus nigrogularis*	P			
Australian Magpie	*Cracticus tibicen*	P			
Pied Currawong	*Strepera graculina*	P			
Grey Fantail	*Rhipidura albiscapa*	P			
Willie Wagtail	*Rhipidura leucophrys*	P			
Australian Raven	*Corvus coronoides*	P			
Leaden Flycatcher	*Myiagra rubecula*	P			
Restless Flycatcher	*Myiagra inquieta*	P			
Black-faced Monarch (M)	*Monarcha melanopsis*	P			
Magpie-lark	*Grallina cyanoleuca*	P			
White-winged Chough	*Corcorax melanorhamphos*	P			
Apostlebird	*Struthidea cinerea*	P			
Jacky Winter	*Microeca fascinans*	P			
Red-capped Robin	*Petroica goodenovii*	P			
Eastern Yellow Robin	*Eopsaltria australis*	P			
Silvereye	*Zosterops lateralis*	P			
Welcome Swallow	*Hirundo neoxena*	P			
Tree Martin	*Petrochelidon nigricans*	P			
Common Starling*	*Sturnus vulgaris*	P			
Mistletoebird	*Dicaeum hirundinaceum*	P			
Double-barred Finch	*Taeniopygia bichenovii*	P			
Red-browed Finch	*Neochmia temporalis*	P			
Australasian Pipit	*Anthus novaeseelandiae*	P			
Reptiles					
Dtella	*Gehyra dubia*		3		
Thick tailed Gecko	*Underwoodisaurus milii*		4		

Common Name	Scientific Name	Diurnal	Nocturnal	Camera/Audio recordings	Captures
Eastern Spiny-tailed Gecko	*Strophurus williamsi*		5		
Tree Skink	*Egernia striolata*	P			
Wall Skink	*Cryptoblepharus sp.*	P			
Bearded Dragon	*Pogona barbata*	P	2		
Lace Monitor	*Varanus varius*	P			
Curl Snake	*Suta suta*		Nearby		
Amphibians					
Green Tree Frog	*Litoria caerulea*		10		
Red Tree Frog	*Litoria rubella*		P		
Spotted Marsh Frog	*Limnodynasties tasmaniensis*		1		

KEY: * = introduced species; bold = listed as vulnerable or migratory under TSC or EPBC Acts; P = present on site but not seen during a formal survey period.

GLOSSARY AND ABBREVIATIONS

GLOSSARY

Direct impacts	Impacts that directly affect the habitat and/or individual plants and animals and cannot be avoided or mitigated. They include, but are not limited to, death through predation, trampling, poisoning of the animal/plant itself and the removal of suitable habitat (DEC 2007).
Indirect impacts	Impacts that affect species, populations or ecological communities in a manner other than through direct loss or disturbance. These can usually be avoided or mitigated. Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas (DECC 2007).
Local occurrence	The distribution of an ecological community within the study area and continuous with it.
Local population	The population that occurs in the study area and contiguous with it.
Locality	The area within 10 km of the study area.
Study area	The site and any additional areas which may potentially be affected by the proposal either directly or indirectly.
Site	The area directly affected by the proposal.
Subject species	List of threatened species considered in the assessment
Threatened biodiversity	Threatened species, populations, ecological communities or their habitats listed on the TSC and/or EPBC Acts.

ABBREVIATIONS

CMA	Catchment management authority
EEC	Endangered ecological community
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPI	Environmental planning instrument
LGA	Local government area
Matters of NES	matters of national environmental significance.
OEH	NSW Office of Environment and Heritage
RDP	Rapid data point
SEPP	State environmental planning policy
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
TEC	Threatened ecological community as listed on the TSC and or EPBC Acts. Includes vulnerable, endangered and critically endangered ecological communities.
TSC Act	NSW *Threatened Species Conservation Act 1995*

Appendix B: Koala Plan of Management

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KOALA PLAN OF MANAGEMENT

Mary's Mount Blue Metal Gravel Quarry

May 2013

DOCUMENT CONTROL

Business unit	Niche Environment and Heritage - /Hunter Office		
Project no.	1466		
Document description	Koala Plan of Management		
	Name	**Signed**	**Date**
Supervising manager(s)	Rod Kavanagh		11 May 2013

Person managing this document	**Person(s) writing this document**
Mark Aitkens	Mark Aitkens, Rhidian Harrington

Document revision no.	**Date prepared**	**Reviewed by**	**Date**
Rev0	11/05/2013	Rhidian Harrington	13 May 2013

Prepared for:	**Organisation**
	Gunnedah Quarry Products Pty Ltd

Front cover photograph: Koala (*Phascolarctos cinereus*) in Tumbledown Red Gum (*Eucalyptus dealbata*) at the Mary's Mount Gravel Quarry site.

EXECUTIVE SUMMARY

Context

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Gunnedah Quarry Products Pty Ltd (GQP) to prepare a Koala Plan of Management (KPoM) describing the way in which a proposed Mary's Mount Blue Metal Quarry (the Project) would be managed to protect Koala habitat.

Aims

This KPoM aims to document the regional and local significance of the area for Koala conservation, to describe the vegetation types present within the project area and their relative importance as habitat for the Koala, and to discuss the actions required to protect Koala habitat. This KPoM is intended to satisfy the requirements of NSW State Environment Planning Policy, Koala Habitat Protection (SEPP 44)as a site specific plan and will have regard for any overlap with other relevant plans, regulations and legislation le.

Methods

The number of Koala individuals, their distribution within the project area and habitat preference were estimated using a combination of direct observation of the animals while spotlighting at night, direct observation the day, and by searching for Koala faecal pellets near the base of a large sample of trees. These observations and sampling efforts were distributed across, and stratified by, the vegetation types in the project area. Spotlighting and pellet searches were conducted during 16-18 January 2013 and 4-8 March 2013. The significance of this population was assessed in relation to the distribution of records and habitat connectivity and extent within the surrounding area and region.

Key Results

Eighteen individual Koalas, including at least one adult female with dependent young, were recorded in the project area during simultaneous observations. Another animal was observed outside of the project area, but within 250 m. Habitat area was used to estimate the total number of Koala individuals in the project area, which is approximately 30 animals. Most Koalas were observed in one particular tree species, Tumbledown Red Gum *Eucalyptus dealbata*, and this tree species was by far the most commonly utilised tree based on the results of faecal pellet searches. Other tree species used occasionally were White Box *E. albens*, Poplar Box *E. populensis*, White Cypress Pine *Callitris glaucophylla* and Wilga *Geijera parviflora*. The most important (core) habitat for the Koala (Red Gum Open Woodland) is limited in extent, occurring within only 6.2% of the project area.

Management

The protection of preferred Koala habitat and Koala individuals would be achieved as follows:

- Removal of livestock grazing from retained vegetation;
- Targeted use of fire to stimulate the regeneration of overstorey species;
- Selective revegetation of 45 hectares of currently cleared and partly cleared lands;
- Use of Tumbledown Red Gum and White Box in progressive rehabilitation;

- ❒ Use of pre-clearence surveys; and
- ❒ Management of Tiger Pear and use of fencing to limit Koala injury.

These management actions would increase the area of suitable habitat available for the Koala within the project area and provide improved connectivity with areas currently occupied by the species on adjacent properties. A program to monitor the effectiveness of these measures will also be implemented.

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Gunnedah Quarry Products Pty Ltd (GQP) to prepare a Koala Plan of Management (KPoM) for the proposed expansion of the Marys Mount Blue Metal Gravel Quarry (the Project).

1.1 The Project

This KPoM is to accompany a Development Application (DA) that is to be assessed by Gunnedah Shire Council and the NSW Department of Planning and Infrastructure (DoPI) under Part 4 of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act). The Project has also been declared a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 28/11/2012 (referral reference number: 2012/6603).

1.1.1 Location

The Project is located approximately 28 km west-southwest of Gunnedah, NSW (Figure 1). The Project comprises areas referred to as the 'site' or 'development area', 'study area' and 'project area'. Definitions for these are as follows:

- Site - the area where direct impacts from the quarry is expected;
- Study area - the investigation area used to prepare this KPoM; and
- Project area - the area including direct and indirect impacts and lands where management actions are proposed.

The boundary that defines the Project area is currently the subject of a subdivision application and is an area contained within the study area boundary.

1.1.2 Background

The Project involves the expansion of the previously approved Marys Mount blue metal gravel quarry covering an operational area of approximately 6.6 ha. The proposed expansion, as described in the Environmental Impact Statement (Stewart Surveys, 2013), was for an impact area of 39 hectares. This has since been revised to an impact area of 14.6 hectares following the findings of recent biodiversity surveys (Niche, 2013). The revised Project reflects the need to avoid impacts on listed threatened species and ecological communities.

The Project would involve the staged clearing of native vegetation over a 36 year period. The native vegetation to be cleared has been identified as containing core Koala habitat due to the presence of breeding Koala individuals (Niche, 2013). Developments that impact core Koala habitat require the implementation of an approved KPoM prepared in accordance with the NSW *State Environmental Planning Policy No. 44 - Koala Habitat Protection* (SEPP 44).

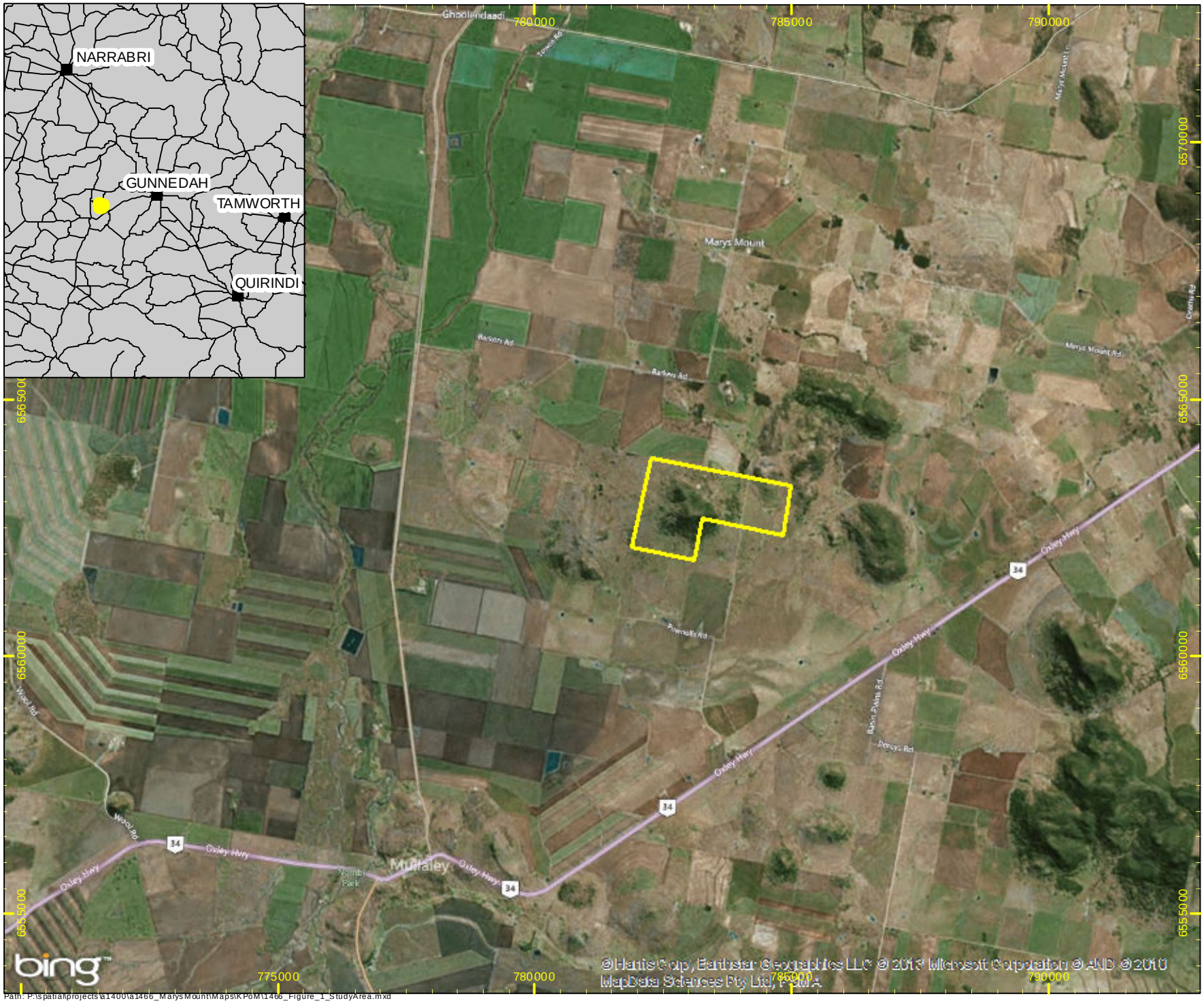

Figure 1: Project location

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 19/04/2013

Study Area

N
W
E
S

km
0 1 2 3 4

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Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Path: P:\spatial\projects\a1400\a1466_MarysMount\Maps\KPoM\1466_Figure_1_StudyArea.mxd

