HUNTER QUARRIES

Karuah Hard Rock Quarry

Flora and Fauna Management Plan

September 2020

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
10 Kings Road
New Lambton NSW 2305 Australia
(PO Box 447 New Lambton NSW 2305)
T: +61 2 4037 3200
E: newcastleau@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Hunter Quarries (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Aspect	Date	Prepared	Authorised
HQP00-003	Draft	June 2006	Nicole Reilly	Lachlan Crawford
HQP00-003	Final Report	August 2006	Chrissie Eckersley	Nicole Reilly
HQP00-003	Final Report	August 2008	Dean Jarvis	Stephen Bragg
HQP00-003	Revisions	January 2011	Chris Jones	Andrew Hutton
630.HQO00-003	Update	June 2014	Bonnie Redman	Andrew Hutton
630.HQO00-003-R01-v1.0	Update	September 2020	Megan Crowhurst and Sam McDonald	Mathew Radnidge

ABBREVIATIONS

AEMR	Annual Environmental Management Report
BCD	Biodiversity Conservation Division of DPIE (formerly OEH)
CCC	Community Consultative Committee
DA	Development Application
DPIE	Department of Planning Industry and Environment
DPIE – HD	Department of Planning Industry and Environment – Heritage Division (formerly NSW NPWS)
EMP	Environmental Monitoring Program
HQPL	Hunter Quarries Pty Ltd
km	Kilometre
MCC	MidCoast Council
POEO Act	*Protection of the Environment Operations Act 1997*

CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

1 Introduction

The MidCoast Council (MCC) granted conditional Development Consent for a hard rock quarry and crushing plant at Karuah on 3 December 1997. Hunter Quarries Pty Limited (HQPL) purchased the site from Mountain Industries in 2002 and has since operated a hard rock quarry at the site, known as Karuah Hard Rock Quarry (the Quarry). The material extracted at the Quarry is andesite, which is a hard, blue rock used for various purposes such as road base material, construction aggregate, aggregate used for concrete batching, drainage works, fill, landscaping and other uses.

The site is contained wholly within the MCC Area and is located approximately 40km north of Newcastle and 4km north of the Karuah town centre (see **Figure 1**).

Development Consent was granted by the Minister for Infrastructure, Planning and Natural Resources on the 3 June 2005 (ref. DA 265-10-2004), with the approved development including:

- Implementing the remainder of the approved Stage 1 quarry operation;
- Extending the quarry operations into the Stage 2 area;
- Upgrading and using existing infrastructure on site;
- Rehabilitating the site by re-contouring and revegetating exposed surfaces; and
- Producing up to 500,000 tonnes of product a year over the next 22 years.

The site has Development Consent (DA 265-10-2004) approval to operate until 3 June 2027. It should be noted that the current lease agreement between HQPL and the owner of Lot 11 expires on 6 May 2024. It is proposed that the Quarry will enter a closure phase for Lot 11 in early 2021. Rehabilitation at Lot 11 will commence in early 2021 and will be completed by 6 May 2021. This will allow three years of rehabilitation monitoring prior to the Lot 11 lease agreement ceasing on 6 May 2024. Lot 21 will continue to be operational until the end of the Development Consent (DA 265-10-2004) (3 June 2027). A rehabilitation program for Lot 21 will be implemented after this date. For more information regarding rehabilitation schedules refer to the Rehabilitation and Closure Plan and subsequent Annual Environmental Management Review (AEMRs).

