Blakebrook Quarry

Biodiversity & Rehabilitation Management Plan

EMS-MP4

Revision 4.1

for Lismore City Council

March 2019

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Prepared by:	*Louis Penny*
Position	Project Manager
Signed:	
Date:	*11 March 2019*
Approved by:	*Paul Douglass*
Position:	Partner
Signed:	
Date:	*11 March 2019*

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Rev	Date	Description	By	Review	Approved
1.0	May 2010	Final Draft Landscape and Biodiversity Management Sub-plan	Lismore City Council	Phil Klepzig	Phil Klepzig
			ERM Australia	Steve O'Connor	Steve O'Connor
Rev A	June 2010	Landscape and Biodiversity Management Sub-Plan	Lismore City Council;	Phil Klepzig	Phil Klepzig
			ERM Australia	Steve O'Connor	Steve O'Connor
			Director General of DoP	-	-
Rev B	April 2011	Landscape and Biodiversity Management Sub-plan	Lismore City Council;	Phil Klepzig	Phil Klepzig
			ERM Australia	Will Weir	Will Weir
			Director General of DoP	-	-
2.0	December 2017	Draft Biodiversity and Rehabilitation Management Plan	Lismore City Council	Kevin Trustum	Kevin Trustum
			ERM Australia	Louis Penny	Paul Douglass
			Secretary of DPE	-	-
3.0	March 2018	Draft Biodiversity and Rehabilitation Management Plan	Lismore City Council	Kevin Trustum	Kevin Trustum
			ERM Australia	Guy Williams	Paul Douglass
			Secretary of DPE	-	-
3.1	August 2018	Draft Biodiversity and Rehabilitation Management Plan	Lismore City Council	Eleisha Went	Phil Klepzig
			ERM Australia	Louis Penny	Paul Douglass
			Secretary of DPE	-	-
4.0	February 2019	Updated to reflect approved Biodiversity Offset Strategy	Lismore City Council	Eleisha Went	Eleisha Went
			ERM Australia	Louis Penny	Paul Douglass
			Secretary of DPE	-	-
4.1	March 2019	Final Biodiversity and Rehabilitation Management Plan	Lismore City Council	Eleisha Went	Eleisha Went
			ERM Australia	Louis Penny	Paul Douglass
			Secretary of DPE		

This management plan is considered a dynamic document and will be reviewed as part of the annual review process. The management plan and any subsequent revisions must be approved by the relevant Lismore City Council manager. Initial approval of the management plan must also be obtained from the Secretary (or delegate), NSW Department of Planning and Environment in accordance with the Minister's Conditions of Approval. Subsequent management plan revisions do not require Secretary (or delegate) approval; however, a copy of the revised management plan will be submitted for information.

CONTENTS

GLOSSARY

Term	Definition
Audit	Systematic, independent and documented process for obtaining evidence and objectively evaluating it to determine the extent to which environmental management system meets the criteria set
Auditor	Person with appropriate training and competence to perform an audit
Contractor	Contractor engaged by Lismore City Council in order to achieve improvements in overall environmental performance
EM Strategy	Environmental Management Strategy
Environment	Surroundings in which Contractor operates including: air, water, land, natural resources, flora, fauna, humans, heritage and their interrelation
Environmental Aspect	Element of organisational activities or products that can interact with the environment
Environmental impact	Any changes to the environment, whether adverse or beneficial, wholly or partially resulting from an organisational aspect
Environmental management	The management system used to develop and implement the environment system policy and manage environmental aspects
Environmental objective	Overall environmental goal, consistent with the environment policy that an organisation sets itself to achieve
Environmental Performance	Measurable results of an organisation's management of environmental aspects
Non-conformance	Non fulfilment of a requirement
Performance indicators	Indicators that have been developed as leading or lagging to monitor and assess performance
Procedure	Specified way to carry out an activity or a process
Record document	Document stating results achieved or providing evidence of activities performed
Subcontractor	Any company, body or person who is contracted to the Contractor for the purpose of supplying services or goods

ABBREVIATIONS

Abbreviation	Meaning
LCC	Lismore City Council
CoA	Conditions of Approval
DP	Deposited Plan
DPE	Department of Planning and Environment
EAR	Environmental Assessment Report
EM Strategy	Environmental Management Strategy
EMP	Environmental Management Plan
EMS	Environmental Management System
ERM	Environmental Resources Management
LEP	Local Environmental Plan
LGA	Local Government Area

1 INTRODUCTION

This Biodiversity and Rehabilitation Management (BRMP) has been prepared by Environmental Resources Management Australia Pty Ltd (ERM), on behalf of Lismore City Council in order to manage biodiversity and rehabilitation at Blakebrook Quarry.

A separate Koala Plan of Management was prepared by Conacher Environmental Group (2006) and approved as part of the Project Approval (MP 07_0020), in consultation with the (former) NSW Department of Environment, Climate Change and Water (DECCW), and is provided as ***Annex A***.

1.1 PURPOSE

This plan has been prepared in accordance with the Minister's Conditions of Approval (CoA) – specifically, Schedule 3, Condition #28 (refer ***Section 3.2.1***) for the proposed quarry expansion, and provides strategies for the revegetation, rehabilitation, management and protection of a Dedicated Vegetation Protection Areas (DVPA) on the quarry site as shown in ***Figure 1.1***.

As part of the CoA, a Biodiversity Offset Strategy must be established for an area within the DVPA as well as off-site (Schedule 3, Condition #5). The on-site DVPA area covers an area of approximately 34 hectares (ha), with 17.6ha of this to be protected as an on-site Biodiversity Offset Area. As stipulated in the CoA, land must also be sourced elsewhere within the local government area (LGA) that covers a minimum area of 45ha to account for the off-site Biodiversity Offset Area. This land cannot be within an existing conservation area and must be secured in perpetuity through a Voluntary Conservation Agreement (VCA), land covenant or similar.

The offset land has been acquired by LCC and is already being managed for this purpose. A strategy for managing and maintaining this offset area is available for download: *www.lismore.nsw.gov.au.* The key principles associated with the Biodiversity Offset Strategy have been included in ***Section 10.0***.

1.2 OBJECTIVES

The aims and objectives of this plan are to specify actions for:

- ensuring that the relevant stakeholders are involved in the formulation and implementation of this LBM Sub-Plan;
- addressing the requirements of applicable legislation and any ongoing approvals as they are applicable to the Project;
- meeting the Project CoA;

- addressing the requirements of the Project Environmental Assessment Report (EAR) (ERM, 2009);
- undertaking the mitigation/management of biodiversity impacts within active quarry areas associated with the proposed quarry expansion and ongoing quarrying activities;
- implementing the rehabilitation and protection of on-site biodiversity values outside of active quarry areas (delineated by the DVPA); and
- undertaking the progressive rehabilitation of active quarry areas, following extraction of quarry material.

1.3 REVIEW SCHEDULE

In accordance with the CoA for the Blakebrook Quarry expansion, this BRMP will be formally reviewed internally within Lismore City Council each year, with an official update submitted to the NSW Department of Planning and Environment (DPE) every 10 years, unless requiring revision as part of the outcomes of the yearly review.

Accordingly, the next reviews of the BRMP are listed in ***Table 1.1***.

Table 1.1 Review Schedule

No.	Date	Review Type	Reviewer
R2	18-Dec-2017	**Amended Draft BRMP**	Lismore City Council / DPE
R3	20-Mar-2018	**Amended BRMP**	Lismore City Council / DPE
R4	14-Feb-2019	**Out of Sequence Review (Biodiversity Offset Plan)**	Lismore City Council / DPE
R5	15-Dec-2019	**Internal Review**	Lismore City Council
R6	15-Dec-2020	**Internal Review**	Lismore City Council
R7	15-Dec-2021	**Internal Review**	Lismore City Council
R8	15-Dec-2022	**Internal Review**	Lismore City Council
R9	15-Dec-2023	**Internal Review**	Lismore City Council
R10	15-Dec-2024	**Internal Review**	Lismore City Council
R11	15-Dec-2025	**Internal Review**	Lismore City Council
R12	15-Dec-2026	**Internal Review**	Lismore City Council
R13	15-Dec-2027	**Internal Review**	Lismore City Council
R14	15-Dec-2028	**External Review**	Lismore City Council / DPE

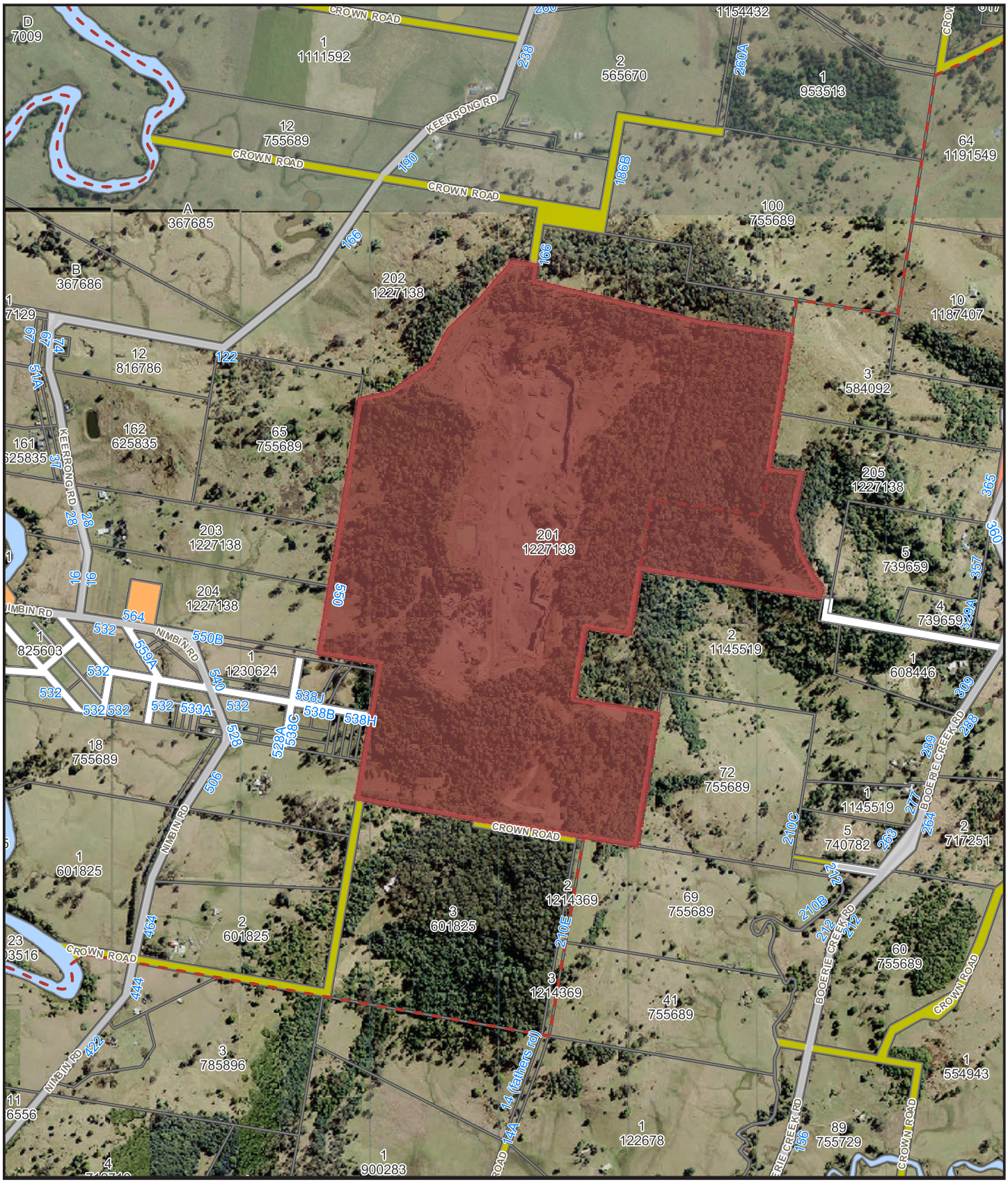

Figure 1.1

Quarry Location

Legend

- Quarry Site Boundary
- Roads
- Water Courses

Source:

Client:	Lismore City Council		
Project:	Blakebrook Quarry		
Drawing No:	0436793b_BQ_C001_R1.cdr		
Date:	18.12.17	Drawing Size:	A4
Drawn By:	DR	Reviewed By:	LP
Source:	Lismore City Council		
Scale:	Refer to Scale Bar (approximate only)		

0 1km

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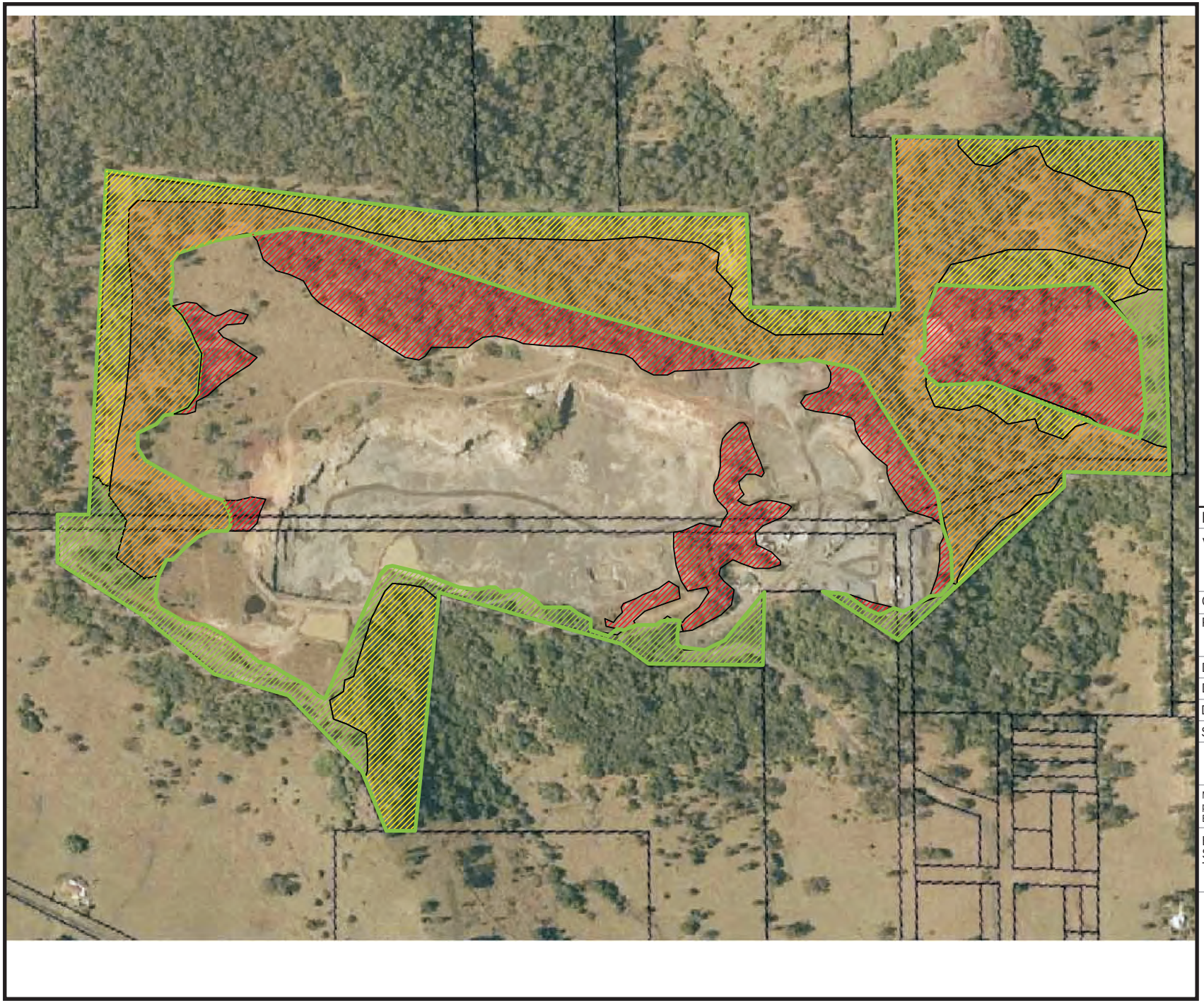

Legend

- Vegetation to be Removed
- Vegetation Protection Area
- Zone A - Revegetation
- Zone B - Regeneration
- Zone C - Protected Habitat

Source:

Conacher Environmental Group 2008

Figure 1.2

Vegetation Protection Area

Client:	Lismore City Council	
Project:	Blakebrook Quarry	
Drawing No:	006641PM_VPA_01	
Date:	11/06/2010	Drawing size: A4
Drawn by:	TH	Reviewed by: MC
Scale:	Refer to Scale Bar	

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2 QUARRY OPERATIONS

The Blakebrook Quarry development consent limits production to 500,000 tonnes per annum and transport of 600,000 tonnes of quarry materials from the site per calendar year, or dispatch more than 100 laden trucks from the site on any calendar day. Production at the quarry has remained at or below the allowable rate over the life of the current consent. The quarry has also maintained compliance with all other relevant conditions of consent over the current life.

2.1 BACKGROUND

Blakebrook Quarry has an identified resource of approximately 13.6 million tonnes which based on an extraction rate of 600,000 tonnes per annum, would allow for quarrying for approximately 22 years. The maximum proposed extraction rate was not expected be achieved in all years of quarrying. Project approval was therefore sought for an area sufficient for 30 years of quarrying with maximum extraction rate of 600,000 tonnes per annum, continuing in the existing main pit (herein also referred to as the 'North Pit') and a new smaller pit (herein also referred to as the 'South Pit') located to the south of the existing pit.

In August 2017, Lismore City Council submitted a Modification Application to the DPE seeking to mine the first 10 metres of the cap rock in the South Pit at Blakebrook Quarry. The South Pit was previously unable to be mined until late 2018, at the completion of the detailed groundwater assessment. On 18 September 2017, approval was granted to Lismore City Council to undertake these works, in accordance with revised CoA.

2.2 AREA OF OPERATION

The site is located approximately seven kilometres north west of Lismore on the Nimbin Road on Lot 102 DP 817730 and Lot 1 DP 845473 (184 and 184A Keerrong Road) Lismore (see ***Figure 1.1*** in ***Section 1.0***). Specifically, this BRMP applies to a dedicated DVPA within the quarry site as shown in ***Figure 1.2*** in ***Section 1.0***. The DVPA is located outside of active or future extraction areas within the site.

2.3 OPERATIONAL OVERVIEW

Quarrying has initially commenced laterally in the existing main pit before extraction in the southern pit occurs, in order to ensure continued demands for the hard rock material can be met. Council has purchased mobile crushing and screening plant for operation in the quarry pits which will result in a significant reduction in plant noise.

It is expected that that over the initial 10 years of the 30 year life of the quarry that production will average in the order 450,000 tonnes per annum including extraction of high quality product from the southern pit. The production is expected to increase beyond 10 years to the maximum 600,000 tonnes per annum.

3 STATUTORY REQUIREMENTS

3.1 LEGISLATION & POLICIES

The relevant applicable legal and other requirements related to flora and fauna environmental management for Blakebrook Quarry are outlined in ***Table 3.1.***

Table 3.1 Legislation & Policies of Relevance

Legislation and Policies
Commonwealth Legislation
Environment Protection and Biodiversity Conservation Act 1999
New South Wales Legislation
Environmental Planning and Assessment Act 1979
National Parks and Wildlife Act 1974
Local Land Conservation Act 2013
Biodiversity Conservation Act 2016
Biosecurity Act 2015
State Environmental Planning Policy #44 – Koala Habitat Protection (SEPP 44)
Regional Planning Documents
North Coast Regional Environmental Plan 2014 (NCREP)
Local Government Documents
Lismore Local Environmental Plan 2012 (Lismore LEP)

3.2 APPROVAL CONDITIONS

3.2.1 *Minister's Conditions of Approval.*

Pursuant to section 75B(1) of the *Environmental Planning and Assessment Act 1979* (EP&A Act), the Project was declared to be a project under Part 3A of the Act and Project Approval has been granted by the Minister for Planning.

Conditions #25 to #30 of the CoA outline the requirements for the preparation of a Biodiversity and Rehabilitation Management Plan by the proponent and its approval by the Minister. These conditions are provided as follows:

REHABILITATION AND LANDSCAPE MANAGEMENT

Biodiversity Offset Strategy

5. The Proponent shall:

(a) implement the Biodiversity Offset Strategy (see also Table 5);

(b) ensure that adequate resources are dedicated towards the implementation of this strategy;

(c) *provide appropriate long term security for the offset area;*

(d) *provide a timetable for the implementation of the offset strategy prior to 30 June 2010, or as otherwise agreed by the Secretary, to the satisfaction of the Secretary.*

Table 5: Biodiversity Offset Strategy

Offset Areas	***Minimum Size***
On-site offset (Protection Zone in Appendix 4)	17.6 hectares
Off-site offset (within Lismore local government area, and not already within a conservation area)	45 hectares
Total	62.6 hectares

Rehabilitation Objectives

26. The Proponent must rehabilitate the site to the satisfaction of the Secretary. This rehabilitation must be generally consistent with the rehabilitation strategy in the EIS and must comply with the objectives in Table 6.

Table 6: Rehabilitation Objectives

Feature	***Objective***
All areas of the site affected by the project	• *Safe* • *Hydraulically and geotechnically stable* • *Non-polluting* • *Fit for the intended post-mining land use(s)* • *Final landform integrated with surrounding natural landforms as far as is reasonable and feasible, and minimizing visual impacts when viewed from surrounding land*
Surface Infrastructure	• *Decommissioned and removed, unless otherwise agreed by the Secretary*
Quarry benches and pit floor	• *Landscaped and vegetated using native tree and understorey species*
Final Void	• *Minimise the size, depth and slope of the batters of the final void* • *Minimise the drainage catchment of the final void*

Progressive Rehabilitation

27. The Proponent must rehabilitate the site progressively, that is, as soon as reasonably practicable following disturbance. All reasonable and feasible measures must be taken to minimise the total area exposed for dust generation at any time. Interim stabilisation measures must be implemented where reasonable and feasible to control dust emissions in disturbed areas that are not active and which are not ready for final rehabilitation.

Note: It is accepted that parts of the site that are progressively rehabilitated may be subject to future re-disturbance.

Biodiversity and Rehabilitation Management Plan

28. The Proponent must prepare a Biodiversity and Rehabilitation Management Plan for the project to the satisfaction of the Secretary. This plan must:

(a) *be prepared by a suitably qualified expert;*

(b) *be prepared in consultation with OEH and Council;*

(c) *be submitted to the Secretary for approval within 3 months of the determination of Modification 1, unless otherwise agreed by the Secretary;*

(d) *provide details of the conceptual final landform and associated land uses for the site;*

(e) *describe how the implementation of the Biodiversity Offset Strategy will be integrated with the overall rehabilitation of the site;*

(f) *include a Koala Management Plan prepared in accordance with SEPP 44;*

(g) *include detailed performance and completion criteria for evaluating the performance of the*

Biodiversity Offset Strategy and rehabilitation of the site (including progressive rehabilitation), including triggers for any necessary remedial action;

(h) *describe the short, medium and long term measures to be implemented to:*
- *manage remnant vegetation and habitat on site, including within the Biodiversity Offset Strategy area; and*
- *ensure compliance with the rehabilitation objectives and progressive rehabilitation obligations in this approval;*

(i) *include a detailed description of the measures described in paragraph (h) to be implemented over the next 3 years (to be updated for each 3 year period following initial approval of the plan) including the procedures to be implemented for:*
- *maximising the salvage of environmental resources within the approved disturbance area, including tree hollows, vegetative and soil resources, for beneficial reuse in the enhancement of the offset area or site rehabilitation;*
- *restoring and enhancing the quality of native vegetation and fauna habitat in the biodiversity offset and rehabilitation areas through assisted natural regeneration, targeted vegetation establishment and the introduction of fauna habitat features;*
- *protecting vegetation and fauna habitat outside the approved disturbance area on-site, including core Koala habitat;*
- *minimising the impacts on native fauna, including undertaking pre-clearance surveys;*
- *establishing vegetation screening to minimise the visual impacts of the site on surrounding receivers;*
- *ensuring minimal environmental consequences for threatened species, populations and habitats;*
- *collecting and propagating seed;*
- *controlling weeds and feral pests;*
- *controlling erosion; and*
- *managing bushfire risk.*

(j) *include a program to monitor and report on the effectiveness of these measures, and progress against the performance and completion criteria;*

(k) *identify the potential risks to the successful implementation of the Biodiversity Offset Strategy, and include a description of the contingency measures to be implemented to mitigate these risks; and*

(l) *include details of who is responsible for monitoring, reviewing, and implementing the plan.*

The Proponent must implement the Biodiversity and Rehabilitation Management Plan as approved from time to time by the Secretary.

Biodiversity and Rehabilitation Bond

29. *Within 6 months of the approval of the Biodiversity and Rehabilitation Management Plan, the Proponent must lodge a Biodiversity and Rehabilitation Bond with the Department to ensure that the Biodiversity Offset Strategy and rehabilitation of the site are implemented in accordance with the performance and completion criteria set out in the plan and the relevant conditions of this approval. The sum of the bond must be determined by:*

(a) *calculating the full cost of implementing the Biodiversity Offset Strategy;*

(b) *calculating the cost of rehabilitating all disturbed areas of the site, taking into account the likely surface disturbance over the next 3 years of quarrying operations; and*

(c) *employing a suitably qualified quantity surveyor or other expert to verify the calculated costs, to the satisfaction of the Secretary.*

Notes:

- *Alternative funding arrangements for long term management of the Biodiversity Offset Strategy, such as provision of capital and management funding as agreed by OEH as part of a Bio Banking Agreement, or transfer to conservation reserve estate can be used to reduce the liability of the Biodiversity and Rehabilitation Bond.*
- *If capital and other expenditure required by the Biodiversity and Rehabilitation Management Plan is largely complete, the Secretary may waive the requirement for lodgement of a bond in respect of the remaining expenditure.*
- *If the Biodiversity Offset Strategy and/or rehabilitation of the site area are completed (or partially completed) to the satisfaction of the Secretary, then the Secretary will release the bond (or relevant part of the bond). If the Biodiversity Offset Strategy and rehabilitation of the site are not completed to the satisfaction of the Secretary, then the Secretary will call in all or part of the bond, and arrange for the completion of the relevant works.*

30. *Within 3 months of each Independent Environmental Audit (see condition 12 of Schedule 5), the Proponent must review, and if necessary revise, the sum of the Biodiversity and Rehabilitation Bond to the satisfaction of the Secretary. This review must consider the:*
    (a) *effects of inflation;*
    (b) *likely cost of implementing the Biodiversity Offset Strategy and rehabilitating all disturbed areas of the site (taking into account the likely surface disturbance over the next 3 years of the project); and*
    (c) *performance of the implementation of the Biodiversity Offset Strategy and rehabilitation of the site to date.*

3.3 GUIDELINES & STANDARDS

Relevant project environmental standards, policies and guidelines, applicable to this management plan are provided in ***Table 3.2***.

Table 3.2 Environmental Standards, Policies and Guidelines

Standards and Guidelines
NSW Mining Operations Plan (MOP) Guidelines, September 2013 (ESG3)
NSW Biodiversity Offset Policy for Major Projects, 2014
State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44)
State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007
Mining Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth, 2016)

3.4 RELATED MANAGEMENT PLANS

This BRMP forms part of an overarching EM Strategy for Blakebrook Quarry. Where relevant, reference will also be made to the other management plans, as listed in ***Table 3.3.***

Table 3.3 Blakebrook Quarry Management Plans

Reference No.	Management Plan
EMS	Environmental Management Strategy
EMS-MP1	Noise and Blast Management Plan
EMS-MP2	Air Quality Management Plan
EMS-MP3	Soil and Water Management Plan
EMS-MP5	Aboriginal Heritage Management Plan
EMS-MP6	Traffic Management Plan
EMS-MP7	Ground Water Management Plan

4 BASELINE ASSESSMENT

4.1 LAND USE

The land surrounding the site is used for agricultural and rural purposes including horse and cattle grazing, pasture production and horticultural activities. There are a number of residences within close proximity to the quarry, with the closest dwelling approximately 650 metres to the south west of the quarry.

4.2 CLIMATE

The climate of the Lismore LGA is warm temperate tending to subtropical in certain areas with moderately high temperatures and high rainfall (LCC, 2004).

4.3 TOPOGRAPHY

The site is located on steeply sloping land associated with the upper south western slope of Booerie Hill. Elevation at the site ranges from 90m to 130m Australian Height Datum (AHD).

4.4 GEOLOGY AND SOIL

The geology of the site predominantly comprises tertiary basalts which have given rise to the rich brown soils that dominate the site. These soils were found to have the following soil characteristics:

- shallow soils with loose basalt floaters (increased depth on plateaus);
- low to moderate erodibility;
- low to neutral pH;
- high phosphorous content; and
- high Cation Exchange Capacity (Morand, 1994).

4.5 HYDROLOGY

The site is located within the Richmond River catchment and the Terania Creek sub-catchment. Surface water drainage on the site flows to the west towards tributaries of Terania Creek.

4.6 ECOLOGY

4.6.1 *Vegetation Overview*

Vegetation within the site is typical of remnant vegetation associated with the upper slopes and plateaus of the local area, being highly fragmented as a result of historical clearing associated with logging and agricultural practices (CEG, 2008).