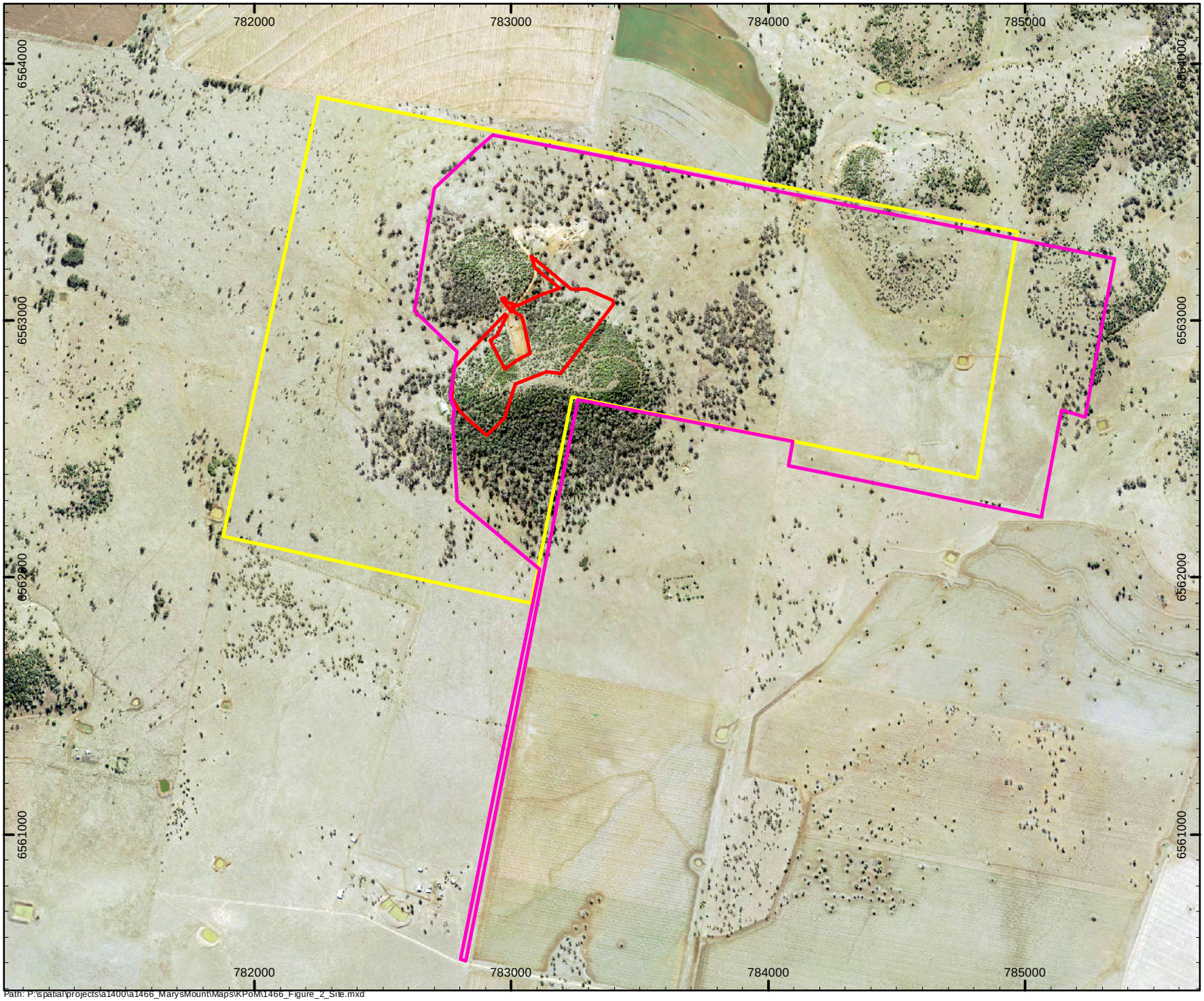

Figure 2: Development site, study area and project area

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

- Project Area
- Study Area
- Development Site

N
W E
S

Metres
0 200 400 600 800

niche
Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

Path: P:\spatial\projects\a1400\a1466_MarysMount\Maps\KPoM\1466_Figure_2_Site.mxd

1.1.3 Biophysical context

The Project is proposed to take place within an overall study area of 367 ha, approximately 17.5% of which is forest/woodland, 30.2% open woodland, 28.7% native shrubland and 23.7% derived native grassland (Figure 2). Most of the impact from the proposal would occur within the forest or woodland vegetation types.

1.1.4 Staging

The Project would operate over three successive stages for an estimated 36 year period. Vegetation removal during these stages is outlined as follows:

Stage 1 - Years 1 to 12

Years 1 – 5 Approximately 2.3 hectares of vegetation removal.

Years 5 – 12 Approximately 4.3 hectares of vegetation removal.

Stage 2 - Years 12 to 23

Year 12 Approximately 1.5 hectares of White Box Woodland.

Stage 3 – Years 23-36

Remainder of vegetation would be removed comprising approximately 6.5 hectares of native vegetation.

The final landform would be subject to progressive rehabilitation using native species consistent with current native vegetation cover. Efforts to re-establish vegetation similar to Semi-evergreen Vine Thicket and tumbledown red gum dominated vegetation would form the focus of this rehabilitation work.

1.2 Statutory requirements

The Project is currently being assessed in accordance with Part 4 of the EP&A Act. Through this assessment it was determined that the site constitutes core Koala habitat as per the definition provided in SEPP 44 and, as such, a site-specific KPoM is required where a comprehensive KPoM does not apply.

1.2.1 SEPP 44

SEPP 44 aims to encourage the 'proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline'. SEPP 44 contains matters for consent authorities to consider in the assessment of impacts on Koalas for development proposals subject to Part 4 of the EP&A Act.

Circular B35 (NSW Department of Planning) was issued in 1995 to provide guidelines on the interpretation of SEPP 44. These guidelines state that 'the aim of the policy will be achieved by ensuring that:

i) For any development application (DA) to which the policy applies, consent is not issued without investigation of the presence of core Koala habitat.

"Core Koala habitat" is defined in the policy (clause 4) as "an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young), and recent sightings of and historical records of a Koala population".

ii) That any identification of core Koala habitat will require that a plan of management must accompany any DA relating to such areas before Council can consider the granting of consent.'

This KPoM has been prepared with reference to the above aims and the Director Generals guiding principles for the preparation of such plans.

1.2.2 TSC Act

The NSW *Threatened Species Conservation Act 1995* (TSC Act) provides legal status for biota of conservation significance in NSW. The Act aims to, *inter alia*, 'conserve biological diversity and promote ecologically sustainable development'. It provides for:

- The listing of 'threatened species, populations and ecological communities', with endangered species, populations and communities listed under Schedule 1, 'critically endangered' species and communities listed under Schedule 1A, vulnerable species and communities listed under Schedule 2;
- The listing of 'Key Threatening Processes' (under Schedule 3);
- The preparation and implementation of Recovery Plans and Threat Abatement Plans;
- Requirements or otherwise for the preparation of Species Impact Statement (SIS); and
- Requirements or otherwise for the preparation of BioBank Statements or BioBanking Agreements (Part 7A Biodiversity Banking and Offsets Scheme).

The Koala, which is listed as Vulnerable on the TSC Act, is the subject of this KPoM. An impact assessment for this species has been assessed in accordance with Part 7A of the TSC Act (Biodiversity Banking and Offsets Scheme).

1.2.3 EPBC Act

The purpose of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to ensure that actions likely to cause a significant impact on 'matters of national environmental significance' (MNES) undergo a process of assessment and approval. Under the EPBC Act, an action includes a project, undertaking, development or activity. An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities (SEWPaC).

The EPBC Act identifies MNES as:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;

- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

The proposed development has been deemed a controlled action (ref: 2012/ 6603) under Section 75 and Section 87 of the EPBC Act with the relevant controlling provisions being *listed threatened species and communities* (sections 18 & 18A). The decision on the assessment approach is preliminary documentation. A request for additional information is provided in a letter dated 4/12/2012 from SEWPaC, which states *inter alia*:

> 1. Detailed, on ground, flora and fauna surveys targeting EPBC Act listed threatened species and ecological communities, especially:
>
> 1.2 Habitat and population surveys for the Koala (*Phascolarctos cinereus*) (combined populations of QLD, NSW and the ACT) in and around the proposed quarry site.

An impact assessment for the Koala has been undertaken to satisfy SEWPaC's assessment requirements specified to this controlled action. The KPoM would integrate with the mitigation and monitoring recommended in that assessment.

1.2.4 Local planning instruments

Greenloaning Biostudies (2013) have prepared a Draft Comprehensive KPoM (CKPoM) for the Gunnedah LGA on behalf of Gunnedah Shire Council. The CKPoM seeks to ensure that a permanent free-living population of Koalas will continue to occur over the present range into the future and integrate Koala habitat conservation into local and state government planning.

1.3 Purpose, aims and objectives

The purpose of this KPoM is to protect preferred Koala habitat that is known to be used by Koala individuals of the Mary's Mount locality. The following aims and objectives define how the purpose of the KPoM would be achieved.

1.3.1 Aims

The following aims define this KPoM:

- Protect retained Koala habitat within the Project area throughout the duration of the quarry operational period (estimated to be 36 years);
- Deliver a maintain outcome through each Project stage by establishing compensatory Koala habitat prior to anticipated habitat losses of the following development stage; and
- Deliver an improve outcome by the end of the expected quarry operational period (i.e. 36 years) through an increase in the availability of preferred Koala habitat for Koala's within the locality.

The successful achievement of the above aims would be determined through an analysis of monitoring data collected during the implementation of this KPoM. Monitoring data would be assessed against predefined key performance criteria established for each of the three development stages. This is the basis for an adaptive management framework designed to maximise the likelihood of this plan meeting its purpose.

1.3.2 Objectives

The objective of this KPoM is to adequately address the requirements of SEPP 44, in particular clause 17 of the policy. Clause 17 states that such plans are to be prepared with reference to the Director Generals guidelines. These guidelines are outlined as follows:

- Provide an estimate of the Koala population size;
- Identification of preferred feed tree species for the locality and the extent of resource available;
- An assessment of the regional distribution of koalas and the extent of alternative habitat available to compensate for that to be affected by the actions;
- Identifications of linkages of core koala habitat to other adjacent areas of habitat, movement of koalas between areas of habitat. Provision of strategies to enhance and manage these corridors;
- Identification of major threatening processes such as disease, clearance of habitat, road kill and dog attack which impact on the population. Provision of methods for reducing these impacts;
- Provision of detailed proposals for amelioration of impacts on koala populations from any anticipated development within zones of core koala habitat;
- Identification of any opportunities to increase size or improve condition of existing core koala habitat, and this should include land adjacent to areas of identified core koala habitat;
- The plan should state clearly what it aims to achieve (for example maintaining or expanding the current population size or habitat area);
- The plan should state the criteria against which achievement of these objectives is to be measured (for example, a specified population size in a specific time frame or the abatement of threats to the population); and
- The plan should also have provisions for continuing monitoring, review and reporting. This should, include an identification of who will undertake further work and how it will be funded.

The KPoM would include, where relevant, information and guidance from the following:

- CKPoM (Greenloaning Biostudies 2013);
- Relevant EPBC Act assessments;
- The Approved Recovery Plan for the Koala (*Phascolarctos cincereus*) (DECC 2008); and
- The National Koala Conservation and Management Strategy 2009-2014 (National Resource Management Ministerial Council 2009).

1.4 Stakeholder consultations

The Gunnedah Shire Council was approached and invited to advise Niche of any specific or additional issues that may be relevant to this proposal and which should be taken into consideration in the preparation of a KPoM for the site. Council's response identified a requirement to consider the draft Comprehensive Koala Plan of Management for the Gunnedah local government area (Greenloaning Biostudies 2013).

2 REGIONAL AND LOCAL CONTEXT

2.1 Overview

Koalas are scattered throughout the local landscape but their continued viability is likely to depend on the protection of the remaining vegetated areas of preferred habitat, the creation of new or supplementary habitat and improved connectivity between areas of suitable habitat. Factors considered important in the protection of Koala habitat in the locality are discussed in the following sections.