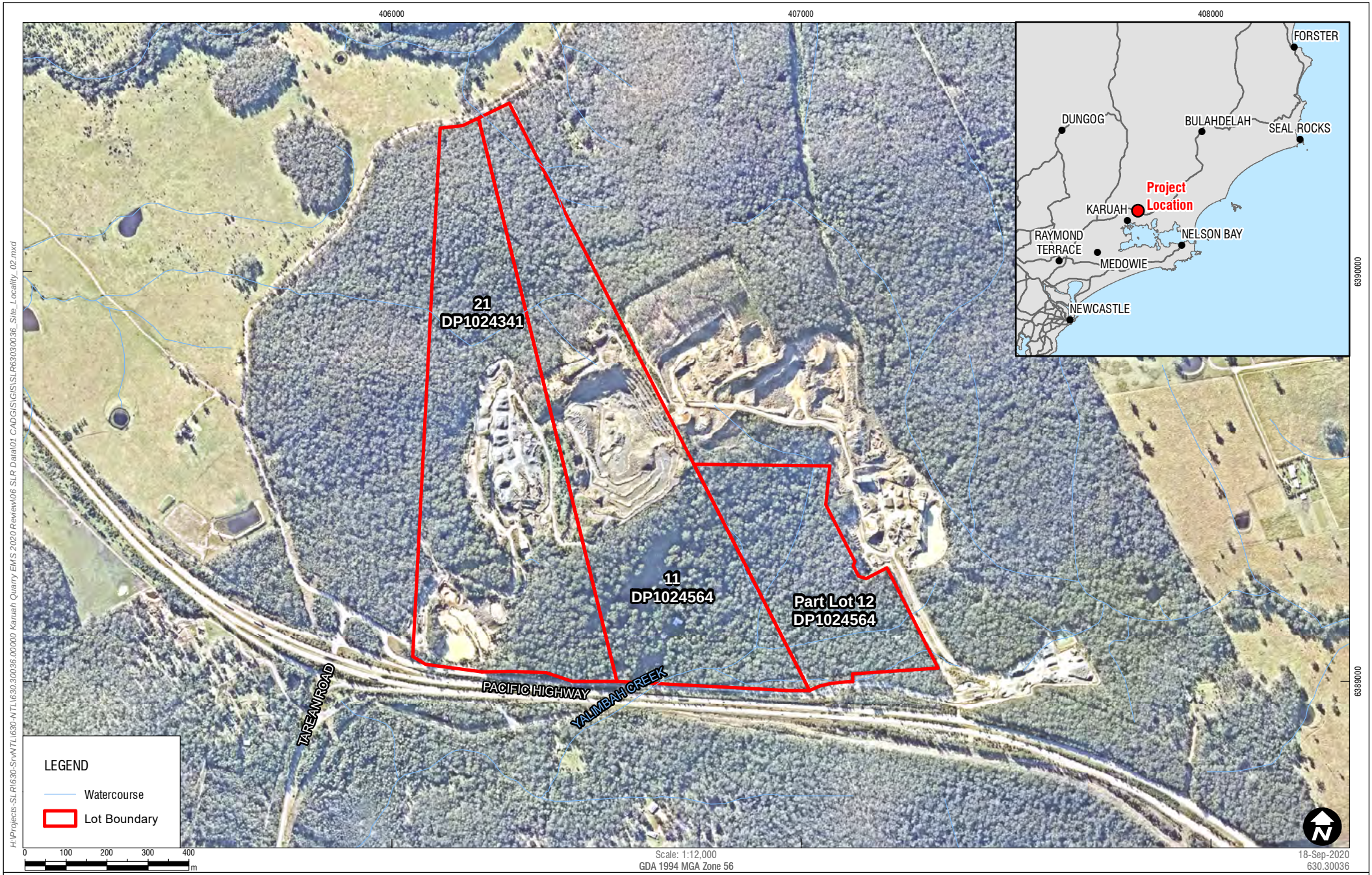
HWR Ecological Pty Ltd (HWR) was engaged by HQPL in 2005 to prepare a *Flora and Fauna Management Plan* (Schedule 3 Condition 19 DA 265-10-2004) which is required to address Schedule 3, condition 20 (Vegetation Clearing Protocol), Condition 21 (Remnant Vegetation Conservation Plan) and condition 22 (*Conservation offset Management Plan*) of the Development Consent (DA 265-10-2004).

RPS HSO prepared an addendum to the *Flora and Fauna Management Plan* in 2008 and included changes to several sections of the original document. GSS Environmental completed a minor review of all HQPL Environmental Management Plans in 2011 and has consolidated the *Flora and Fauna Management Plan*. SLR Consulting (SLR) undertook a review of key HQPL Environmental Management Plans in 2014, including this management plan.

SLR completed a review of this document in 2020, with the following changes completed:

- Minor structure and content changes throughout;
- Update of monitoring completed 2011-2019;
- Monitoring for 2020 added; and
- A more comprehensive outline of the responsibilities of personnel in regard to implementing this plan.

Figure 1 shows the location of the subject land, which includes Lot 21 DP 1024341, Lot 11 DP 1024564 and part of Lot 12 DP 1024564.