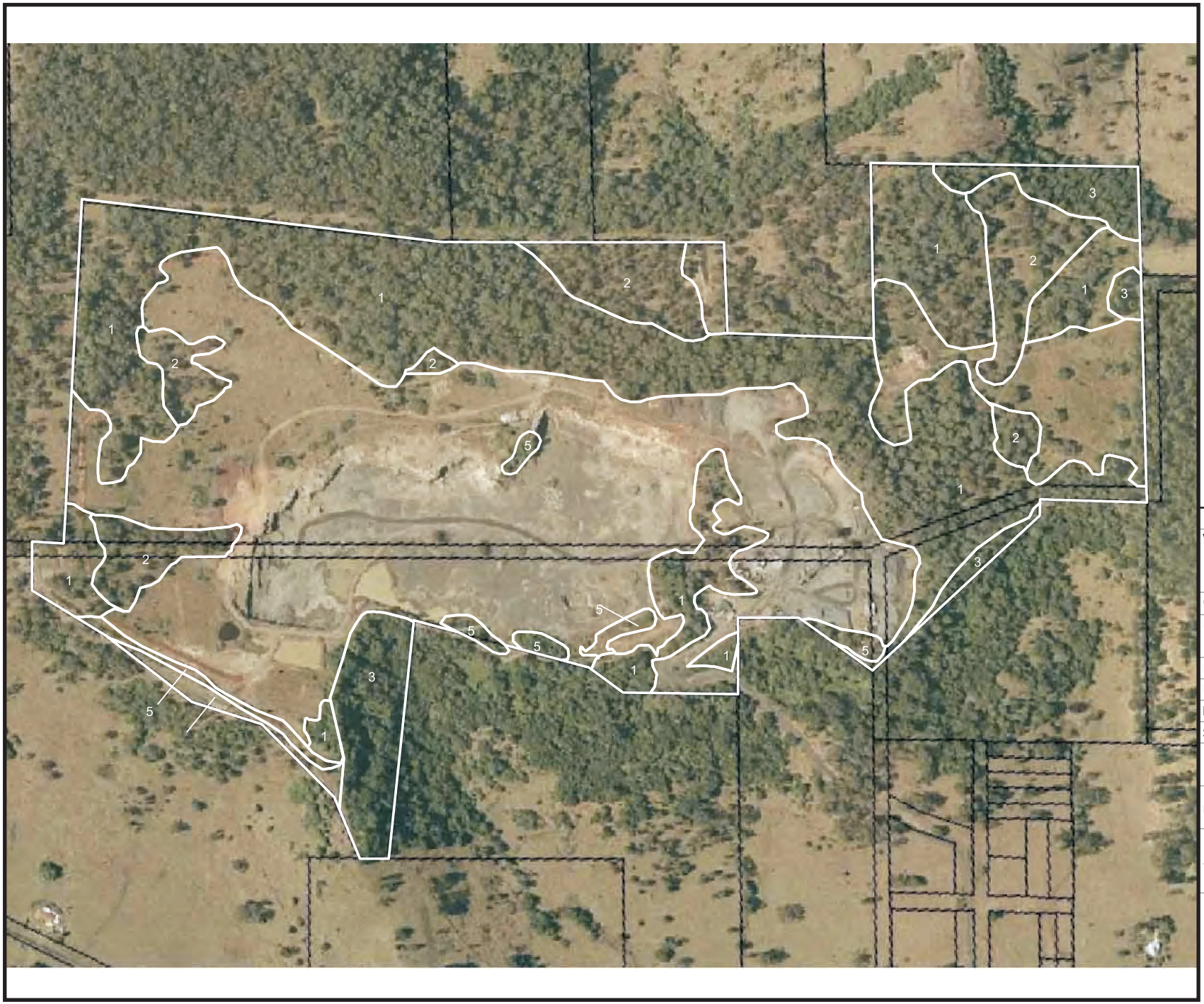
As shown in ***Figure 4.1***, the following five vegetation communities have been identified on-site:

- Tall Open Forest (Pink Bloodwood (*Corymbia intermedia*), White Mahogany (*Eucalyptus acmenoides*), Tallowwood (*Eucalyptus microcorys*) and Brush Box (*Lophostemon confertus*));
- Tall Open Forest/Woodland (Broad-leaved Apple (*Angophora subvelutina*), Forest Red Gum (*Eucalyptus tereticornis*) and Swamp Turpentine (*Lophostemon suaveolens*));
- Closed Forest;
- Regrowth Scrub; and
- Disturbed Grassland (CEG, 2008).

These communities are described in greater detail in ***Annex B***. The Open Forest, Woodland and Closed Forest communities within the site are part of a relatively large, high quality remnant that extends to the north, south, east and west of the site (CEG, 2008) (refer to ***Figure 4.1***).

The Closed Forest vegetation community qualifies as the Endangered Ecological Community (EEC) *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions* (Lowland Rainforest EEC) (CEG, 2008). This community comprises subtropical rainforest and some related, structurally complex forms of dry rainforest associated with high nutrient geological substrates (notably basalts and fine-grained sedimentary rocks) on coastal plains, plateaus, footslopes and foothills of the NSW North Coast and Sydney Basin Bioregions (DECCW, 2008a). In an undisturbed state, this community has a closed canopy characterised by a high diversity of trees whose leaves may be mesophyllous and encompass a wide variety of shapes and sizes (DECCW, 2008a).

The presence of a variety of growth forms (e.g. palms, vines, epiphytes) is another common feature of Lowland Rainforest EEC (DECCW, 2008a).



Legend

1 Tall Open Forest
2 Tall Open Forest/Woodland
3 Closed Forest (Lowland Rainforest EEC)
4 Disturbed Grassland
5 Regrowth Scrub

Source:

Conacher Environmental Group 2008

Figure 4.1
Vegetation Communities

Client:	Lismore City Council	
Project:	Blakebrook Quarry	
Drawing No:	0066641PM_VC01	
Date:	11/06/2010	Drawing size: A4
Drawn by:	TH	Reviewed by: MC
Scale:	Refer to Scale Bar	

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4.6.2 Fauna

The site provides a range of potential fauna habitat for locally occurring fauna species associated with the Open Forest, Closed Forest and Woodland vegetation variants (CEG, 2008). Available on-site fauna habitat comprises:

- flower, nectar, fruit and seed producing trees and shrubs – providing a foraging resource for birds, arboreal mammals and megachiropteran bat species;
- hollow-bearing trees – providing suitable breeding and refuge opportunities for a number of arboreal mammal, bird, microchiropteran bat and reptile species;
- dams, semi-permanent flooded grasslands and small ephemeral drainage lines and gullies – providing aquatic habitat for amphibian species;
- sparse to moderately dense understorey and leaf litter layer – providing foraging and sheltering habitat for bird, terrestrial mammal and reptile species;
- small rocky outcrops, fallen timber and hollow logs – providing habitat for small terrestrial mammal and reptile species;
- slashed/disturbed areas – providing foraging habitat for raptors; and
- sheds and equipment - providing artificial habitat for a small number of fauna species (CEG, 2008).

A list of fauna species recorded on the site by CEG (2008) is provided at ***Annex C***.

Continuous vegetation linkage have been identified to the north, south, east and west of the site although the patchy distribution of vegetation within the locality due to previous clearing has resulted in a relatively isolated ridgetop remnant with some tenuous fauna habitat connectivity (CEG, 2008).

4.6.3 Threatened Species

Two threatened flora species and eight threatened fauna species have been recorded on-site. Details of these species including their legal status under the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are provided in ***Table 4.1***. A third threatened flora species, the Fragrant Myrtle (*Gossia fragrantissima*) has been recorded within the adjacent offsite offset area (Dawson 2018).

Further information regarding potential impacts to these species as a result of the proposed quarry expansion is provided in **Section 5.0**.

Table 4.1 Threatened Species Identified On-Site

Common Name	Scientific Name	Legal Status	
		BC Act	EPBC Act
Flora			
Arrow-head Vine[1]	*Tinospora tinosporoides*	V	V
Thorny Pea[3]	*Desmodium acanthocladum*	V	V
Fauna			
Birds			
Glossy Black-cockatoo[1]	*Calyptorhynchus lathami*	V	-
Masked Owl[2]	*Tyto novaehollandiae*	V	-
Mammals			
Common Bentwing-bat[2]	*Miniopterus schreibersii oceanensis*	V	-
Eastern False Pipistrelle[1]	*Falsistrellus tasmaniensis*	V	-
Grey-headed Flying-fox[1]	*Pteropus poliocephalus*	V	V
Koala[1,2]	*Phascolarctos cinereus*	V	-
Little Bentwing-bat[1,2]	*Miniopterus australis*	V	-
Squirrel Glider[1]	*Petaurus norfolcensis*	V	-

References:

1. CEG, 2008
2. Parker, 1995
3. Dawson 2018

5 ENVIRONMENTAL IMPACTS & RISK ANALYSIS

5.1 ENVIRONMENTAL IMPACTS

A detailed Ecological Site Assessment was prepared by Conacher Environmental Group (CEG) in 2008 to inform the Environmental Assessment Report (EAR) and subsequent project approval. The assessment included desktop assessment, targeted flora and fauna surveys and included a comprehensive ecological impact assessment and characterisation of the site.

5.1.1 *Vegetation Communities*

Vegetation within the site is typical of remnant vegetation associated with the upper slopes and plateaus of the local area, being highly fragmented as a result of historical clearing associated with logging and agricultural practices (CEG, 2008).

Vegetation on the site equates to approximately 60ha. Expansion of Blakebrook Quarry would result in the removal of approximately 10.8ha of this vegetation. A breakdown of existing vegetation on-site and vegetation requiring removal is provided in ***Table 5.1***.

Table 5.1 ***Breakdown of Vegetation Removal***

Vegetation Community	Total Amount	Vegetation Removal (ha)
Tall Open Forest	25.7	8
Tall Open Forest/Woodland	9.1	1.3
Closed Forest	1.9	0
Disturbed Grassland	21.2	1.3
Regrowth Scrub	2.1	0.2
TOTAL	**60**	**10.8**

Source: CEG, 2008

These vegetation communities are described in greater detail in ***Annex B.***

5.1.2 *Fauna Habitat*

The quarry expansion would result in the removal of large numbers of native trees that provide suitable foraging, breeding and refuge habitat for locally occurring fauna species (CEG, 2008). Rehabilitation of the DVPA has been designed to protect on-site biodiversity values and minimise impacts associated with removal of fauna habitat, including the retention of areas identified as providing important Koala habitat (CEG, 2008). The site provides a low density of hollow bearing trees due to a low number of senescing trees (CEG, 2008). The majority of hollow bearing trees on-site

would be retained, however a number will be removed as a result of the expansion (CEG, 2008).

The removal of habitat may result in local decreases in biodiversity due to the decrease in habitat extent and type (CEG, 2008). This in turn may result in the movement of fauna species to adjacent areas and subsequently may impact upon the proportion and type of species currently present at the site (CEG, 2008).

5.1.3 Mature Trees

Mature trees within the approved quarry footprint will need to be removed to allow for extraction of the resource. The mature trees within the footprint will be selective removed, in a manner such that disturbance to any resident fauna is minimised (e.g. 'soft falling' - clearing of vegetation surrounding the mature tree, stockpiling, then felling tree into stockpile, disturbing tree and allowing time for fauna to evacuate before felling).

Infrastructure required outside of the quarry footprint such as surface water control bunds and sediment basins, access tracks and laydown yards will be designed and installed with consideration to the location of mature trees, with avoidance of removal where feasible. Mature trees, and more importantly, hollow bearing trees, will only be removed in areas outside of the quarry footprint where it can be justified that removal of the mature tree will improve site safety or environmental value (through installation of surface water controls for example) or where retainment is economically not feasible to modify infrastructure around the mature trees.

5.1.4 Threatened Species and Endangered Ecological Communities

A summary of the potential impacts to threatened species identified within the site as a result of the quarry expansion is provided in ***Table 5.2***.

Table 5.2 Threatened Species Impacts

Species	Potential Habitat Type	Potential Habitat-Area (ha)	Removal of Potential Habitat (ha)
Flora			
Arrow-head Vine[1]	Closed Forest	1.9 ha	0 ha
Thorny Pea	Tall Open Forest; Tall Open Forest/Woodland; Closed Forest;	36.7	9.3 ha
Fragrant Myrtle	Closed Forest	1.9 ha	0 ha
Fauna			
Birds			
Glossy Black-cockatoo	Tall Open Forest; Tall Open Forest/Woodland	34.8 ha	9.3 ha

Species	Potential Habitat Type	Potential Habitat-Area (ha)	Removal of Potential Habitat (ha)
Masked Owl	Tall Open Forest; Tall Open Forest/Woodland; Disturbed Grassland	58.1 ha	26.1 ha
Mammals			
Common Bentwing-bat	Tall Open Forest; Tall Open Forest/Woodland; Closed Forest; Regrowth Shrub; Disturbed Grassland	60 ha	26.1 ha
Eastern False Pipistrelle	Tall Open Forest; Tall Open Forest/Woodland; Closed Forest; Regrowth Shrub; Disturbed Grassland	60 ha	26.1 ha
Grey-headed Flying-fox	Tall Open Forest; Tall Open Forest/Woodland; Closed Forest; Disturbed Grassland	38.8 ha	9.6 ha
Koala	Tall Open Forest; Tall Open Forest/Woodland; Closed Forest;	36.7 ha	9.3 ha
Little Bentwing-bat	Tall Open Forest; Tall Open Forest/Woodland; Closed Forest; Regrowth Shrub; Disturbed Grassland	60 ha	26.1 ha
Squirrel Glider	Tall Open Forest; Tall Open Forest/Woodland;	34.8 ha	9.3 ha

Known occurrences of Arrow-head Vine (*Tinospora tinosporoides*) and the Lowland Rainforest EEC have been conserved and improved on-site as part of the DVPA. Key habitat features for identified threatened fauna species and fauna movement corridors have also been targeted for protection within the DVPA.

5.2 *RISK ANALYSIS*

Given that the activities undertaken at Blakebrook Quarry have the potential impact on the surrounding environment, as detailed in **Section 5.1**, the commensurate level of risk associated with these impacts is required to be identified so as to better ensure that it can be mitigated and managed to an acceptable level through this management plan.

Accordingly, ***Table 5.3***, summarises the likely risk level associated with each of the prospective environmental impacts, assuming that no mitigation measures or controls are put in place to manage the impacts. The risk assessment process is in accordance with that described in the Environmental Management Strategy for Blakebrook Quarry.

Table 5.3 Environmental Impact Risk Analysis

ID	Aspect	Impact	Risk
BR1	Threatened flora and fauna species and ecological communities	Loss of habitat/ Fragmentation	Medium
BR2		Increased edge effects	Medium

Note:

Risk Ratings: High (serious impacts and potential repercussions)
Medium (significant impacts and potential repercussions)
Low (minor impacts and potential repercussions)

As previously stated, the risk rating assigned in ***Table 5.3*** assumes no mitigation or control measures are in place to respond to the identified environmental impact. By implementing the measures outlined in this BRMP, these environmental impacts and associated risks can be managed to an acceptable level, such that the risk would be considered negligible.

6 PERFORMANCE CRITERIA & INDICATORS

The overall objective of the rehabilitation plan is to develop a relatively weed-free, functional ecosystem that provides ecological services to maintain and enhance fauna populations.

The 'Mining Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry' (Commonwealth, 2016) adopts the following definition of rehabilitation:

> *Rehabilitation comprises the design and construction of landforms as well as the establishment of sustainable ecosystems or alternative vegetation, depending upon desired post-operational land use.*

The guideline also states that mine site rehabilitation will be designed to meet three key objectives:

1. the long-term stability and sustainability of the landforms, soils and hydrology of the site;
2. the partial or full repair of ecosystem capacity to provide habitats for biota and services for people; and
3. the prevention of pollution of the surrounding environment.

To achieve these objectives, the following performance criteria and associated Performance Indicators have been developed to guide the rehabilitation process (refer to ***Table 6.1***).

Table 6.1 Performance Objectives and Indicators

Performance Criteria	Performance Indicator	Management/Control
C1: Stabilise all excavated areas to minimise erosion	**I1.1:** Following completion of excavation in an area, rehabilitation is to commence.	Refer to **Section 7.3.2**
C2: Revegetate area with local provenance species	**I2.1:** Seed or tubestock to be sourced from local stock. Certification must be obtained from the nursery.	Refer to **Section 7.5.1**
C3: Ensure the worked out areas are safe for future uses	**I3.1:** Revegetation and stabilisation to be carried out as soon as completion of excavation.	Refer to **Section 8.2.4**
C4: Maintain and enhance habitat for existing flora and fauna	**I4.1:** Retention and use of logs within rehabilitated areas.	Refer to **Section 7.5.1**
	I4.2: 2:1 replacement of nest boxes to hollows removed to be erected as compensatory habitat.	Refer to **Section 7.5.1**
	I4.3: Revegetation with a range of grasses, ground covers, shrubs and trees.	Refer to **Section 7.5.1**

Performance Criteria	Performance Indicator	Management/Control
	I4.4: Revegetation with *Allocasuarina torulosa* to provide forage feed plants for Glossy Black Cockatoos[1].	Refer to **Section 7.5.1**
	I4.5: Revegetation with koala feed tree species (*Eucalyptus tereticornis* and *Eucalyptus microcorys*)[1].	Refer to **Section 7.5.1**
C5: Provision of fauna movement corridors	**I5.1:** Retention of 50m wide vegetation strip between the main pit and the pit to the south1. Revegetation on north-west boundary to link the Closed Forest to the Open Forest[1].	Refer to ***Figure 1.2*** Refer to **Section 8.0** *Note: Revegetation is further addressed in the Bushland Regeneration Plan for the Blakebrook Quarry, attached as Annex B of the Biodiversity Offset Strategy, available (available from www.lismore.nsw.gov.au).*

Reference: Conacher Environmental Group, 2008, *Ecological Site Assessment*

7 SHORT AND MEDIUM TERM MANAGEMENT & MITIGATION CONTROLS

7.1 "BEST PRACTICE" MANAGEMENT APPROACH

In managing the Blakebrook Quarry, Council is seeking to ensure that a "Best Practice" management approach is used across all areas of potential impact. This approach has been used in the BRMP to minimise, mitigate and manage biodiversity and rehabilitation.

Specifically, this BRMP has been prepared in accordance with the following "Best Practice" management approaches:

- NSW Mining Operations Plan (MOP) Guidelines, September 2013 (ESG3) and
- Mining Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth, 2016).

7.2 ON-SITE REHABILITATION MANAGEMENT SCHEDULE

The management of biodiversity values on-site can be divided into three categories relating to:

- the mitigation/management of biodiversity impacts within active quarry areas associated with the proposed quarry expansion and ongoing quarrying activities;
- the rehabilitation and protection of on-site biodiversity values outside of active quarry areas; and
- the progressive rehabilitation of active quarry areas, following extraction of quarry material.

7.3 MITIGATION AND MANAGEMENT OF BIODIVERSITY IMPACTS WITHIN ACTIVE QUARRY AREAS

A number of management measures are proposed for the site to mitigate biodiversity impacts within active quarry areas. These measures are described below.

7.3.1 *Protection of Adjoining Native Vegetation*

Activity on-site has the potential to introduce or spread weed seeds, propagules and pathogens such as *Phytophthora cinnamomi* (an introduced soil- borne pathogen with the ability to kill native plants by attacking root systems and inhibiting the movement of water and nutrients within the plant) to vegetation adjoining active quarry areas.

Prior to the commencement of works, native vegetation adjoining the active quarry area will be delineated and access to these areas restricted to authorised personnel only. Due to low amounts of traffic, fencing of rehabilitation areas is not required although areas identified as Lowland Rainforest EEC will be fenced to deter entry of unauthorised personnel (CEG, 2008).

Signage indicating that rehabilitation works are in progress will also be erected to discourage disturbance to these areas. On-site personnel will be inducted on their responsibilities in relation to avoiding restoration areas (CEG, 2008) and personnel with access to rehabilitation areas will be provided with information regarding appropriate hygiene practices (eg cleaning of shoes and machinery) to prevent the spread of weeds and pathogens to rehabilitation areas

7.3.2 Erosion and Sediment Control Measures

Vegetation removal within the site will result in localised disturbance of soils. In areas with a high risk of erosion (e.g. steep slopes, edges of waterways), control measures will need to be implemented to prevent erosion of adjoining vegetation areas (CEG, 2008). Sediment and erosion control measures that will continue to be used at the site, depending on level of erosion risk and suitability, include:

- installation of sediment fencing in areas upslope of gutters, drainage lines or riparian areas, prior to the commencement of works on the site (CEG, 2008);
- prioritising revegetation of areas at high risk of erosion as soon as practicable according to the progressive rehabilitation approach detailed in *Section 8.1.1*;
- planting of areas at high risk of erosion with rapidly establishing, non-invasive ground cover for temporary management during operational works; and
- avoid any unnecessary impacts to retained vegetation, including trunks and root systems.

7.3.3 Stockpiling of Topsoil

Topsoil from areas identified for vegetation removal has been stockpiled on-site (away from drainage lines) for later use in on-site rehabilitation works. Stockpiles will be free of weed seeds and propagules and stabilised with a sterile cover crop if they are to be in place for more than 10 days (CEG, 2008).

7.3.4 Vegetation Clearing and Removal of Fauna Habitat

During removal of vegetation within the approved quarry area, the following protocol for clearing hollow bearing trees will continue to be adopted.

Pre-Clearing

At least one week notice is required prior to the clearing of native vegetation to allow adequate time for inspections of use by native fauna (CEG, 2008).

After notice has been given, an ecologist trained in the handling and relocation of native fauna, will inspect hollow bearing trees for native fauna (CEG, 2008). This may include inspection of trees at sunset (stag watching) to allow for the detection of diurnal fauna returning to hollows or nocturnal fauna leaving hollows (CEG, 2008). In some cases physical inspections of hollows by a suitably qualified arborist under the direction and supervision of an ecologist may be required (CEG, 2008).

During Clearing

Where fauna are identified within a hollow and the risk of death or injury as a result of machine felling is high, the tree may be felled in sections (CEG, 2008). This would involve the removal of hollow limbs in sections using a chainsaw and lowering the limb to the ground for safe relocation of fauna (CEG, 2008). These works would be carried out by a suitably qualified arborist under the direction of an ecologist (CEG, 2008).

For trees that contain hollows where no fauna has been observed, the tree will be machine felled (CEG, 2008). In this instance, the blade or bucket of the machinery would be tapped against the base of the tree to disturb any fauna present and provide time for evacuation of the hollow (CEG, 2008). The tree would then be felled as gently as possible under supervision of an ecologist (CEG, 2008). All hollows would be inspected post-felling for fauna occupation and any detected fauna would be removed or relocated to adjoining areas of suitable habitat (CEG, 2008).

In cases where young fauna are identified and it is determined that the survival of the individual would be at risk due to the removal of the hollow or felling of a tree, then clearing would not be undertaken until those young were old enough to leave the hollow (CEG, 2008). For this reason, clearing will be undertaken outside of breeding periods (generally between spring and early summer) (CEG, 2008).

In the event of injured fauna, a local wildlife rescue organisation (e.g. WIRES) will be contacted for care and rehabilitation.

Following inspection of felled tree hollows, these will be removed from the tree and relocated to other suitable trees within areas of adjoining native vegetation (CEG, 2008). Fallen hollow logs and rocks that potentially provide habitat for native fauna will also be relocated to areas of adjoining habitat during the clearing process.

7.3.5 *Disposal of Cleared Vegetation*

Native vegetation requiring removal will be immediately mulched or chipped and stockpiled on-site to be used in rehabilitation works (CEG, 2008).

Weeds removed during vegetation clearing will be safely transferred off-site and disposed of at an approved waste transfer facility (CEG, 2008). They must not be disposed of on-site or allowed to invade adjoining native vegetation (CEG, 2008).

7.3.6 *Progressive Rehabilitation*

Progressive rehabilitation will be implemented in those areas that will be revegetated as soon as practicable after they are no longer required for quarry operations. This strategy is detailed in *Section 8.1.1.*

7.4 REHABILITATION AND PROTECTION OF BIODIVERSITY VALUES OUTSIDE OF ACTIVE QUARRY AREAS

As part of post-approval works, a Dedicated Vegetation Protection Area (DVPA) has been established on-site to offset predicted ecological impacts. The DVPA is shown on ***Figure 1.2*** and covers an area of approximately 34ha within the site. This VPA has been divided into three zones according to the broad management strategies required for each zone. These zones are:

- **Zone A – Revegetation Zone:** this zone is highly degraded due to past clearing which has resulted in a loss of topsoil, native vegetation and fauna habitat availability;
- **Zone B – Regeneration Zone:** areas identified within this zone have a high degree of weed invasion and are located at the edges of vegetation communities and the site boundary; and
- **Zone C – Protected Habitat Zone:** covers approximately 17.6ha comprising less disturbed bushland areas within the site that require weed removal (CEG, 2008) and is identified as the On-site Offset in the Consent Conditions.

A breakdown of the DVPA according to the three management zones and vegetation communities is provided in ***Table 7.1***.

Table 7.1 Management Zones within the DVPA

Vegetation Community	Zone A* – Revegetation Zone (ha)	Zone B* – Regeneration Zone (ha)	Zone C *– Protected Habitat Zone/Offset Area (ha)	Total Area (ha)
Tall Open Forest	1.54	4.86	11.84	18.24
Tall Open Forest/Woodland	0.03	3.63	3.93	7.59
Closed Forest (Lowland Rainforest EEC)	0.02	1.78	0.05	1.85
Disturbed Land	2.53	1.094	1.82	5.44
Regrowth Scrub	0.86	0	0	0.83
Total	**4.98**	**11.36**	**17.64**	**33.98**

** It is noted that these three broad management zones have been referred to in this BRMP and the Biodiversity Offset Strategy to confirm dedication of a 17.6 ha on-site offset area as required in the CoA. Refer to the Blakebrook Quarry Bush Regeneration Plan (Dawson 2018) (attached as Annex B of the Biodiversity Offset Strategy, available at www.lismore.nsw.gov.au). and Section 11 for the identification of specific work zones and management actions.*

7.5 PROPOSED MANAGEMENT CONTROLS

7.5.1 Management Actions

Management actions adopted for each zone are largely dependent upon the condition and extent of native vegetation and involve one or more of the following broad approaches:

- **Regeneration** – generally used in areas with a high level of resilience and minimal weed invasion. Involves the gradual removal of weeds in a methodical manner to allow the regeneration of native plant species;
- **Assisted Regeneration** – generally used in areas with a moderate level of resilience. Involves planting native flora species grown from locally sourced seed in conjunction with the gradual removal of weeds; or
- **Revegetation** – generally used in areas with a low level of resilience, often dominated by weeds and few native species. Involves weed removal and control and the use of native flora species grown from locally sourced seeds to reconstruct vegetation communities that would previously have occupies the area prior to clearing.

The proposed strategy for enhancing vegetation on-site would involve a combination of these approaches although would generally be divided into the three zones as follows:

- **Zone A – Revegetation Zone:** these areas have been prioritised for revegetation works with the aim of increasing the quality and quantity

of native vegetation and available fauna habitat and restoring connectivity within the site;

- **Zone B – Regeneration Zone:** these areas have been identified for assisted regeneration works involving weed removal and replanting; and

- **Zone C – Protected Habitat Zone:** these areas have been identified for regeneration works with the aim of enhancing existing fauna habitat (CEG, 2008).

The management actions proposed for the DVPA are summarised in ***Table* 7.2**. Details of these actions are provided below.

Table 7.2 Management Actions for the DVPA

Action	Management Zone
On-site delineation of DVPA and management zones, fencing of Lowland Rainforest EEC and erection of signage	A, B, C
Management of pest fauna species	A, B, C
Primary weed control	A, B, C
Enrichment of disturbed soils with stockpiled topsoil	A, B
Installation of erosion and sediment control measures	A, B
Erection of nest boxes, relocation of tree hollows, fallen hollow logs and rocky outcrops	A, B, C
Revegetation using native species	A, B
Secondary and maintenance weed control	A, B, C

Site Preparation

In heavily disturbed areas (i.e. *Zone A* and parts of *Zone B*), compacted soils will be ripped and enriched with topsoil that has been stockpiled from quarry areas during vegetation removal, prior to the commencement of revegetation works.

Erosion and sediment control measures are to be implemented within the DVPA as required to minimise indirect impacts associated with weed removal. The minimisation of soil erosion on-site and sedimentation of nearby waterways will be achieved via soil stabilisation methods (e.g. use of jute matting, terracing etc.), sediment fencing, water control techniques and revegetation of cleared surfaces (CEG, 2008).

Weed Removal and Control

The level of weed invasion within the site varies according to the degree of disturbance as a result of clearing and past grazing (CEG, 2008). Weed invasion is highest within disturbed areas in the north of the site, along the perimeter of the site boundary and along the edges of vegetation

communities (CEG, 2008). Other weed infestations occur in the south of the site in areas that have been historically cleared (CEG, 2008).

Weed control is essential for native plant regeneration and revegetation success. The finely divided, dense roots of many weeds especially grasses, compete with native seedlings for nutrients and water. Removing competing weed species encourages successful native plant growth and establishment.