2.2 Regional

2.2.1 Biogeography

The topography of the project area is dominated by two low, forested hills that contrast with most of the surrounding, predominantly cleared, flat landscape. These forests and woodlands are dominated primarily by White Box *Eucalyptus albens* with varying understorey structure and plant species composition. The steeper, rocky slopes are characterised by closed shrublands grading to open shrublands, and open woodlands where Tumbledown Red Gum (*Eucalyptus dealbata*) is the dominant tree species, which has been observed growing on northern aspects and on exposed hilltops. A summary of the biogeographical features relevant to the study area is provided in Table 1.

Table 1. Biogeographical context of the study area

Geographical Feature	Description
Bioregion	Brigalow Belt South
Catchment management authority	Namoi
Sub-catchment	Liverpool Plains Part B
Mitchell Landscape	Nombi Plateau and Pinnacles
Local government area	Gunnedah local government area
Watercourses	n/a
Nearby conservation areas	Pilliga Nature Reserve

2.2.2 Land use

The Liverpool Plains region of northern NSW has been extensively cleared for grazing and cropping. This is in part due to the geology of the area, which includes basalt from mafic extrusives (Garawilla volcanics). Rich soils derived from this basalt are intensively farmed to grow wheat, sorghum, sunflowers, maize and cotton (Figure 1).

2.2.3 Koala records

The Gunnedah LGA is well known as a 'hot spot' for Koalas in NSW (Smith 1992, Lunney *et al*. 2009, Kavanagh and Stanton 2012), as are the adjacent Pilliga forests (Kavanagh and Barrott 2001). This is supported by 798 location records for the Koala (many of which included multiple animals at the same location) within a 50 km radius of the study area

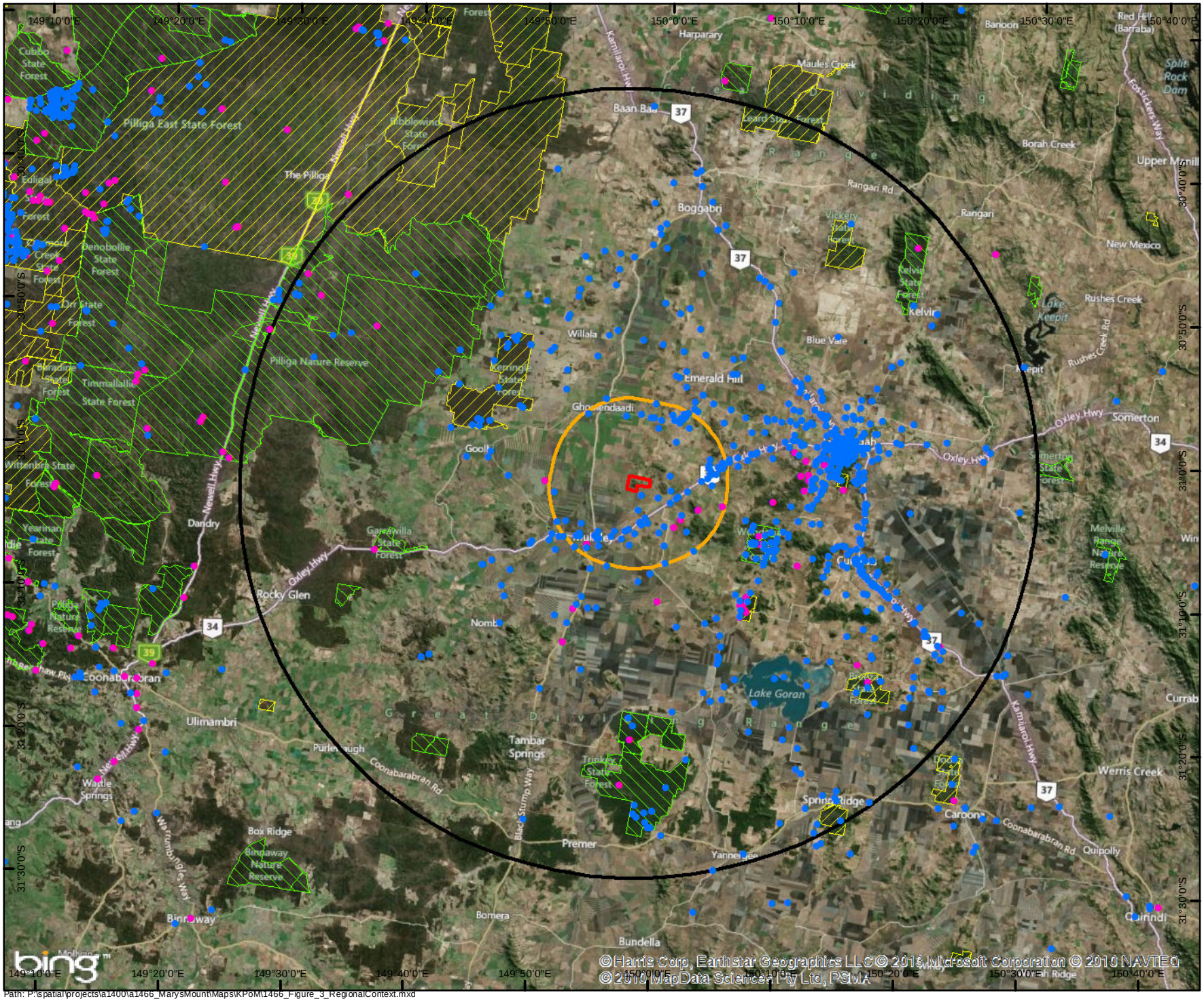

Figure 3: Regional Context

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

- Koala => yr 2000
- Koala < yr 2000
- 50kmSearch
- 10kmSearch
- Study Area
- Conservation Areas
- State Forest

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Horizontal Datum:
GDA 1994 MGA Zone 55

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(BioNet search, April 2013: OEH Atlas of NSW Wildlife, Figure 3). Most of these were recent records with 94.5% observed since 2000.

Location records indicate that the Koalas is widespread throughout the region although many records appear strongly biased to those areas frequented by people (i.e. Gunnedah and the main roads leading into and out of Gunnedah). This suggests that the mapped distribution of records is unlikely to be a true representation of Koala distribution in the region.

2.2.4 Koala habitat

Koala habitat throughout the Gunnedah area is generally associated with the regional vegetation community "White Box – Pine – Silver-leaved Ironbark shrubby open forests, Brigalow Belt South and Nandewar" (Namoi CMA 2013). According to ELA (2007), this vegetation is widespread and common throughout the region.

Lunney *et al*. (2012) and Smith (1992) identify the following tree species as important for feed and shelter on the Liverpool Plains; *Eucalyptus albens* (white box), *E. camaldulensis* (river red gum), *E. blakelyi* (Blakely's red gum), *E. dealbata* (tumbledown red gum), *E. populnea* (poplar box), *E. crebra* (narrow-leaved ironbark), *E. pilligaensis* (narrow-leaved grey box), *E. melliodora* (yellow box), *Casuarina cristata* (belah) and *Callitris glaucophylla* (white cypress pine).

2.3 Locality

Vegetation mapping and recent satellite imagery show the study area as part of a larger area of variously connected native vegetation surrounded by intensively cropped lands. This area is defined by a line linking Mullaley, Boggabri, Gunnedah, Breeza and Lake Goran and comprises an estimated 42,492 hectares of preferred Koala habitat (Greenloaning Biostudies 2013). The surrounding cropped lands are, for the purposes of this plan, considered barriers that would substantially limit the movement of individual Koalas into adjacent parts of the region such as the Pilliga.

2.3.1 Koala records

The native vegetation within a 10 km radius of the site, and indeed for the broader Liverpool Plains region, has been extensively cleared for cropping and grazing. This clearing has greatly reduced the amount of habitat available for the Koala in the local area and region. Koalas are now largely restricted to the remaining areas of native vegetation in the landscape, whether this occurs as strips of remnant trees along roadsides, remnant trees and sparse woodland in paddocks, or larger patches of remnant forest and woodland.

The Koala records within the local area (i.e. 10 km radius of the study area) confirm the above described occurrence. Many of these records are located along roads and other areas frequented by people. Although no records of the Koala have been previously reported from the project study area, there are several recent records within 3 km (Figure 4).

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Figure 4: Local context

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

- Koala => yr 2000
- Koala < yr 2000
- 10kmSearch
- Study Area
- Conservation Areas
- State Forest

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Horizontal Datum:
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2.3.2 Koala habitat

Gunnedah area

An area estimate of the available preferred Koala habitat in the Gunnedah area has been defined by Greenloaning Biostudies (2013). Preferred Koala habitat in the Gunnedah area includes:

- 1,508 hectares of primary habitat;
- 682 hectares of secondary habitat (class A);
- 15,006 hectares of secondary habitat (class A-B); and
- 25,296 hectares of secondary habitat (class B).

An estimated 42,492 hectares of preferred Koala habitat or *habitat critical to the survival of the species* (SEWPaC 2012) is estimated to occur within the Gunnedah area. The study area has been mapped as secondary habitat (class B) and would by definition be classed as *habitat critical to the survival of the species* (SEWPaC 2012).

Study area

Niche (2013) has previously mapped the native vegetation within the study area (Figure 5). The area of each vegetation type and its structural form is provided in Table 2.

Table 2. Spatial extent of mapped vegetation types in relation to NSW Vegetation Types within the study area

Vegetation Community [NSW Vegetation Type] (OEH 2012)	Grassland (ha)	Shrubland (ha)	Open Woodland (ha)	Woodland (ha)	Total (ha)
White Box [NA225]	73.06	0	83.40	62.96	**220.83**
Red Gum [NA225]	1.08	0	22.68	0	**22.36**
Semi-evergreen Vine Thicket [NA199]	0	9.92	0	0	**9.92**
Poplar Box [NA185]	11.34	0	2.62	0	**13.96**
Western Rosewood [NA235]	0	93.40	0	0	**93.40**
Total	**85.48**	**103.32**	**108.7**	**62.96**	**360.46**

This mapping identifies a Red Gum plant community dominated by Tumbledown Red Gum, which is known to occur in the Mullaley area (Benson *et al* 2010). This vegetation has been confirmed as preferred Koala habitat and is the most favoured Koala foraging habitat within the study area (Niche 2013).

Vegetation mapped as White Box Woodland represents a second type of preferred Koala habitat. This conforms to the regional vegetation community described as "White Box – Pine – Silver-leaved Ironbark shrubby open forests, Brigalow Belt South and Nandewar". This vegetation type is less preferred than the Tumbledown Red Gum and approximately fewer foraging Koala individuals were observed in this vegetation.

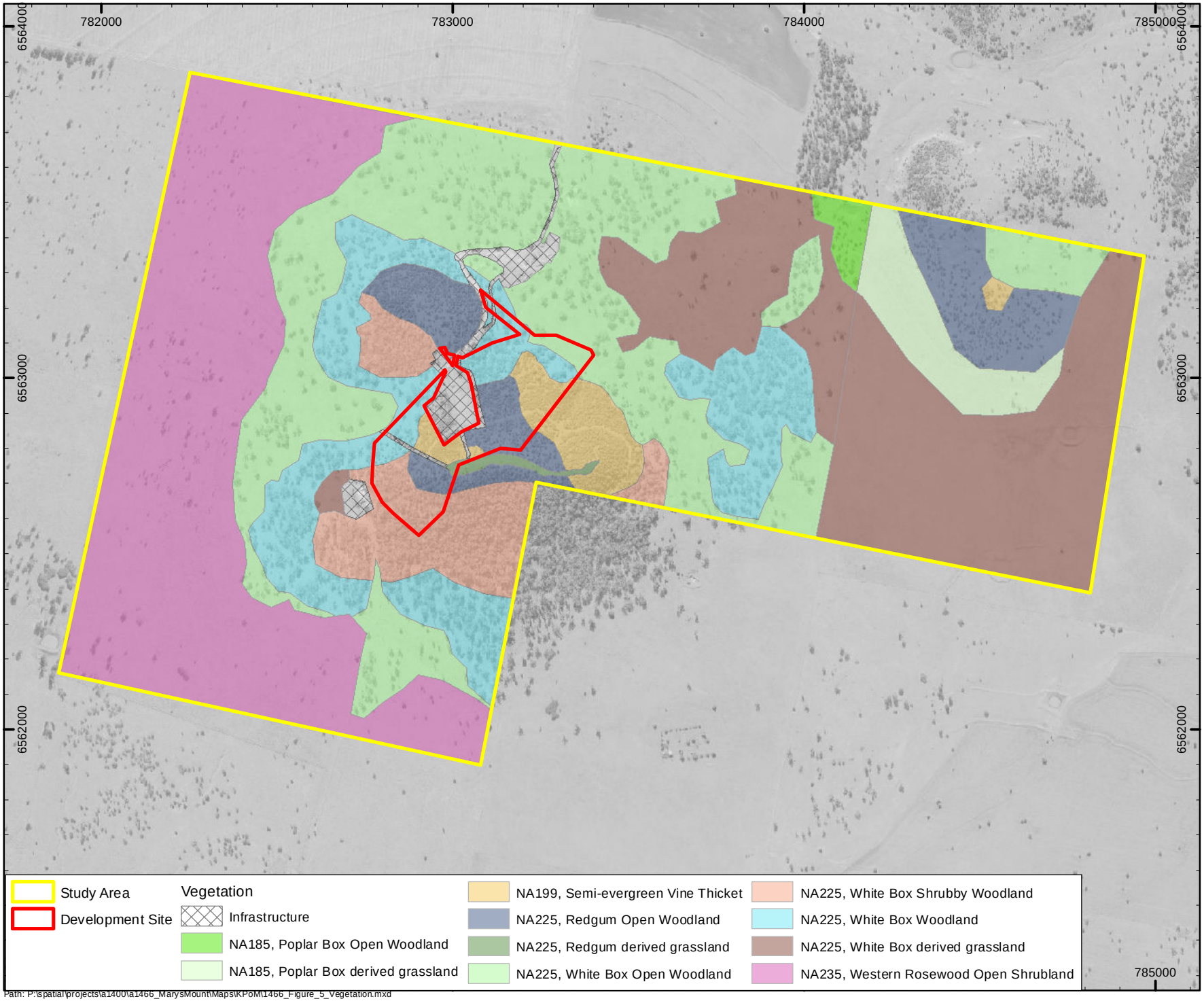

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Figure 5: Native vegetation of the study area