Scale: 1:12,000
GDA 1994 MGA Zone 56

18-Sep-2020
630.30036

Source: Nearmap (June 2020)

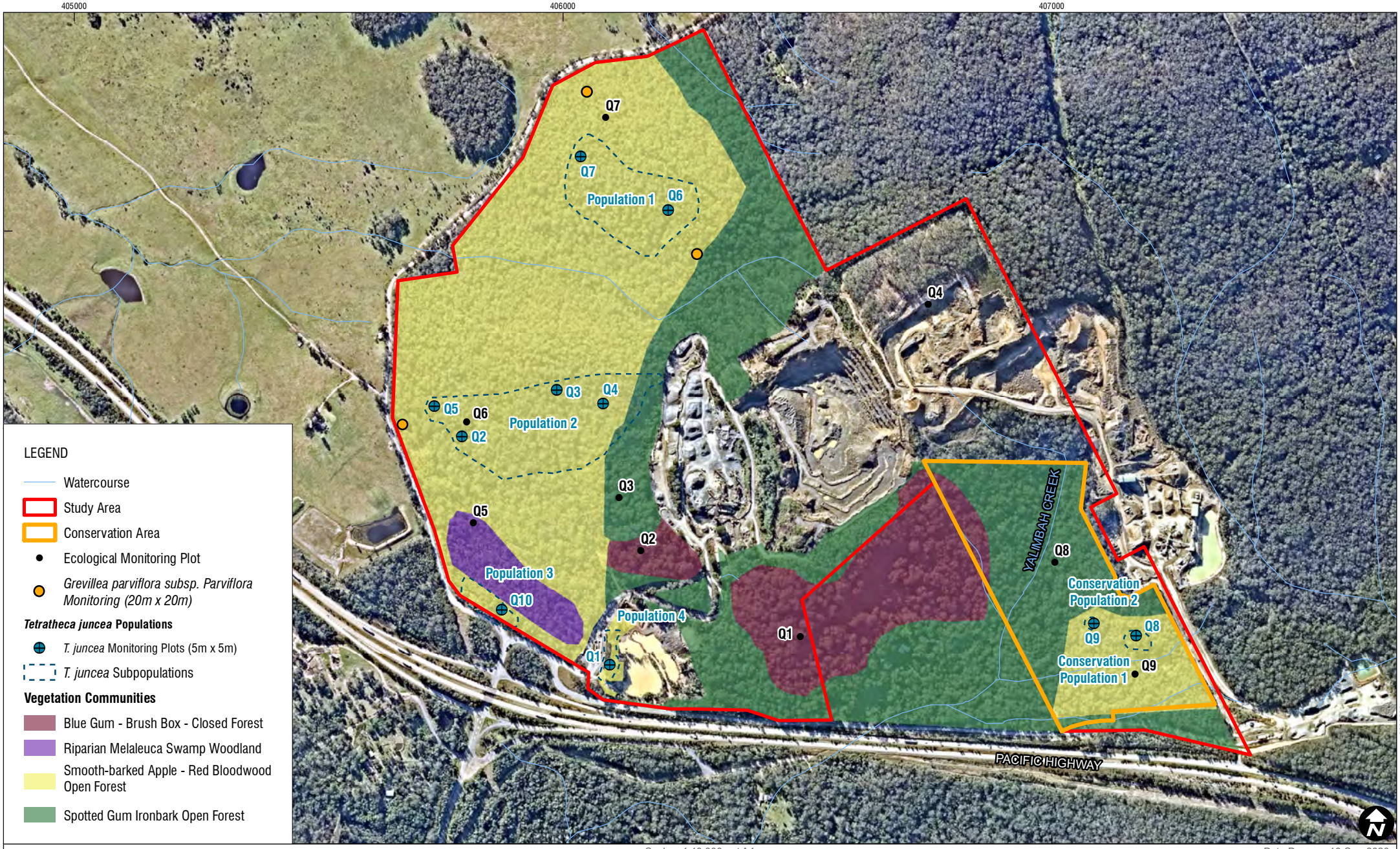
Sheet Size : A4

SLR
www.slrconsulting.com

Karuah Hard Rock Quarry
Site Locality

FIGURE 1

Figure 2 (prepared by RPS and updated by SLR) outlines the location of ecological monitoring points, vegetation communities and the location of *Tetratheca juncea.*



Scale: 1:10,000 at A4
Coordinate System: GDA 1994 MGA Zone 56

Date Drawn: 18-Sep-2020
630.30036

Sheet Size : A4

SLR

Data Source: Nearmap (June 2020)

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

Karuah Hard Rock Quarry
Location of Tetratheca juncea Populations and Monitoring Plots

FIGURE 2

H:\Projects-SLR\630-SrvNTL\630-NTL\630.30036.00000 Karuah Quarry EMS 2020 Review\06 SLR Data\01 CADGIS\GIS\SLR63030036_FFMP_Flora_03.mxd

Figure 3 illustrates the fauna survey point locations.