Exotic species (including listed weeds of national significance (WONS) and noxious weeds) recorded on-site and targeted for removal are provided in ***Table 7.3***. Profiles for WONS recorded on site are provided in ***Annex D***.

Table 7.3 Exotic Species Identified On-Site

Scientific Name	Common Name
Noxious Weeds*	
Ageratina adenophora	Crofton Weed
Ageratina riparia	Mistflower
Baccharis halimifolia	Groundsel Bush
Cinnamomum camphora	Camphor Laurel
Lantana camara+	Lantana
Rubus anglocandicans+	Blackberry
Other Weeds	
Andropogon virginicus	Whisky Grass
Anredera cordifolia	Madeira Vine
Asclepias curassavica	Blood Flower
Asparagus aethiopicus	Asparagus Fern
Axonopus fissifolius	Narrow-leafed Carpet Grass
Bidens pilosa	Cobbler's Pegs
Chloris gayana	Rhodes Grass
Cirsium vulgare	Spear Thistle
Conyza bonariensis	Flaxleaf Fleabane
Cyperus eragrostis	Umbrella Sedge
Ehrharta erecta	Panic Veldtgrass
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush
Hydrocotyle bonariensis	Pennywort
Hyparrhenia hirta	Coolatai Grass
Hypochaeris radicata	Catsear
Juncus acutus	Sharp Rush
Ligustrum lucidum	Large-leaved Privet
Ligustrum sinense	Small-leaved Privet
Lilium formosanum	Formosan Lily
Melinis minutiflora	Molasses Grass
Melinis repens	Red Natal Grass

Scientific Name	Common Name
Panicum maximum	Guinea Grass
Paspalum dilatatum	Paspalum
Paspalum urvillei	Vasey Grass
Passiflora suberosa	Cork Passionfruit
Pennisetum clandestinum	Kikuyu Grass
Phytolacca octandra	Inkweed
Plantago lanceolata	Lamb's Tongues
Richardia brasiliensis	Mexican Clover
Senecio madagascariensis	Fireweed
Senna pendula var. glabrata	Cassia
Setaria sphacelata	South African Pigeon Grass
Sida rhombifolia	Paddy's Lucerne
Solanum mauritianum	Wild Tobacco Bush
Stellaria media	Common Chickweed
Verbena bonariensis	Purpletop
Verbena officinalis	Common Verbena
Verbena rigida	Veined Verbena

* Listed in accordance with the *Noxious Weeds Act 1993;* +denotes weeds of national significance (WONS)

Source: CEG, 2008

The implementation of a methodical and thorough weed management program is vital to controlling weed infestations and encouraging native plant growth. Weed control within the DVPA requires the removal of weeds in three stages as follows:

- **Primary Weed Removal -** This is the initial stage of weed control and involves the removal of dominant weeds within the site. Primary weeding may take up to three months;

- **Secondary Weed Removal -** Primary weed removal promotes propagation of weed seeds and propagules stored within the soil. Consequently, it is important that intensive secondary weed removal of areas that have already undergone primary weed removal is conducted. Secondary weeding will be be undertaken within three to six months following primary weed removal. Secondary weeding may take up to three months or be undertaken progressively over 12 months;

- **Maintenance Weeding -** Following primary and secondary weed removal, the majority of native species present on-site will be at a competitive advantage to prevent reinvasion of exotic weed species. However, weed seeds and propagules are still able to reinvade the site via birds and other animals, wind, water and other mechanisms for dispersal. Consequently, maintenance weeding will be undertaken six

to twelve times per year until such time as native species are at a competitive advantage against invading weed species (CEG, 2008).

All weed removal must be conducted by appropriately trained and licensed personnel experienced in weed removal and the use of herbicides. Use of herbicide near waterways must be conducted in accordance with the Safe and Effective Herbicide Use: A handbook for near-water applications (EPA, 2017).

As a general rule, weed removal will be undertaken in a methodical manner and commence in areas of least disturbance, progressing towards areas of greater disturbance. This allows progressive regeneration of native species over time and reduces the competition between invading weed species. When working along waterways, weed removal will commence upstream and progressively work downstream. This helps to prevent the reinvasion of areas with weed seeds and propagules that may be contained in upstream water.

Where possible, weed removal will be conducted in a manner that minimises soil disturbance, erosion and the risk of native fauna habitat removal. Minimising disturbance to the soil reduces opportunities for weeds to re-establish as many species maintain a large seed bank in the soil and soil disturbance can provide optimal conditions for weed regeneration. Minimising soil disturbance can also reduce overall weed management costs.

Where planting of native species is required, weed removal will commence immediately in order to provide native seedlings with a competitive advantage against invading weed species.

Pest Fauna Species Management

The following pest fauna species were observed within the site during surveys:

- Cane Toad (*Rhinella marina*);
- Rabbit (*Oryctolagus cuniculus*);
- Dog (*Canis lupus*); and
- Fox (*Vulpes vulpes*) (CEG, 2008).Pest fauna species cause problems in natural landscapes such as:
- soil erosion;
- degradation of native flora and fauna habitat;
- competition between native fauna species for resources;
- predation of native fauna species;
- distribution of disease and weeds;

- increased management costs to control environmental impacts; and
- human health impacts as a result of the spread of disease (CEG, 2008).

The management of pest fauna species is governed by the *Rural Lands Protection Act 1989* and the *National Parks and Wildlife Act 1974*. The Livestock Health and Pest Authority (LHPA) (formerly the Rural Lands Protection Board) and local Council are the control authorities for feral and domestic animals. These agencies, in coordination with the Office of the Environment and Heritage (OEH) (formerly Department of Environment, Climate Change and Water (DECCW)) are able to provide a wide range of technical advice on control and management strategies. Further information and control strategies for each of the four invasive fauna species observed during site surveys is included below. Ongoing pest control is required for five years to maintain target pest fauna populations. A licensed pest removal contractor will be engaged to complete these works

Cane Toad (*Rhinella marina*)

No effective methods currently exist for the eradication of cane toads. However, the use of cane toad 'super traps' is suggested by the NSW National Parks and Wildlife Service (2007).

Rabbit (*Oryctolagus cuniculus*)

Rabbit control programs must take the density of individuals into account. The scientific literature identifies a threshold of 0.5 rabbits per hectare, above which native species can be severely impacted (DoE 2015). Rabbit control is best implemented on regional scales, however the following measures have been identified by the Department of Primary Industries:

- **Fencing**: Rabbit proof netting fences are expensive to construct, but provide largely permanent exclusion of rabbits.
- **Trapping**: Soft-jawed spring traps and mesh barrel traps are a suitable option in more urban areas but will not be relied upon for medium to high density populations. Traps may be set in the active openings of the warren in the late evening. Note, the use of steel-jawed traps in NSW is an offence under the *Prevention of Cruelty to Animals Act 1979*.
- **Shooting**: suitable and effective when numbers are low. A professional contractor will be consulted for this option.
- **Poisoning**: this measure is to be implemented only during the non-breeding season and is not suitable for closely settled areas. This strategy is optimal during mid to late summer. 1080 and Pindone are toxins registered for the control of rabbits and both are covered by product labels and Pest Control Orders issued by the NSW Environment Protection Authority (EPA). The use of 1080 currently requires a minimum chemical use accreditation at AQF3 or the EPA accredited

course delivered by Local Land Services and distance, notification and signage restrictions apply.

- **Harbour destruction**: destruction of warrens is highly target specific and can be successfully used during the breeding season. The aim of warren destruction or 'warren ripping' is to simultaneously destroy the structure of the warren and kill the resident rabbits.

- **Fumigation**: this measure may be used when poisoning and harbour destruction are unsuitable. Phosphine and carbon monoxide pressure fumigators may be used. All burrows entrances must be closed. It should also be noted that these chemicals are toxic to humans.

- **Myxomatosos and RHDV**: also listed as options but are subject to suitability determination only following contact with Local Land Services.

Dog (*Canis lupus*)

Wild dogs may cause negative impacts by preying on native fauna. The Department of Primary Industries lists the following strategies for wild dog control:

- **Fencing**: Barrier fencing may provide an effective barrier providing it is adequately maintained. Electric fences are more effective, however conventional fences are more appropriate for the site.

- **Trapping:** Trapping wild dogs is best conducted by experienced or trained operators. Only soft-jawed or padded jawed spring traps may be used for the control of wild dogs in NSW.

- **Shooting:** Shooting may be effective in situations where wild dogs are known to be in the area. Most shooting however is opportunistic. Shooting can play an important role in controlling wild dogs, but usually does not have as significant an impact on a regional basis as poisoning.

- **Poisoning:** Wild dog poisoning with 1080 in NSW is regulated by the *Pesticide Act 1999* and can be carried out only under the conditions set down in the current 1080 Pesticide Control Order (PCO). The use of 1080 currently requires a minimum chemical use accreditation at AQF3 or the EPA accredited course delivered by Local Land Services and distance, notification and signage restrictions apply.

Fox (*Vulpes vulpes*)

- **Fencing**: Electric fences are somewhat effective for fox control, but may not be suitable for the site.

- **Trapping:** The use of both cage traps and leg-hold traps for capture of the red fox is successful if time consuming. The use of leg-hold traps

requires skill and training. Legislation governs what traps can be used and how and where they can be set

- **Shooting:** Shooting may be an effective option, however restrictions apply to types of firearms and equipment used.

- **Poisoning:** Wild dog poisoning with 1080 in NSW is regulated by the Pesticide Control Order (PCO) and is best implemented over a large area. The use of 1080 currently requires a minimum chemical use accreditation at AQF3 or the EPA accredited course delivered by Local Land Services and distance, notification and signage restrictions apply.

Enhancement of Fauna Habitat and Fauna Movement Corridors

To compensate for the removal of den, breeding and refuge habitat provided by hollow-bearing trees, nest boxes will be erected within the DVPA as compensatory habitat. A minimum 2:1 replacement of nest boxes to hollows removed will be erected as compensatory habitat (CEG, 2008). Hollow limbs and fallen hollow logs salvaged during vegetation removal within active quarry areas will also re-used within the DVPA.

The following guidelines will be adopted during the erection of nest boxes:

- appropriate trees and locations for nest boxes are to be determined by an ecologist;

- a combination of nest boxes specifically designed for the Squirrel Glider (*Petaurus norfolcensis*), possum, parrot and microchiropteran bat species will be erected as replacement habitat;

- all replacement nest boxes are to be secured to trees (by an experienced arborist) at a minimum height of four metres above ground level with entrances facing the east or north east direction;

- all nest boxes will be entered into a GPS (global positioning system) and inspected regularly (at least annually) for signs of use and any damaged or missing boxes that need to be repaired or replaced; and

- feral bee invasion of nest boxes need to be identified and controlled by a pest control contractor (CEG, 2008).

In addition to the replacement of den, breeding and refuge habitat, revegetation using native species within the VPA would also enhance existing on-site foraging and sheltering habitat and increase fauna connectivity.

Planting Program

The promotion of natural regeneration in preference to planting regimes will be encouraged (CEG, 2008). However, where soils or vegetation has been significantly altered as a result of vegetation removal and weed invasion,

suitable locally occurring native (endemic) plant species will be used during rehabilitation (CEG, 2008).

Species Composition and Planting Design

Where planting of native species is required (i.e. *Zone A* and parts of *Zone B*), species will be selected that:

- emulate vegetation that naturally occurs in the area;
- provide a structurally diverse community (ie comprise tree, shrub and groundcover species);
- provide potential foraging, sheltering and breeding habitat for native fauna, particularly threatened fauna species; and
- are suitable for local environmental conditions.

Species listed in ***Table 7.4*** occur naturally within the site and are recommended for on-site revegetation works, subject to availability.

Table 7.4 Recommended Revegetation Species List

Scientific Name	Common Name	Growth Habitat	Planting Method	Notes
Upper Stratum				
Acacia irrorata	Green Wattle	Shrub or tree to 10m	Direct drilling/tubestock	fast growing shade species
Acronychia oblongifolia	Common Acronychia	Shrub or tree to 30m	Tubestock	foraging resource for frugivores (eg birds and bats)
Allocasuarina torulosa	Forest Oak	Tree to 20m	Direct drilling/tubestock	Foraging resources for Glossy-black Cockatoo
Alphitonia excelsa	Red Ash	Small or medium tree to 10m	Tubestock	Foraging resources for frugivores (eg birds and bats)
Corymbia gummifera	Red Bloodwood	Tree to 30m	Direct drilling/tubestock	Foraging habitat; Hallow producing
Eucalyptus microcorys	Tallowwood	Tree to 40m	Direct drilling/tubestock	Koala feed tree
Eucalyptus tereticornis	Forest Red Gum	Tree to 50m	Direct drilling/tubestock	Koala feed tree; Hollow producing;
Glochidion ferdinandi	Cheese Tree	Small or medium tree to 15m	Tubestock	Foraging resources for frugivores (eg birds and bats)
Lophostemon confertus	Brush Box	Tree to 40m	Direct drilling/tubestock	Refuge/foraging habitat
Lophostemon suaveolens	Swamp Turpentine	Tree to 30m	Direct drilling/tubestock	Refuge/foraging habitat

Scientific Name	Common Name	Growth Habitat	Planting Method	Notes
Melaleuca quinquenervia	Broad-leaved Paperbark	Medium tree to 15m	Direct drilling/tubestock	Ideal canopy tree in water-logged soils or wet environments
Melia azedarach	White Cedar	Small or medium tree to 10m	Tubestock	Foraging resources for frugivores (eg birds and bats)
Mid Stratum				
Acacia falcata	-	Shrub or small tree to 5m	Direct drilling/tubestock	Fast growing shade species
Breynia oblongifolia	Coffee Bush	Shrub to 3m	Direct drilling/tubestock	Refuge/foraging habitat
Hibiscus heterophyllus	Native Rosella	Shrub or small tree to 8m	tubestock	Nectar producing
Homalanthus populifolius	Bleeding Heart	Shrub or small tree to 6m	Direct drilling/tubestock	Pioneer species
Indigofera australis	Australian Indigo	Shrub to 3m	Direct drilling/tubestock	Refuge/foraging habitat
Rhodamnia rubescens	Scrub Turpentine	Shrub or tree to 25m	tubestock	Foraging resources for frugivores (eg birds and bats)
Sambucus australasica	Native Elderberry	Shrub to 4m	Direct drilling/tubestock	Refuge/foraging habitat
Trema tomentosa	Native Peach	Shrub or small tree to 6m	Direct drilling/tubestock	Ideal replacement plant for Lantana, provides similar habitat
Groundcover				
Adiantum aethiopicum	Common Maidenhair	Fern	tubestock	Ideal in moist conditions
Centella asiatica	Indian Pennywort	Herb	tubestock	Soil stabilisation
Cymbopogon refractus	Barbed Wire Grass	Grass	Direct drilling/tubestock	Soil stabilisation
Doodia aspera	Prickly Rasp Fern	Fern	tubestock	Ideal in moist situations
Echinopogon ovatus	Forest Hedgehog Grass	Grass	Direct drilling/tubestock	Soil stabilisation
Fimbristylis dichotoma	Common Fringe-sedge	Sedge	tubestock	Ideal in moist situations
Geitonoplesium cymosum	Scrambling Lily	Climber	tubestock	Biodiversity function
Gymnostachys anceps	Settler's Twine	Herb	Direct drilling/tubestock	Soil stabilisation

Scientific Name	Common Name	Growth Habitat	Planting Method	Notes
Imperata cylindrica	Blady Grass	Grass	Direct drilling/tubestock	Soil stabilisation
Lepidosperma laterale	Variable Sword-sedge	Sedge	tubestock	Ideal in moist situations
Lomandra filiformis	Wattle Mat-rush	Tufted herb	Direct drilling/tubestock	Soil stabilisation
Lomandra longifolia	Spiny-headed Mat-rush	Tufted herb	Direct drilling/tubestock	Soil stabilisation
Pratia purpurascens	Whiteroot	Herb	tubestock	Soil stabilisation
Themeda australis	Kangaroo Grass	grass	Direct drilling/tubestock	Soil stabilisation

Source: CEG, 2008

Planting density depends on the growth form and rate of various species and the nature of the root system. In areas where broad-scale planting is required, seedlings will be planted at a ratio to achieve quick vegetative cover to maximise soil stability and prevent weed invasion. Planting densities may also be increased in areas where there is a high risk of soil erosion (eg on slopes and the edge of waterways).

As a general guideline, the following plant densities are recommended:

- **Trees:** 1 per 10 square metres (m2);
- **Shrubs:** 1 per square metre; and
- **Groundcovers:** 2-5 per square metre.

Native Seed Collection and Propagation

Local provenance species will be used in revegetation works. Where possible, seedlings will be grown from seed stock collected from native species growing on the site or under similar conditions elsewhere within the catchment. Seed collection will be conducted by appropriately trained and licensed personnel and will commence immediately to allow a supply of native seedlings for revegetation works.

Where native seed is not immediately available (due to seasonal constraints), native seedlings will be sourced from a nursery specialising in the propagation of native seed sourced from within the local provenance.

Seedlings will be ordered at least six to twelve months prior to scheduled planting to ensure enough time for seed collection, propagation and hardening-off. Native seed collection and propagation will be ongoing until the need for planting works have ceased.

Planting Guidelines

In order to maximise survival and growth of new plantings, there are a number of procedures that will be followed. These include:

- where possible, planting works will be carried out in spring or early autumn as these times provide the most favourable soil moisture levels and soil temperatures for plant growth and establishment (Buchanan, 1999);

- prior to planting, the site will be prepared by removing and controlling weeds;

- when planting native seedlings, holes will be dug at least as deep as the container itself and twice as wide to ensure that soil is broken up enough to provide for easy root penetration;

- plants will be watered thoroughly prior to and after planting to help the plant adapt to its new environment and ensure that adequate water is available for healthy plant growth. Following planting, a saucer-shaped depression will be made in the soil around the base of the plant to assist in water collection and ensure that water is directed towards the roots of the plant;

- a layer of mulch applied around the base of each plant will assist in prevention of weed establishment and control water loss and soil temperature suitable for plant growth. As mulch decomposes it increases soil nutrient content thereby reducing the need for fertilisers. Mulch will be spread to a layer of approximately 75 millimetres (mm) thick but will be kept away from the stems of plants so as not to encourage rotting and insects. Care will also be taken to ensure that the mulch is free of weed seeds by using only mulched native vegetation; and

- plant guards (grow tubes) will be erected around each plant to protect plants from rabbits and other herbivores and to assist in rapid plant growth by acting as a miniature glass house.

7.5.2 Rehabilitation of Quarry Areas

LCC is committed to rehabilitation and development of the best end use for the quarry. Development of the most appropriate end use for a quarry is best undertaken within the last five to 10 years of operation and within the context of market conditions and environmental and land uses in the region at the time. Quarry rehabilitation work is to be undertaken in accordance with the "best practice" approach outlined in **Section 7.1**, or what is otherwise considered "best practice" at the time of rehabilitation. The Concept Quarry Rehabilitation Strategy is outlined in **Section 8.2** of this BRMP.

7.5.3 Bush Fire Management

Bushfire management on the site will be undertaken in accordance with the document 'Planning for Bush Fire Protection' (RFS, 2006 or any subsequent updates) to minimise the bush fire risk associated with quarrying operations to impact upon neighbouring properties. In accordance with the guidelines the following management actions will be undertaken:

- regular maintenance of perimeter access to fire trail standards identified in the guidelines (RFS, 2006);
- maintenance of a defendable space around all site sheds and buildings associated with the quarrying activities that pose a potential risk of fire ignition; and
- provision of an appropriate water supply suitable for firefighting purposes.

These measures must be implemented in cooperation with the NSW Rural Fire Service (RFS).

7.5.4 Visual Impacts

The quarry site is located at the top of a hill and cannot be seen from the surrounding area. The quarry expansion will involve the removal of native vegetation, however this will not significantly increase the visual impacts of the quarry. The site currently contains a number of vegetated earthen bunds designed to reduce visual impacts associated with the quarrying activities. The adoption of rehabilitation works is also expected to further reduce any potential visual impacts associated with the quarry site. Any remaining, additional impacts will be minimised through use of vegetation screening.

8 LONG TERM MANAGEMENT STRATEGY

This section outlines the long term management and rehabilitation of the disturbed quarry areas. It is currently proposed to progressively rehabilitate areas disturbed by quarrying so that they resemble a similar structure and function to that of surrounding native vegetation communities. To date, minor rehabilitation works have commenced on the western side of the site.

The ongoing rehabilitation strategy for the quarry is to be an opportunistic progressive approach, whereby rehabilitation occurs in stages to coincide with the completion of excavation areas. This approach allows for rehabilitation to occur alongside excavation activities, resulting in the progressive establishment of vegetation as areas become available following completion of quarrying activities. Such an approach is beneficial to the overall structure and function of the ecosystem following the conclusion of quarrying activities as it will promote vegetation of differing ages and heights that will provide habitat niches for a diversity of native fauna species. This approach also allows for the refinement of management and rehabilitation techniques during the preliminary stages of rehabilitation (Australian Mining Industry Council, 2006).

Topsoil stockpiled as a result of quarrying activities on the site will be used in rehabilitation works. Management actions outlined in **Section 7.5** relating to revegetation and weed control will be applied to rehabilitation areas following the progressive completion of quarrying activities. Native species listed in ***Table 7.4*** are to be used in revegetation works following the staged completion of quarrying activities and rehabilitation of the landform in accordance with the conceptual rehabilitation design.

At this stage the final landform design is conceptual only as local variation in rock strength and quality may vary the final benching and batter design. Development of the most appropriate end use for a quarry is best done within the last 5 to 10 years of the quarry's operational life within the context of market, environmental and land uses in the region at the time. Quarry rehabilitation work will be undertaken in accordance with "best practice" approach outlined in **Section 7.1**, or what is otherwise considered "best practice" at the time.

8.1 REHABILITATION STRATEGIES

8.1.1 *Progressive Approach*

The ongoing rehabilitation strategy for the quarry is to be an opportunistic progressive approach. Rehabilitation activities will commence in areas no longer required by the quarry, such as areas where excavation activities are complete. This approach will allow for rehabilitation to occur alongside excavation activities, resulting in pockets of vegetation being established in different areas of the site as areas become available following completion of excavation.

The progressive approach helps minimise the liability falling on the operator by rehabilitating the quarry during the operation, rather than undertaking the larger task of rehabilitating the quarry following the closure of the quarry, when there is no direct income from quarrying activities (Commonwealth, 2016). The progressive approach will allow for rehabilitation methods to be tested and consequently improved to ensure rehabilitation methods are effective (Commonwealth, 2016).

Benefits will include bank stabilisation and erosion control while improving the local habitat. The progressive approach will be beneficial to the overall structure of the ecosystem following the conclusion of quarrying activities. The diversity of the ecosystem will be enhanced by the stands of vegetation of differing ages, heights and depths from the staggered timing of the revegetation activities.

8.2 CONCEPTUAL QUARRY REHABILITATION PLAN

8.2.1 *Final Land Use*

The final intended land use purpose is to support an established ecosystem for the conservation of native vegetation and to provide fauna habitat.

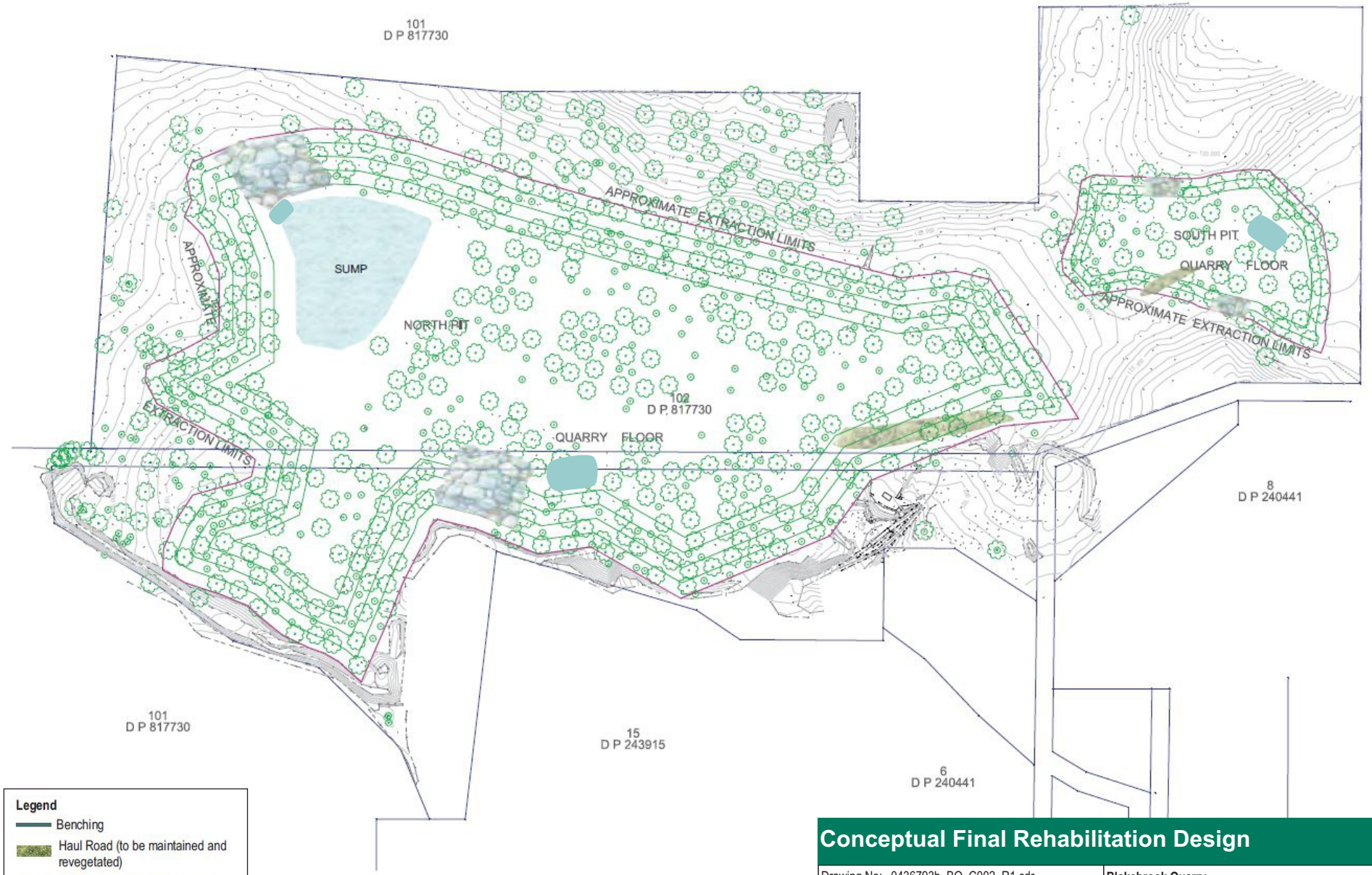
Alternative associated land uses may include ongoing light industrial activities, however, logistical considerations, suitable zoning, assessments and planning approvals would be required.

8.2.2 *Final Landform Concept*

The objective of the final landform conceptual design is to cost effectively develop a sustainable, self-sustaining post-quarrying land use that effectively manages any potential adverse environmental impacts (Commonwealth, 2016).

The final landform of the proposed quarry areas can only be considered conceptual as local variation in rock strength and quality may vary the final benching and batter design. The floor will be required for ongoing processing and stockpiling and as such, will not be available for rehabilitation until the conclusion of excavation activities.

As excavation areas are finalised, rehabilitation activities will commence immediately. The final landform of the northern quarry pit is to consist of a number of benches, in addition to the existing bench. The final configuration will be determined closer to the commencement of rehabilitation. The expected maximum dimensions of the benches will be up to 15m wide by 20m high. The height of the benches may vary depending on the extent of the basalt flows. The access ways are to be revegetated and will act as corridors to the quarry floor (refer to ***Figure 8.1***).



Conceptual Final Rehabilitation Design

8.1

Drawing No:	0436793b_BQ_C002_R1.cdr		**Blakebrook Quarry**
Date:	27/02/2019	Drawing size: A4	
Drawn by:	DR	Reviewed by: LP	Client: Lismore City Council

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The final floor level of the northern quarry is to be approximately 55m AHD. The proposed southern quarry pit is to be excavated to a floor level of 105m AHD. Three benches are proposed for the southern pit at 10m depths and 10m wide. Blasting of quarry benches will be carried out at specified locations to provide opportunity for fauna ingress and egress from the pit.

Figure 8.2 provides a conceptual diagram of the proposed quarry bench design. The quarry floor will have a fall to the north to facilitate on-going water management.