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 14/05/2013

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Metres
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Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

2.4 Corridors and habitat connectivity

Connectivity from the study area for Koalas is principally limited to the vegetated hills to the northeast and east. Limited connectivity also occurs to the southeast to the vegetated hills south of the Oxley Highway. Connectivity to the north, south and west is highly limited or non-existent due to the presence of cleared grazing and cropping lands.

Some connectivity exists beyond the hills to the east of the study area along the road reserve of the Oxley Highway and through native grasslands with isolated trees. Koala records indicate that the Oxley Highway provides some level of connectivity between the study area and vegetated areas to the east near Gunnedah and, to a lesser extent, to the west near Mullaley.

3 THE KOALA IN THE STUDY AREA

The following sections outline the Koala habitat values of the study area including an estimate of the number of individuals within this area.

3.1 Koala counts

The number of Koalas within the study area is likely to be within the range of 18 to 40 animals. A reasonable estimate of the number of individuals within the study area is likely to be about 30 Koalas. Investigations and analysis supporting this estimate are detailed in the following sections.

3.1.1 Spotlighting counts

Spotlight searches were undertaken at night for Koalas using walked area-searches within patches of approximately 2-4 ha that were designed to sample each of the major vegetation types that were present in the study area (Niche 2013; Figure 6). A simultaneous count using four observers was conducted on one night and the locations of this sampling effort are also shown in Figure 6.

Eight plots were spotlighted on 16th and 17th January 2013 during which 7 and 10 Koalas, respectively, were observed. A further 14 plots were spotlighted on 4th, 5th, 6th and 7th March 2013 during which 6, 18, 0 and 0 Koalas, respectively, were observed. In summary, 22 plots totalling 72 ha were spotlighted and 41 Koalas were observed (Figure 7; Niche 2013). Estimates of Koala density in the study area ranged between 0 and 1.14 animals per ha, depending on vegetation type (Table 3). These data provide a plausible, but likely upper, estimate of 40 Koalas inhabiting the study area. This estimate should be viewed with caution because certain widespread vegetation types may have had an undue influence given the low numbers of animals recorded in them.

A simultaneous count by four observers on one night (5th March 2013) spotlighted 19 ha and recorded 18 individual Koalas within the study area (Figure 7; Niche 2013). Two of these animals included an adult female accompanied by a large, but dependent, young.

Table 3. Distribution of nocturnal spotlighting records of the Koala by vegetation type in the project area and estimated number of individuals

Vegetation Type	Koala Records	Area Searched	Density (#/ha)	Available hectares	Predicted total Koalas
Red Gum Woodland (upper)	25	22	1.14	11.13	12.6
Red Gum Woodland (lower)	0	4	0.00	11.55	0.0
White Box Shrubby Woodland	11	16	0.69	20.96	14.4
White Box Woodland	3	12	0.25	42.00	10.5
White Box Open Woodland	0	8	0.00	83.40	0.0
Semi-evergreen Vine Thicket	0	4	0.00	9.92	0.0
Rosewood Open Shrubland	0	4	0.00	93.40	0.0
Poplar Box Open Woodland	2	2.3	0.87	2.30	2.0
Total	**41**	**72**	**0.57**	**275**	**40**

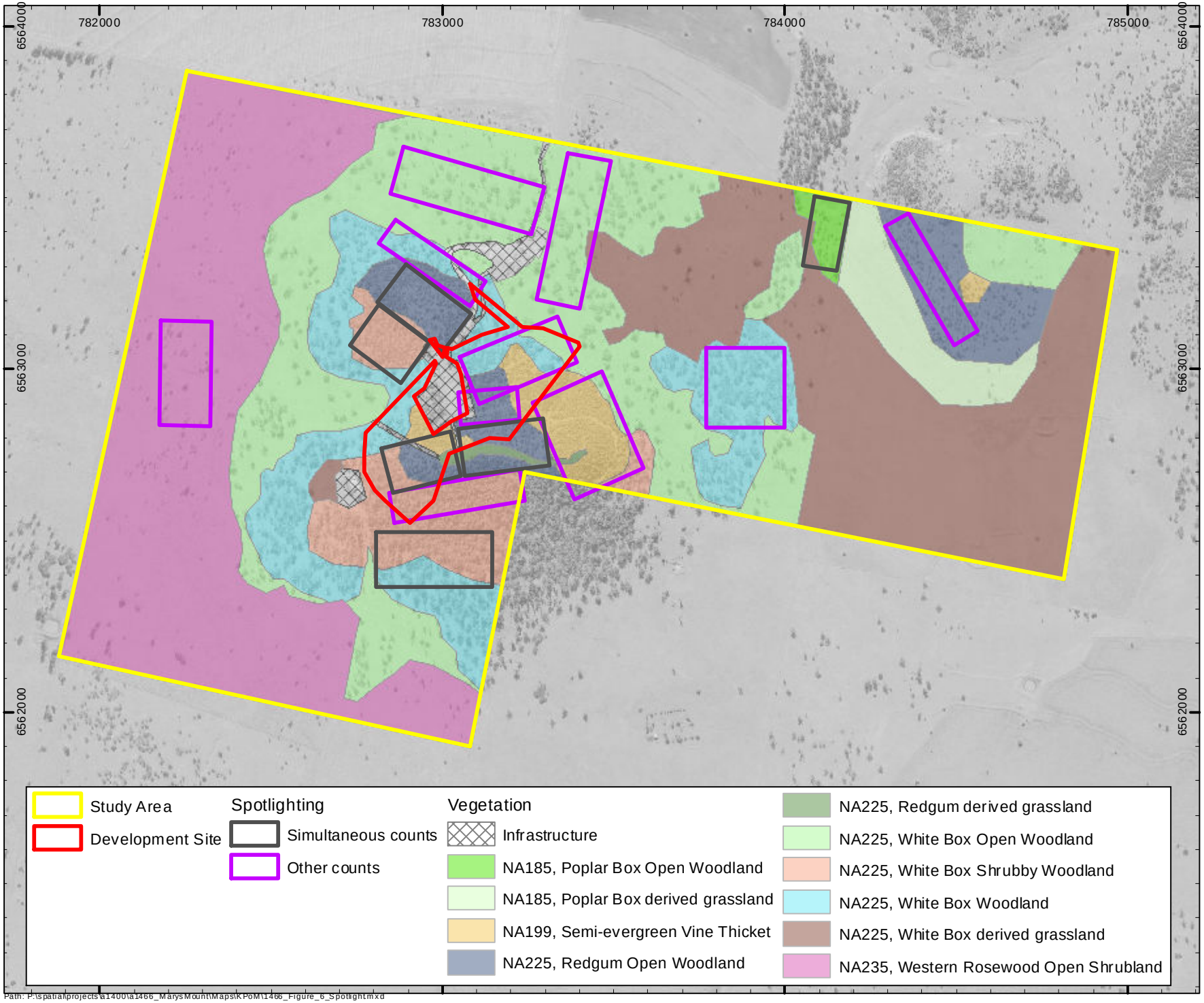

Figure 6: Spotlight sampling effort

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 19/04/2013

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Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

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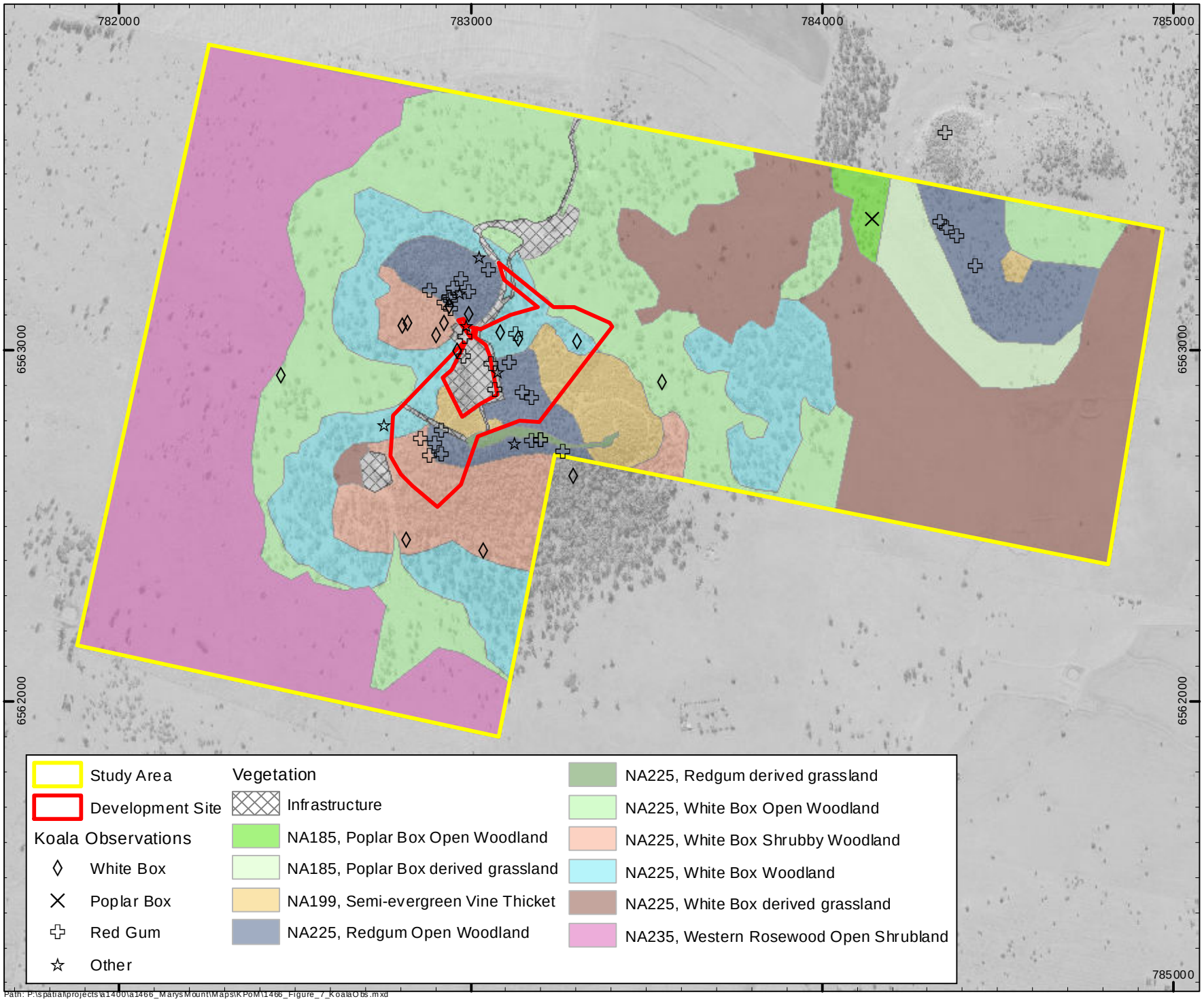

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Figure 7: Koala observations

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 19/04/2013

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Horizontal Datum:
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Imagery:
(c) 2007 LPI

Table 4. Distribution of nocturnal spotlighting records of the Koala by vegetation type during simultaneous counts by four observers on 5 March 2013

Vegetation Type	Koala Records	Area Searched	Density (#/ha)	Available hectares	Predicted total Koalas
Red Gum Woodland (upper)	12	10	1.20	11.13	13.4
White Box Shrubby Woodland	4	7	0.57	20.96	12.0
Poplar Box Open Woodland	2	2.3	0.87	2.30	2.0
Total	**18**	**19**	**0.95**	**34.39**	**27.4**

3.1.2 Faecal pellet surveys

A total of 486 trees located within 17 plots distributed throughout the study area were searched for evidence of Koala faecal pellets (Niche 2013; Figure 8). The plot sampling method involved a two minute search within a 1 m radius around the base of at least 30 trees (Phillips and Callaghan 2011). Plots varied size (area), depending on tree density.