Source: Nearmap (June 2020)

Sheet Size : A4

SLR
www.slrconsulting.com

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

Karuah Hard Rock Quarry
Fauna Survey Points

FIGURE 3

2 Vegetation Clearing Protocol

2.1 Condition 20 DA 265/10/2004

Schedule 3, Condition 20 of DA 265-10-2004 states that the Vegetation Clearing Protocol must describe procedures implemented in regard to various aspects of vegetation clearing. **Table 1** outlines this condition and states the sections of this plan where each aspect is addressed.

Table 1 Vegetation Clearing Protocol

Conditions	Section
The Vegetation Clearing Protocol shall describe the procedures that would be implemented for: a. minimising the areas of remnant vegetation to be cleared;	2.2
b. delineating areas of remnant vegetation to be cleared;	2.2
c. protecting areas outside of the disturbance areas;	2.2
d. undertaking pre-clearance surveys (including observations/surveys for threatened species);	2.4
e. identification of fauna management strategies;	2.4
f. conserving and reusing topsoil;	2.3
g. collecting seed from the site for rehabilitation works;	2.6
h. salvaging and reusing material from the site for habitat enhancement; and	2.4.4
i. controlling weeds.	2.7

2.2 Aims and Objectives

The Quarry layout is outlined in **Figure 1**.

The vegetation clearing protocol aims to:

- Ensure that disturbance to vegetation is minimised;
- Provide procedures for the relocation of unharmed fauna to adjacent habitats;
- Provide procedures for the handling of injured fauna and transportation to a specialist vet for examination and relocation;
- Provide a protocol for collection of seed, topsoil and fauna habitat attributes (hollow logs etc.) for rehabilitation and habitat enhancement; and
- Provide a protocol for controlling the spread of weeds.

It should be noted that the disturbance footprint has been finalised at Karuah Hard Rock Quarry with no additional clearing planned at the site.

To ensure that the aims of the vegetation clearing protocol are achieved, the following tasks are required:

- All areas of vegetation to be retained will be clearly delineated using temporary barrier fencing;
- No clearance is to be completed outside of delineated areas;

- The felling of trees will be supervised to ensure that fauna can be captured and relocated or transported to a vet if injured;
- Seed will be collected from flora within the proposal area and will be used for propagation of plant stock for rehabilitation;
- Fauna habitat attributes such as hollow logs will be saved for future rehabilitation; and
- Weed infestations within the development site will be managed using appropriate techniques prior to earthworks to ensure that weed propagules are not spread.

2.3 Topsoil Management

Topsoil management will be completed in accordance with the following:

- Prior to clearing, topsoil and subsoil materials will be characterised to assess potential constraints/opportunities for use in rehabilitation;
- Where practical, measures will be adopted to maintain the viability of any biological resources within the topsoil that may be suitable for use in rehabilitation (e.g. soil seed bank);
- Preference will be given to placing topsoil directly on re-contoured areas. Where possible, topsoil will be stripped when moist to help maintain soil structure and to reduce dust generation;
- Topsoil stockpiles are to be located away from extraction, traffic areas and watercourses;
- Appropriate sediment controls will be installed to prevent soil loss;
- Stockpiles to be kept longer than six months will be sown with a suitable cover crop to minimise soil erosion and invasion of weed species;
- Prior to re-spreading, weed growth will be scalped from the top of the stockpiles, if required, to minimise the transport of weeds into rehabilitated areas; and
- Any stockpiles have evidence of any weed growth will be treated prior to the use in rehabilitation.

2.4 Pre-Clearance Surveys

There is no additional clearance planned, hence there are no requirements for pre-clearance surveys. The below section outlines methods when clearing was completed.

Surveys are conducted within the proposal area prior to clearing for hollow dependant fauna to determine which hollow trees are used by fauna so the most appropriate removal method can be implemented for these trees. This involves the following surveys detailed in **Section 2.4.1** – **2.4.4**.

2.4.1 General Searches

Important habitat elements are surveyed within the development site prior to clearing. All hollow bearing trees are flagged or marked with spray paint and contractors are notified of the importance of these trees. Fauna habitats to be relocated such as large fallen timber will be marked and/or relocated into retained areas of bushland or future rehabilitation areas. Other important habitat will also be marked such as bird nests and the most appropriate management methods will be implemented.

2.4.2 Spotlighting – Stag Watching

Hollow bearing trees suitable for *Phascogale tapoatafa* (Brush-tailed Phascogale) or *Ninox strenua* (Powerful Owl) will be observed at dusk for the presence of fauna. Hollow trees known to be used by particular species such as Brush-tailed Phascogale will be removed in such a way to minimise harm to fauna.