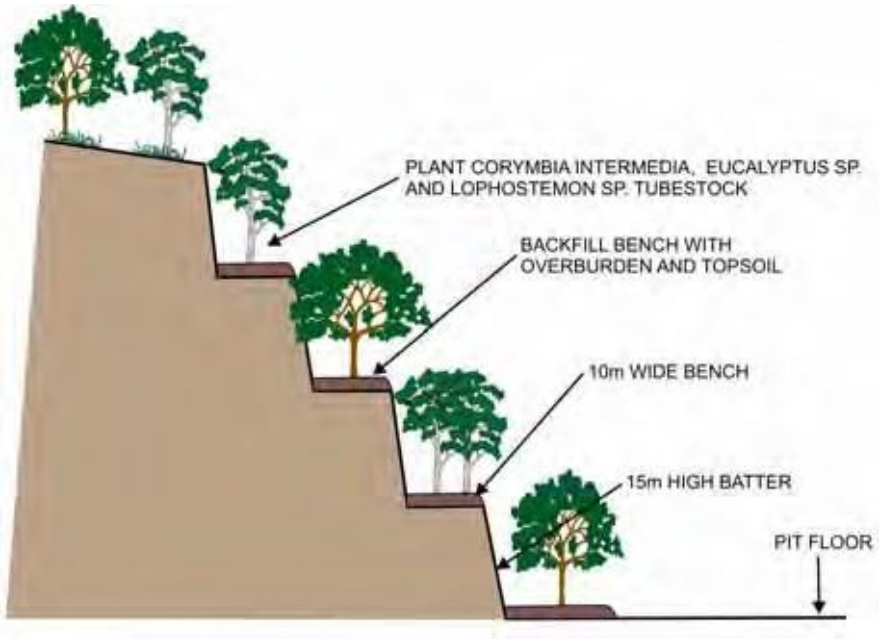


Figure 8.2 Final Landform Concept Design

These benches will be capped with previously stockpiled overburden and topsoil in preparation for planting with native vegetation. Benches will be planted with a variety of plant types including grasses, groundcovers, shrubs, and trees to provide for species and structural diversity.

To manage water being captured by the benches, a minimum fall of 2% into the quarry face will be constructed. The benches are also to be constructed with a minimum longitudinal grade of 0.25%. Surface runoff will flow down the harder bedrock to the quarry floor where it will collect in the northern sump. At any key drainage areas, filters or sediment fences will be established to mitigate sedimentation until site stabilisation is achieved.

8.2.3 Topsoil and Overburden Management

Topsoil and overburden will be segregated and managed during quarry operations for later use in rehabilitation activities. The segregated overburden and topsoil will be stored in stabilised and vegetated stockpiles. The overburden and topsoil will be salvaged to sculpt the soil profile on the quarry face batters. The overburden will be utilised to construct the lower soil horizons

of the soil profile on the batter surfaces. This overburden profile will then be scarified and overlayed with topsoil to form the uppermost horizon of the soil profile.

The topsoil contains native species seeds that are adapted to local environmental conditions, essential minerals and beneficial micro-organism populations (Commonwealth, 2016). For the seed bank to be utilised the topsoil must be spread to the rehabilitated area soon after excavation as the seed bank depletes with increased storage time.

Topsoil handling will be undertaken with great care as to maintain the soil structure and minimise compaction. The mining handbook (Commonwealth, 2016) identifies the use of a front end loader, a truck and bulldozer as the best equipment for removing, transporting and spreading topsoil to maintain soil structure.

There is potential for a deficit of topsoil in the later stages of the rehabilitation. The potential deficit is due to the significant requirement of topsoil necessary to landscape the final landform. Should this be the case, investigation will need to commence into the possibility of using the overburden as the planting medium or sourcing topsoil from elsewhere.

8.2.4 Revegetation

The objective of the revegetation is to produce a community of similar vegetation type and function to that surrounding the quarry. Revegetation of the disturbed areas of the quarry will utilise native species of local provenance, with a species list provided within Table 4.4. The vegetation communities surrounding the quarry will be used as reference sites and are composed of:

- Tall Open Forest (dominated by *Corymbia intermedia, Eucalyptus acmenoides, Eucalyptus microcorys* and *Lophostemon confertus*);
- Tall Open Forest/Woodland (dominated by *Angophora subvelutina, Eucalyptus tereticornis* and *Lophostemon suaveolens*); and
- Closed Forest.

These reference sites will provide useful information on the composition and percentage of vegetation cover. The reference site also provides a benchmark to assist in determining the influence of climatic and seasonal variations on the progress of rehabilitated areas (Commonwealth, 2016).

Pioneer species including native grasses and acacia shrubs will be incorporated into the seed mix to be distributed in the rehabilitation areas. Upon establishment of the grass layer, tree and shrub seed stock will be planted in patches where a sufficient overburden and topsoil profile has been created.

To provide the seed stock with the highest chance of becoming established, the following measures will be put in place:

- biodegradable tree guards when required;
- watering on planting and a watering program during the initial stages of development;
- weeding/mulching/weed matting to reduce competition and assist water retention; and
- replacement of dead trees.
- Natural regeneration will be fostered within the bushland areas where possible. This may be provided by fencing and the implementation of a stringent weed and pest management program.

As recommended in the CEG (2008) report, preferred Koala feed tree species (*Eucalyptus tereticornis* or *Eucalyptus microcorys*) are to be incorporated into rehabilitation areas. The site also contains *Allocasuarina torulosa* which is suitable foraging habitat for the glossy black cockatoo (*Calyptorhynchus lathami*) as well as bearing trees of sufficient size for nesting of the species (CEG 2008). It is proposed to retain the *Allocasuarina torulosa* within the vegetation protection area and incorporate the species into the revegetation areas.

The feasibility of planting into the hard rock quarry floor will need to be investigated as it is developed. This investigation will involve trial plantings using small patches of overburden capped with topsoil and planted. If the trial plantings indicate that planting on the quarry floor will be successful, the quarry floor will be cultivated to allow for seed germination and plant establishment. Stocks of overburden and topsoil will be spread into contoured mounds on the cultivated quarry floor to provide a suitable base for tubestock planting.

Haul roads, as indicated in ***Figure 5.1***, will be maintained, with deep cultivation to ameliorate soil compaction and soil moisture retention. Similar to the other areas within the quarry, the cultivated haul roads are to be revegetated using local provenance species. The revegetated haul roads will allow access for rehabilitation staff and native fauna to the benches and quarry floor.

8.2.5 Quarry Closure

The progressive rehabilitation approach as proposed to be undertaken allows for the refinement of management and rehabilitation techniques during the preliminary stages of the rehabilitation (Commonwealth, 2016). These refined rehabilitation methods that have been developed to the local conditions can then be applied to the remaining disturbed areas following the closure of the quarry.

In final stages of the life of the quarry, the community and stakeholders will be consulted to establish the criteria and monitoring methods to determine the success of the quarry rehabilitation.

Safety of the public is a key requirement to the closure of a quarry (Commonwealth, 2016). This is to be achieved on-site by a combination of different methods, such as fencing off of the main site access or the construction of a large bund around the exposed excavation area.

8.3 FUNDING FOR REHABILITATION ACTIVITIES

Lismore City Council is committed to the ongoing allocation funds for the progressive rehabilitation of the Quarry in the determination of its annual operational budget. The allocation of funds will be tied to demand and the output of the Quarry, with the allocation to be in the order of $30,000 to $50,000. The allocated money will be accumulated pending the availability of areas to be rehabilitated. The budget allocation may also be increased over the lifetime of the quarry to reflect inflationary changes and rehabilitation needs as necessary.

Lismore City Council shall also lodge a rehabilitation bond for the works in accordance with the CoA. The sum of the bond shall be calculated in accordance with the DPE Rehabilitation Cost Estimation Tool (available at www.resourcesandgeoscience.nsw.gov.au).

8.4 MAINTENANCE AND MONITORING

Maintenance and monitoring are integral components of the rehabilitation process, providing documentation of rehabilitation activities, identifying trends and revealing the need for any improvements to rehabilitation strategies and assessing the success of the rehabilitation (Commonwealth, 2016).

Maintenance and Monitoring of rehabilitation areas is addressed in ***Section 9.0.***

9 MAINTENANCE & MONITORING PLAN

Newly established plants will need to be monitored and maintained for a minimum of five years following final planting and until such time as a minimum 80% survival rate for all native plantings and a maximum five percent weed cover is achieved. Maintenance will consist of secondary weed control and general native plant care.

A suitably qualified and experienced professional will be engaged to carry out ongoing maintenance and monitoring. This will involve activities such as bushland rehabilitation, weed removal and nest box erection.

To minimise disturbance to rehabilitation areas, it is proposed to fence off the perimeter of the site and provide signage to indicate the area is being rehabilitated.

Restoration areas will be identified using signage. On-site staff and contractors will be inducted on their responsibilities in relation to avoiding restoration areas.

Weed growth is particularly rapid during warmer months. Consequently, extra vigilance will be required during this time to ensure that weeds do not re-establish themselves at the site.

Regular maintenance of nest boxes, sediment and erosion control structures, fencing and signage will also need to be undertaken on a regular basis.

9.1 OBJECTIVES

Monitoring the health and vigour of newly established native plants is essential until they are able to tolerate a range of environmental conditions and are at a competitive advantage against invasive weed species

9.2 SCHEDULE

The maintenance and monitoring schedule for Blakebrook Quarry is integrated into the wider schedule for rehabilitation works. This schedule is provided in **Section 11.0** of this BRMP.

9.3 METHODOLOGY

Implementation of a monitoring program whereby the success of rehabilitation works can be documented and measured over time, is an essential component of adaptive management and provides the necessary information to make adjustments to the on-going maintenance regime.

Monitoring will include an assessment of plants for signs of poor health such as insect attack, disease, lack of water and weed invasion.

Brief notes will be taken, documenting any signs of poor health. A record of seedling mortality rates will also be kept. Notes will also be taken detailing actions taken to address any problems identified.

The establishment of photo points at various locations within the site and taking photographs at regular intervals (e.g. every six months for the first five years, then annually) can also provide a beneficial visual assessment of rehabilitation progress over time. Photo points will be identified by GPS co-ordinates for future reference.

Inspection of nest boxes and the adoption of targeted fauna surveys to monitor threatened species populations will also be undertaken to provide an indication of the success of rehabilitation works and the effectiveness of the site to function as a fauna movement corridor and provide suitable fauna habitat.

The success of rehabilitation of quarry areas post-extraction will be monitored in accordance with the 'Mine Rehabilitation Handbook' (Australian Mining Industry Council, 2006).

9.4 PERFORMANCE CRITERIA

A maintenance regime will be established where newly established plants are maintained regularly so as to prevent against seedling mortality. This regime will ensure:

- that plants are receiving enough water;
- that plants are not subjected to insect attack or disease;
- that plant guards are not suffocating growing plants;
- that newly established plants are at a competitive advantage against invasive weed species (a minimum one metre weed free buffer zone will be maintained around native plants); and
- any dead seedlings will need to be replaced as soon as practicable to ensure the success of revegetation works.

9.5 INTERNAL AUDIT, RECORDING & REPORTING

9.5.1 *Recording of Maintenance Undertaken*

All maintenance will be undertaken in accordance with maintenance schedule for Blakebrook Quarry and will be recorded in the appropriate CAPEX and OPEX program.

9.5.2 Reporting Against Performance Criteria

Reporting will detail the effectiveness of the measures outlined in *Section 8* and progress against the performance and completion criteria in *Section 9.* Reporting details are outlined in *Section 13*.

In addition to the 34ha (which includes the 17.6ha on-site offset area) that is already being protected and enhanced on-site, an additional 45ha has been purchased by Lismore City Council as part of this Biodiversity Offset Strategy. This area has been chosen to offset predicted ecological impacts, and has been developed in accordance with NSW Biodiversity Offsets Policy and the requirements of the CoA.

In order to improve or maintain existing biodiversity values within the local area, the following criteria was used when selecting an appropriate area to offset predicted biological impacts associated with on-site quarrying activities:

- the offset area must be at least 45ha in size;
- the offset area must be located off-site although must occur elsewhere within the LCC LGA;
- the offset area cannot be funded by another offset scheme or contained within an existing conservation area protected on private land (unless additional security or management actions are implemented) or managed by government (e.g. national park, reserve, public open space etc.);
- the offset area will need to have similar ecological characteristics including vegetation structure, ecosystem function and compositional elements (e.g. floristics, habitat type and connectivity, topography, soil, geology, drainage) as that being removed as a result of on-site quarrying activities; and
- the biodiversity value of the offset area will need to be such that enhancement and conservation works result in a net improvement in biodiversity values within the local area. Generally total reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is less preferable to the enhancement or conservation of existing biodiversity values (DECCW, 2008b).

Based on this criteria, offset sites adjacent to the Blackbrook Quarry (and within the LCC LGA) were selected and purchased by LCC. The offset sites amount to 45ha and include extensive areas of mature native vegetation.

The quarry and 45ha offset sites are now located on Lot 201 DP 1227138, Parish of Blakebrook, County of Rous.

The Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au) includes an assessment of the biodiversity values for the offset area compared with those impacted by the quarrying activities as well as detailed management actions for the offset area aimed at maintaining or enhancing

biodiversity values within the local area. A summary of the Biodiversity Offset Strategy follows.

10.1 VEGETATION TYPES

Section 3.4 of the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au) outlines the vegetation communities within the site, and includes:

- 25ha of Tall Open Forest (Pink Bloodwood (*Corymbia intermedia*), White Mahogany (*Eucalyptus acmenoides*), Tallowwood (*Eucalyptus microcorys*) and Brush Box (*Lophostemon confertus*));
- 3.6ha of Tall Open Forest / Woodland (Broad-leaved Apple (*Angophora subvelutina*), Forest Red Gum (*Eucalyptus tereticornis*) and Swamp Turpentine (*Lophostemon suaveolens*));
- 24ha of Closed Forest;
- 18.5ha of Regrowth Scrub; and
- Disturbed Grassland.

The vegetation communities are also depicted in ***Figure 10.1***.

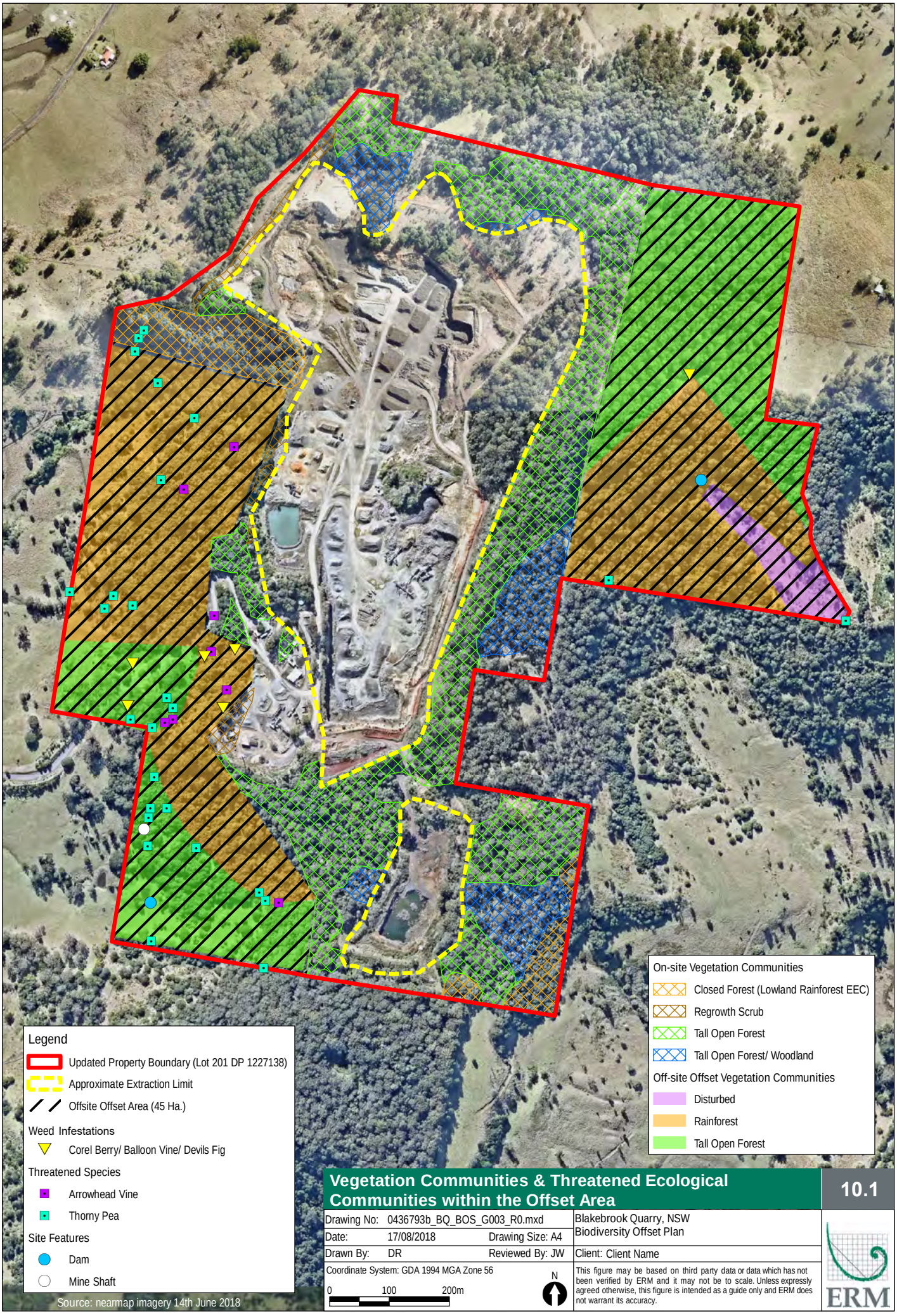
10.2 THREATENED SPECIES HABITATS

The offset sites provide potential habitat for locally occurring fauna species associated with Open Forest, Woodland, and Closed Forest vegetation communities. Notably, three threatened flora species and one threatened fauna species were recorded within the offset sites.

A population of approximately six koalas was also identified within the offset site. This lead to recommendations for koala management, including:

- increasing the densities of naturally occurring preferred koala food tree species, Tallowwood and Forest Red Gum; and
- improve habitat / landscape connectivity over the longer term.

The Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au) also noted other threatened species have been recorded in adjacent sites, and management measures are being applied.



Vegetation Communities & Threatened Ecological Communities within the Offset Area

10.1

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Date:	17/08/2018	Drawing Size: A4	
Drawn By:	DR	Reviewed By: JW	Client: Client Name

Coordinate System: GDA 1994 MGA Zone 56

0 100 200m

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10.3 MANAGEMENT ACTIONS FOR THE OFFSITE OFFSET AREA

As stated within the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au), management of the offsite offset sites will be undertaken in accordance with the Blakebrook Quarry Bush Regeneration Plan (Dawson 2018), provided in Annex B. This includes:

- weed removal;
- sediment and erosion control measures,;
- protection of native vegetation;
- pest fauna species management;
- enhancement of fauna habitat and fauna movement corridors;
- fencing and stock exclusion;
- management of fire; and
- Aboriginal heritage values.

10.3.1 *Weed Removal*

A weed management program will be undertaken by trained and licensed personnel who are experienced in weed removal and use of herbicides. Herbicide use near waterways must be conducted in accordance with the Safe and Effective Herbicide Use: A handbook for near-water applications (EPA, 2017).

Although weed removal will be conducted methodologically, where planting of native species is required, weed removal in this area will commence immediately. This is to provide native seedlings with a competitive advantage against invasive weed species.

Further detail is provided in the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au).

10.3.2 *Sediment and Erosion Control Measures*

Sediment and erosion control measures will be utilised in accordance with measures detailed in **Section 7.3.2** of this report..

10.3.3 *Protection of Native Vegetation*

Were access permits, signage indicating that rehabilitation works are in progress will be erected to discourage disturbance to these areas. On-site personnel will be inducted on their responsibilities in relation to avoiding restoration and biodiversity offset areas and personnel with access to

rehabilitation areas will be provided with information regarding appropriate hygiene practices (e.g. cleaning of shoes and machinery) to prevent the spread of weeds and pathogens.

. Examples of information that will presented in the induction are included in the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au).

10.3.4 Pest Fauna Species Management

Four pest fauna species have been observed within the adjacent habitats, and are assumed to be present within the offset area, being:

- Cane Toad *(Rhinella marina);*
- Rabbit *(Oryctolagus cuniculus)*;
- Dog *(Canis lupus);* and
- Fox *(Vulpes vulpes)* (CEG, 2008).

None of these species are likely to constitute a threat to the conservation and management of the offset site although it is recognised that pest fauna species can cause problems in natural landscapes such as soil erosion, degradation of native flora and fauna habitat, competition for resources, predation; distribution of disease and weeds; and increased management costs.

Management measures proposed in the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au) are summarised as:

- ensure all food waste is disposed of in covered waste bins;
- encourage fringing vegetation along edges of dams to prevent access by Cane Toads;
- continue wild dog baiting program in consultation with the Local Land Services and with reference to the NSW Wild Dog Management Strategy 2017-2021; and
- undertake ongoing pest control for five years to maintain target pest fauna populations by a licensed pest removal contractor.

10.3.5 Enhancement of Fauna Habitat and Fauna Movement Corridors

The management and assisted rehabilitation of the offset sites as detailed in the Bush Regeneration Plan, (attached as Annex B of the Biodiversity Offset Strategy, available at www.lismore.nsw.gov.au) will ensure that the long term viability of the identified fauna corridors are enhanced and protected. Where planting of native species is required, species listed in Table 4.1 Recommended Revegetation Species List of the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au) should be considered (subject to availability).

10.3.6 Fencing and Stock Exclusion

Existing fences are located at Blakebrook Quarry and the offset areas. The condition of existing fences and gates will be monitored as part of the ongoing monitoring program. Failed or damaged fencing or gates will be replaced as soon as practicable once detected.

Any proposed fencing is subject to requirements of adjacent property owners' requirements to secure livestock, and in accordance with LCC (2013) requirements to allow safe koala movement. Identified fences suitable for use at this site include:

- fences where the bottom of the fence is a minimum of 300 mm above the ground to allow koalas (and other native wildlife) to freely move underneath;
- fences that are easy for koalas to climb (e.g. sturdy chain mesh fences not topped by barbed wire, or solid style fences with a timber 'post and bridge' system over the fence at regular intervals of less than 20 metres; or
- open post and rail fences.

Important note: Where fencing is proposed, the final design will be also be subject to the adjacent property owners requirements to secure livestock.

10.3.7 Management of Fire

It is noted that under section 63 of the NSW Rural Fires Act 1997, owners and occupiers of land have a duty to take practicable steps to prevent the occurrence of bushfires on, and to minimise the danger of the spread of bushfires on or from that land. The offset areas are located within bushfire prone land as mapped within the RSF bush fire prone land online mapping tool and the recommendations detailed in the Biodiversity Offset Plan are intended to assist LCC to minimise the physical and environmental impact of fires. Even after these recommendations are implemented a residual bushfire risk will remain.

Various fire management measures are detailed within the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au) that includes a list of threatened species, their vulnerabilities to bushfire, and recommended hazard reduction burning.

Key principles and recommendations of the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au) for bushfire management within the offset sites are:

- any wildfire/bushfire should be extinguished as soon as possible unless a conscious decision is made not to extinguish the fire immediately and resources are available to manage the event to the

desired end point (such as to burn safely out to formed containment lines);

- cooperation among land managers/owners and NSW RFS is important for successful bushfire suppression and maintenance of any perimeter fire trails. Unimpeded access in the event of a fire is critical during suppression activities. The RFS must be aware of any locked gates or notified in the event that any key access roads or perimeter tracks are no longer accessible;

- applying fire which varies in frequency, duration, intensity and seasonality will maximise biodiversity. Through a program of appropriately prescribed burns, ecosystem resilience to unplanned fire and other threats can be improved within the offset sites and low intensity fires within the areas of open forest and woodland are to be undertaken in a mosaic pattern at no greater than once every 10 years;

- woody weed control will reduce fire fuel load and therefore risk of fire;

- hazard reduction burns to be excluded from the areas of Closed Forest;

- consideration of alternative means of reducing fuel loads within the offset areas may include intermittent grazing within selected areas of the site to maintain a mosaic of reduced fuel loads;

- post-fire maintenance must include weed control; and

- monitoring the impacts of all fires, whether planned or unplanned, allows land managers to evaluate and modify fire management practices.

10.3.8 Aboriginal Heritage Values

The Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au) does not authorise any person to harm, damage or desecrate an Aboriginal Object or Aboriginal Place in, on, or under the Offset Areas.

An unexpected (chance) finds procedure should be included within the site induction procedures for any locations subject to soil disturbance activities. In the event that site workers identify any potential Aboriginal heritage sites, the unexpected finds procedure outlined within the Blakebrook Quarry Heritage Management Plan (2018) (available from www.lismore.nsw.gov.au) will also apply to the offset areas as follows:

1. **STOP WORK IMMEDIATELY**. Any person that observes or uncovers potential Aboriginal heritage objects during the works must notify machinery operators immediately. All activities and/or works in the immediate area must cease (DO NOT collect samples to show someone);

2. **NOTIFY**. Notify the site supervisor immediately. The site supervisor will contact, notify and consult with LCC, OEH and an appropriately qualified

heritage professional (archaeologist). Consultation with the LCC Aboriginal Advisory Group and Ngulingah Local Aboriginal Land Council will also be undertaken as required;

3. **AVOID DISTURBANCE** of the area at and adjacent to the cultural finds;

4. **PROTECT THE SITE**. Any sand/soils removed must be identified and set aside for assessment. The disturbed area needs to be cordoned off as an exclusion zone so that no further disturbance occurs (include a minimum 10m wide buffer area);

5. **ASSESS THE FIND**. The archaeologist will investigate the nature; extent and location of the find. If the find is suspected to be Human Remains the site supervisor will contact the Police who may then take control of the site and any further investigation;

6. **RECORD/SALVAGE THE FIND**. The archaeologist will, in consultation with the site supervisor and OEH, arrange recording of the objects and if required salvage.; and

7. **RESUME WORK**. Subject to the archaeologist's assessment, work may be able to recommence under the terms once the site is assessed and appropriately salvaged. Alternatively, where possible, work methods or location may be altered to minimise further harm to the find, or objects associated with the find. Aboriginal Heritage Information Management System (AHIMS) sites cards and/or Aboriginal Site Impact Recording (ASIR) form will be completed and submitted to the AHIMS Registrar as soon as practicable.

10.4 MAINTENANCE AND MONITORING

It is recognised that maintenance and monitoring are essential parts of the rehabilitation process. The maintenance and monitoring schedule for the Offset sites is integrated into the wider schedule of rehabilitation works for the Project.

11 SCHEDULE OF WORKS

A summary of the on-site rehabilitation works (first ten years) is provided in ***Table 11.2***. This is a conceptual timetable that will be formalised and continually updated by the Manager of Commercial Services.

It will be reviewed and updated on a regular basis in accordance with conditions at the site to ensure that rehabilitation works are a success.

Detailed weed control actions and timing are not included as it is assumed that professional bush regenerators possess this information and plan work days in accordance with weather, seasons and specific weed requirements.

The management zones detailed in the schedule of works have been prepared based on the specific work zones in the Blakebrook Quarry Bush Regeneration Plan (Dawson 2018) (attached as Annex B of the Biodiversity Offset Strategy, available at www.lismore.nsw.gov.au) as outlined in ***Table 11.1*** below.

Table 11.1 ***Onsite Management and Work Zones.***

Management Zone Figure 1.2 and the CoA.	Equivalent onsite work zone (Dawson 2018) – refer to Annex E	High and medium priority zones (Year 1 - 10) - refer to Table 11.2	Low priority zones (Year 11-20)
Zone A	e5	yes	-
	n1	-	yes
	n2	yes	-
	s4	-	-
	w6	-	yes
Zone B	e5	yes	-
	n2	yes	-
	n3	yes	-
	s3	yes	-
	s4	yes	-
	s5	-	Yes
	w5	-	Yes
Zone C	n3	yes	-
	s3	yes	-
	s4	yes	-

A summary of the timing of offsite rehabilitation works is provided as part of the Biodiversity Offset Strategy (available from www.lismore.nsw.gov.au). This is also include here as Table 11.3 noting that these are indicative only and will be continually updated as required by the Manager of Commercial Services.

Table 11.2 Indicative Onsite Rehabilitation Schedule, Year 1-10 (Medium and High Priority Onsite Zones)

Task	2018 / Year 1				2019 / Year 2				2020 / Year 3				2021 / Year 4				2022 / Year 5				2023 / Year 6				2024 / Year 7				2025 / Year 8				2026 / Year 9				2027 / Year 10			
Implement the Biodiversity & Rehabilitation Management Plan	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
On-site delineation of DVPA and management zones, establish monitoring photo points in all management zones and flag known threatened species				X																																				
Management of pest fauna species (or as required)				X				X				X				X				X				X				X				X				X				X
Primary Weed Control																																								
Zone n3 Assisted Natural Regeneration	C																																							
Zone e5 Assisted Natural Regeneration	X	X																																						
Zone n2 Assisted Natural Regeneration					X	X																																		
Zone s3 Assisted Natural Regeneration																					X	X																		
Zone s4 Assisted Natural Regeneration																									X	X														
Revegetation using native species. Note that revetation within Zone w6 (low priority) is scheduled for Year 14. Progressive revegetation within the active quarry																																								

Task	2018 / Year 1				2019 / Year 2				2020 / Year 3				2021 / Year 4				2022 / Year 5				2023 / Year 6				2024 / Year 7				2025 / Year 8				2026 / Year 9				2027 / Year 10			
has not yet been triggered.																																									
Source local tubestock for supplementary planting within Zone w6 and during the progressive revegetation of the quarry as required. Seedlings to be ordered at least six to twelve months prior to scheduled planting to ensure enough time for seed collection, propagation and hardening-off.																																								
Secondary and Maintenance Weed Control (or as required)																																								
Zone n3 Assisted Natural Regeneration			X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		
Zone e5 Assisted Natural Regeneration			X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		
Zone n2 Assisted Natural Regeneration							X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		
Zone s3 Assisted Natural Regeneration																							X		X		X		X		X		X		X		X		X		
Zone s4 Assisted Natural Regeneration																											X		X		X		X		X		X		X		
Install gates, signage and fencing	n3 + e5				n2																		s3				s4														
Monitoring of nest boxes, relocation of tree hollows, fallen hollow logs and rocky outcrops (or as required)				X				X				X				X				X				X				X				X				X				X

Task	2018 / Year 1				2019 / Year 2				2020 / Year 3				2021 / Year 4				2022 / Year 5				2023 / Year 6				2024 / Year 7				2025 / Year 8				2026 / Year 9				2027 / Year 10			
Monitoring and maintenance of fencing and signage				X				X				X				X				X				X				X				X				X				X
Monitoring and maintenance of erosion control measures				X				X				X				X				X				X				X				X				X				X
Monitoring and maintenance of newly established native plants				X				X				X				X				X				X				X				X				X				X
Visual assessment of rehabilitation and regeneration areas (photographic record at all monitoring points)		X		X		X		X		X		X		X		X		X		X				X				X				X				X				X
Reporting on the success of rehabilitation and regeneration works (to be reported in AEMR)				X				X				X				X				X				X				X				X				X				X
Review of Rehabilitation, Revegetation and Biodiversity Offset Strategy Management Plan																																									X

12 ENVIRONMENTAL & OPERATIONAL PERFORMANCE

12.1 ROLES & RESPONSIBILITIES

The Blakebrook Quarry Manager will be responsible for the implementation of this plan under the direction of the Manager (Commercial Services) .