The number of trees where Koala faecal pellets were observed was expressed as a percentage of the number of trees sampled and termed "activity level". Activity level averaged across all plots in each vegetation type ranged from 9% to 83% (Figure 8; Table 5). Vegetation types comprising few, or very sparse, eucalypt trees were not sampled. When these data were inspected by tree species, 81% of all Red Gum trees sampled were found to have Koala faecal pellets near their base (Figure 9). Comparative data were 58% for Poplar Box and 18% for White Box (Figure 9). Activity levels greater than 33-47% are regarded as being indicative of high Koala density (Phillips and Callaghan 2011).

Table 5. Koala activity in the project area, based on faecal pellet counts

Vegetation Type	Plots sampled	Trees sampled	% of trees used	Hectares available
Red Gum Woodland (upper)	6	193	83%	11.13
Red Gum Woodland (lower)	1	31	16%	11.55
White Box Shrubby Woodland	3	87	28%	20.96
White Box Woodland	3	60	13%	42.0
White Box Open Woodland	3	80	9%	83.4
Poplar Box Open Woodland	1	35	60%	2.3
Total	**17**	**486**	**46%**	**171**

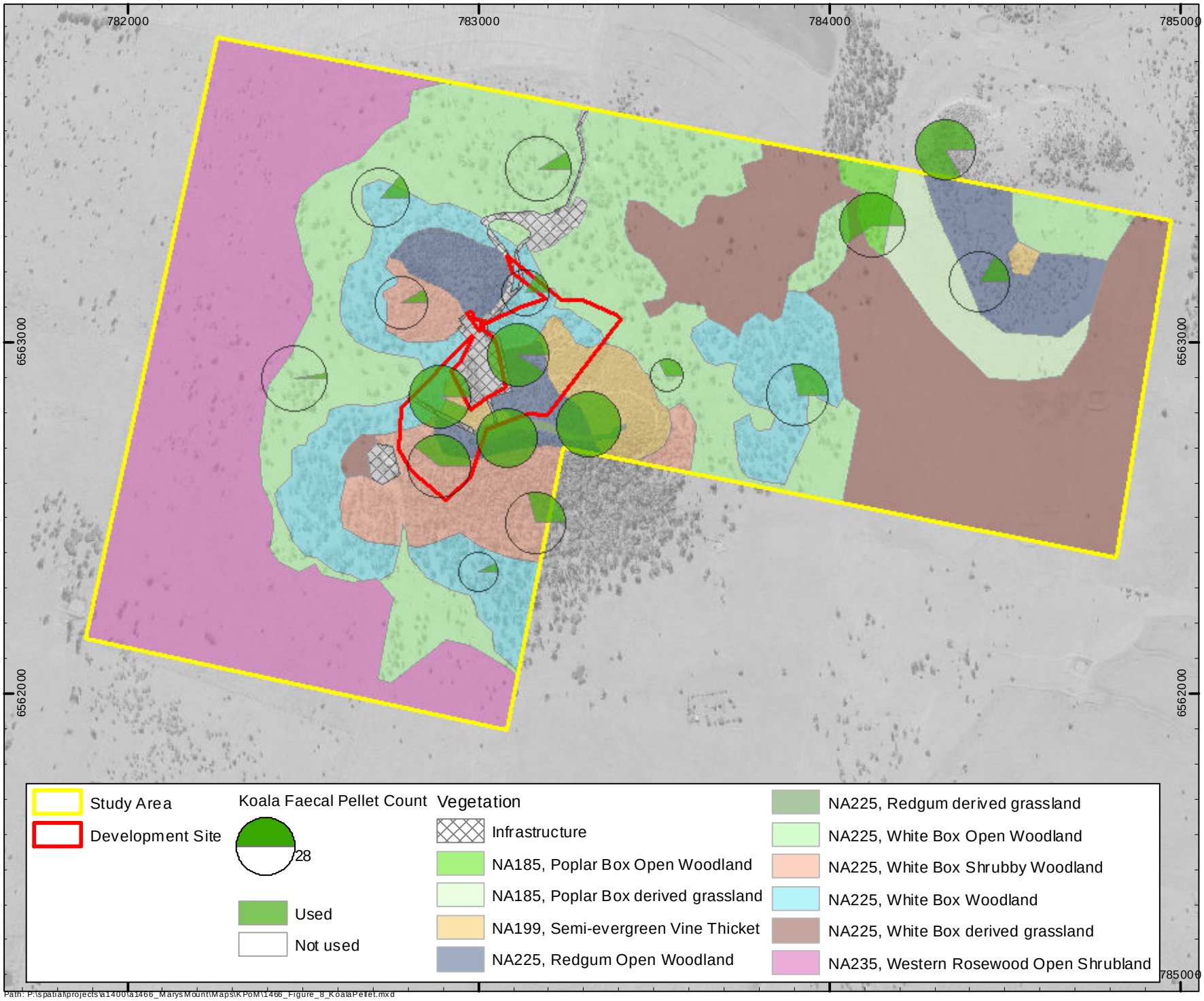

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Figure 8: Koala faecal pellet counts

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 19/04/2013

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Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

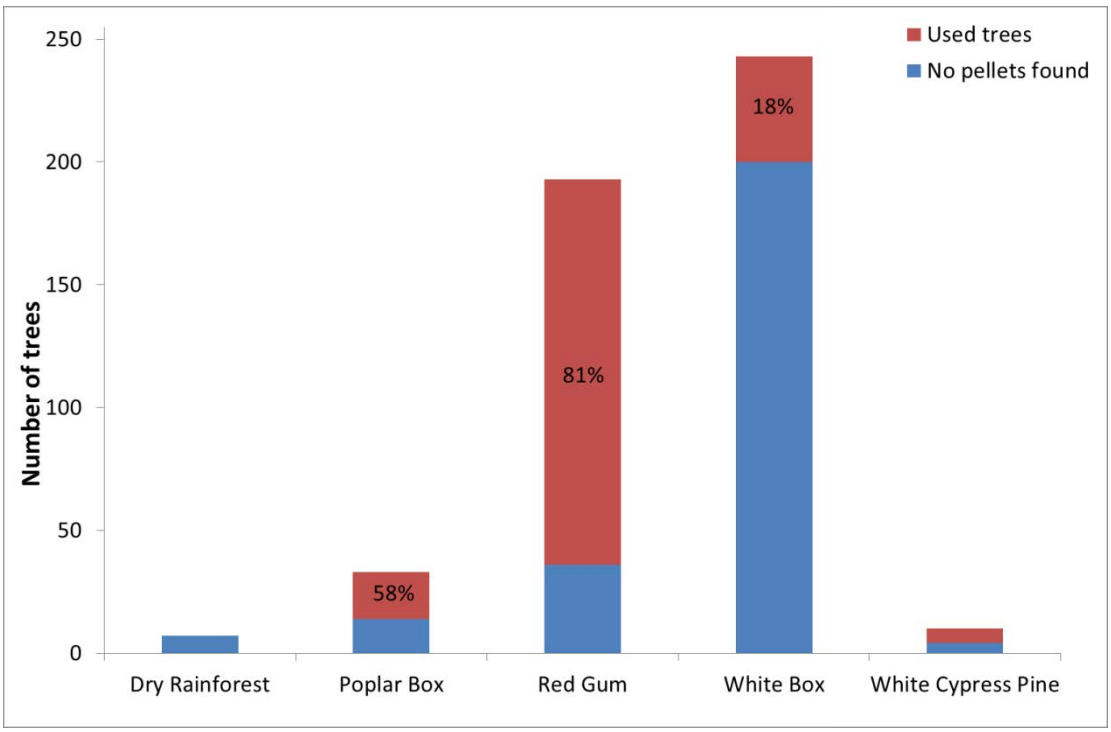

Figure 9. Proportion of tree species sampled that had Koala faecal pellets at their base

3.1.3 Summary

The estimated 12,700 Koalas and 42,492 hectares of preferred Koala habitat within the Gunnedah area implies an average density of 0.3 individuals per hectare (Greenloaning Biostudies 2013). This compares with densities of between 0.29 and 1.14 estimated within the study area.

Approximately one animal per hectare have been identified within the Red Gum open woodlands of the study area (Niche, 2013), which exceeds the average for the Gunnedah area (Greenloaning Biostudies 2013). The habitat values of the Red Gum open woodland conforms with the definition for secondary habitat (class A) as Tumbledown Red Gum is a listed secondary food tree species exceeding 50% of the overstorey species (DECC 2008) and has been mapped as such (Greenloaning Biostudies 2013). SEWPaC (2012) identify this classification as *habitat critical to the survival of the species*.

The number of Koala individuals per hectare within the White Box woodlands of the development site range from 0.25 to 0.69, which is largely consistent with the average density found in preferred Koala habitat of the Gunnedah area (Greenloaning Biostudies 2013). As for Tumbledown Red Gum, White Box woodlands also conforms to the definition of secondary habitat (class A) (DECC 2008), has been mapped as such (Greenloaning Biostudies 2013) and is *habitat critical to the survival of the species* (SEWPaC 2012).

3.2 Population estimate

3.2.1 Definitions

The following definitions have been used in defining local, important and regional populations.

Local population

Breeding individuals that occur within a locality that regularly interact throughout a single breeding season. Local populations often form part of larger meta population.

Important population

An area that contains individuals that is consistent with the following criteria (DEWHA, 2009):

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- *key source populations either for breeding or dispersal.*
- *populations that are necessary for maintaining genetic diversity, and/or*
- *populations that are near the limit of the species range.*

It is considered that one or more local populations may meet the definition of an important population.

Regional population

Individuals within an area that corresponds with an appropriate predefined biogeographical reference.

3.2.2 Local population

The local population is defined by the sum of Koala individuals within the Mary's Mount locality. For the purposes of this plan, the Mary's Mount locality is defined by the area mapped as 'Nombi Plateau and Pinnacles', as shown in Figure 10. This area contains connected native vegetation founded on similar geological and topographical formations to those of the study area.

Aerial photography interpretation within the Mary's Mount locality indicates the presence of approximately 50 hectares of Red Gum open woodland and 200 hectares of box woodlands (i.e. composite of White Box and Poplar Box). These woodlands occur outside the study area and are accessible for individual Koala's observed within the study area. However, it should be noted that ground surveys have not been conducted outside the study area to support these habitat area estimates.

The local population would comprise the 30 individuals estimated to occur within the study area and those that would simultaneously occur within accessible adjacent areas of suitable habitat identified above. A conservative estimate for the number of individuals within the adjacent habitat outside the study area is based on the following assumptions:

- 200 hectares of box woodlands with a Koala density[1] of 0.25/ hectare;
- 50 hectares of Red Gum open woodland with a Koala density[2] of 1.14/ hectare; and
- No Koalas with areas of low habitat value (i.e. semi-evergreen vine thicket).

Approximately 107 Koala individuals were calculated from the above assumptions. When combined with the Koala estimate for the study area it is estimated that the local population numbers approximately 137 individuals. Again, it is important to note that surveys have not been conducted outside the study area to validate the assumptions used to calculate this estimate.

3.2.3 Important population

For the purposes of this KPoM it is considered that the definition of important population is the Gunnedah population with estimated numbers ranging between 3,000 and 12,700 individuals (TSSC 2012; Greenloaning Biostudies 2013). The rationale for this conclusion is provided as follows.

Koala individuals within the study area are considered to be part of a Koala population that occupies the Gunnedah area (i.e. meta-population). According to the listing advice (TSSC 2012), the Gunnedah population is estimated to number approximately 3,000 individuals. This compares with a larger estimate of 12,700 individuals for the same area (Greenloaning Biostudies 2013).