2.4.3 Koala Faecal Pallet Counts

Prior to tree removal, trees are to be inspected by a qualified fauna ecologist to ensure *Phascolarctos cinereus* (Koalas) are not occupying trees. In the event a Koala is identified, the ecologist will instruct workers as to whether or not works will commence and the prescribed actions to be undertaken to ensure the Koala safety.

2.4.4 Fauna Habitat Augmentation Methods

Terrestrial habitat can be degraded by many anthropogenic impacts. Some impacts are direct and easily detected such as clearing and log removal (threatening process under the TSC Act), while other impacts such as past disturbance regimes including grazing and slashing leading to loss of biodiversity and decreased structural complexity are less obvious to the untrained eye but have equally harmful effects. The augmentation of fauna habitat will involve the removal of decaying logs, rocks and hollow branches for placement on the ground and tree hollows where possible will be re-erected or used as habitat in future rehabilitation areas.

The implementation of the fauna habitat augmentation will involve collection of all decaying/hollow fallen logs on the ground with a diameter greater than 15cm and all rock boulders greater than 30cm diameter within the proposal area before construction is initialised.

Logs from remnant vegetation will be stored at site, with these to be used in final rehabilitation at the site.

2.5 Clearing Methods

All staff involved in clearing activities will be inducted about the ecological issues present and the methods that will be employed for the removal of hollow bearing trees. Fauna likely to be present within hollow bearing trees to be removed comprise Brush-tailed Phascogale, Sugar Glider, Possums and Antechinus. Although no further clearing is planned for the site, the procedure for clearing of vegetation is as follows:

1. Suitable hollow logs and boulders found within the proposal area are to be kept on site for use in rehabilitation;
2. Weed infestations within the proposal area removed (see **Section 2.7**);
3. All hollow bearing trees within the proposal area will be marked by an ecologist using fluorescent flagging tape and/or spray paint;
4. All understorey vegetation to be removed. Any suitable logs found within proposal area after underscrubbing are to be kept on site for use in rehabilitation;
5. All trees that do not contain hollows removed;
6. The removal of hollow bearing trees will require the ecologist to work closely with the machinery operator who should be well experienced with tree removal. Trees will be gently pushed a few times to allow any fauna present to escape if willing, then the tree will be gently felled. It is possible for machinery to have some control over the falling tree provided the trunk does not split.
7. Once the tree has been felled and machinery disengaged the ecologist is to inspect hollows for fauna and/or capture any fleeing fauna and relocate to adjacent areas of remnant bushland. If possible, all

hollow bearing trees should be removed in a single day to ensure relocated fauna do not take up residency in remaining trees.

8. Hollow bearing trees should be stockpiled separately so hollow limbs etc can be removed and relocated to surrounding vegetation.
9. All fauna captured and relocated will be recorded along with their sex, breeding status, hollow type occupied and point of relocation.

2.6 Seed Collection

The Florabank Seed Collection Guidelines (Mortlock W, 1998) comprises a detailed range of methods for different species which will be followed for the collection of seeds throughout the proposal area. Where possible, seed will be collected from vegetation being removed including ground covers, shrubs and canopy species. Collection of seeds for each species will generally occur in the months following flowering. The development of fruits on a flora species is relatively unpredictable and can be influenced by many factors, therefore any seed collection program needs to focus on monitoring the development of fruit/seeds in the area of interest to ensure the seed collected is relatively viable.

2.7 Weed & Pest Control

The proposed disturbance area will have all weeds and/or weed seeds and propagules removed prior to clearing to ensure that these are not spread into adjacent areas of remnant vegetation.

Weed and pest management will be undertaken within the development site to minimise habitat degradation, encourage growth of native species, and protect native fauna within retained vegetation and the Conservation Offset Area through the following process:

- Inspections of the development site and adjoining vegetation will be undertaken periodically to identify weeds and evidence of pest species, focusing on retained vegetation and the Conservation Offset Area;
- The locations and specific methods for weed and pest management will be directed by monitoring inspections (i.e. recommendations from monitoring reports);
- Weed control will generally be undertaken using a combination of manual removal and targeted chemical application using an appropriate herbicide. Chemical methods will only be used for larger weed outbreaks and/or where there is negligible risk for indirect impacts on native vegetation. The weeds which will be targeted based on monitoring results collected between 2008-2011 (RPS, 2011) are as follows:
    - *Lantana camara* (Lantana), *Bidens Pilosa* (Cobbler's Pegs), *Gomphocarpus fruiticosus* (Narrow Leaf Cotton Bush), *Cirsium vulgare(* Spear Thistle), *Conyza sumatrensis* (Fleabane), *Hypochaeris radicata* (Flatweed), *Senecio madagascariensis* (Fireweed), *Stellaria media* (Common Chickweed), *Plantago lanceolate* (Ribwort), *Andropogon Virginicus* (Whisky Grass), *Paspalum dilatatum* (Paspalum), *Paspalum urvillei* (Vasey Grass), *Setaria gracilis* (Slender Pigeon Grass), *Solanum mauritianum* (Wild Tobacco), *Verbena bonariensis* (Purpletop).
- Any vertebrate pest control will be conducted in accordance with *Humane Pest Animal Control: Codes of Practice* (DPI 2014);
- If pest control is required it would generally involve a routine (six monthly) baiting program. Other control methods such as shooting or trapping can also be used if deemed necessary or appropriate. Advice may be requested from the Biodiversity Conservation Division (BCD) (formerly OEH), within the Department of Planning Industry and Environment (DPIE), or the Local Land Services;

- Weeds will be monitored within areas of remnant vegetation within the development site. Weed management programs will focus on disturbed areas, the Conservation Offset Area and areas adjacent to the development site (remnant vegetation areas); and
- All weed and pest control works will be undertaken by suitably trained personnel.

HQPL strives to work with local community groups (such as the Bulahdelah District Pest Animal Control) in an effort to combat the spread of pest species and the damaging impact they have on native flora and fauna.

3 Remnant Vegetation Conservation Plan

3.1 Condition 21 DA 265/10/2004

Schedule 3, condition 21 of DA 265/10/2004 states that the Remnant Vegetation Conservation Plan must describe remnant vegetation conservation measures and monitoring of these measures. **Table 2** outlines this condition and states the sections of this plan where each aspect is addressed.

Table 2 Remnant Vegetation Conservation Plan Requirement

Condition	Section
The Remnant Vegetation Conservation Plan shall: a) describe what measures would be implemented to conserve, maintain and enhance the vegetation on the site which will not be cleared as part of the development (in particular sub-populations of *Tetratheca juncea*); and	3.2
b) describe how the performance of these measures would be monitored over time.	3.4

3.2 Aims and Objective

The aim of the Remnant Vegetation Conservation Plan is to conserve, maintain and enhance the remnant vegetation remaining (not including the offset) (see **Figure 2**). Particular focus will be given to populations of *Tetratheca juncea* surrounding the development site. This will be achieved through the implementation of the following:

- Establish baseline numbers for all subpopulations of *Tetratheca juncea*;
- Collect quantitative information for all areas of remnant vegetation;
- Establish a monitoring program to record and predict any changes to remnant vegetation;
- Implement adaptive management strategies for remnant vegetation if the condition is shown to be in decline;
- Training of staff (toolbox talks);
- Progressive rehabilitation where possible; and
- Extraction footprint limit.

3.3 Baseline Data Collection

The collection of baseline data provides the basis on which to assess any changes to the vegetation over time. Baseline data has been collected on *Tetratheca juncea* which includes population size, vegetative floristic and structure and the location of the *Tetratheca juncea* subpopulations. Baseline data for the floristic and structure of each vegetation community within areas surrounding the Quarry has been collected. These vegetation communities will be subject to ongoing monitoring. *Grevillea parviflora subsp. Parviflora* monitoring will occur during 2020 to provide a baseline data set for future monitoring.

3.3.1 *Tetratheca juncea*

The *Tetratheca juncea* subpopulations, detailed in the original Environmental Impact Statement for the Karuah Quarry (2003), have been substantially impacted from bushfire, although some plant clumps were recorded during the 2011 ecological monitoring (RPS, 2011). The current extent and size of these populations will be detailed in monitoring activities.

Surveys of *Tetratheca juncea* is relatively difficult due to the counting of the species being subjective due to the clumping nature of the plant and therefore the methods must be standardised and a protocol developed that will remove subjective decisions when counting plants. A standardised distance measure between plant stems may be useful for determining population sizes.

A map of the known subpopulations and individuals of *Tetratheca juncea* on and adjacent to the development site and areas of likely occurrence is shown in **Figure 2**. Systematic searches throughout areas of suitable habitat have been conducted. All subpopulations/clumps have had baseline data recorded using the protocol developed for the surveys (RPS, 2008).

Permanent quadrats (5x5m) have been established within the identified *Tetratheca juncea* subpopulations. Currently, 4 main patches of *Tetratheca juncea* have been identified at the site, with two additional populations identified in the Conservation Offset Area (see **Figure 2)**. Of these, sub-population 4 is on an island surrounded by disturbance areas within the development site, sub-populations 1 and 2 are partially within the development site and partly on adjoining Lot 201 DP 1042537 (which is outside the development site) while sub-population 3 is outside the development site (located on Lot 201 DP 1042537).