All quarry personnel and contractors are accountable through conditions of employment or contracts with each individual responsible for ensuring that their work complies with the procedures outlined in this plan. Further details of the responsibilities of personnel are provided in ***Table 12.1***. A diagram outlining the organisational structure for implementing this plan is provided at ***Figure 12.1***.

Table 12.1 Roles and Responsibilities

Manager o(Commercial Services)		
Action No.	**Action**	**Timing**
BRM.MCS.01	Ensure that Approval Conditions are adhered to during the implementation of this plan.	At all times
BRM.MCS.02	Provide the DoP and other relevant stakeholders with the opportunity to contribute to this plan.	Prior to commencement of construction
BRM.MCS.03	Ensure all staff and contractors are provided with information outlining the significance of biodiversity on the site (including identified management and mitigation measures) as part of a general environmental management site induction.	Prior to commencement of construction
BRM.MCS.04	Respond to any complaints from the public in regard to biodiversity impacts.	As required
BRM.MCS.05	Co-ordination of any necessary site investigations in relation to any incidents affecting biodiversity at the site.	As required
BRM.MCS.06	Ensuring all monitoring, reporting and review commitments included in this plan are implemented	As detailed in this plan
Blakebrook Quarry Manager		
Action No.	**Management Procedure**	**Timing**
BRM.OC.01	Ensure that Approval Conditions are adhered to during the implementation of this plan.	At all times
BRM.OC.02	Ensure all quarrying activities are undertaken in a manner that minimises impacts on biodiversity in accordance with the procedures outlined in this plan.	At all times
BRM.OC.03	Notifying the Manager (Commercial Services) before any clearing is undertaken.	Prior to commencement of works
BRM.OC.04	Ensure directions and procedures associated with this plan and any necessary approvals or licences are obtained and adhered to, to the satisfaction of the Manager (Commercial Services) Manager of Commercial Services.	At all times
BRM.OC.05	Engaging suitably qualified and experienced contractors to undertake procedures outlined in this plan.	Prior to commencement of works

Quarry Personnel and Contractors		
Action No.	**Management Procedure**	**Timing**
BRM.QP.01	Personnel must take reasonable steps to prevent and control impacts to biodiversity during quarrying activities.	At all times
BRM.QP.02	Responsible for fulfilling roles and contracts in accordance within the procedures outlined.	At all times
BRM.QP.03	Ensure approval has been given by Manager (Commercial Services) / Blakebrook Quarry Manager prior to the commencement of works within sensitive areas.	Prior to commencement of works

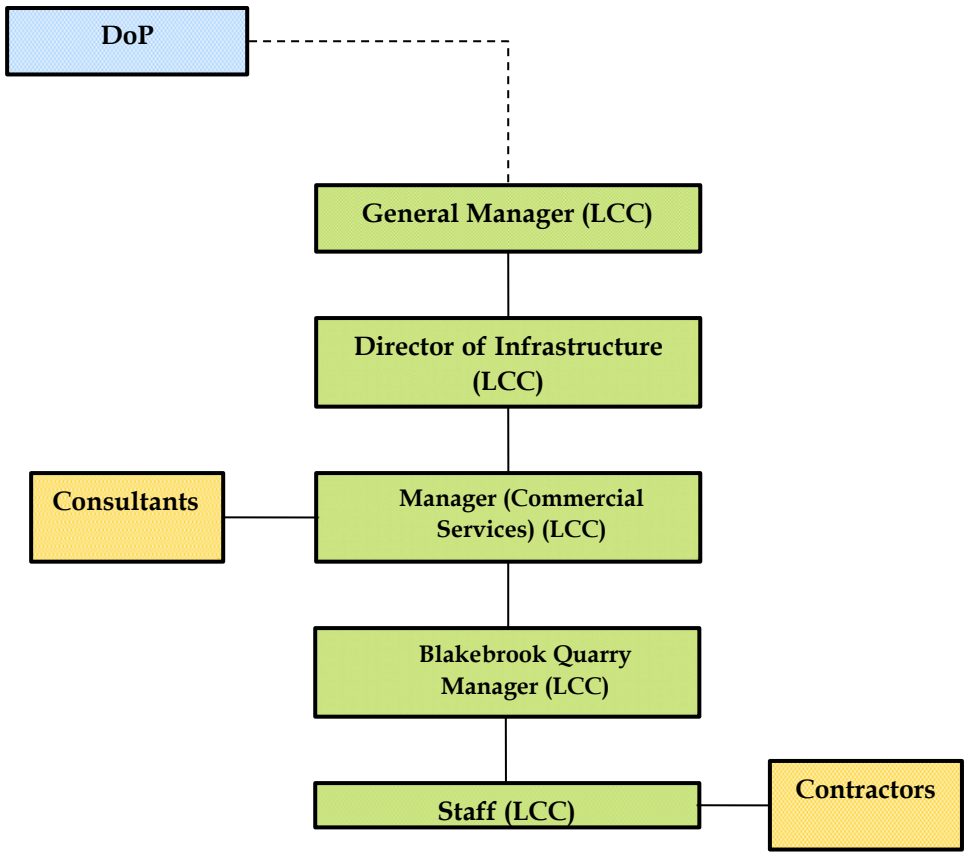

Figure 12.1 Organisational Structure

12.2 CONTACTS

The following contacts are likely to provide additional direction and advice in relation to issues of vegetation management on the site:

Manager (Commercial Services)
Lismore City Council
PO Box 23A Lismore NSW 2480
Ph: 02 6623 2001

Environmental Strategies Coordinator
Lismore City Council
Ph: 1300 87 83 87

Australia Association of Bush Regenerators
c/- Total Environment Centre
PO BOX K61 Haymarket NSW 1240
Ph: 02 9456 6626
Email: enquiries@aabr.org.au

Greening Australia NSW
Level 1, 1 Smail Street, Ultimo NSW 2007
(PO Box 59, Broadway NSW 2007)
Ph: 02 8218 1500

Far North Coast Weeds
Po Box 230 Lismore NSW 2480
Ph: 02 6623 3833
Email: fncw@fncw.nsw.gov.au

12.3 FUNDING

Lismore City Council is committed to the ongoing allocation of funds for the progressive rehabilitation of the site in the determination of its annual operational budget.

The allocation of funds will be tied to demand and the output of the quarry, with the allocation to be in the order of $30 000 to $50 000. The allocated money will be accumulated pending the availability of areas to be rehabilitated.

Budget allocation may also increase over the lifetime of the quarry to reflect inflationary changes and rehabilitation needs as necessary

12.4 STAKEHOLDER CONSULTATION SCHEDULE

The CoA prescribe the regulatory authorities and community groups to be consulted in the preparation of the BRMP (and associated monitoring program). These requirements are summarised in ***Table 12.2***.

Table 12.2 ***BRMP Consultation Requirements***

Regulatory Authority	Interest
Department of Planning and Environment (DPE)	DPE is the lead agency in ensuring compliance with the requirements of the CoA, and will review and approve amendments to the BRMP.
Environmental Planning Authority (EPA)	The EPA is to be involved in the preparation and revision of the BRMP to ensure that it

Regulatory Authority	Interest
	complies with the requirements of the CoA and other NSW legislation, policy, and technical requirements.

Draft copies of the BRMP have been provided to the appropriate authorities and community groups, with a final version prepared taking into consideration comments received. Any amendments or updates to BRMP will follow the same process.

12.5 *TRAINING & AWARENESS*

Lismore City Council will provide environmental training to its employees. The objective of the training will be to provide a base level understanding of their individual role in maintaining the BRMP. Training will also be provided for specific tasks to ensure employees are competent to perform their required duties.

Lismore City Council will identify environmental training requirements during construction and operational activities at Blakebrook Quarry using a specific Identification of Immediate Training Needs analysis and maintaining a Staff Training Register. The Blakebrook Quarry Manager will assist in the identification of training needs, the preparation of training material and the running of training sessions where appropriate.

In accordance with the EM Strategy, Lismore City Council will also undertake the following with respect to training and awareness:

- Induct all employees, contractors, subcontractors and visitors prior to commencing works (and conduct annual refresher inductions);
- Hold daily pre-start talks;
- Hold "Toolbox" training/meetings;
- Issue Project Environmental Alerts (if required).

12.6 *RECORD KEEPING & DOCUMENT CONTROL*

Record keeping and document control will be managed in accordance with the requirements set forth in the EM Strategy.

12.7 *SITE INSPECTIONS*

Upon commencement of rehabilitation, weekly inspections of rehabilitation work areas will be conducted by the Blakebrook Quarry Manager to monitor work practices and identify non-conforming areas and activities or work practices which could lead to potential environmental harm.

A Quarry Conditions Checklist will be used to record and report any improvements required. The purpose of the inspections is to:

- provide a surveillance tool to ensure that safeguards are being implemented;
- identify where problems might be occurring (or have the potential to occur);
- identify where sound environmental practices are not being implemented; and
- facilitate the identification and early resolution of problems.

It is noted that weekly inspections of work sites also provide an opportunity for the Blakebrook Quarry Manager to address issues raised by Staff, Contractors or Consultants and assist in the implementation of environmental controls to manage biodiversity and rehabilitation works. Often this continued support leads to better ownership of environmental management and becomes a coaching exercise for field personnel to improve their skills in this specialised and complex discipline.

12.8 EXTERNAL COMMUNICATION & NOTIFICATION

General information regarding the environmental performance of the quarry and contact details will be available at all times through Lismore City Council's website.

Community Meetings will be held at least once per annum, where information regarding the activities being undertaken at Blakebrook Quarry as well as environmental performance information will detailed.

Authorities will be kept informed regarding the operation and environmental performance of the quarry through the Annual Reporting requirements of the CoA.

12.9 COMPLAINT INVESTIGATION & RESPONSE CONTROL

Complaints regarding the Blakebrook Quarry will be received through the existing Lismore City Council complaints handling process. Complaints regarding the quarry, whether received via email, telephone or written communications are to be entered into a Complaints Register by Council staff.

Details that are to be logged by Council staff include:

- complainants name;
- telephone number/email address/postal address;

- date of contact;
- nature of complaint; and
- date transferred to Lismore City Council Commercial Services Compliance division for response. A response will be provided within five (5) days of receipt of the complaint.

The details of the complaint will be passed on to the Lismore City Council Commercial Services Compliance division, with a response being provided within five (5) days of receipt of the complaint.. Management commits to rectifying an activity that has caused a complaint as soon as practicable.

The Lismore City Council Commercial Services Compliance division will respond to all complaints within five (5) days of receipt of the complaint, and undertake actions to identify and initiate appropriate action in response to complaint and follow-up contact with complainant as soon as practicable. A record of discussion will be kept. Problems and/or issues will be reviewed and procedures modified as appropriate. If the problem cannot be resolved by the Blakebrook Quarry Manager, the Lismore City Council Commercial Services Compliance Manager will become involved to resolve the dispute.

Records of all complaints received are to be kept within Lismore City Council's Complaints Management System.

All quarry staff are responsible for reporting any complaints to the Blakebrook Quarry Manager. Complaints must be made through the correct channel to Lismore City Council in order to initiate is responsible for initiating follow-up action and contact with complainant.

12.10 DISPUTE RESOLUTION PROCESS

In the case that a dispute between the complainant and Lismore City Council arises with respect to the management and/or outcomes of the Complaint Investigation and Response Protocol (**Section 12.9**), either party may refer to the matter to the DPE for resolution.

If a matter is referred to the DPE, and the DPE is satisfied that the dispute is genuine, the DPE will then commence an independent dispute resolution process in order mediate between the two parties, in order to arrive at an agreed outcome.

13 REVIEW & REPORTING

Annual reporting is required to assess the success of revegetation works and to provide outcomes from the monitoring program and recommendations for future monitoring. Reporting will also include a review of the effectiveness of this plan and an assessment of completed works against annual budgets and targets.

Any issues noted regarding the success of management works will also be relayed to the site manager on an ongoing basis so that relevant improvements can be made.

A report will be prepared on an annual basis for 10 years, following the commencement of rehabilitation works. This plan is valid for a 10 year period and will be formally reviewed and updated every 10 years.

13.1 EXTERNAL REPORTING

All external reporting required by the CoA or other obligation for Blakebrook Quarry will be approved by the Manager (Commercial Services). This includes management and monitoring documentation associated with this BRMP.

13.2 NON-COMPLIANCE REPORTING PROTOCOL

All non-compliance will be reported in accordance with the requirements of the CoA that relate to incident reporting. The CoA require that where there is an exceedance of the limits/performance criteria in the CoA that the DPE and relevant agencies being informed within 24 hours.

In addition, within seven days of the date of the incident, a written report is to be provided to the DPE and other relevant agencies detailing the following:

- date, time and nature of the exceedance/incident;
- cause (or likely cause) of the exceedance/incident;
- describe what action has been taken to date; and
- describe the proposed measures to address the exceedance/incident.

Lismore City Council will meet the requirement of the DPE to address the cause or impact of any incident within the required period as defined by the DPE. Lismore City Council will maintain a register of accidents and incidents.

13.3 CONTINGENCY PLANNING & PROTOCOL

Should at any time the management and/or monitoring results of the BRMP be determined to be negatively impacting a sensitive areas identified in the EAR

(ERM, 2009) for the Blakebrook Quarry expansion (e.g. endangered ecological community) then the BRMP may need to be intensified to allow better identification and understanding of the impacts, and facilitate design of appropriate mitigation measures.

Before any changes are made to the BRMP, Lismore City Council will consult with DPE and obtain their approval. Subsequent to receipt of DPE approval, the BRMP will be revised in line with any approved changes.

13.4 ANNUAL REVIEWS

13.4.1 Content of Annual Reviews

Lismore City Council will review the BRMP, and its operation and implementation, annually. The purpose of the review is to ensure that the system is meeting the requirements of relevant legislation, standards, policies, licences, permits, approvals and objectives. A report will be provided to the Manager (Commercial Services) with any recommendations for change to the system. The Manager (Commercial Services) will review and approve changes to the system (as required).

The review will consider a range of aspects which are denoted within Section 9.4 of the EM Strategy for Blakebrook Quarry. The Blakebrook Quarry Manager will implement any changes arising from the reviews. Records of such reviews will be maintained.

The annual review will report on the following:

- Description of the project that was carried out in the previous calendar year, and the project that is proposed to be carried out over the current calendar year;
- A comprehensive review of the monitoring results and complaints records of the project over the previous calendar year;
- Evualation and report of the effectiveness and compliance of air quality and noise management systems;
- Non-compliance over the past calendar year;
- Trends in the monitoring data over the life of the project;
- Discrepancies between the predicted and actual impacts of the project;
- Describe what measures will be implemented over the current calendar year to improve the environmental performance of the project.

Details of any significant changes made to the BRMP will be summarised in a table and forwarded in a memo to all relevant project personnel.

13.4.2 Environmental Performance Review

In accordance to the Minister's CoA, an annual environmental performance review is to be prepared to the satisfaction of the DPE. The review will be submitted by the end of March each year and in accordance with CoA Schedule 5, Condition #11.

13.5 INDEPENDENT ENVIRONMENTAL AUDIT

Within three years of quarrying operation, and every three (3) years thereafter, a major review of the BRMP will be undertaken by a suitably qualified person to assess what, if any, socio-environmental impacts have occurred as a result of the expanded operations.

14 REFERENCES

Australian Mining Industry Council (2006) **Mine Rehabilitation Handbook.** Australian Mining Industry Council, Dickson ACT.

Buchanan R (1999) **Bush Regeneration: Recovering Australian Landscapes.** Open Training and Education Network – Distance Education (OTEN-DE), Strathfield NSW.

Commonwealth (2016) **Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry.**

Conacher Environmental Group (CEG) (2006) **Blakebrook Quarry: Koala Plan of Management.** CEG, Lismore NSW.

Conacher Environmental Group (CEG) (2008) **Proposed Quarry Extension: Ecological Site Assessment.** CEG, Lismore NSW.

Department of Environment (DoE) (2015) **Draft threat abatement plan for competition and land degradation by rabbits**. Department of Environment, Australian Government.

Department of Environment, Climate Change and Water (DECCW) (2008a) **Final Determination: Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregion.** DECCW, Hurstville NSW.

Department of Environment, Climate Change and Water (DECCW) (2008b) **Principles for the Use of Biodiversity Offsets in NSW.**

Environmental Protection Authority (EPA) (2017) Safe and Effective Herbicide Use: A handbook for near-water applications. EPA, SA.

Environmental Resources Management (ERM) (2009) **Blakebrook Quarry Expansion: Environmental Assessment Report.** ERM, Port Macquarie NSW.

Lismore City Council (LCC) (2004) **State of the Environment Report.** LCC, Goonellabah NSW.

Lismore City Council (LCC) (2013) **Comprehensive Koala Plan of Management for south-east Lismore.** Lismore City Council, Lismore, NSW.

Morand D (1994) **Soil Landscapes of the Lismore-Ballina 1:100 000 Sheet (Mullumbimbyb, Byron Bay, casino, Kyogle).** Department of Conservation and Land Management, Sydney NSW.NSW National Parks and Wildlife Service (2007) Cane Toad control – Using the Super Trap. Available from: http://www.environment.nsw.gov.au/resources/pestsweeds/cane_toad_infosheet.pdf

Parker P (1995) **Flora and Fauna Assessment for Blakebrook Quarry.** Peter Parker Environmental Consultant, Broken Head NSW.

Rural Fire Service (RFS) (2006) **Planning for Bush Fire Protection.** RFS, Lidcombe NSW.

Annex A

Koala Plan of Management (Conacher Environmental Group, 2006)

CONACHER TRAVERS
environmental consultants

KOALA PLAN OF MANAGEMENT

BLAKEBROOK QUARRY
LOT 102 DP 817730
NIMBIN ROAD
BLAKEBROOK

SEPTEMBER 2006
(REF: 6088)

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PREFACE

This Koala Plan of Management has been prepared at the request of Lismore City Council to address the management of Koalas within Lot 102 DP 817730 Blakebrook Quarry, Nimbin Road, Blakebrook. The Koala Plan of Management will accompany a development application for the extension of extraction activities within the site.

This Koala Plan of Management has been completed in accordance with State Environmental Planning Policy No. 44 (SEPP 44) Koala Habitat Protection. SEPP 44 requires a Koala Plan of Management to be prepared where Core Koala Habitat is identified within a site. This plan details the management objectives for the protection of Koalas within the site during the construction and active phases of the development. The plan also details the actions to be implemented to reach these objectives.

The Koala habitat status of the site has been assessed by a suitably qualified Ecologist with professional qualifications and experience as required by SEPP 44.

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KOALA PLAN OF MANAGEMENT

SECTION 1.0 INTRODUCTION

This Koala Plan of Management has been prepared to identify and address issues and actions relevant to the protection and provision of habitat for the Koala within Lot 102 DP 817730 Blakebrook Quarry, Nimbin Road, Blakebrook, known herein as the subject site. This Koala Plan of Management has been completed to accompany a Development Application for an extension of quarrying and extraction operations within the subject site.

1.1 Background

Koala Observations

The Koala was recorded within the site on a number of occasions during surveys by *Conacher Travers* (2006). This species was also recorded within the site during surveys by Peter Parker (1995).

Koala Habitat

The Flora and Fauna Assessment (*Conacher Travers* 2006) identified forested sections of the site as containing likely Core Koala Habitat according to the provisions of State Environmental Planning Policy (SEPP) 44 Koala Habitat Protection. This was based on evidence of Koala observations within the site, the presence of feed tree species (*Eucalyptus tereticornis, Eucalytptus microcorys*) and the presence of faecal pellets indicating use. As such a Koala Plan of Management was recommended for the site. The Flora and Fauna Assessment (*Conacher Travers* 2006) including the 7-part test of significance in accordance with Section 5A of the *Environmental Planning and Assessment Act* (1979) concluded that with implementation of a Koala Plan of Management for the site, the development would not be likely to significantly impact upon the local population of the Koala.

The works and measures detailed within this report in relation to Koala habitat management are to be carried out in conjunction with those strategies to be developed for the Vegetation and Habitat Management Plan proposed for the site.

Spot Assessment Techniques

Ten of the total sixteen survey points sampled showed signs of Koala activity (i.e. scats at base of trees). Each of these ten survey points showed activity levels of less than 25%. Based on these survey results it was considered that the habitats within the site fall predominantly into the following class as described by Phillips and Callaghan (1995):

Where the results of a spot assessment return an activity level of less than 25% and the activity level is derived from scattered trees with low faecal pellet counts (generally less than 5 and usually 1's and 2's), and the faecal pellets appear old and/or decayed – the current level of use by Koalas is unlikely to be significant.

The results of Spot Assessment Technique surveys are included as Appendix I to this Plan of Management.

Previous Work

A Koala Plan of Management was completed for the site by Peter Parker Environmental Consultants in 1995. This Koala Plan of Management provided information on the Koala, suitable habitats within the site and detailed management strategies for the protection of the

Koala within the site. This new Koala Plan of Management has been prepared to replace the original due to changes since the plans preparation in 1995. These are:

- An extension in the proposed quarrying activities in comparison to that proposed in the original Koala Plan of Management
- Changes in legislation
- Increases in knowledge in regards to the Koala and subsequent changes in management practices
- Changes in the vegetation condition within the site

Where appropriate, reference is made to the original Koala Plan of Management (Parker 1995) within this report.

1.2 Legislative Framework

This Koala Plan of Management is part of a Development Application for Lot 102 DP 817730 Blakebrook Quarry, Nimbin Road Blakebrook. State Environmental Planning Policy No. 44 Koala Habitat Protection provides a legislative framework for the identification of Koala habitat and implementation of management strategies to protect Koala habitat. Where Core Koala Habitat is identified within an area, SEPP 44 requires a Koala Plan of Management to control and minimise impacts upon Koala habitat. This Koala Plan of Management forms the basis of satisfying those relevant requirements of SEPP 44.

Lismore City Council has completed a Draft Comprehensive Koala Plan of Management (DCKPoM) for part of the local government area. This Plan of Management is in Draft form and as such is not appropriate to the subject site. Additionally the study area encompassed by the Draft Comprehensive Koala Plan of Management does not include the Blakebrook Quarry area. This Plan of Management for Blakebrook Quarry has been completed in accordance with information contained within SEPP 44 Koala Habitat Protection. Where considered appropriate, reference has been made to the Lismore Draft Comprehensive Koala Plan of Management.

1.3 Proposed Development

It is proposed to extend the current quarry operation within Lot 102 for the purposes of blue metal extraction. This will require the clearing of vegetation within the site for the excavation operations.

The remaining vegetation within the site will be retained and conserved within a Vegetation Protection Area. The establishment of this Vegetation Protection Area will be accompanied by a Wildlife and Vegetation Management Plan that will detail management actions and strategies for the protection and rehabilitation of the vegetation and wildlife within this area.

1.4 Site Description

The subject site, known as Blakebrook Quarry, is situated at Blakebrook approximately 8 kilometres north-west of Lismore on Nimbin Road. The site is accessed via a paved formed road from Nimbin Road and covers approximately 77 hectares. The site is currently used as an active quarry extracting and processing blue metal for local use.

Geology

The subject site is located within the Lismore Basalt member of the Tertiary Lamington Volcanics. The geology of the site generally consists of light yellow-brown and red-brown clayey silt soils containing basalt boulders overlying massive columnar basalt.

Topography and Drainage

The subject site is situated on the crest/plateau of a local hill or ridge that runs in a north south direction. The site has mostly flat to gently sloping topography at a height of 100m to 130m AHD.

There are no major drainage lines on the site. Small primary drainage lines flow east and west feeding larger drainage lines and creek systems to these directions. At present a number of small channels flow into the main pit, where the water is collected.

Vegetation

The subject site contains the following vegetation communities:

- Tall Open Forest (*Corymbia intermedia, Eucalyptus acmenoides, Eucalytptus microcorys and Lophostemon confertus*)
- Tall Open Forest/Woodland (*Angophora subvelutina, Eucalyptus tereticornis* and *Lophostemon suaveolens*)
- Closed Forest
- Disturbed Land
- Regrowth Scrub

Land Use

The subject site landscape has been affected by the following impacts:

- *Clearing:* A large amount of the site has been historically cleared for timber collection, grazing and for the quarry operation.

- *Bushfire:* There are no signs of recent bushfire.

- *Agriculture:* There appears to have been a long history of grazing however at the time of surveys no cattle were present within the site.

- *Earthworks:* A large proportion of the site has been disturbed as part of the current quarry operation.

- *Introduced weeds:* The majority of the subject site has been significantly impacted by incursions of a variety of exotic species, particularly pasture grasses in the cleared areas and *Lantana camara* (Lantana) in the bushland areas.

- *Feral, Introduced and Domestic Fauna:* Native fauna within the subject site has been impacted upon by the predation of European Red Fox (*Vulpes vulpes*), Cats (*Felis catus*) and Dogs (*Canis familiaris*).

1.5 Objectives of this Plan of Management

Measures contained within this Koala Plan of Management will be implemented in line with the following objectives:

- Identification of Core Koala Habitat and Koala population numbers
- Maintenance of identified Koala habitat
- Rehabilitation of habitat
- Provision of safe movement areas for Koalas through the site

- Protection of habitat areas
- Maintenance of current Koala population size
- Monitoring for effectiveness of Koala management measures and decisions

1.6 Format of this Plan of Management

This Plan of Management has been developed in accordance with the guidelines contained within State Environmental Planning Policy (SEPP) 44 Koala Habitat Protection. This policy document identifies the development of an Individual Plan as appropriate for this site, as opposed to a Comprehensive Plan for the entire local government area. This Plan of Management will provide details on the following as detailed within SEPP 44. These considerations will form the basis of management strategies and decisions to be implemented within this plan.

- Estimation of Koala population size.
- Identification of preferred feed tree species for the locality and the extent of the resource available.
- Assessment of the regional distribution of Koalas and the extent of alternative habitat available to compensate for that to be affected by the actions.
- Identification of linkages of Core Koala Habitat to adjacent areas and movement of Koalas between habitat areas. Provision of strategies to enhance and maintain these corridors.
- Identification of major threatening processes such as disease, clearance of habitat, road kill and dog attack which impact upon 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 habitat, including lands adjacent to areas of identified core Koala habitat.
- Clear definition of what the plan aims to achieve (e.g. maintaining or expanding the current population size or habitat area).
- Identification of criteria against which achievement of these objectives is to be measured (e.g. a specified population size in a specific time frame of the abatement of threats to the population).
- 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 area to which this plan applies is the area bound by Lot 102 DP 817730.

This report contains four figures. Figure 1 shows the location of Koala observations and spot assessments, Figure 2 shows the extent of Koala habitat adjacent to the subject site within the local landscape and Figure 3 shows a conceptual location of the Vegetation Protection Area and vegetation communities within the site.

SECTION 2.0 KOALAS WITHIN THE SITE AND LOCAL AREA

2.1 Koala Survey Methodology

Initial surveys were completed within the site as part of a Flora and Fauna Assessment completed in August 2006. As a result of the observation of the Koala during surveys more detailed methodologies were proposed to provide information on the Koalas use of the site and estimates of the number of Koalas within the site.

Koala Spot Assessments were completed within the site to gather data on the use of specific areas of the site by the Koala. The Spot Assessment Technique consisted of searches of the base of twenty trees around a centralised base tree (preferred feed tree *E. tereticornis* or *E. microcorys*) for the presence of Koala scats. Any scats collected that could not be identified in the field were sent for identification to Barbara Triggs of Dead Finish. The percentage of trees that contained scats within each Spot Assessment point was recorded to calculate activity levels. Surveys were completed on the 21st April and 3rd May 2006. Locations for each Spot Assessment point are included in Figure 1. The results of Spot Assessment surveys are included as Appendix I.