According to DEWHA (2009) an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

In terms of defining important populations SEWPaC (2012) provides additional interim guidance for the Koala where it states:

A koala population is defined by the capacity of individuals to move from one habitat patch to another. If two groups of koalas are separated by a substantial barrier to movement (e.g. river, mountain range, greater than 15 km of cleared rural land or artificial barriers), and there is very little likelihood of exchange of individuals between the two groups, then the two may be considered separate populations.

With respect to the above it is considered that the Koala individuals contained within the Gunnedah area, which is defined by the management area mapped by Greenloaning Biostudies (2013), meets the definition of an important population. Reference to the Gunnedah population in this plan is synonymous with the definition of important population.

[1] Density used is below the recently reported average number of Koala individuals per hectare in the Gunnedah area (Greenloaning Biostudies 2013).

[2] Density used correlates with Tumbledown Red Gum open woodland within the study area.

Figure 10: Local extent of the Nombi Plateau and Pinnacles Landscape

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 24/04/2013

Development Site
CMA Region: Subregion
Mitchell Landscapes

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Horizontal Datum:
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3.2.4 Regional population

The Gunnedah LGA falls within the Western Slopes and Plains Koala Management Area (KMA), which includes the Pilliga, Gunnedah and Walgett areas (DECC 2008). This is one of the seven KMAs defined within the recovery plan (DECC 2008) and is the definition of region for this KPoM. Within this geographic area it is estimated that the Koala population numbers approximately 20,000 individuals (TSSC 2012; Greenloaning Biostudies 2013).

Recent studies indicate that most of these individuals occur within the Gunnedah area, which numbers approximately 12,700 animals. It is believed that this number is the result of population growth and an increase in the habitat occupancy rate over the last 3–5 Koala generations (Greenloaning Biostudies 2013).

3.3 Koala habitat preferences

As required by the guiding principles of SEPP 44 this section identifies the preferred feed tree species for the study area and the extent of those resources available.

3.3.1 Vegetation types

The greatest density of Koala individuals (1.14 animals per ha; activity level 83%) was recorded in the Red Gum Open Woodland that occurs on the upper slopes of the two hills which dominate the project area (Figure 7 and 8; Table 4 and 5). A similar density of individuals was observed in another Red Gum Open Woodland patch that occurs on lower slopes in the eastern section of the project area with 4 animals observed during daylight hours on the morning of 5th March 2013. However, the results for this woodland patch were inconsistent between sampling methods because none of these animals was observed during spotlighting searches on the 6th March 2013 (Niche 2013) and only a low activity level (16%) was recorded there (Table 5).

The White Box dominated vegetation types had low to moderate levels of Koala activity (9-28%; Table 5). Most (11/14) animals observed during spotlighting surveys were recorded in White Box Shrubby Woodland, while all other White Box vegetation types accounted for the remainder (Table 5). Koalas appeared to occur at very low density within White Box Open Woodland. The widespread distribution of White Box vegetation communities in the project area, combined with occasional records of the Koala, may have led to an over-estimation of Koala density in the project study area (Figure 7; Table 5). Tree density was greater and forest structure was multi-layered in the White Box Shrubby Woodland community and these factors may explain the relative importance to Koalas of this vegetation type compared to other White Box vegetation types. The proximity of the White Box Shrubby Woodland to the preferred red gum habitat may also have been a factor in the higher densities of Koala individuals in this White Box vegetation type.

Poplar Box Open Woodland was very limited in its distribution throughout the project area. Tree cover within this vegetation type extended across only 2.3 ha, but two Koalas (a mother and young) were observed.

No Koalas were observed in Western Rosewood Open Shrubland (Figure 7; Table 5), and it seems unlikely to be important for the Koala at this location, however, no faecal pellet plots were conducted in this vegetation type.

Semi-evergreen Vine Thicket (an endangered ecological community) appeared to be expanding its distribution throughout the upper slopes of the largest hill in the study area, presumably due to infrequent fire. Occasionally, Red Gum trees (*E. dealbata*) occurred within the perimeter of areas mapped as Semi-evergreen Vine Thicket and at least one Koala was observed during daylight searches occupying a Red Gum tree in this situation. However, no Koalas were observed during spotlight searching (Table 5) and no faecal pellet plots were conducted in this vegetation type.

3.3.2 Tree species

Koalas were observed by day and by night occupying a range of tree species, but the clear preference of the Koala was for Tumbledown Red Gum (Table 6). Red Gums were used extensively by the Koala and should be regarded as the primary food tree species in the study area. Red Gums are also well known as a primary food tree species in many other locations in NSW, including Blakely's Red Gum *E. blakelyi* and Dirty Red Gum *E. chloroclada* in the nearby Pilliga forests (Kavanagh *et al*. 2007) and River Red Gum *E. camaldulensis* as planted trees on the Liverpool Plains (Kavanagh and Stanton 2012).

White Box (*E. albens*) was also utilised, but it should be regarded as a secondary food tree species for the Koala. Although 13 observations of Koalas were made in this tree species, this is unlikely to be significant given the large number of White Box trees in the study area (Figure 7; Table 6). A large number of Koala faecal pellets were observed under two particular White Box trees.

Poplar Box (*E. populnea*) was used extensively by two Koalas (Table 6), and although it appears to be an important food tree, this species has a very limited distribution in the study area.

The remaining tree species listed in Table 6 (*Geijera parviflora* and *Callitris glaucophylla*) were likely used primarily for shelter.

Table 6. Tree species in which Koalas were observed (includes observations at night as well as during the day)

Tree species	Koala records
Tumbledown Red Gum *Eucalyptus dealbata*	32
White Box *Eucalyptus albens*	13
Poplar Box *Eucalyptus populnea*	2
Wilga *Geijera parviflora*	2
White Cypress Pine *Callitris glaucophylla*	4
Dead tree	1
Total	**54**

4 THREATENING PROCESSES

4.1 Overview

The principal threats to the Koala are habitat loss and fragmentation, habitat degradation, road kills, predation by dogs and foxes, drought, climate change, wildfire, overbrowsing, disease and septicaemia caused by thorn-stick injuries from the introduced Tiger Pear *Opuntia aurantiaca* (Kavanagh *et al*. 2007, DECC 2008, NRMMC 2009, Anon. 2011, Lunney *et al*. 2012). The majority of these threats are active within the study area with those considered relevant to the preparation of this KPoM discussed in the following sections.

4.2 Habitat loss

The Project comprises a 14.60 hectare footprint, inclusive of a management buffer, that would be developed in three stages over a 36 year period including 11.43 hectares of preferred Koala habitat (i.e. White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (NA225)). The extent of NA225 impacted by the Project comprises two distinct mapping units that describe variation in this vegetation type. Impacts according to these map units are:

- 7.62 hectares of White Box shrubby woodland; and
- 3.81 hectares of Tumbledown Red Gum open woodland.

Project staging would have the following effect on this area of preferred Koala habitat.

Stage 1 - Years 1 to 12

- Years 1-5: Approximately 1.2 hectares of vegetation comprising 1.0 hectares of White Box Woodland and 0.2 hectares of Tumbledown Red Gum open woodland.
- Years 5-12: Approximately 4.3 hectares of vegetation, comprising 1.2 hectares of Tumbledown Red Gum open woodland and 3.1 hectares of White Box Woodland.
- Predicted habitat loss: The Projects impact in the first 12 years is likely to result in the loss of habitat that would otherwise support two Koala individuals and reduce available habitat for a third Koala individual (i.e. 60% reduction in habitat).

Stage 2 – Years 12 to 23

- Year 12: Approximately 1.5 hectares of White Box Woodland.
- Predicted habitat loss: The Projects impact from years 12 to 23 is likely to reduce available habitat for an individual Koala (i.e. 38% reduction in habitat).

Stage 3 – Years 23-36

- ❒ The remaining 4.5 hectares of Koala habitat would be removed during this period, comprising 2.4 hectares of Tumbledown Red Gum open woodland and 2.1 hectares of White Box woodland.
- ❒ Predicted habitat loss: The Projects impact from years 23 to 36 is likely to result in the loss of habitat that would otherwise support three Koala individuals.

It is estimated that preferred Koala habitat for approximately seven individuals would be removed over the 36 year quarrying period. The most intense impact periods are in years 5-12 (i.e. habitat for two individual Koalas) and years 23-36 (i.e. habitat for three individual Koalas).

These are the key target periods where pre-emptive mitigation outcomes are required. Pre-emptive management actions would include revegetation works and pre-clearing surveys.

4.3 Overbrowsing

Overbrowsing of preferred food trees by the Koala is a well known phenomenon, often reported from areas in Victoria and South Australia where high-density populations occur, but it has rarely been reported in NSW. In the present study, many of the primary Red Gum food trees were in very poor condition showing evidence of extensive defoliation, presumably caused by the high density of Koalas overbrowsing this food resource. The reason for the overbrowsing is not understood, but likely to relate to habitat availability and condition.

Photo: Koala feeding in an overbrowsed Red Gum

Understanding the observed overbrowsing within the study area is complicated. For the purposes of this plan overbrowsing would be managed through the pre-emptive establishment of preferred Koala habitat (i.e. through revegetation and natural regeneration management actions) that exceeds the predicted near term habitat loss.

4.4 Inappropriate fire regimes

The Red Gum Open Woodland in the project area is potentially threatened by inappropriate fire regimes. Absent or rare fire events appear to favour the expansion of the Semi-evergreen Vine Thicket vegetation community, which is gradually encroaching on areas mapped as Red Gum open woodland. In this respect it is considered that the use of fire may be required to stimulate the regeneration of overstorey canopy species such as the Red Gum food tree resource. Although care must be taken in using this management technical as Semi-evergreen Vine Thicket is an endangered ecological community (EEC) listed under both the TSC and EPBC Acts and therefore any prescribed burning regime needs to ensure that the extent of this community is not reduced or altered.

4.5 Livestock grazing

Red Gum seedlings are palatable to domestic stock and so it follows that cattle grazing is likely to threaten the sustained replenishment of Koala habitat. The removal of cattle from the study area is an obvious and powerful management action for the protection of Koala habitat.

Eucalypt plantings, in general, are palatable to macropod species in particular the Swamp Wallaby (known to occur within the study area). The effects of macropod browsing would be monitored annually and, where appropriate, managed through additional replanting.

4.6 Injury

There is potential for Koala individuals to be impacted by vehicle strike and/or accidental entry into the quarry area from the highwall. It is considered that the restriction of quarry operations to diurnal periods would substantially limit the potential occurrence of vehicle strike as Koala movements generally occur outside the diurnal operational period (i.e. nocturnal movements).

Protecting Koala individuals from accidental injury through falls into the quarry area should be managed through the installation of suitable fencing along the quarry highwall. This should be established prior to the initiation of each stage and could be used, in part, to limit the potential for interaction during pre-clearing events.

5 AMELIORATIVE MEASURES

5.1 Overview

Ameliorative measures are required to manage the habitat loss from within the Project area and to address relevant threats identified in Section 4. The following sections provide details of the below listed ameliorative measures that would be required to address the threats identified in Section 4.

- Revegetation works to increase the area of preferred Koala habitat;
- Managing retained preferred Koala habitat; and
- Avoiding Koala deaths and injuries.

Ameliorative measures would be applied across the Project area. Table 7 identifies the areas applicable to the management actions specified in this section.

Table 7. Area (hectares) of preferred Koala habitat to be revegetated and retained

Vegetation Type	Area revegetated (hectares)	Area Retained (hectares)	Total (Hectares)
Red Gum Woodland	1.1	11.6	12.7
White Box Shrubby Woodland		1.6	1.6
White Box Woodland		12.4	12.4
White Box Open Woodland	8.8	6.9	15.7
White Box derived grassland	23.8		23.8
Semi-evergreen Vine Thicket			0
Rosewood Open Shrubland			0
Poplar Box Open Woodland		2.6	2.6
Poplar Box Open Woodland	11.3		11.3
Total (hectares)	**45**	**35.1**	**80.1**

5.2 Revegetation of preferred Koala habitat

The need to increase the area of preferred Koala habitat and its availability through improved connectivity with native forest and woodland on adjacent properties to north and east is fundamental to the mitigation of adverse residual effects, and this would be addressed through the habitat planting program referred to below. These new plantings are expected to be occupied initially by young dispersing animals and some older, wide-ranging males (Kavanagh *et al*. 2007, Kavanagh and Stanton 2012). These animals will subsequently hold new territories of their own and produce their own offspring that will, in turn, continue to spread throughout the planted areas.

5.2.1 Background

Eucalypt plantings established elsewhere on the Liverpool Plains have been shown to provide suitable foraging habitat for the Koala within seven years of establishment (Kavanagh and Stanton 2012). Hence, the "value" and "time to ecological benefit" of this mitigation measure are likely to be "moderate" by seven years after planting, provided

there are some larger trees nearby (e.g. in adjacent woodland) to serve as diurnal shelter for Koalas, rising to "very high" by the time these plantings are 20 years old.