Suitable methodology for monitoring these sub-populations included the establishment (at random using a nested hierarchical table) of permanent quadrats within these 4 subpopulations, providing access to all populations can be obtained. This method identifies suitable areas of *Tetratheca juncea* habitat, searches for subpopulations within these habitat areas and randomly located quadrats within subpopulations once they are defined. Information to be collected from the quadrats is precise data on the change in *Tetratheca juncea* numbers using the standardised survey protocol. Additional to the plant number data collected within these quadrats, information which was collected in baseline surveys (RPS, 2008) included:

- Exact locations of plants;
- A description of the surrounding vegetation;
- The foliage cover of clumps;
- Approximate shape and number of stems coming from clumps;
- Above ground biomass;
- Number of flowers, fruits and buds;
- Photos of clumps; and
- Any other relevant information.

Each new clump must be given an identification key and mapped.

3.3.2 Ecological Communities

Baseline data for each ecological community have been established. The vegetation communities of the subject site are displayed in **Figure 2**. The methods for monitoring these vegetation communities will comprise the use of permanent quadrats within each community surrounding the Quarry. The permanent quadrats will be 400m^2 (20x20m) established for collection of baseline data and then sampled/monitored as per **Section 3.4** with the exception of monitoring at Q4, given that it is now located within the quarry pit of the separate Karuah East Hard Rock Quarry (PA 09_0175).

3.4 Monitoring

Two yearly flora and fauna monitoring in Remnant Vegetation and the Conservation Offset, as required under Schedule 3 Condition 23, (implementation and performance of the Flora & Fauna Management Plan and *Conservation Offset Strategy*), of the Development Consent (DA 265/10/2004) will occur in 2020 and every two years thereafter until the Development Consent is relinquished or the requirement to monitor is removed.

Location of plots, surveys and transects are predefined in the baseline ecological monitoring report (RPS Harper Somers O'Sullivan, 2008). The 2020 management plan update includes some minor amendments to monitoring techniques and surveys to reflect current monitoring methodology. Details of the surveys, in accordance with the Flora and Fauna Management Plan (2005) and addendum (2008) are described in **Section 3.4.1** - **3.4.4**. These sections provide the methodology for monitoring within remnant vegetation areas and the Conservation Offset Area. For further details regarding the Conservation Offset Area refer to **Section 4.6.3**.

3.4.1 Ecological Monitoring

All flora monitoring is scheduled for the flowering period (August – December) for optimum results.

Ecologists engaged by HQPL have advised the following surveys will be undertaken within remnant vegetation areas:

- 6 Ecological monitoring plots (20x20m);
- 3 *Grevillea parviflora subsp. parviflora* monitoring plots (20x20m); and
- 8 *Tetratheca juncea* monitoring plots (5x5m).

Ecological Monitoring Data

Data to be collected includes:

- Flora species diversity;
- Total number of flora species;
- Number and percent of native flora species;
- Number and percent of introduced flora species;
- Flora species abundances are to be recorded utilising a modified Braun-Blanquet (1982) cover abundance six ranking scale as shown in **Table 3**;
- Projected foliage cover for each vegetation layer; and
- Vegetation height of each vegetation layer in metres.

Table 3 Flora Species Abundances Rankings

Cover Code	Projected Canopy Cover
1	<5% and uncommon
2	<5% and common
3	6-20%
4	21-50%
5	51-75%
6	76-100%

Topographic information is to be collected along with measurements of altitude, slope and aspect. Information on geology, soils, fire, weed incursions and other disturbances are to be collected for each monitoring site.

3.4.2 Grevillea parviflora subsp. Parviflora

As discussed in **Section 3.3** *Grevillea parviflora subsp. parviflora* monitoring will be conducted during August to December 2020 to establish baseline data. Monitoring will occur every two years thereafter until the Development Consent (DA 265-10-2004) is relinquished or the requirement to monitor is removed.

Grevillea parviflora subsp. Parviflora Monitoring Data

Data to be collected includes:

- Count of all individuals;
- Height of individuals;
- Presence/absence of flowers; and
- Evidence of recruitment.

3.4.3 Fauna

Fauna monitoring is scheduled for the summer months (December – February) when most fauna species are active.