Spotlight surveys were also carried out within the site in gathering information on the use and occurrence of the Koala within the site. Surveys were carried out using a 55 watt spotlight, powered by a 12 volt rechargeable battery. Spotlighting was carried out along existing tracks, roads, fencelines, earth bunds and other more easily accessible locations throughout the site.

The following table provides information on Koala spotlight surveys.

TABLE 1
KOALA SPOTLIGHT SURVEY DETAILS

Date	Weather Conditions	Survey Details	Results
22/3/06	Mild 14-18°C, 8/8 cloud, slight SE wind, o/night rain	1.75 hrs 1915-2100	No Koalas observed
29/3/06	Mild 17°C, 0/8 cloud, ¼ moon, no wind, no rain	1.5 hrs 1915-2045	No Koalas observed
5/4/06	Mild 18°C, 7/8 cloud, ½ moon, no wind, no rain	1.5 hrs 1800-1930	One Koala observed
8/5/06	Mild 16°C, 3/8 cloud, ½ moon, mod SE wind, no rain	2.25 hrs 1800-2015	One Koala observed
11/5/06	Mild 16°C, 8/8 cloud, 4/4 moon, no wind, no rain	2.5 hrs 1800-2030	Three Koalas observed
17/5/06	Mild 16°C, 8/8 cloud, 4/4 moon, no wind, no rain	2.5 hrs 1745-2015	One Koala observed

The locations of Koala observations are shown in Figure 1.

2.2 Koalas within the Subject Site

The Koala was observed within the subject site on five occasions during surveys (four during spotlighting and one opportunistically during diurnal surveys). A maximum of three individuals were observed at any one time indicating a minimum population size of three individuals. Given the low number of Koala sightings on each survey occasion (one individual on four occasions and three individuals on one occasion) it is considered that the population occupying the site and surrounding remnant area is small in size.

During surveys by Parker (1995) three individual Koalas were observed within the subject site. It was considered by Parker that a population of at least two females and one male, possibly form a small breeding unit within the site. It was considered that the actual Koala population size was likely to be higher as spotlighting is an opportunistic sampling technique that underestimates density.
At this stage it is considered that a low number of Koalas currently use the site periodically due to low activity levels detected during Spot Assessment Techniques and low number of

sightings during surveys. Evidence of use of the site was found at ten of the sixteen sites surveyed. However given the low number of trees with pellets found at the base, activity levels were observed to be less than 25% at each of these sites. As such according to Phillips and Callaghan (1995) the current level of use of the site by Koalas is unlikely to be significant.

A search of the Atlas of NSW Wildlife (DEC 2006) database found 95 recent (>1995) records of Koala habitation within a 10 km radius from the subject site. Only four records could be found within 5 km of the site. These were at Meadow Drive North Lismore, Lismore Heights, Woodlawn and Upper Boerie Creek (closest record) however none of these records are within the last ten years. It is considered that the lack of recent local records within the locality may be due partly to the lack of fauna survey completed in the local area.

No LGA wide estimate of the Koala population has been made at this stage. The "Goonellabah and East Lismore" population of the Koala has been estimated at 100-300 individuals. However this population is thought to have declined (Lismore City Council 2003).

The locations of Koala observations within the Lismore LGA are attached as Appendix II to this Plan of Management (Lismore City Council 2006).

SECTION 3.0 KOALA HABITAT WITHIN THE SUBJECT SITE AND LOCALITY

Two (2) Koala food tree species listed on Schedule 2 of State Environmental Planning Policy No. 44 - Koala Habitat Protection are present within the subject site. These species are *Eucalyptus microcorys* (Tallowwood) and *Eucalyptus tereticornis* (Forest Red Gum).

According to SEPP 44 Potential Koala Habitat occurs where the occurrence of preferred Koala food tree species, in this case *E. tereticornis* and *E. microcorys* is greater than 15%. Within the subject site the Tall Open Forest variants contain high percentages of abundance of *E. microcorys and E. tereticornis* indicating the presence within these communities of Potential Koala Habitat. The extent of these communities within the site is shown in Figure 1.

Spot Assessment Techniques were carried out within the site and combined with the results of spotlighting and other Koala search methods to assess the presence of Core Koala Habitat within the site. Based on the results of surveys (presence of Koala(s) within the site, observation of scats and scratches) it is considered that areas of Core Koala Habitat within the site generally correspond with the Tall Open Forest variant vegetation communities.

The vegetation within the subject site is part of remnant vegetation within a highly disturbed rural landscape. To the north of the site the vegetation consists of similar Open Forest vegetation dominated by Tallowwood constituting likely Core Koala habitat. This vegetation extends approximately 200 meters north of the site and represents the northern most extremity of the remnant. This site is isolated from scattered vegetation to the north by cleared areas approximately 400 metres in width.

The vegetation along the eastern boundary of the site consists of similar Open Forest vegetation containing a mix of Tallowwood dominated communities. The site shows some low level connectivity to vegetated areas approximately 1.2 km to the north-east however the landscape has been highly disturbed through clearing and any movement areas or linkages are tenuous. Areas of vegetation adjacent to the eastern boundary of the site contain likely Core Koala Habitat.

The vegetation adjacent to the southern boundary of the site contains similar Tallowwood dominated Tall Open Forest type that constitutes likely Core Koala Habitat. This vegetation

extends approximately 1.5 kilometres to Nimbin Road at the southern extremity of the larger remnant.

The western boundary of the site consists of steep slopes containing Closed Forest types that are not suitable Koala habitat. The lower plain areas to the west are completely cleared and as such isolate the larger remnant to any larger patch of vegetation to the west.

The vegetation within the subject site and adjacent areas in the context of the local landscape is included as Figure 2. The occurrence of suitable Koala habitat within areas adjacent to the subject site is also shown in Figure 2. The occurrence of extensive areas of cleared land surrounding the site suggests that dispersal and recruitment by individuals within the local population is unlikely. As such, it is considered that any koala population within the site is limited to the current existing vegetation.

Within the subject site the vegetation communities containing suitable Koala food trees and areas of core Koala habitat occupy approximately 31.4 hectares (Tall Open Forest *Corymbia intermedia, Eucalyptus acmenoides, Eucalytptus microcorys* and *Lophostemon confertus* 25.1 ha, Tall Open Forest/Woodland *Angophora subvelutina, Eucalyptus tereticornis and Lophostemon suaveolens* 6.3 ha). These vegetation communities are part of a greater remnant area containing similar vegetation and Koala habitat types that occupies approximately 198 hectares. This area is shown in Figure 2.

SECTION 4.0 THREATENING PROCESSES

The *Threatened Species Conservation Act* 1995 identifies “clearing of native vegetation” as a Key Threatening Process for the Koala. Other threatening processes for the Koala include the deforestation of prime habitat for agriculture and urbanisation, disease, wildfire and past hunting pressures (Martin 1988; Reed *et al.* 1991). The habitat of the Koala has undergone serious change over the last century with many habitat areas and populations being isolated from one another through clearing and land use practises (Reed *et al.* 1991). The Koala is able to exist within modified habitat but is sensitive to the removal of core habitat areas and feed trees. The Koala is also vulnerable to attacks by domestic dogs and road kills. The survival of many populations will depend upon appropriate management (Martin 1983).

The Department of Environment and Conservation (DEC 2006) have listed the following as threats to the Koala in NSW:

- Loss, modification and fragmentation of habitat
- Predation by feral and domestic dogs
- Intense fires that scorch or kill the tree canopy
- Road kills

The major threat posed by the proposed development is the removal of habitat through the clearing of vegetation for the extension of the pit. It is not considered that the proposed development will result in any an introduction or exacerbation of any other of those listed threatening processes.

SECTION 5.0 PROPOSED MANAGEMENT ACTIONS

The following Koala habitat management strategies are recommended for the long term management of the Koala within the subject site.

These are:

- Habitat protection requirements
- Habitat restoration requirements
- Traffic management requirements
- Feral animal management
- Bushfire management
- Monitoring and reporting requirements

5.1 Habitat Protection

Objectives:

- Maximise protection of retained preferred feed trees (*E. tereticornis, E. microcorys*) within the site.
- Maximise protection of retained shelter and refuge trees within the subject site.
- To introduce bushfire protection measures to ensure the long term protection of Koala habitat.
- Control access to restoration areas.
- Provision of appropriate signage.

Actions:

- The extension of the quarry area will ultimately require the removal of areas of suitable habitat containing preferred Koala feed trees. The identification of areas to be cleared as part of the proposal has been carried out in conjunction with the objective of minimising the removal of Koala habitat areas. Areas previously cleared have been identified for quarrying to aid in minimisation of the removal of Koala habitats.
- A Vegetation Protection Area will be identified and established prior to any clearing operations. This area will de identified for long term protection and provision of Koala habitat. The Vegetation Protection Area was identified by mapping and field surveys based on the following factors:

  – Location of vegetation communities
  – Maintenance of vegetative linkage within the site
  – Location of Koala observations
  – Retention of significant trees

- The Vegetation Protection Area will be designed so as to provision movement through the site. Any clearing associated with the extension of the current pit or excavation of new pits will not occur where it interrupts any potential current movement areas or isolates currently connected vegetation within the site. An indicative conceptual plan is provided as Figure 4.
- Vehicular access to Vegetation Protection Areas will be limited to the purposes of maintenance of the Vegetation Protection Area and for bushfire protection purposes.
- The Vegetation Protection Area will be suitably signed and identified on site.

5.2 Habitat Restoration

Objectives:

- Restore degraded habitats within the site
- To revegetate areas with preferred koala food species
- Monitor and maintain restored/revegetated areas

Actions:

- A Vegetation Protection Area will be identified and established prior to any clearing operations. This area will de identified for long term protection and provision of Koala habitat.
- Native plantings within Vegetation Protection areas will contain preferred Koala feed tree species currently found on site. These are *Eucalyptus microcorys* (Tallowwood) and *Eucalyptus tereticornis (*Forest Red Gum*)*. Replanting will also include restoration of the understorey using suitable locally occurring shrub species.
- A Vegetation and Habitat Management Plan will be produced for the site to provide information on the following:
  - Identification of areas for replanting/rehabilitation and management
  - Details on species for replanting
  - Protection/maintenance measures for replanted areas
  - Schedule for planting
  - Weed removal techniques
  - Planting densities
  - Short and long term monitoring of rehabilitated vegetation
- Restoration areas should include disturbed areas and areas no longer actively quarried in the subject site.
- Revegetation areas will be designed to link currently isolated areas of vegetation within the site.
- The Vegetation Protection Area will be suitably signed and identified on site.
- It is proposed that, if possible, revegetation of habitats will occur at an area greater than that to be removed resulting in a net gain in Koala habitat.
- Clearing operations will be staged over time to allow for growth of new trees to be viable as potential food trees prior to clearing of each progressive stage.

5.3 Traffic Management

Objectives

- Minimise potential for injury/death to Koalas within the site as a result of vehicle strike.
- Increase driver awareness of the risks vehicles pose to Koalas.
- Increase koala awareness by quarry employees and visitors

Actions

- All local quarry traffic will be limited to 40km/h. Speed limits are currently set at 40km/h within the site due to safety issues.
- Koala signs will be placed in areas of potential Koala activity.
- Quarry operation times are currently limited to 7am to 5pm. This reduces the risk of local traffic encountering Koalas during periods of high nocturnal activity.
- Include information on Koalas as part of employee and visitor site inductions.

5.4 Dog/Feral Animal Management

Objectives

- Minimise the incidence of Koala injury/death as a result of attacks by dogs or feral animals.
- Restrict access of dogs to the site.
- Increase awareness of risks posed by dogs and feral animals on Koalas.
- Maximise efforts to eliminate the presence of feral animals within the site that may pose a risk to the local Koala population.

Actions

- Domestic dogs will be prohibited from the site. This is to include entry of dogs to the site from neighbouring residences. Residents will be made aware of their responsibilities in restricting access of dogs to the site.
- The sighting of feral animals (dogs/foxes/cats) by employees will be recorded as part of the site incident reporting system. Employees will be made aware of their responsibilities in reporting any sightings.
- Where feral animals are observed contingency will be made for removal of these individuals from the site by licensed pest exterminator.

5.5 Bushfire Management

Objectives

- To minimise bushfire hazard on the subject site and subsequent risks of wildfire upon the local Koala population.
- To minimise the risk of bushfire hazard reduction practices upon the local population of the Koala.

Actions

- Regular maintenance of trails around the perimeter of the site to reduce risk of fire spreading into the site from neighbouring properties.
- If bushfire control methods are required then a low intensity mosaic burn of the site should be implemented to reduce bushfire risk with minimal direct impact upon the Koala.
- Any fire management should be carried out in conjunction with a Fire Management Plan to be prepared for the site.

5.6 Monitoring and Reporting

Objectives:

- To implement an ongoing survey and monitoring program that will determine use of the area by Koalas.
- To record and report on results of the Koala monitoring program.
- To report on all other actions implemented as part of the Management Plan.

Actions:

- A report detailing the ongoing management and restoration activities being carried out within the Vegetation Protection Area is to be submitted to Council twice yearly for three (3) years after planting for revegetation has commenced and annually thereafter for a further five (5) years. The report is to be provided by a qualified ecologist and to confirm the following:

(i) That monitoring and watering of the restoration areas has taken place as follows:

TABLE 2
FREQUENCY OF MONITORING, WATERING AND MAINTENANCE REQUIRED WITHIN KOALA MANAGEMENT CORRIDOR

Period Since Planting (months)	Frequency
0 – 3	Weekly
3 – 12	Monthly

TABLE 2 (Cont) FREQUENCY OF MONITORING, WATERING AND MAINTENANCE REQUIRED WITHIN KOALA MANAGEMENT CORRIDOR	
12 – 24	Quarterly
24 – 36	Three (3) monthly
36 - 96	As considered necessary by Project Ecologist

(ii) Confirmation of the species of plant and how many individuals have been planted within the canopy, understorey and groundcover layers
(iii) Confirm the rate of plant loss and the measures undertaken to replace lost plantings
(iv) An estimation of the height of species within each vegetation layer and the rate of growth since the last monitoring period
(v) Details of any other work undertaken within the Vegetation Protection Area
(vi) Other issues as deemed relevant by the Project ecologist

- A bi-annual Koala survey for five years following the adoption of the management plan will be undertaken. Surveys will consist of spotlighting and call playback for three nights during each bi-annual survey period. The Spot Assessment Technique will also be carried out at standard survey locations, likely to be the same as those locations used within the Flora and Fauna Assessment (*Conacher Travers* 2006). A report will be supplied to Council at the completion of each bi-annual monitoring period.

SECTION 6.0 TIMING OF WORKS

The following table outlines the timing of works proposed as part of this Koala Plan of Management.

TABLE 3 TIMING OF WORKS FOR KOALA PLAN OF MANAGEMENT					
	Pre-Clearing (Pre-development)	**Clearing/ Operation**	**Year 1**	**Year 2**	**Ongoing**
Habitat Protection					
Quarry design in maximising habitat retention	√				
Identification of habitat protection areas (Vegetation Protection Area)	√				
Restriction of vehicle access to Vegetation protection Areas	√	√	√	√	√
Signing of Vegetation Protection Area	√				
Habitat Restoration					
Identification of habitat protection areas (Vegetation Protection Area)Corridor	√				

TABLE 3 (Cont) TIMING OF WORKS FOR KOALA PLAN OF MANAGEMENT					
Identification of potential habitat and vegetation linkages	√				
Identification of suitable native plantings	√				
Preparation of Vegetation Management Plan	√				
Signing of Vegetation Protection Area	√				
Revegetation to result in a net gain in habitat	√	√	√	√	√
Habitat Restoration					
Staging of clearing operations	√	√	√	√	√
Traffic Management					
Speed limit local traffic	√				
Signage	√				
Include Koala info in site inductions	√				
Dog/Feral Animal Management					
Prohibit dogs from site	√	√	√	√	√
Inclusion of feral animal sightings in incident reporting procedure	√	√	√	√	√
Contingency made for feral animal removal	√	√	√	√	√
Bushfire Management					
Maintenance of firetrails/fencelines			√		√
Low intensity mosaic burns (if required)					√
Preparation of Fire Management Plan (if required)	√				
Monitoring and Reporting					
Bi-annual Koala surveys			√	√	√
Vegetation Protection Area monitoring			√	√	√
Regular reporting			√	√	√

Note 1: The timing of works may vary where staging of clearing for operations occurs. Where staging of clearing occurs in accordance with regeneration of habitat areas and suitably aged Koala feed trees the timing of works in certain areas of the site may be staggered according to the above format.

SECTION 7.0 FUNDING OF WORKS

The costs incurred as a result of the actions within this Koala Plan of Management will be met by the operators of Blakebrook Quarry.

SECTION 8.0 CONCLUSION

It is considered that the works and measures detailed in this plan provide for the highest level of consideration of Koala management within the site. Clearing of Core Koala habitat is required for the proposed extension of the current operation. The measures outlined in this management plan will provide for the persistence of the Koala in the area and maintenance of Koala habitat within the locality. It is considered that the rehabilitation and protection of vegetation and habitats within the site will result in the protection of the long term viability of the local Koala population.

REFERENCES

Conacher Travers (2006) *Flora and Fauna Assessment Proposed Quarry Extension Lot 102 DP 817730 Nimbin Road Blakebrook (Ref: 6047F).*

Department of Environment and Conservation (2006 Atlas of NSW Wildlife. (Lismore 1:100,000 scale map sheet, January 2006) DEC Hurstville.

Department of Environment and Conservation (NSW) (2006) Threatened Species – species, populations and ecological communities of NSW – Koala profile retrieved 21st November 2006 from
http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10616

Environmental Planning and Assessment Act (1979). New South Wales Government.

Phillips, S. & Calllaghan, J. (1995) *The Spot Assessment Technique for Determining the Significance of Habitat Utilisation by Koalas*. Australian Koala Foundation.

Lismore City Council (2003) *Draft Comprehensive Koala Plan of Management for the South-eastern portion of the Lismore Local Government Area – June 2003 (Part A: The Plan)..* Prepared by Lismore City Council.

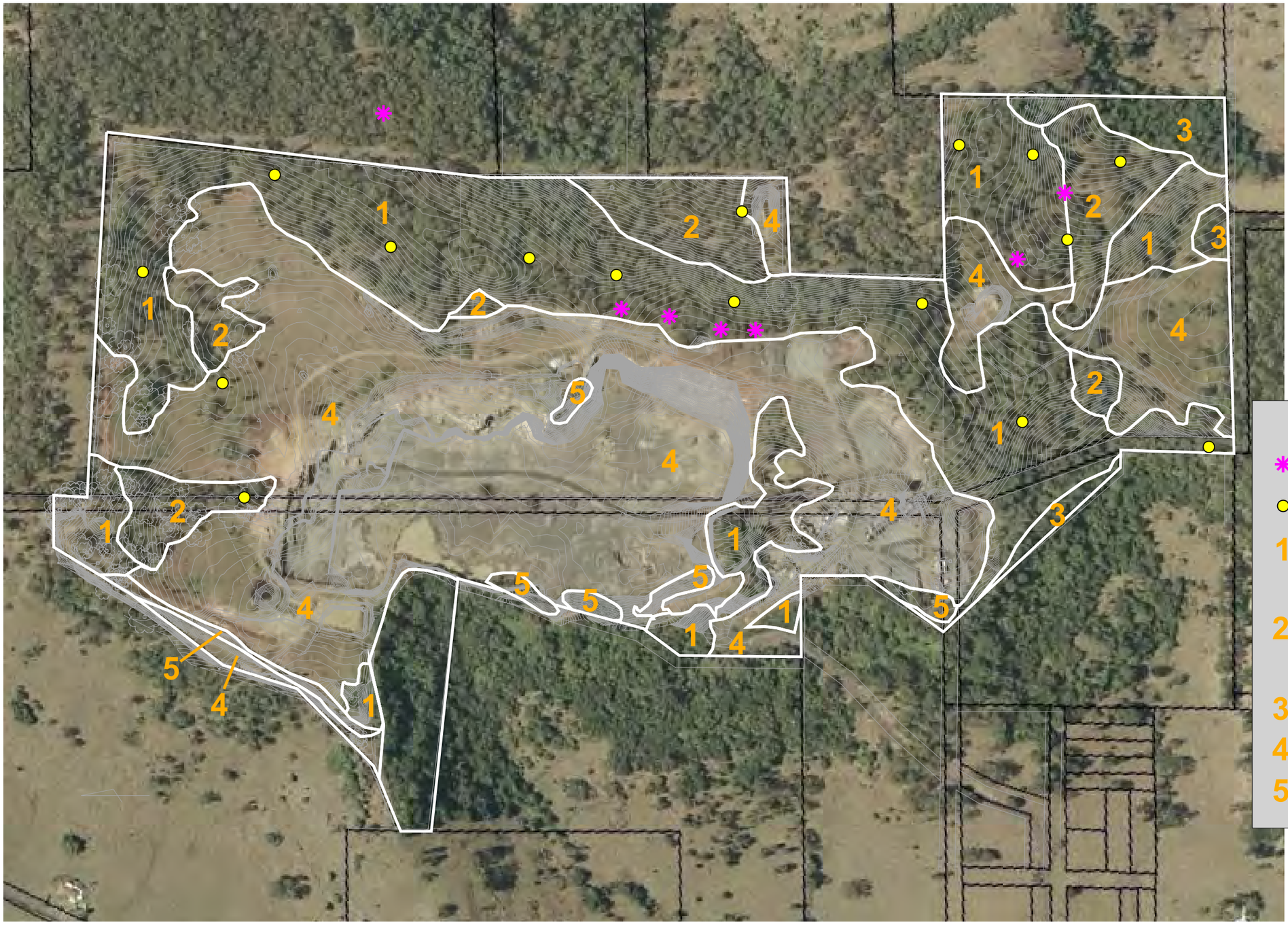
Martin, R.W. (1988) Koala (*Phascolarctos cinereus)*. In *The Australian Museum Complete Book of Australian Mammals.* R. Strahan (Ed.). Angus and Robertson Publishers, Sydney.

Peter Parker Environmental Consultant (1995) State Environmental and Planning Policy No. 44 Koala Habitat Management: A Plan of Management for Blakebrook Quarry Prepared for Lismore City Council.

Reed, P.C., Lunney, D. and Walker, P. (1991). A 1986-1987 survey of the Koala *Phascolarctos cinereus* (Goldfuss) in New South Wales and an ecological interpretation of its distribution. In: *Biology of the Koala*. A. K. Lee, K. A. Handasyde and G. D. Sanson, (Eds). Surrey Beatty and Sons, Chipping Norton, Sydney. Pp. 55-73.

State Environmental Planning Policy No 44 Koala Habitat Protection under the Environmental Planning and Assessment Act (1979). New South Wales Government.

Threatened Species Conservation Act (1995), Sydney, New South Wales.



Flora and fauna survey locations are approximate and have not been fixed by land survey.

*Subject Site boundary subject to final survey

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e-mail: ecology@conachertravers.com.au

50 0 50 100 150 200 metres

Scale 1:5,000

Original plan produced in A3 colour

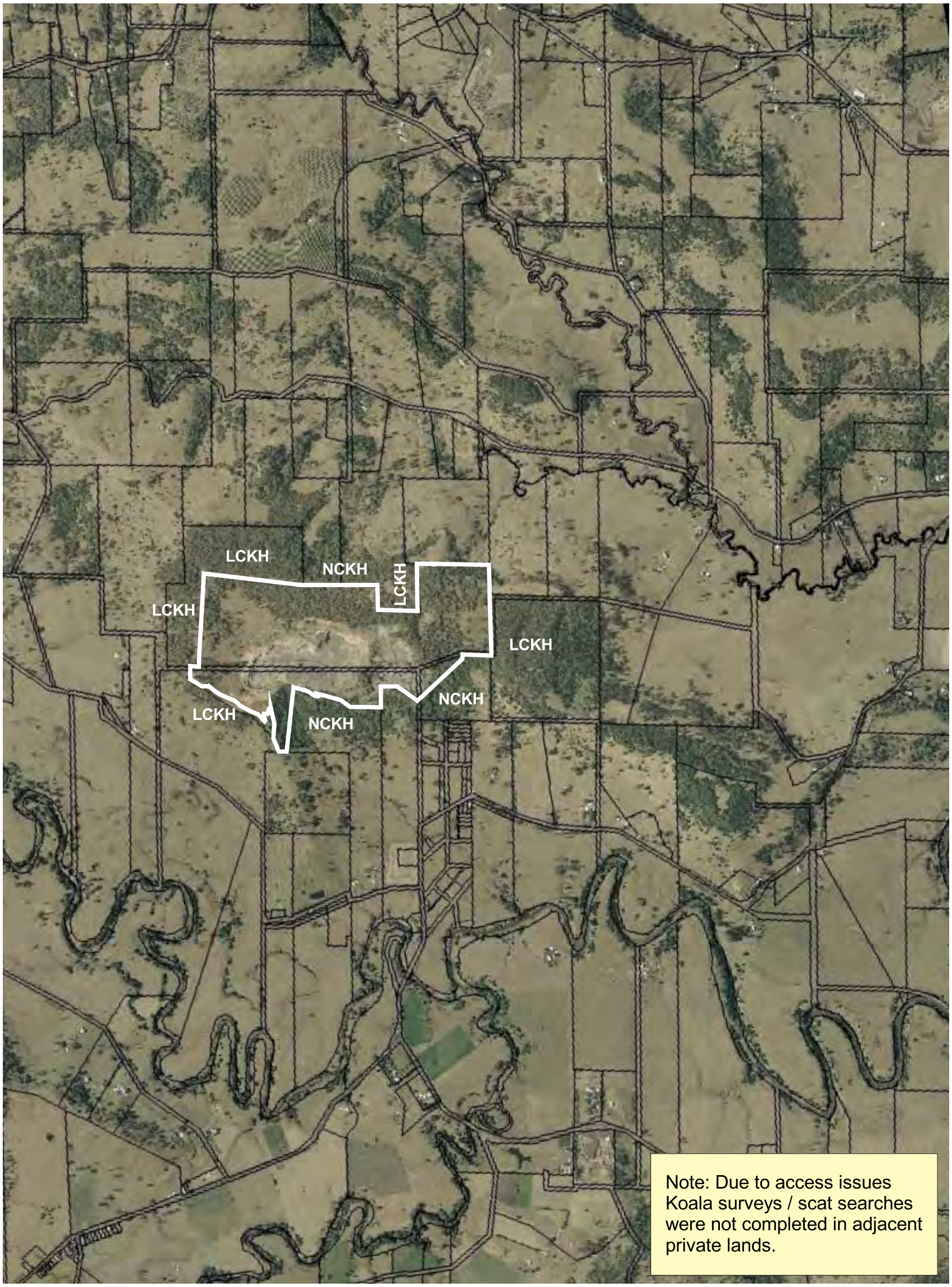
Drawing No.	6088		Date
Drawn By	MC		18/05/06
Amendment			Date
A	Added Koala Observation Points		19/05/06
B			
C			

Figure 1 -

Spot Assessment Locations, Vegetation Communities and Koala Habitat Types

Blakebrook, Nimbin Road

Source: DLWC 1:25,000 Aerial Photograph,



Legend

	*Subject Site Boundary
LCKH	Likely Core Koala Habitat (Tallowwood / Forest Red Gum dominant vegetation communities)
NCKH	Non-Core Koala Habitat (Tallowwood / Forest Red Gum absent or in low numbers <15%)

200 0 200 400 600 800 metres

Scale 1:20,000

N

Original plan produced in A3 colour

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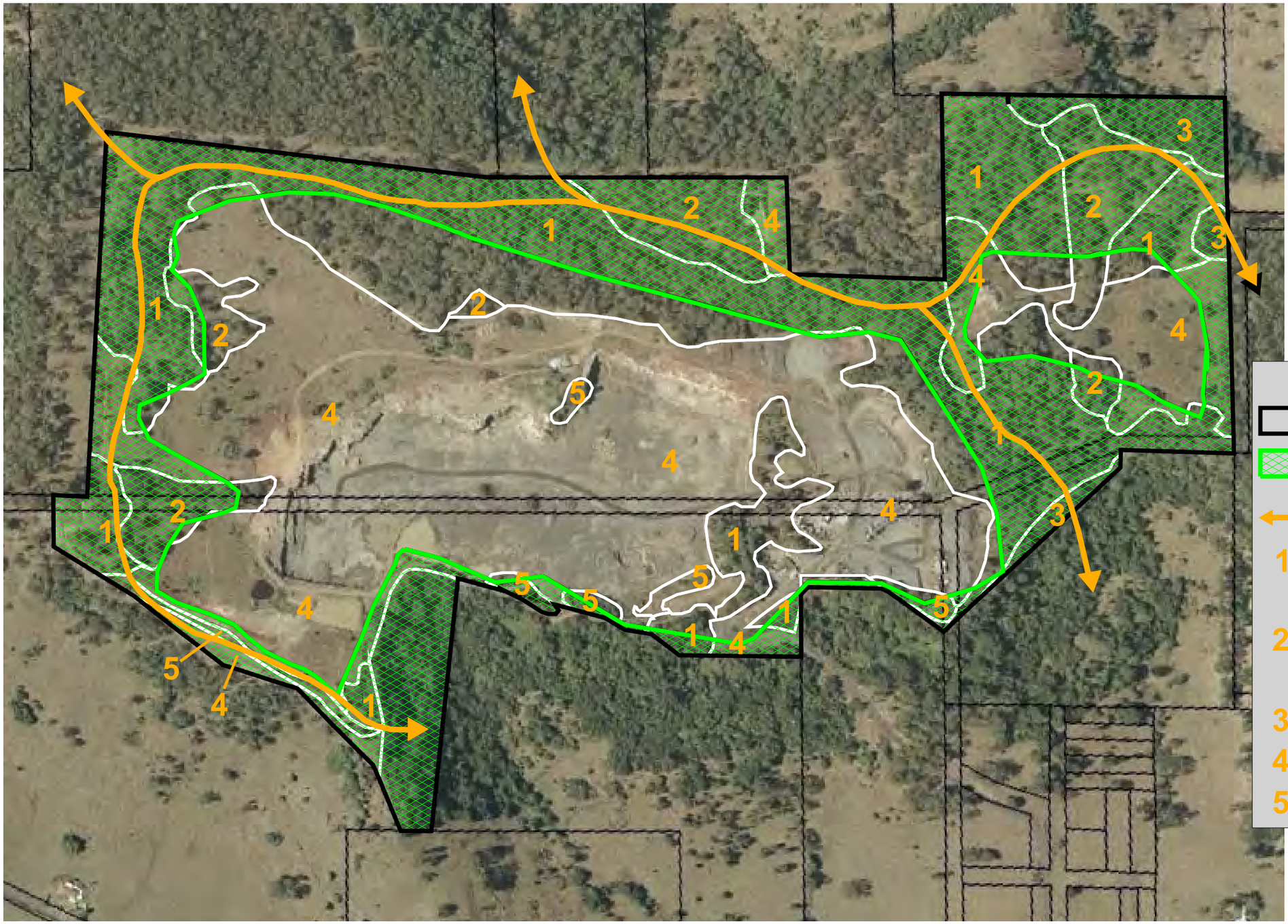
Figure 2 -

Remnant Vegetation within the Locality and Koala Habitat Types Adjacent to Subject Site

Blakebrook, Nimbin Road

Ver.F1
18/05/06
Ref.No.6088

Source: DLWC 1:25,000 Aerial Photograph,



Flora and fauna survey locations are approximate and have not been fixed by land survey.