The standard tree planting density for forestry purposes in this low-moderate rainfall environment is 1,000 trees per ha on a spacing of 4 m between rows and 2.5 m within rows. However, a much lower planting density of 400 trees per ha (5 x 5 m spacing) is appropriate in farm-forestry or woodland environments (Johnson *et al*. 2009a). Standard forestry practices include ripping, mounding and herbicide application prior to planting, however, in a woodland setting such as the present study area, spot-spraying with herbicide prior to planting may be adequate.

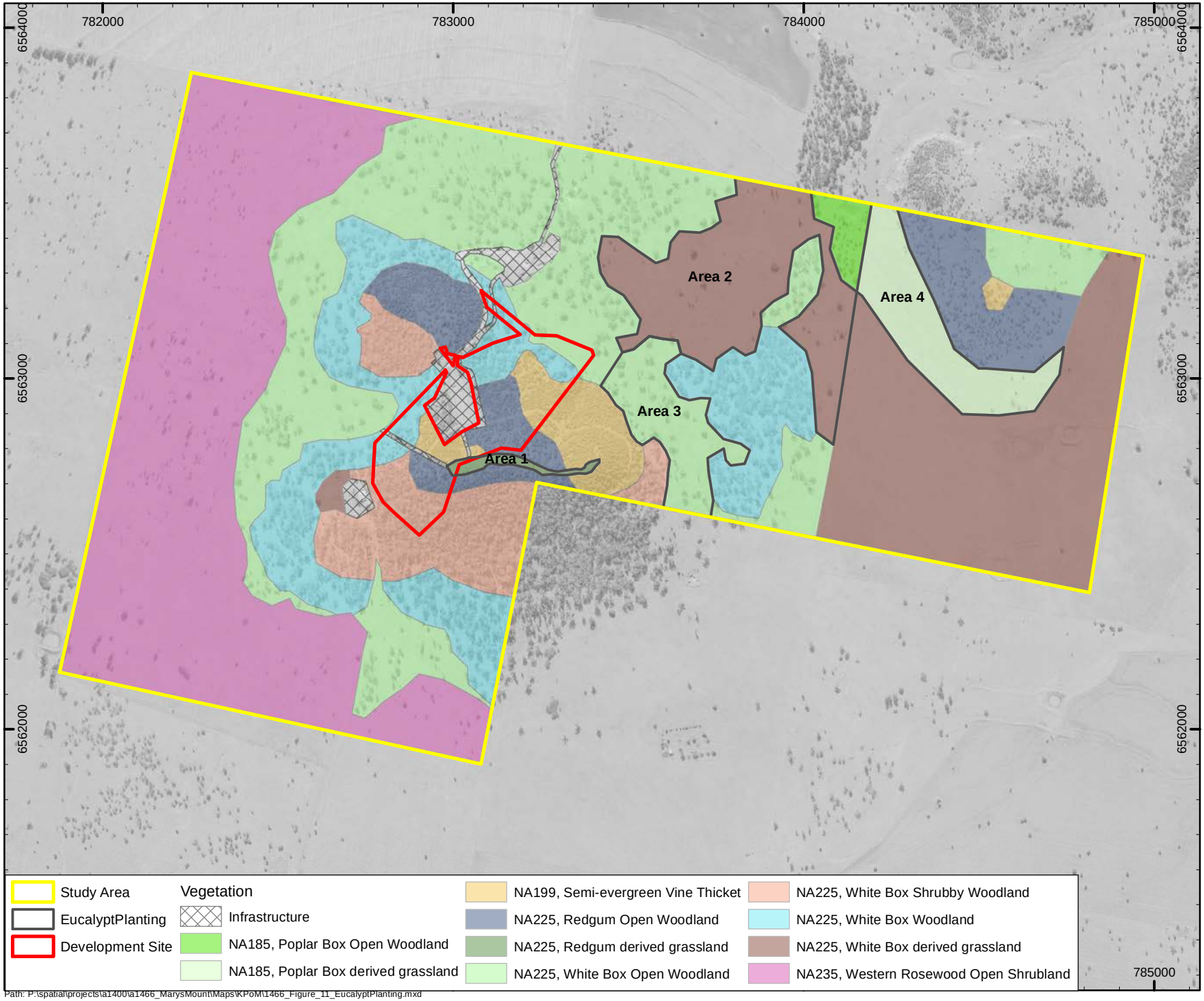
5.2.2 Strategy

Foremost, is the need to replant areas of habitat for the Koala within the study area. This would have the combined benefit of replacing habitat lost from the Project and improving connectivity to areas of habitat outside the study area. To best achieve these outcomes Koala habitat should be replanted in four locations (Figure 11):

- ❒ The area mapped as Red Gum Derived Grassland, which is located on the top of the hill immediately adjacent to the development site (Area 1, 1.1 ha);
- ❒ Part of the area mapped as White Box Derived Grassland (Area 2, 23.8 ha);
- ❒ Part of the adjacent White Box Open Woodland (Area 3, 8.8 ha) – this area is needed particularly to provide direct connectivity with core Koala habitat on Melville Hill, which is otherwise only moderately connected to surrounding habitat, and;
- ❒ The area mapped as Poplar Box Derived Grassland (Area 4, 11.3 ha).

The replanting, which must take place within the first two years of project approval, would result in the establishment of 45 ha with supplementary eucalypt plantings. These plantings would increase the area of preferred Koala habitat and its availability for individual within the project area. These plantings would also provide improved connectivity with areas currently occupied by the species on adjacent properties. The tree species to be planted should include *E. dealbata*, *E. populnea* and River Red Gum *E. camaldulensis*, Yellow Box *E. melliodora* and Narrow-leaved Ironbark *E. crebra*. The last three tree species are suitable for the sites listed above (Walsh *et al*. 2008, Johnson *et al*. 2009a) and are known to be utilised by Koalas in the region (Kavanagh *et al*. 2007, Kavanagh and Stanton 2012).

Trees should be planted in autumn and after rain or when the soil moisture levels are high. Trees require watering, at least once at the time of planting and potentially again during any prolonged dry periods that occur within the first year. Grass around the young trees may require mowing until the trees become established. All planted areas need to be fenced to exclude grazing by domestic stock. Further guidelines on the establishment of tree plantings in this region can be found in Johnson *et al*. (2009b, 2009c).



Path: P:\spatial\projects\a1400\a1466_MarysMount\Maps\KPoM\1466_Figure_11_EucalyptPlanting.mxd

Figure 11: Areas scheduled for eucalypt plantings

1466 Marys Mount Gravel Quarry

Drawn by: RJ
Project Mgr: MA

Date: 24/04/2013

N
W E
S

Metres
0 100 200 300 400 500 600

niche Environment and Heritage

Horizontal Datum:
GDA 1994 MGA Zone 55

Imagery:
(c) 2007 LPI

5.2.3 Revegetation specification

Revegetation experiences in the region indicate that unmanaged revegetation works are likely to result in high mortality rates thereby increasing the risk of mitigation failure (Rod Kavanagh pers com). To minimise the likelihood of mitigation failure it is recommended that revegetation works are managed by a qualified and suitably experienced bush regenerator, hereafter referred to as the Project regenerator. The Project regenerator is responsible for the delivery of a successful revegetation programme that would meet the following performance criteria:

- Establish a minimum of 60 tree stems per hectare by the end of year two for Areas 1, 2 and 4, with the youngest age of any individual tree being greater than 6 months;
- Establish a minimum of 40 tree stems per hectare by the end of year two for Area 3 with the youngest age of any individual tree being greater than 6 months;
- Maintain 60 stems per hectare on an annual basis as the minimum stem density for at least a seven year period (i.e. maintenance period);
- Establish a minimum of 400 tree stems per hectare for a total of four hectares in Areas 2 and 3 using Tumbledown Red Gum by the end of year two with the youngest age of any individual tree being greater than 6 months. This is to be maintained at this density for at least seven years; and
- Tree species used in revegetation works are to be as follows:
  - Area 1 – Tumbledown Red Gum
  - Area 2 – White Box, Tumbledown Red Gum and Yellow Box
  - Area 3 – White Box, Tumbledown Red Gum
  - Area 4 – Poplar Box, River Red Gum, Yellow Box and Narrow-leaved Ironbark.

The Project regenerator is to provide written evidence showing that the above criteria have been met. This is to be in the form of an annual report to be supplied by February of the following year for the seven year maintenance period. This report is to detail the effort required to achieve the above stated performance criteria including the provision of the minimum information:

- Estimated number of dead trees per revegetation area, including the species type;
- Number of trees replanted to mitigate observed mortalities per revegetation area. Species type and number are to be recorded; and
- Observations, if any, that may indicate causal factors for the tree mortalities are to be noted for consideration by the quarry operator and Project ecologist.

This annual report is to be reviewed by the Project ecologist. Where necessary, the Project ecologist would recommend adjustments to the revegetation programme to ensure the ecological objectives of the KPoM are being achieved. If it is found at the end of the seven year maintenance period that revegetation works have not succeeded in establishing a revegetated landscape comprising self sustaining trees of at least 60 stems per hectare then the maintenance period is continue annually until it can be demonstrated that target tree density has been achieved.

Following the completion of a successful revegetation programme it is anticipated that woody vegetation types of grassy understory would be established with tree stem densities commensurate with grassy woodland formations typically found within the region (i.e.

mature tree density of 40-50 trees per hectare). If stems per hectare within the revegetation areas exceed the 40-50 stems per hectare benchmark after year 23 then the consideration of tree thinning may be examined by the Project ecologist, should an appropriate ecological benefit be justified (e.g. increase total length of fallen logs).

5.3 Managing retained preferred Koala habitat

In addition to the areas to be replanted, it would also be necessary to protect and enhance the existing areas of woody vegetation in the eastern parts of the Project area, including the White Box Woodland, White Box Open Woodland, Poplar Box Open Woodland and Red Gum Open Woodland. With the exception of Area 3, replanting is not required in these areas as management actions, such as the exclusion of stock, use of appropriate fire regimes and weed management, would result in the natural regeneration of those areas. The area of White Box derived grassland in the southeast of the study area is highly modified and it is not necessary that this area is replanted or managed as Koala habitat.

5.3.1 Livestock grazing

All livestock grazing is to be removed from the Project area for the duration of the quarrying period. This is a critical management action designed to aid the establishment of replanted areas and to allow for the natural regeneration of overstorey tree species such as those that are important to the establishment of preferred Koala habitat.

5.3.2 Fire regimes

The selective use of low intensity fires is recommended to stimulate the natural regeneration of overstorey tree species particularly throughout areas of grassy White Box woodland and open woodland. A low intensity fire could be implemented in Area 3 prior to any proposed plantings to potentially minimise any replanting requirements for this area.

Fire is to be excluded from any areas that are classified as Semi-evergreen Vine Thicket, as this vegetation would be adversely impact by the use of fire.

5.3.3 Pest management

Weed management to control the occurrence of Tiger Pear *Opuntia aurantiaca* is required to limit the potential for Koala individuals being directly impacted by the spines of this species. The control of feral animals such as wild pigs is also considered important for the protection of replanting areas and any natural regeneration stimulated by the use of fire or removal of livestock.

5.4 Avoiding Koala injury

5.4.1 Habitat clearance

Local translocation of animals is unnecessary provided that clearing does not occur on a day when trees planned for removal are occupied by Koalas. Pre-clearing surveys should be conducted by an ecologist and each tree inspected before it is felled to ensure that no

Koalas are killed or injured in the process of tree removal. Clearing should follow a two-staged process where understory vegetation is cleared first, followed by a 24 hour break to allow any Koalas to present to vacate the area, before the trees area removed. Any trees to be removed that contain Koalas should be left until the Koala leaves the tree and area. If a Koala does not leave the area within the period allocated for clearing, then the animal will need to be captured by an ecologist experienced in Koala capture and immediately released in adjacent habitat.

5.4.2 Koala movements

There is the potential for Koalas to be injured following movements in and around the quarry area. Koala individuals may inadvertently access the quarry area or fall from the highwall. It is recommended that a fence of suitable design be progressively installed along the highwall as needed to limit the potential for Koala injuries that may arise from this threat.

5.5 Rehabilitation

In addition to revegetation works it is considered that progressive rehabilitation and replanting of the quarry itself would be beneficial. The proponent is committed to a staged removal of native vegetation by clearing approximately one third of the development site each decade: Stage 1, 1-12 years; Stage 2, 13-22 years; and Stage 3, 23-36 years (see Section 1.1). The rehabilitation of quarried areas is proposed to begin in year 14, with the area cleared in Stage 1 to be rehabilitated and planted by year 22, Stage 2 to be rehabilitated and planted by year 38, and the remainder (Stage 3) to be rehabilitated and planted by year 40. Rehabilitation should include the provision of appropriate site drainage, replacement of the original soil cover (stockpiled on-site) and replanting with native species consistent with the current native vegetation cover.