**Subject Site boundary subject to final survey*

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50 0 50 100 150 200 metres

Scale 1:5,000

Original plan produced in A3 colour

Drawing No. 6088			Date
Drawn By MC			18/05/06
Amendment			Date
A	Changed base aerial		23/05/06
B	Layout adjustments		26/05/06
C	Brought in surveyed protection area boundaries		08/09/06

Figure 3 -

Layout- Koala Management

Blakebrook, Nimbin Road

Source: DLWC 1:25,000 Aerial Photograph,

ATTACHEMENT I

RESULTS OF SPOT ASSESSMENT TECHNIQUES

TABLE 1 RESULTS OF SPOT ASSESSMENT TECHNIQUES				
Survey Point	**No. Trees with Scats**	**No Trees with Indicative Scratches**	**No of Scats at Tree Bases**	**Activity Levels**
SA1	0/20	-	-	0%
SA2	2/20	-	Generally 1-2	<25%
SA3	0/20	4	-	0%
SA4	0/20	-	-	0%
SA5	2/20	4	Generally 1-2	<25%
SA6	1/20	1	Generally 1-2	<25%
SA7	0/20	-	-	0%
SA8	0/20	1	-	<25%
SA9	3/20	1	Generally 1-2	<25%
SA10	4/20	-	Generally 1-2 however 1 tree >5	>25%
SA11	0/20	-	-	0%
SA12	5/20	-	Generally 1-2	<25%
SA13	4/20	-	Generally 1-2	<25%
SA14	1/20	3	Generally 1-2	<25%
SA15	2/20	5	Generally 1-2	<25%
SA16	4/20	-	Generally 1-2 however 1 tree >5	>25%

Annex B

Vegetation Community Descriptions (Conacher Environmental Group, 2008)

B.1 TALL OPEN FOREST

B.1.1 Structure

Trees: to 35m high with 45-50% Projected Foliage Cover (PFC)

Shrubs: to 4m high with 55-60% PFC

Groundcover: to 1.5m high with variable 40-65% PFC

B.1.2 Dominant Species

Family	Scientific Name	Common Name
Trees		
LAURACEAE	*Cinnamomum camphora**	Camphor Laurel
MYRTACEAE MYRTACEAE MYRTACEAE MYRTACEAE	*Corymbia intermedia* *Eucalyptus acmenoides* *Eucalyptus microcorys* *Lophostemon confertus*	Pink Bloodwood White Mahogany Tallowwood Brush Box
Shrubs		
ASTERACEAE	*Ozothamnus diosmifolius*	White Dogwood
CASUARINACEAE EUPHORBIACEAE EUPHORBIACEAE	*Allocasuarina littoralis* *Acalypha capillipes Macaranga tanarius*	Black She-oak - Blush Macaranga
FABACEAE (MIMOSOIDEAE) VERBENACEAE	*Acacia* spp. *Lantana camara**	Wattle Lantana
Groundcover		
BLECHNACEAE	*Doodia aspera*	Prickly Rasp Fern
CONVOLVULACEAE DENNSTAEDTIACEAE	*Dichondra repens Pteridium esculentum*	Kidney Weed Bracken
FABACEAE (FABOIDEAE)	*Desmodium* spp.	-
LOMANDRACEAE LUZURIAGACEAE LUZURIAGACEAE POACEAE POACEAE POACEAE POACEAE POACEAE POACEAE	*Lomandra* spp. *Eustrephus latifolius Geitonoplesium cymosum Chloris gayana** *Eragrostis brownii Hyparrhenia hirta* Imperata cylindrica Paspalum dilatatum* Themeda australis*	Mat-rush Wombat Berry Scrambling Lily Rhodes Grass Brown's Lovegrass Coolatai Grass Blady Grass Paspalum Kangaroo Grass

B.1.3 Location and Distribution

This vegetation community occurs throughout the eastern portion of the site and occupies the majority of the remaining vegetated areas on the plateau.

B.1.4 Variation

There are a number of minor variations within the canopy of this community, particularly in regards to structure and species dominance. One of the more significant variations is the association dominated by Brush Box (*Lophostemon confertus*) and a variety of mesophilic rainforest species in the far southwest of the site. This variation gradually grades into the Closed Forest community that occupies the very steep gullies and slopes.

B.1.5 Disturbance

This community has been disturbed by extensive weed invasion in the shrub and ground layers, a history of rural activities, massive earth movement, numerous vehicle tracks, selective clearing and stockpiles of quarry waste.

B.1.6 Weed Invasion

This community exhibits extensive weed invasion in both the shrub and ground layers. Large areas of Lantana (*Lantana camara*) and to a lesser extent Large-leaved Privet (*Ligustrum lucidum*) dominate the shrub layers, while a variety of exotic herbs and pasture grasses, including Coolatai Grass (*Hyparrhenia hirta*), dominate the ground layer.

B.2 TALL OPEN FOREST/WOODLAND

B.2.1 Structure

Canopy Trees: to 20-30m high with 25-55% PFC

Shrubs: to 2m high with variable 5-35% PFC

Groundcover: to 1.5m high with 75-95% PFC

B.2.2 Dominant Species

Family	Scientific Name	Common Name
Canopy Trees		
MYRTACEAE	*Angophora subvelutina*	Broad-leaved Apple
MYRTACEAE	*Eucalyptus tereticornis*	Forest Red Gum
MYRTACEAE	*Lophostemon suaveolens*	Swamp Turpentine
MYRTACEAE	*Melaleuca quinquenervia*	Broad-leaved Paperbark
Shrubs		
MYRTACEAE	*Callistemon salignus*	Willow Bottlebrush
RHAMNACEAE	*Alphitonia excelsa*	Red Ash

Family	Scientific Name	Common Name
VERBENACEAE	*Lantana camara*	Lantana
Groundcover		
ASTERACEAE	*Ageratina adenophora**	Crofton Weed
POACEAE	*Chloris gayana**	Rhodes Grass
POACEAE	*Hyparrhenia hirta**	Coolatai Grass
POACEAE	*Imperata cylindrica*	Blady Grass
POACEAE	*Paspalum dilatatum**	Paspalum
POACEAE	*Pennisetum alopecuroides*	Swamp Foxtail

*denotes introduced species

B.2.3 Location and Distribution

This community occupies a number of small areas associated with impeded drainage in the north, east and south of the site.

B.2.4 Variations

Previous clearing and associated disturbances have led to an altered structure and age class of the canopy within some areas of this community.

B.2.5 Disturbance

This community has been disturbed by extensive weed invasion in the shrub and ground layers, a history of rural activities, massive earth movement, numerous vehicle tracks, selective clearing and stockpiles of quarry waste.

B.2.6 Weed Invasion

This community exhibits extensive weed invasion in both the shrub and ground layers. Large areas of Lantana dominate the limited shrub layer, while a variety of exotic herbs and pasture grasses, including Coolatai Grass, dominate the ground layer.

B.3 CLOSED FORREST

B.3.1 Structure

Canopy Trees: 15-25m high with 35-65% PFC

Sub-canopy Trees: 10-15m high with 65-80% PFC

Shrubs: to 4m high with variable 5-50% PFC

Groundcover: to 1m high with variable 15-40% PFC

B.3.2 *Dominant Species*

Family	Scientific Name	Common Name
Canopy Trees		
MORACEAE	*Ficus obliqua*	Small-leaved Fig
MYRTACEAE	*Lophostemon confertus*	Brush Box
Sub-canopy Trees		
ARALIACEAE EBENACEAE PUTRANJIVACEAE RHAMNACEAE SAPINDACEAE STERCULIACEAE	*Polyscias* spp. *Diospyros australis Drypetes deplanchei Alphitonia excelsa Guioa semiglauca Brachychiton populneus*	- Black Plum Yellow Tulipwood Red Ash - Kurrajong
Shrubs		
APOCYNACEAE	*Alyxia ruscifolia*	Prickly Alyxia
LAURACEAE MALVACEAE MORACEAE MORACEAE OLEACEAE SAPINDACEAE VERBENACEAE	*Neolitsea dealbata Hibiscus heterophyllus Ficus fraseri* *Streblus brunonianus Ligustrum lucidum* Alectryon tomentosus Lantana camara**	Hairy-leaved Bolly Gum Native Rosella Sandpaper Fig Whalebone Tree Large-leaved Privet - Lantana
Groundcover		
ADIANTACEAE	*Adiantum hispidulum*	Rough Maidenhair
ARECACEAE ASPLENIACEAE ASTELIACEAE POACEAE VITACEAE	*Calamus muelleri Asplenium australasicum Cordyline rubra Oplismenus imbecillis Cissus antarctica*	Southern Lawyer Cane Bird's Nest Fern Palm-lily Basket Grass Water Vine

* denotes introduced species

B.3.3 *Location and Distribution*

This community occurs along the south eastern and western boundaries of the site on the very steep basalt derived slopes. A small regrowth remnant of this community is also located along the southern boundary of the site, associated with a single large Fig tree.

B.3.4 *Variation*

There are a number of variations within this community associated with topography and wind exposure. Transitional areas adjoining Open Forest communities are dominated by Large-leaved Privet and Lantana. The upper slopes of the eastern remnants contain a high proportion of characteristic dry rainforest species.

B.3.5 *Disturbance*

The main disturbance to this community has been a result of previous clearing and weed invasion.

B.3.6 *Weed Invasion*

Weed invasion is moderate to high in the shrub and ground layers of ecotone areas between adjoining communities and low within the core of the eastern remnant portion.

B.4 REGROWTH SCRUB

B.4.1 *Structure*

Shrubs – to 4m high with variable 5-80% PFC

Groundcover – to 1.5m high with a variable 15-80% PFC

B.4.2 *Dominant Species*

Family	Scientific Name	Common Name
Shrubs		
EUPHORBIACEAE	*Macaranga tanarius*	Blush Macaranga
FABACEAE (MIMOSOIDEAE)	*Acacia falcata*	-
LAURACEAE	*Cinnamomum camphora**	Camphor Laurel
OLEACEAE	*Ligustrum lucidum**	Large-leaved Privet
VERBENACEAE	*Lantana camara**	Lantana
Groundcover		
BLECHNACEAE	*Doodia aspera*	Prickly Rasp Fern
CONVOLVULACEAE	*Dichondra repens*	Kidney Weed
DENNSTAEDTIACEAE	*Pteridium esculentum*	Bracken
FABACEAE (FABOIDEAE)	*Desmodium* spp	-
LOMANDRACEAE	*Lomandra* spp.	Mat-rush
LUZURIAGACEAE	*Eustrephus latifolius*	Wombat Berry
LUZURIAGACEAE	*Geitonoplesium cymosum*	Scrambling Lily
BLECHNACEAE	*Doodia aspera*	Prickly Rasp Fern
POACEAE	*Chloris gayana**	Rhodes Grass
POACEAE	*Eragrostis brownii*	Brown's Lovegrass
POACEAE	*Hyparrhenia hirta**	Coolatai Grass
POACEAE	*Imperata cylindrica*	Blady Grass
POACEAE	*Paspalum dilatatum**	Paspalum
POACEAE	*Themeda australis*	Kangaroo Grass

Family	Scientific Name	Common Name

*denote introduced species

B.4.3 *Location and Distribution*

This community is scattered throughout disturbed areas of the site.

B.4.4 *Variation*

There is little variation within this community.

B.4.5 *Disturbance*

This community has a high level of disturbance resulting from extensive weed invasion, clearing, earth movement, quarrying, stockpiling of quarry material and waste, construction of roads and alterations to the natural drainage.

B.4.6 *Weed Invasion*

This community exhibits extensive weed invasion in both the shrub and ground layers.

B.5 DISTURBED GRASSLAND

B.5.1 *Structure*

Shrubs - to 6m high with 5-15% PFC

Groundcover – to 1.5m high with variable 40-95% PFC

B.5.2 *Floristics*

Family	Scientific Name	Common Name
Shrubs		
VERBENACEAE	*Lantana camara**	Lantana
Groundcover		
BLECHNACEAE	*Doodia aspera*	Prickly Rasp Fern
CONVOLVULACEAE	*Dichondra repens*	Kidney Weed
DENNSTAEDTIACEAE	*Pteridium esculentum*	Bracken
FABACEAE (FABOIDEAE)	*Desmodium* spp.	-
LOMANDRACEAE	*Lomandra* spp.	Mat-rush
LUZURIAGACEAE	*Eustrephus latifolius*	Wombat Berry
LUZURIAGACEAE	*Geitonoplesium cymosum*	Scrambling Lily
POACEAE	*Chloris gayana**	Rhodes Grass
POACEAE	*Eragrostis brownii*	Brown's Lovegrass
POACEAE	*Hyparrhenia hirta**	Coolatai Grass
POACEAE	*Imperata cylindrica*	Blady Grass

Family	Scientific Name	Common Name
POACEAE	*Paspalum dilatatum**	Paspalum
POACEAE	*Themeda australis*	Kangaroo Grass

*denotes introduced species

B.5.3 Location and Distribution

This vegetation community occurs throughout the central and southern portions of the site, associated with areas of high disturbance.

B.5.4 Variation

This community contains a number of considerable variations largely associated with the degree of disturbance. The southern and northern portions of this community are dominated by a dense cover of exotic and native grasses, herbs, and to a lesser extent, shrubs. The central portion of this community associated with the quarry is largely devoid of any vegetation and contains only scattered patches of exotic grasses and herbs. Within the central portion of this community, there are a number of artificial dams and permanent water bodies. These water bodies contain a variety of exotic aquatic and semi-aquatic herbs around their perimeters.

B.5.5 Disturbance

This community has a high level disturbance resulting from extensive weed invasion, clearing, earth movement, quarrying, stockpiling of quarry material and waste, construction of roads and alterations to the natural drainage.

B.5.6 Weed Invasion

This community exhibits extensive weed invasion in both the shrub and ground layers.

Annex C

Fauna Species List

Family	Scientific Name	Common Name	Legal Status	
			BC Act	EPBC Act
Frogs				
BUFONIDAE	*Rhinella marina**	Cane Toad	-	-
HYLIDAE	*Litoria caerulea*	Green Tree Frog	-	-
HYLIDAE	*Litoria fallax*	Eastern Dwarf Tree Frog	-	-
HYLIDAE	*Litoria lesueuri*	Lesueur's Frog	-	-
HYLIDAE	*Litoria peronii*	Peron's Tree Frog	-	-
HYLIDAE	*Litoria tyleri*	Tyler's Tree Frog	-	-
MYOBATRACHIDAE	*Adelotus brevis*	Tusked Frog	-	-
MYOBATRACHIDAE	*Crinia signifera*	Common Eastern Froglet	-	-
MYOBATRACHIDAE	*Limnodynastes peronii*	Brown-striped Frog	-	-
MYOBATRACHIDAE	*Limnodynastes tasmaniensis*	Spotted Grass Frog	-	-
MYOBATRACHIDAE	*Pseudophryne bibronii*	Bibron's Toadlet	-	-
MYOBATRACHIDAE	*Uperoleia fusca*	Dusky Toadlet	-	-
Reptiles			-	-
AGAMIDAE	*Physignathus lesueurii*	Eastern Water Dragon	-	-
BOIDAE	*Morelia spilota*	Diamond Python	-	-
COLUBRIDAE	*Dendrelaphis punctulatus*	Common Tree Snake	-	-
SCINCIDAE	*Bellatorias major*	Land Mullet	-	-
SCINCIDAE	*Lampropholis guichenoti*	Pale-flecked Garden Sunskink	-	-
SCINCIDAE	*Saiphos equalis*	Three-toed Skink	-	-
Birds			-	-
ACANTHIZIDAE	*Acanthiza lineata*	Striated Thornbill	-	-
ACANTHIZIDAE	*Sericornis frontalis*	White-browed Scrubwren	-	-
ACCIPITRIDAE	*Aquila audax*	Wedge-tailed Eagle	-	M
ACCIPITRIDAE	*Aviceda subcristata*	Pacific Baza	-	M
ANATIDAE	*Anas superciliosa*	Pacific Black Duck	-	M
ANATIDAE	*Chenonetta jubata*	Australian Wood Duck	-	M
ARDEIDAE	*Egretta novaehollandiae*	White-faced Heron	-	-
ARTAMIDAE	*Cracticus nigrogularis*	Pied Butcherbird	-	-
ARTAMIDAE	*Cracticus tibicen*	Australian Magpie	-	-
ARTAMIDAE	*Cracticus torquatus*	Grey Butcherbird	-	-
ARTAMIDAE	*Strepera graculina*	Pied Currawong	-	-
CACATUIDAE	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V	-
CACATUIDAE	*Eolophus roseicapillus*	Galah	-	-
CAMPEPHAGIDAE	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	-	-
CAMPEPHAGIDAE	*Eurostopodus mystacalis*	White-throated Nightjar	-	-
CHARADRIIDAE	*Vanellus miles*	Masked Lapwing	-	M
COLUMBIDAE	*Columba leucomela*	White-headed Pigeon	-	-
COLUMBIDAE	*Geopelia humeralis*	Bar-shouldered Dove	-	-
COLUMBIDAE	*Leucosarcia picata*	Wonga Pigeon	-	-
COLUMBIDAE	*Lopholaimus antarcticus*	Topknot Pigeon	-	-

Family	Scientific Name	Common Name	Legal Status	
			BC Act	EPBC Act
COLUMBIDAE	*Ocyphaps lophotes*	Crested Pigeon	-	-
CORVIDAE	*Corvus coronoides*	Australian Raven	-	-
CUCULIDAE	*Cacomantis pallidus*	Pallid Cuckoo	-	-
DICRURIDAE	*Dicrurus bracteatus*	Spangled Drongo	-	-
MALURIDAE	*Malurus cyaneus*	Superb Fairywren	-	-
MALURIDAE	*Malurus lamberti*	Variegated Fairy-wren	-	-
MALURIDAE	*Malurus melanocephalus*	Red-backed Fairy-wren	-	-
MEGAPODIIDAE	*Alectura lathami*	Australian Brush-turkey	-	-
MEGAPODIIDAE	*Anthochaera chrysoptera*	Little Wattlebird	-	-
MEGAPODIIDAE	*Entomyzon cyanotis*	Blue-faced Honeyeater	-	-
MEGAPODIIDAE	*Lichmera indistincta*	Brown Honeyeater	-	-
MEGAPODIIDAE	*Manorina melanocephala*	Noisy Miner	-	-
MEGAPODIIDAE	*Meliphaga lewinii*	Lewin's Honeyeater	-	-
MEGAPODIIDAE	*Phylidonyris niger*	White-cheeked Honeyeater	-	-
MEGAPODIIDAE	*Grallina cyanoleuca*	Magpie-lark	-	-
NECTARINIIDAE	*Dicaeum hirundinaceum*	Mistletoebird	-	-
PACHYCEPHALIDAE	*Colluricincla harmonica*	Grey Shrikethrush	-	-
PETROICIDAE	*Eopsaltria australis*	Eastern Yellow Robin	-	-
PODARGIDAE	*Podargus strigoides*	Tawny Frogmouth	-	-
PSITTACIDAE	*Platycercus eximius*	Eastern Rosella	-	-
PSITTACIDAE	*Trichoglossus haematodus*	Rainbow Lorikeet	-	-
PSOPHODIDAE	*Psophodes olivaceus*	Eastern Whipbird	-	-
RHIPIDURIDAE	*Rhipidura albiscapa*	Grey Fantail	-	-
RHIPIDURIDAE	*Rhipidura leucophrys*	Willie Wagtail	-	-
THRESKIORNITHIDAE	*Threskiornis spinicollis*	Straw-necked Ibis	-	-
TIMALIIDAE	*Zosterops lateralis*	Silvereye -	-	-
Mammals			-	-
CANIDAE	*Canis lupus familiaris**	Dog	-	-
CANIDAE	*Vulpes vulpes**	Fox	-	-
DASYURIDAE	*Antechinus stuartii*	Brown Antechinus	-	-
LEPORIDAE	*Oryctolagus cuniculus**	Rabbit	-	-
MACROPODIDAE	*Macropus rufogriseus*	Red-necked Wallaby	-	-
MACROPODIDAE	*Wallabia bicolor*	Swamp Wallaby	-	-
PETAURIDAE	*Petaurus breviceps*	Sugar Glider	-	-
PETAURIDAE	*Petaurus norfolcensis*	Squirrel Glider	V	-
PHALANGERIDAE	*Trichosurus caninus*	Short-eared Possum	-	-
PHASCOLARCTIDAE	*Phascolarctos cinereus*	Koala	V	-
PTEROPODIDAE	*Pteropus alecto*	Black Flyingfox	-	-
PTEROPODIDAE	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V
VESPERTILIONIDAE	*Chalinolobus gouldii*	Gould's Wattled Bat	-	-
VESPERTILIONIDAE	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V	-

Family	Scientific Name	Common Name	Legal Status	
			BC Act	EPBC Act
VESPERTILIONIDAE	*Miniopterus australis*	Little Bentwing-bat	V	-
VESPERTILIONIDAE	*Scotorepens sp 1/greyii*	Broad-nosed Bat	-	-
VESPERTILIONIDAE	*Vespadelus pumilus*	Eastern Forest Bat	-	-
VESPERTILIONIDAE	*Vespadelus vulturnus*	Little Forest Bat	-	-

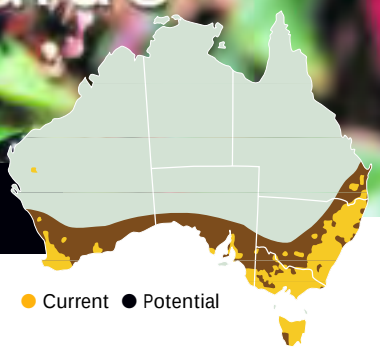
*denotes introduced species; M = migratory, V=vulnerable

Annex D

Weed Profiles

Weed Management Guide

Blackberry –
***Rubus fruticosus* aggregate**



Blackberry (*Rubus fruticosus* aggregate)

The problem

Blackberry is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Blackberry has invaded the banks of watercourses, roadsides, pastures, orchards, plantations, forests and bushland throughout temperate Australia. On farms blackberries reduce pasture production, restrict access to water and land, and provide food and shelter for pest animals such as foxes. In some cases the cost of plantation forestry may be increased, especially during establishment, because blackberries impede access for manual operations.

Other impacts are increased fire hazards caused by the large amount of dead material present in blackberry thickets and a substantial decrease in property values where heavy infestations occur. Control costs are often high.

Weeds such as blackberries also affect tourism, reducing the natural attraction of the bush and hindering recreational activities where thickets prevent access to natural features.

The weed

The name 'blackberry' covers at least 14 different but closely related species, some of which may be hybrids, that have become naturalised in Australia.

Blackberries hinder recreational activities by preventing access to natural features: Loddon River in central Vic.
Photo: Kate Blood

Blackberry is a perennial, semi-deciduous shrub with prickly stems (canes) that take root where they touch the ground, often forming thickets up to several metres high. It varies from sprawling to almost erect. The stems, which grow up to 7 m long, may be green, purplish or red, and are generally thorny and moderately hairy. Young canes emerge from buds on the woody root crown each spring and grow very rapidly (50–80 mm a day).

Leaves are usually dark green on top with a lighter green underside. The leaf veins and stalks are covered with short prickles. Clusters of flowers are white or pink.

The berries change colour from green to red to black as they ripen. The plant is semi-deciduous and sheds its leaves in winter.

Key points

- At least 14 different but closely related species of blackberry are naturalised in Australia.
- Some species could spread further within the climatic limits of blackberry's range.
- Blackberry management programs must be planned and sustained over a number of years.
- Biological control will not eradicate blackberry, but will slow the rate of spread and allow more time for control by other means. Rust has been the most successful biocontrol so far.
- In revegetation programs, native seedlings that are able to germinate and actively grow over winter have a competitive advantage.

Natural Heritage Trust
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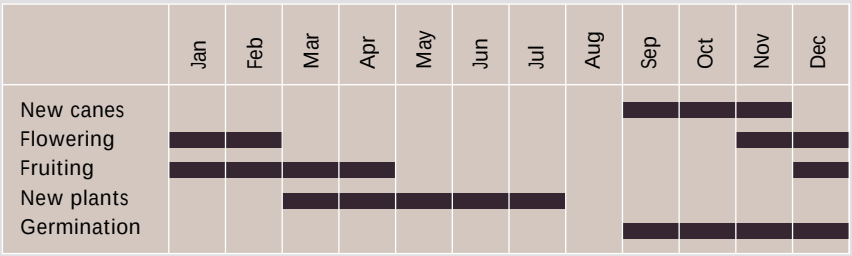
Growth calendar



Blackberry has a two-year growth pattern. Young canes start growing in spring, flowering occurs from late November to late February and fruiting from late December to April. New (daughter) plants develop at the tips of first-year canes throughout autumn and winter. Most germination takes place during spring and early summer.

Blackberry plants produce clusters of white or pink flowers.
Photo: Kate Blood

How it spreads

One berry may contain as many as 80 seeds which are easily spread by birds, mammals (especially foxes) and water. Bushwalkers and other recreational users can also spread seeds, as can moving soil from one place to another. Blackberry roots can be spread to clean areas by cultivation.

Blackberry will persist indefinitely in an area unless it is treated. Plants that die are replaced by seedlings or daughter plants produced by nearby individuals. Plants may produce up to 13,000 seeds per square metre.

Where it grows

About 8.8 million ha of Australia is infested with blackberry, which thrives in a wide range of habitats. It can dominate pastures and native ecosystems as well as invade disturbed sites in urban areas. In badly affected areas, dense infestations often fill whole gullies and can extend for a width of tens of metres along both sides of streams.

The plant is restricted to temperate climates with an annual rainfall of at least 700 mm, and can occur at any altitude in Australia. Blackberry plants grow above the snowline in Victoria at about 1950 m altitude.

Potential distribution

Blackberry has probably reached the climatic limits (in terms of temperature and rainfall) of its potential range in Australia. However, individual species may spread further within these climatic limits. A few scattered infestations exist outside of the projected range under ideal conditions in Western Australia.

Berries change colour from green to red to black as they ripen.
Photo: Kate Blood

Blackberry bushes often form thickets up to several metres high.
Photo: John Hosking

What to do about it

The major challenges in managing blackberry are to prevent its spread, control and reduce existing infestations, and rehabilitate treated areas to prevent reinfestation.

In its long history as a noxious weed, blackberry has been managed by a range of control techniques, including burning, slashing, grazing, grubbing, chemical spraying and biological control.

Blackberry management programs must be planned and sustained over a number of years to prevent the rapid return of the infestation.

Apply herbicides to healthy plants

In general, the best time to spray blackberry is during the flowering–fruiting period, but the effective spraying season can start before flowering and extend long after fruiting, into autumn.

It is easy to kill young blackberry seedlings with herbicide. However, well established blackberry thickets have a large number of root crowns of different ages, and the older and bigger ones are usually hard to kill.

If using herbicides taken up by the leaves, avoid slashing in the season before application; it can reduce the effectiveness since only the new canes will be available to take up the herbicide.

The prickly stems, known as canes, may grow up to 7 m long. The leaves are usually dark green on top with a lighter green underside.
Photo: John Hosking

Do not apply herbicides to stressed plants. Conditions such as drought or severe low or high temperatures can decrease the effectiveness of herbicide action. As a guide, look at the tips of the canes. In times of active growth (the best time to spray) these will be producing fresh new leaves, and any new growth should be healthy, not wilted.

The success of herbicide treatment can also vary between the different groups of blackberry. Some produce fewer crowns per square metre than others and fewer canes per crown. Other features such as larger leaves and canes and hairier leaf surfaces (which may reduce absorption) can also affect herbicide uptake.

Methods of herbicide application

High-volume spraying is recommended for spot spraying, particularly in dense infestations or large blackberry thickets. If using this method, spray the inside of bushes first, ensuring good coverage of stems and leaves. Then spray outside leaves, runners and tips. Take particular care with this method because it is very easy to overdose and affect off-target species or contaminate waterways. Likewise, mist blowers or air blast sprayers can be effective but allow little control over spray distribution due to spray drift. None of these methods are suitable for use near susceptible native species.

In remote areas where water for herbicide application is not available, pellets or granular herbicides can be effective. These are applied to the soil surface and the chemical is leached by rain into the root zone where the roots take it up. This method is not suitable for use near native vegetation. Results of some trials have shown that slashing before application of granular herbicide gives better results than using granules alone.

The use of a gas-powered gun has been suggested as a method which enables very accurate application of herbicide onto target plants. It can be used to control scattered blackberries to a height of 1.5 m. Knapsack units are most suitable for spraying small scattered bushes and seedlings.

For small areas of high conservation significance, the ‘cut and paint’ method is recommended. This involves cutting blackberry canes close to ground level and immediately painting cut stems with herbicide. However, it should be used only on small plants and retreatment is likely to be necessary.

Slashing will not kill blackberry

Although cutting blackberry plants off at ground level does not kill them, slashing can help open up dense stands for follow-up control by other methods. Regular (fortnightly or monthly) slashing or mowing forces the plant to regrow, using up root reserves and making it weaker. Slashing in summer can enhance the effect of blackberry leaf rust because regrowth stimulated by the slashing is very susceptible to the rust fungus.

Hand weeding

This is only effective in very small infestations. Even seedlings and small plants are difficult to pull out by hand. If possible, all of the root system should be removed using a mattock or shovel because blackberry will regrow from any root fragments left in the soil.

Dense infestations may require mechanical control

In dense infestations mechanised weeding with large earthmoving equipment may sometimes be necessary. Remove plants and surface soil with a bulldozer (‘scalping’) to ensure crowns and most of the roots are dug out. Afterwards, rake roots and leave them to dry out in the sun or collect them in piles for burning. Regrowth from crowns, root fragments and seed is inevitable, so follow-up treatment and site rehabilitation are essential.

Grazing with goats

Goats at high stocking rate can be used to control blackberry in pasture but their use must be continuous to prevent regrowth occurring.

Regrowth is inevitable after mechanical removal so follow-up treatment is necessary.
Photo: Ian Walton, DPI Vic

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.a	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

For up-to-date information on which herbicides are registered to control blackberry and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

Biological control with the blackberry leaf rust

The program with the greatest likelihood of success in the foreseeable future includes biological control, particularly on large, inaccessible infestations of blackberry. The blackberry leaf rust *Phragmidium violaceum*, which attacks the leaves, is now present throughout all areas of southern Australia where blackberries are a problem. It affects the leaves and can also grow on flowers, unripe fruit and young canes. The rust is harmless to native *Rubus* species and varieties of commercial raspberry and brambleberry such as loganberry, boysenberry and youngberry. The rust alone will not eradicate blackberry but it slows its rate of spread and allows more time for control by other means.

The rust appears as purple-brown blotches, 2–3 mm in diameter, on the upper surface of the leaf. Corresponding powdery yellow or sticky black pustules of spores appear on the leaf's lower surface.

Epidemics of rust caused by summer spores initially kill leaves in summer and autumn, forcing the plants to grow new leaves, which in turn are attacked by the rust. Rust epidemics result in fewer fruit and seeds, shorter canes and fewer new plants.

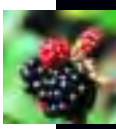
This continuous attack on the leaves weakens plants by depleting root reserves. Light can start penetrating the thicket, which helps revegetation by other plants, especially in autumn and winter. Competing plants can then grow through the blackberry and in turn limit its growth by shading.

The blackberry rust has been so effective in the Gippsland region of Victoria that farmers complained about having to re-do their fencing when blackberry hedges fell down! However, the rust seems to be severe only in regions where the annual rainfall is greater than 800 mm and the average daily maximum temperature for January is close to 20ºC.

Different blackberry species vary in their susceptibility to the rust, from very susceptible to highly tolerant. The effectiveness also varies between years, according to seasonal conditions. A sufficiently high level of infection is not always present early enough to prevent seed production and tip rooting of canes. Although the rust has had a big impact on the more common and widespread blackberry strains, some less widespread groups are resistant, giving them an advantage, and resulting in their gradual takeover and a continuation of the overall blackberry problem.

Slashing can help open up dense stands of blackberry for follow-up control by other methods. Photo: Adam Whitchurch, DPI Vic

Blackberry control strategies must address all the strains present in a region. Management actions which target only some of the species will result in one strain replacing another, with no net decrease in blackberry cover. For example, while the blackberry leaf rust is successfully controlling one species in the Strzelecki Ranges of Victoria, another rust resistant group is rapidly spreading to fill the niche.



To address this issue, additional rust strains are being tested in CSIRO's quarantine facility in Canberra before their expected release throughout Australia during 2003–04. Matching virulent rust strains to susceptible blackberry species is essential for successful biological control. Just as important are suitable weather and blackberry growing conditions for development of rust disease.

Although rust epidemics can look spectacular, blackberry is a very vigorous plant and can survive repeated attacks over a number of years before its root system begins to be depleted. It can take up to five years of rust infection for large well-established blackberry infestations to open up enough to allow other plants to grow through.

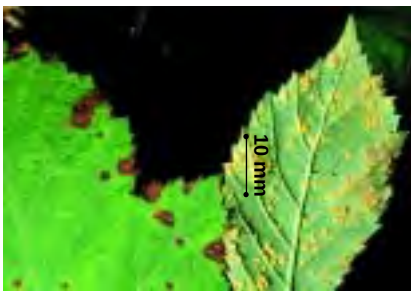
Integrated control

Blackberry should be inspected during summer–autumn and herbicide treatment planned for any infestations that are not attacked heavily by rust. Research has shown that spraying herbicides after the rust has killed some leaves gives equal or better control than application earlier in the season.

Where rust is having little impact, the use of herbicides is usually necessary since mature blackberry is able to regenerate readily from roots following burning or slashing.

Use of competitive native species

Maintaining good quality groundcover can help control blackberry seedlings. If rapid regeneration of fast-growing native species can be achieved, these can out-shade seedlings and outcompete them for water and nutrients. Blackberry roots do not develop much over winter so native seedlings able to germinate and actively grow during this period will have a definite competitive advantage.



The blackberry rust appears as purple-brown blotches on the upper leaf (*left*) and powdery yellow or sticky black pustules of spores on the lower surface (*right*).
Photo: John Hosking

Careful use of prescribed fire

This is used mainly as a follow-up to herbicide application to clear areas of dead canes and re-establish access for rehabilitation of the treated area.

Follow-up

Once an area has been treated it will be necessary to monitor it for many years and destroy new plants.

Legislation

Blackberry is declared noxious in all states and territories except the Northern Territory. Landowners are required to control it. Check with your local council or state/territory government agency about its requirements for blackberry control.

Acknowledgments

Information and guide revision: John Moore (Agriculture WA/Weeds CRC), Kathy Evans (DPIWE Tas/Weeds CRC), Sarah Keel (DPI Vic), Charlie Salonen (CALM WA) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.

...case study

Keeping Western Australia's Porongurup National Park blackberry free

In Western Australia's Porongurup National Park an integrated approach has been adopted to tackle blackberries, involving government departments, landholders and volunteer groups.

The aim of the program, which is targeting satellite infestations on the northeastern edge of the park, is to move the blackberry front 20 km away from the park. This involves controlling infestations both on farms (to stop them entering the park) and in the park (to stop them spreading to farmland).

Agriculture WA provides herbicide to landholders, who contribute the labour.

"While from an individual point of view, there may not be a great incentive to get rid of blackberries, the community is proud of the park, and neighbours will put pressure on each other to clear up infestations", says coordinator of the program, John Moore of Agriculture WA.

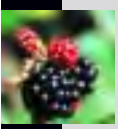
The program runs training days and equipment is available for loan. The landowners include hobby farmers with small holdings where infestations are too large to tackle using hand-held equipment.

The program includes a number of approaches, including the use of specific herbicides for large infestations, which are different from herbicides used in gardens, vineyards and other sensitive areas. Some people don't want to use herbicides at all so they may be using other techniques such as mowing, cultivation, burning or grazing with goats before seed sets.

Landholders can see the impact of blackberries and where they have been controlled in the park. For example, in some unsprayed areas tall karri (*Eucalyptus diversicolor*) trees rise through the blackberries, which dominate the undergrowth. In comparison, native grasses and understorey plants are growing in some sprayed areas where all blackberries and a small amount of native vegetation have been killed.

How to control blackberry

Quick reference guide



Prevention

Keep uninfested areas clear of blackberry and remove isolated plants before they have a chance to seed.

Herbicide control

Consult a specialist for advice on registered herbicides in your state or territory (see the contacts table on p. 4). Apply herbicide to actively growing plants – look at the tips of the canes and spray when they are producing fresh new leaves.

Physical control

Slashing can help open up dense stands for follow-up control by other methods, and in summer can enhance the effect of blackberry leaf rust.

Mechanical control is difficult and most of the root system must be removed for effective control – blackberry will regrow from any root fragments left in the soil. In dense infestations bulldozers may be used to remove plants but follow-up treatment is essential.

Biological control

Biological control offers the greatest likelihood for success in large, inaccessible infestations. The existence of at least 14 different groups or strains of blackberry in Australia makes biological control difficult as some groups are more susceptible to the blackberry leaf rust than others.

Rust fungi have established well in some high rainfall areas but have failed to have an impact elsewhere. Additional rust strains are being tested in quarantine and are expected to be released in 2003–04.

Blackberries are easily spread by birds, mammals and water.
Photo: Kate Blood

The blackberry rust is most effective during late summer and autumn in cool, moist environments such as Gippsland, Vic.
Photo: El Bruzzese, DPI Vic

Control options

Control option	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Herbicide application	✓	✓	✓	✓					✓	✓	✓	✓
Mechanical removal (incl. grazing)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Burning			✓	✓	✓	✓	✓	✓	✓	✓		
Biological control (release rust)	✓										✓	✓

✓ Optimum times for blackberry control methods

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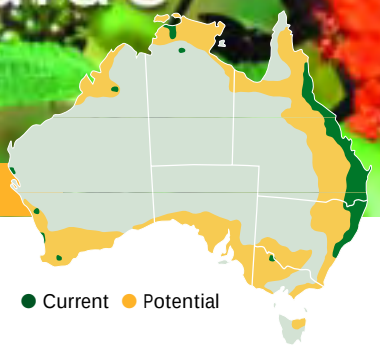
CRC Weed management

Weed Management Guide

Lantana – *Lantana camara*



Lantana (*Lantana camara*)

The problem

Lantana is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Lantana forms dense, impenetrable thickets that take over native bushland and pastures on the east coast of Australia. It competes for resources with, and reduces the productivity of, pastures and forestry plantations. It adds fuel to fires, and is toxic to stock.

Lantana is a serious threat to biodiversity in several World Heritage-listed areas including the Wet Tropics of northern Queensland, Fraser Island and the Greater Blue Mountains. Numerous plant and animal species of conservation significance are threatened. It is listed as the most significant environmental weed by the South-East Queensland Environmental Weeds Management Group.

It is a problem in gardens because it can cross-pollinate with weedy varieties to create new, more resilient forms.

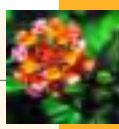
The weed

There are two main forms of lantana in Australia: a cultivated form planted in gardens and a weedy variety found in bushland and pastures. The cultivated form of lantana is non-thorny, produces few seeds and is compact in shape. The weedy form is a prolific seeder with straggly, thorny stems. Both forms include many varieties, which differ from each other in shape, flower colour, prickliness, response to enemies and toxicity.

Lantana is a significant weed of woodlands and pastures east of the Great Dividing Range.
Photo: Qld DNRM

Weedy lantana is a much branched, thicket-forming shrub, 2–4 m tall. The woody stems are square in cross-section and hairy when young but become cylindrical and up to 150 mm thick with age. The ovate (ie tear-shaped) leaves (20–100 mm long) occur in opposing pairs along the stem. The leaves are rough and finely hairy and emit a pungent odour when crushed. Each flower head is made up of 20–40 flowers, ranging in colour from white, cream or yellow to orange, pink, purple and red. The fruit has many berries, which ripen from green to shiny purple-black and contain a single pale seed. Lantana has a short taproot and a mat of many shallow side roots.

Key points



- Lantana is a thicket-forming shrub that has spread from gardens into pastures, woodlands and rainforests on the east coast.
- It typically invades disturbed land and river margins, extending its range in response to rainfall.
- It threatens agriculture and pastoral production, forestry and biodiversity of conservation areas, and may be toxic to stock.
- The highest priority for lantana control is preventing its spread into northern Australia and west of the Great Dividing Range.
- Integrated control should combine fire, mechanical, chemical and biological methods, and revegetation.

Natural Heritage Trust
Helping Communities Helping Australia
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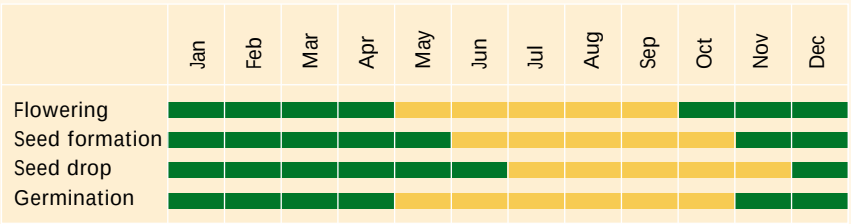
Growth calendar



Lantana flowers whenever the soil is moist and the air is warm and humid. For much of its range along the Queensland and New South Wales coasts, this results in almost continuous flowering and fruiting. Further inland, peak flowering occurs several weeks after soaking rain (25 mm or more) and is usually accompanied by good fruit set.

Germination most frequently occurs following the first summer storms, but may occur at any time of the year when sufficient moisture is present. Initial seedling growth is slow until the roots become established, after which close stems intertwine and begin to form thickets. Flowering does not usually commence until early in the following summer and then continues until March or April.

Lantana can resprout from the base if the shoot dies, extending the life of individual plants.

How it spreads

Lantana spreads in two ways. Layering is a form of vegetative reproduction where stems send roots into the soil, allowing it to quickly form very dense stands and spread short distances. Also, birds and other animals such as foxes consume and pass the seed in their droppings, potentially spreading it over quite large distances. The germination rate of fresh seed is generally low, but improves after being digested.

Butterflies, bees and other insects are attracted by the nectar and pollinate lantana flowers. About half of the flowers produce seeds, typically 1–20 seeds on each flower head. Mature plants can produce up to 12,000 seeds every year. Seeds are thought to remain viable for several years under natural conditions.

Lantana is allelopathic and can release chemicals into the surrounding soil which prevent germination and competition from some other plant species.

First recorded in the Adelaide Botanic Gardens in 1841, lantana spread to east coast gardens and was recorded as a weed in Brisbane and Sydney in the early 1860s. It is now found across four million hectares of land east of the Great Dividing Range, from Mount Dromedary in southern New South Wales to Cape Melville in northern Queensland. Isolated infestations exist in the Top End of the Northern Territory, around Perth in Western Australia, and on Lord Howe and Norfolk Islands. Although present Australia wide as a garden ornamental, it has not naturalised to any serious extent elsewhere.

When ripe, birds and animals consume fruit and spread seed.
Photo: Colin G. Wilson

Flowering lantana infestation in Darwin, NT, in December.
Photo: Colin G. Wilson

Where it grows

Lantana can grow in high-rainfall areas with tropical, subtropical and temperate climates. It does not tolerate salty or dry soils, waterlogging or low temperatures (<5ºC). It thrives on rich, organic soils but also grows on well-drained clay and basalt soils. Sandy soils tend to dry out too rapidly for lantana unless soil moisture is continually replenished. It has been reported at altitudes up to 1000 m in Queensland.

Lantana invades disturbed sites, especially open sunny areas, such as roadsides, cultivated pastures and fencelines. From there it can invade the edges of forests, but it does not fare as well under a heavy canopy as it is not very shade tolerant. Therefore, it is not a problem in intact tropical rainforest but can quickly spread there if the canopy opens out.

Lantana occurs naturally in Mexico, the Caribbean and tropical and subtropical Central and South America. It is considered a weed in nearly 50 countries.

Another weedy species of lantana

Another species of lantana is a popular ornamental that is considered a weed when present in natural ecosystems. Creeping lantana (*Lantana montevidensis*) occurs in coastal and subcoastal Queensland and as far south as Sydney. It is fairly similar to *Lantana camara* but does not have thorns, has mainly pink or purple flowers and trails along the ground, only growing to a height of half a metre. It is also toxic and readily displaces native vegetation.

Creeping lantana (*Lantana montevidensis*) is naturalised in coastal and subcoastal Qld and only grows to a height of half a metre. It is toxic and readily displaces native vegetation. Photo: John Swarbrick

Potential distribution

Lantana may be able to spread west of the Great Dividing Range, and could expand its range throughout southern Victoria, South Australia and southwestern Western Australia.

What to do about it

Lantana is extremely widespread and abundant. Because it is so well established on the east coast, and prevention of spread is the most cost-effective weed management tool, the highest priority for lantana management is to prevent its spread into uninfested areas. This will require three main actions.

1. Restricting further importation of lantana into Australia. Any new varieties brought in could escape cultivation and naturalise, or could cross-breed with naturalised varieties, leading to hardier new varieties more resistant to control.
2. Restricting the sale and use of lantana in gardens as these are potential sources of new infestation and new varieties. There are native and less weedy exotic ornamental alternative species.
3. Strategically controlling infestations that threaten areas where lantana is not yet a weed. Control methods are outlined below.

Integrated management

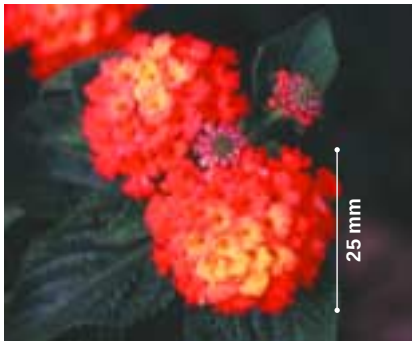
An integrated approach that uses a variety of control methods gives best results when dealing with lantana. A range of methods including herbicides, mechanical removal, fire, biological control and revegetation should be used. Best results are obtained by working from areas of light infestation towards heavier infestation, and long-term follow-up control is required after initial attempts. Minimise both disturbance to land and excessive use of fire to retain vigorous native vegetation and reduce the opportunity for lantana to become established.

Herbicide control – effective but expensive

There are many herbicides registered for lantana control and three main application techniques. Spraying the entire plant (foliar spraying) usually kills plants that are less than 2 m high. Herbicides applied to the lower bark of the stems (the basal bark technique) or immediately painted onto a freshly cut stump (the cut-stump technique) are useful for larger plants. Both of these techniques are time consuming because they require treatment of each stem, which can be difficult to access in large stands of lantana. High costs make herbicide control uneconomical for large infestations, except when there are no other options (eg on steep slopes, where helicopter spraying may be required).

For best results, integrate fire, mechanical, chemical and biological control and revegetation

Herbicides, especially those that are foliar applied, are most effective when plants are actively growing. With lantana, best results are obtained six weeks after good rains (at least 35 mm) when minimum temperatures exceed 15ºC. In Queensland the spraying season generally lasts from early summer to autumn, but earlier control will potentially allow follow-up in the same growing season.



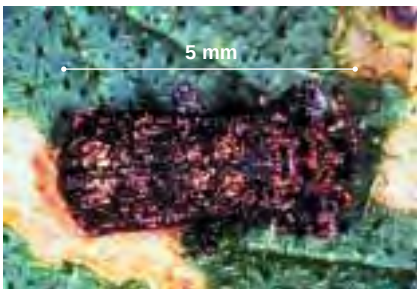
Lantana flowers can be one colour (*left*), or a mix of two (*centre*) or more colours (*right*). Photos: Colin G. Wilson

Weed control contacts

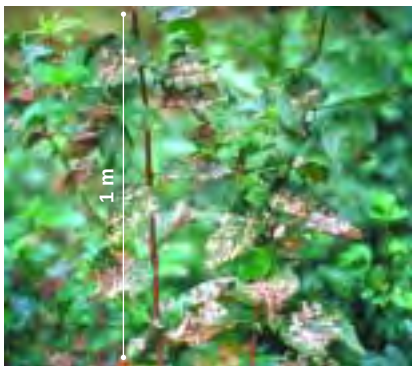
State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Infrastructure, Planning and Environment	(08) 8999 5511	weedinfo.ipe@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

Note that herbicides vary in their effectiveness on different lantana varieties. The red flowered varieties are normally the least susceptible to herbicides while the pink forms are the easiest controlled. Consult your local council or state/territory weed management agency about which herbicides and applications are most suitable for your infestation of lantana. State and territory contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.



Both adults (*above*) and larvae of the leaf-mining beetle *Octotoma scabripennis* feed on lantana leaves. It is present in most lantana infestations, particularly where it is shady and wet in subtropical, coastal areas.
Photo: Michael Day, Qld DNRM



Damage to lantana leaves caused by the leaf-mining beetle *Octotoma scabripennis*.
Photo: Michael Day, Qld DNRM

Mechanical and physical control – suitable for small infestations

Lantana can be removed mechanically or physically in several ways, including stickraking, bulldozing, ploughing and grubbing. These techniques are mainly suited to medium-sized infestations and require extensive follow-up, as they invariably lead to regrowth if the rootstock is not removed, or seedling germination when heavy machinery disturbs the soil. Any soil disturbance should be avoided on steep inclines or in gullies. A permit may be required if native plants are to be affected by mechanical control – check with your local council or state/territory weed management agency.

Fire – inexpensive but caution must be exercised

Fire is often used prior to mechanical or herbicide control to improve their effectiveness, or as a follow-up to such methods. It can also provide some control when used on its own under the right conditions. It is most effective when fires are hot and the lantana is actively growing. In southeastern Queensland best results from fire are achieved during early summer. In New South Wales controlled burns are used opportunistically, mainly in late winter and spring before conditions become too dry and fires could escape control.

Fire is relatively inexpensive and well suited to dense infestations, but the risks to people and property must be carefully managed. Burning is not recommended in rainforest and vine thickets because they are highly sensitive to fire. Disturbance in these habitats may actually promote lantana if the canopy is opened up. A permit may be required to burn – check with your local council or state/territory weed management agency.

Biological control

In 1902 the first attempt at biological control of a weed targeted lantana in Hawaii. In Australia biological control agents were first introduced in 1914; so far, 30 species have been introduced. Research into biological control is ongoing, and several agents are currently being examined for suitability of release.

Of the 16 species that have established, four insects have had a major impact on lantana. They are:

- a sap-sucking bug (*Teleonemia scrupulosa*) (Sydney to northern Queensland).
- a leaf-mining beetle (*Uroplata girardi*) (northern Queensland to Sydney).
- a leaf-mining beetle (*Octotoma scabripennis*) (Sydney to south of Rockhampton).
- a seed-feeding fly (*Ophiomyia lantanae*) (southern New South Wales to northern Queensland).

The biological control agents vary in their effectiveness against the many different types of lantana. For example, lantana can drop its leaves when stressed, depriving some agents of their food.

Revegetation – useful in pastures and forests

Revegetation of a treated site is a key component of a lantana management program. Revegetation helps to reduce erosion, adds fuel for future burning in pastures and is vital in limiting the re-establishment of lantana and other weeds. Sowing an improved pasture that outcompetes and smothers lantana seedlings is assisted by withholding grazing for the first six months, and only allowing light grazing for the next 12–18 months. In forested areas either planting trees or encouraging naturally occurring seedlings will help to shade out lantana in the longer term. Check with your local council or state/territory weed management agency about appropriate species for revegetating pastures or forests in your area.

Follow-up

Follow-up control after an initial effort may include any or all of the above methods. Established pastures can be burnt to control significant lantana regrowth, and any small patches can be spot sprayed with a registered herbicide or grubbed out. In forested areas herbicides are recommended to control regrowth, typically requiring three follow-up sprays after the initial control effort.

Legislation

Landholders are required to reduce lantana infestations throughout some regions of Queensland, New South Wales and the Northern Territory. The sale of lantana in Queensland was banned in late 2003. Lantana importation is prohibited in Western Australia. Check with your local council or state/territory weed management agency for relevant details.

Acknowledgments

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Maps: Australian Weeds Committee.

...case study

Lantana control at Towra Point, Botany Bay, New South Wales

Towra Point Nature Reserve in Botany Bay contains habitats of high conservation status, including wetlands of international importance and open woodlands that are unique in the Sydney region. A coastal rainforest in the region was recently listed as an endangered ecological community under the New South Wales *Threatened Species Conservation Act 1995*. It includes the magenta brush cherry (*Syzygium paniculatum*), a vulnerable tree species.

By the 1990s, lantana made up almost 75% of the vegetation cover in some parts of the reserve and was limiting the regeneration of native species, particularly around a freshwater wetland called Weedy Pond. The Friends of Towra, a volunteer group, commenced weed control in the Weedy Pond rainforest in 1996. In 1998 the Sutherland Shire Environment Centre, working in conjunction with the National Parks and Wildlife Service, gained Coastcare funding to supplement the volunteer program.

Beginning in March 1998, weed control focused on a corridor connecting the rainforest and a casuarina/banksia forest, following up on previous control and initiating new efforts. Lantana was controlled by a combination of cut-stump herbicide application and manual removal of smaller plants. Other weeds were also controlled when they were encountered.

Work was undertaken about every two months throughout 1998 by volunteers and members of local community groups. Follow-up hand weeding and spot spraying, and further control of primary lantana infestations, were also undertaken throughout 1999. This work involved international backpackers, unemployed people from Green Corps 2000, students and personnel from private enterprise, all of whom volunteered their time. The total area cleared of lantana and other weeds was approximately 75 m wide and 100 m long.

In May 2000 the cleared areas were planted with native vegetation by local Cub Scouts and Venturers and members of the Friends of Towra. Approximately 200 banksias were planted. The training of volunteers and community groups on such issues as weed control techniques, bush regeneration and plant identification was another significant outcome.

At each quarterly follow-up visit to the site, approximately 24 man-hours are required to keep on top of any reshooting and newly germinated lantana, and encourage regeneration of native species. It is expected that lantana will become disadvantaged as canopy cover and shade increases, and less work will be required in the future.

How to control lantana

Quick reference guide

Lantana – *Lantana camara*

Minimise spread and future impacts

Although lantana is widespread on the east coast of Australia, it is still absent from parts of its potential range. These areas should be protected by:

- preventing the importation of further varieties and species of lantana
- stopping more planting of lantana in gardens
- strategically controlling infestations which threaten uninfested areas.

A control program for dense infestations in pastures

The Queensland Department of Natural Resources and Mines has produced a pest series fact sheet on lantana (PP#34). They advise that herbicides are too expensive to treat large lantana infestations.

A combination of fire and mechanical control makes spot treatment of small patches with herbicides more cost-effective. The following suggested control program for dense infestations in pastures is based on the fact sheet:

1. Exclude stock to allow a fuel load to build up.
2. Bulldoze, stickrake or plough the infestation to add to the fuel load.
3. Burn the infestation after obtaining a permit. Summer burns are more effective than winter burns.
4. Sow an improved pasture. Seek advice of local council or state/territory government agencies for selection of non-weedy pasture species.
5. Continue stock exclusion until pasture has established and set seed.
6. Burn the infestation again after obtaining a permit.
7. Spot spray or grub out any regrowth or seedlings. Spraying is most effective between summer and autumn.
8. Follow-up burning, spraying and/or grubbing will be required for several years.

Lantana can escape from garden plantings into surrounding bushland.
Photo: Tim Schultz

Control options

Type of infestation	Physical	Mechanical	Chemical	Fire	Biological
Small (few plants, small area)	Hand grubbing only suitable for seedlings. Wear gloves for protection from thorns.	Not suitable.	Spot spray plants less than 2 m in height between summer and autumn with a registered herbicide.	Not suitable.	There are four useful biological control agents. They are already distributed throughout their potential range.
Medium (medium density, medium total area)		Bulldoze, plough, stick-rake or slash infestations. Soil disturbance will lead to mass seed germination, so follow up with further controls. Do not use mechanical control in areas susceptible to erosion. A permit may be required.	Spraying is uneconomical for medium or large infestations. Helicopter spraying is used when there is no access for mechanical control, eg very steep slopes.	Under permit, burn in summer with good fuel load of grass and/or mechanically cleared lantana. Also use as follow-up. Do not burn in rainforests.	
Large (many plants, many ha)					

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