Tumbledown Red Gum *E. dealbata* should be the primary species used when replanting areas previously covered with Red Gum Woodland. The planting of currently non-vegetated areas in the north-eastern quarter of the study area within the first two years (see above) is intended to provide new foraging habitat for the Koala before Stage 2 of the proposal begins. Kavanagh and Stanton (2012) have demonstrated that eucalypt plantings provide habitat for Koalas from seven years of age and, therefore, the planted areas would be suitable for habitation by Koalas before Stage 2 commenced (year 12).

5.6 Implementation and key performance indicators

Key to the success of the amelioration measures is the timing of implementation. Implementation is defined in this KPoM by the quarry staging as outlined in Section 1.1.4. The timing of amelioration measures and associated key performance indicators is outlined in the following sections.

5.6.1 Stage 1

The following ameliorative measures are to be successfully implemented during this stage of the Project:

- ❒ Revegetation works specified in Section 5.2;
- ❒ Suppression of Tiger Pear;
- ❒ Suppression of wild pigs; and
- ❒ Selective use of fire, particularly in Area 3.

Key performance indicators to be met by year seven:

- ❒ The removal of livestock has resulted in the natural regeneration of overstorey species;
- ❒ A rate of 60 tree stems per hectare comprising preferred feed trees are established in Areas 1, 2, 3 and 4 by year 2 and are maintained through to year 7;
- ❒ Four hectares comprising 400 tree stems of Tumbledown Red Gum are established in parts of Area 2 and 3 by year 2 and are maintained at that density through to year 7;
- ❒ There is evidence of Koala activity in the revegetation areas;
- ❒ All known identified Tiger Pear occurrences have been suppressed;
- ❒ New weed species occurrences have been identified and suppressed (e.g. African Box Thorn);
- ❒ Wild pigs have been suppressed; and
- ❒ Natural regeneration of overstory tree species is evident in retained areas.

Key performance indicators to be met by year 14:

- ❒ There is evidence of sufficient available habitat in the revegetation areas that is capable of supporting at least five individual Koalas;
- ❒ Prior Tiger Pear occurrences have been successfully suppressed;
- ❒ New Tiger Pear occurrences have been suppressed;
- ❒ New weed species have been identified and suppressed; and
- ❒ At least 50% of overstorey species natural regeneration observed at year seven in the retained vegetation remains (measured in stems per hectare).

5.6.2 Stage 2

The following ameliorative measures are to be successfully implemented during this stage of the Project:

- ❒ Installation of high wall fencing, where necessary;
- ❒ Suppression of weeds;
- ❒ Suppression of wild pigs; and
- ❒ Selective use of fire (if necessary).

Key performance indicators to be met by year 23:

- ❒ There is evidence of sufficient available habitat in the revegetation areas that is capable of supporting at least eight individual Koalas;
- ❒ Substantial Koala activity is identified in the revegetation areas;
- ❒ Following the consideration of extrinsic factors such as climate and disease, it can be demonstrated that Koala numbers within the Project area are stable and consistent with pre-Project estimates;
- ❒ Known weed species and their occurrences have been successfully suppressed;
- ❒ No new weed occurrences;

- ❒ Wild pig populations are not having any substantive impacts on preferred Koala habitat; and
- ❒ The overstorey canopy in retained native vegetation exceeds the average 2013 of 7.95 per cent (i.e. mean for plot data collected in White Box Woodland, Appendix A).

5.6.3 Stage 3

The following ameliorative measures are to be successfully implemented during this stage of the Project:

- ❒ Installation of high wall fencing, where necessary;
- ❒ Suppression of weeds; and
- ❒ Suppression of wild pigs.

Key performance indicators to be met by year 36:

- ❒ There is evidence of sufficient habitat for more than eight individual Koalas in the revegetation areas with evidence showing that this area is capable of sustaining at least seven individuals;
- ❒ Following the consideration of extrinsic factors such as climate and disease, it can be demonstrated that Koala numbers within the Project area are stable and consistent with pre-Project estimates;
- ❒ Known weed species and their occurrences have been successfully suppressed;
- ❒ No new weed occurrences;
- ❒ Wild pig populations are not having any substantive impacts on preferred Koala habitat; and
- ❒ There is substantial evidence of the overstory stratum comprising a mixed age of preferred Koala feed tree species.

6 MONITORING AND REPORTING

6.1 Timing

The success or otherwise of the revegetation works is to be monitored annually for the first seven years. The first three years is the responsibility of the Project regenerator, who will sign off on the achievement of relevant key performance indicators stated in Section 5.6.1.

Koala population size and density in the project area and the effectiveness of mitigation actions (including revegetation and retained habitat enhancement), is to be monitored by the Project ecologist from year four to year seven (i.e. four annual monitoring events). The results of the four years of monitoring would be compiled in a single report to the agencies following the analysis of collated monitoring data to year seven.

The purpose of this intense monitoring is to ensure the achievement of relevant key performance indicators stated in Section 5.6.1. This monitoring is also important in establishing baseline data prior to the substantial Project impacts expected between years 7 and 14. These baseline data would be relied on to measure the success of the KPoM through the remainder of the Projects operational period.

Monitoring timing and effort is outlined in Table 8.

Table 8. Monitoring intervals and tasks

Interval	Koala counts	Pellet counts	Stem densities	Report
Years 1 to 3 inclusive			X	X
Years 4 to 7 inclusive	X	X	X	X
Years 10 and 13	X	X	X	
Year 14		X	X	X
Years 18 and 22	X	X	X	
Year 23		X	X	X
Years 27, 31 and 35	X	X	X	
Year 36		X	X	X

Reporting intervals coincide with Project staging where the analysis of monitoring results against key performance indicators identified in Section 5.6 is required.

6.2 Method

Monitoring at each interval should take the form of absolute counts, using spotlights at night by multiple observers, of the numbers of animals occupying the Project area. Continued occupancy by Koalas should also be assessed using fixed-area sampling plots (2-4 ha in size) within the main vegetation types in the project area. These survey methods should be supplemented through the use of pellet counts.

Assessments should also be made of tree survivorship, stocking density and regeneration within the revegetated and retained habitat, and within the Red Gum Open Woodland vegetation type (core habitat).

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APPENDIX

Appendix 1: Geo-coordinates of all Koalas observed in the project area.

Date	Count	Zone	Easting	Northing	Method	Tree Species	Comment
16/Jan/2013 21:45	1	55	782915	6562776	Spotlight	*Eucalyptus (red gum)*	
16/Jan/2013 21:50	1	55	782882	6562703	Spotlight	*Eucalyptus (red gum)*	
16/Jan/2013 21:52	1	55	783068	6562889	Spotlight	*Eucalyptus (red gum)*	Male
16/Jan/2013 21:58	1	55	783146	6562883	Spotlight	*Eucalyptus (red gum)*	
16/Jan/2013 23:15	1	55	783199	6562748	Spotlight	*Eucalyptus (red gum)*	Female with wet bottom
16/Jan/2013 23:15	1	55	783199	6562749	Spotlight	*Eucalyptus (red gum)*	Juvenile
16/Jan/2013 23:36	1	55	783056	6562964	Spotlight	*Eucalyptus (red gum)*	Female
17/Jan/2013 09:00		55	782458	6562929	Pellet count	*Eucalyptus albens*	Identified High use tree
17/Jan/2013 10:00		55	783136	6563036	Pellet count	*Eucalyptus albens*	Identified High use tree
17/Jan/2013 20:29	1	55	782984	6563070	Spotlight	*Callitris glaucophylla*	In tree all day
17/Jan/2013 21:00	1	55	782941	6563120	Spotlight	*Eucalyptus (red gum)*	
17/Jan/2013 21:00	1	55	783076	6562940	Spotlight	*Dead tree*	
17/Jan/2013 21:10	1	55	782939	6563155	Spotlight	*Eucalyptus (red gum)*	
17/Jan/2013 21:20	1	55	783050	6563233	Spotlight	*Eucalyptus (red gum)*	
17/Jan/2013 21:30	1	55	782936	6563129	Spotlight	*Eucalyptus albens*	
17/Jan/2013 21:31	1	55	783301	6563029	Spotlight	*Eucalyptus albens*	
17/Jan/2013 21:40	1	55	782924	6563080	Spotlight	*Eucalyptus albens*	
17/Jan/2013 21:50	1	55	782967	6563165	Spotlight	*Geijera parviflora*	
17/Jan/2013 22:11	1	55	783081	6563052	Spotlight	*Eucalyptus albens*	
18/Jan/2013 06:14	1	55	783126	6563050	Incidental	*Eucalyptus (red gum)*	Male
18/Jan/2013 07:00	1	55	783291	6562646	Incidental	*Eucalyptus albens*	
18/Jan/2013 08:08	1	55	783543	6562912	Incidental	*Eucalyptus albens*	Female
04/Mar/2013 18:26	2	55	782752	6562789	Incidental	*Callitris glaucophylla*	Males
04/Mar/2013 20:10	1	55	782820	6563079	Spotlight	*Eucalyptus albens*	
04/Mar/2013 20:41	2	55	782881	6563172	Spotlight	*Eucalyptus (red gum)*	Males
04/Mar/2013 21:12	1	55	782900	6563046	Spotlight	*Eucalyptus albens*	
04/Mar/2013 21:43	1	55	782983	6563042	Spotlight	*Eucalyptus (red gum)*	
04/Mar/2013 22:14	1	55	782995	6563104	Spotlight	*Eucalyptus albens*	
05/Mar/2013 11:00	1	55	784436	6563241	Incidental	*Eucalyptus (red gum)*	Female
05/Mar/2013 11:02	1	55	784385	6563328	Incidental	*Eucalyptus (red gum)*	Female
05/Mar/2013 11:04	1	55	784354	6563352	Incidental	*Eucalyptus (red gum)*	Male
05/Mar/2013 11:06	1	55	784335	6563369	Incidental	*Eucalyptus (red gum)*	Female
05/Mar/2013 20:11	1	55	782977	6562986	Spotlight	*Eucalyptus (red gum)*	Male

05/Mar/2013 20:23	1	55	782961	6563000	Spotlight	*Eucalyptus albens*	Male
05/Mar/2013 20:40	1	55	783033	6562434	Spotlight	*Eucalyptus albens*	
05/Mar/2013 20:51	1	55	783123	6562739	Spotlight	*Callitris glaucophylla*	Juvenile
05/Mar/2013 21:00	1	55	783172	6562746	Spotlight	*Eucalyptus (red gum)*	Resting
05/Mar/2013 21:00	1	55	782816	6562464	Spotlight	*Eucalyptus albens*	
05/Mar/2013 21:17	1	55	783262	6562716	Spotlight	*Eucalyptus (red gum)*	
05/Mar/2013 21:54	1	55	783170	6562868	Spotlight	*Eucalyptus (red gum)*	
05/Mar/2013 22:00	1	55	782994	6563169	Spotlight	*Eucalyptus (red gum)*	Male
05/Mar/2013 22:05	1	55	782972	6563206	Spotlight	*Eucalyptus (red gum)*	Female
05/Mar/2013 22:08	1	55	782949	6563181	Spotlight	*Eucalyptus (red gum)*	Smallish
05/Mar/2013 22:10	1	55	782805	6563072	Spotlight	*Eucalyptus albens*	
05/Mar/2013 22:20	1	55	782924	6563137	Spotlight	*Eucalyptus (red gum)*	Smallish
05/Mar/2013 22:30	1	56	782915	6562709	Spotlight	*Eucalyptus (red gum)*	
05/Mar/2013 22:34	1	55	782943	6563148	Spotlight	*Eucalyptus (red gum)*	Smallish
05/Mar/2013 22:37	1	55	782896	6562739	Spotlight	*Eucalyptus (red gum)*	Sleeping
06/Mar/2013 10:00	2	55	784141	6563375	Spotlight	*Eucalyptus populnea*	Female and dependant young
06/Mar/2013 11:00	1	55	783110	6562969	Incidental	*Eucalyptus (red gum)*	
07/Mar/2013 08:17	1	55	782857	6562752	Incidental	*Eucalyptus (red gum)*	
07/Mar/2013 11:00	1	55	784350	6563621	Incidental	*Eucalyptus (red gum)*	Female
08/Mar/2013 10:21	1	55	783024	6563269	Incidental	*Geijera parviflora*	Female