Ecologists engaged by HQPL have advised the following surveys will be undertaken within remnant vegetation areas:

- 6 Koala plots (Spot Assessment Technique);
- 5 Remote camera monitoring transects (refer to **Figure 3**):
    - 4 remote cameras for transects 1-4.
    - 2 remote cameras for transect 5.
    - Cameras will be active for 10 days/nights.
- 3 Owl call play-back transects:
    - Pre-recorded owl calls will be broadcast for periods of 5 minutes with 5 minutes listening time. Owl calls will generally be broadcast prior to spotlighting;

- 3 Spotlighting transects.
    - Spotlighting will be undertaken at the remnant and Conservation Offset Area targeting Brush-tailed Phascogale, Koala and Powerful Owl.
- 3 Anabat surveys:
    - Each Anabat will be activated for 1 hour each night for two nights.

3.4.4 Monitoring *Tetratheca juncea*

The monitoring program needs to identify as early as possible any decline in health so appropriate management actions can be implemented to maintain the viability of the population.

Methods

Monitoring Prior to 2011

Counts within the permanent quadrats (5x5m) using the standardised methods were conducted once yearly. The vegetation surrounding the permanent quadrats within the *Tetratheca juncea* subpopulations were monitored annually during the flowering period (August - December). Other information to be collected includes:

- The number of stems coming from each clump;
- Number of flowers;
- Other species in vicinity flowering;
- A description of surrounding vegetation;
- Foliage cover;
- Above ground biomass; and
- Photos of quadrats and plant clumps.

Where possible monitoring events are conducted during the fruiting stage to evaluate the amount of seed set. This will give an indication of the level of pollination and the abundance of pollinator species on the site.

Pollinators

A description of the surrounding vegetation needs to be recorded, in particular species flowering at the same time as *Tetratheca juncea* that could potentially provide foraging resources for pollinators of *Tetratheca juncea*. Other factors that will be recorded include:

- The canopy cover, shrub cover and ground cover of the surrounding habitat;
- The condition of the soil (moisture and erosion);
- Litter levels; and
- Any other notable occurrences such as pollinators, insect attack etc.

These methods will be sufficient to establish whether a change in the cover and abundance of surrounding vegetation is affecting *Tetratheca juncea* subpopulations. If so, possible reasons for the change can be developed and management strategies implemented to ensure the persistence of the population.

2011 – 2019 Monitoring

HQPL did not implement the *Flora and Fauna Management Plan* (HWR, 2008) in its entirety for the Quarry during this period (2011 – 2019) and subsequently, in consultation with DPIE, the *Flora and Fauna Management Plan* (this document) has been revised and HQPL will seek approval from DPIE for the revised plan. HQPL have already begun planning monitoring for 2020 and onward, further outlined below. See **Section 4.6.2** for additional detail.

Monitoring Onward from 2020

Eight 5x5m quadrats within remnant vegetation area (within 4 subpopulations). The following information will be collected for each of the *Tetratheca juncea* monitoring quadrats in 2020 (August - December) and every two years thereafter until the Development Consent (DA 265-10-2004) is relinquished or the requirement to monitor is removed:

- Number of *Tetratheca juncea* clumps within each quadrat, adhering to the standardised method as set out by Payne et al. (2002) for counting *Tetratheca juncea* clumps involves the delineation of each plant clump by a distance of 30cm;
- Number of stems on each plant clump (estimate of biomass);
- Number of flowers on each *Tetratheca juncea* plant clump;
- Number of fruit on each *Tetratheca juncea* plant clump;
- Projected foliage cover of *Tetratheca juncea* plant clump;
- Other plant species flowering and or fruiting;
- Figure showing location of each *Tetratheca juncea* plant clump within the quadrat;
- Identification all other vascular plant species within the quadrat;
- Information on floristic structure and vegetation community quadrat occurs;
- Disturbances; and
- Weed incursions.

4 Conservation Offset Management Plan

4.1 Condition 22 DA 265/10/2004

Schedule 3 Condition 22 of DA 265/10/2004 states that the *Conservation Offset Management Plan* must describe the habitat, justify suitability, establish baseline data, describe management measures and monitoring for Conservation Offset Area. **Table 4** outlines this Condition 22 DA 265/10/2004 and states the sections of this plan where each aspect is addressed.

Table 4 Conservation Offset Management Plan Requirement

Condition	Section
The Conservation Offset Management Plan shall: a) describe the habitat in the Conservation Offset Area for following threatened species: • *Phascogale tapoatafa* (Brush-tailed Phascogale); • *Ninox strenua* (Powerful Owl); • *Phascolarctos cinereus* (Koala); and • *Tetratheca juncea* (Black-eyed Susan).	4.5
b) justify why this area is suitable as a conservation offset for the species described in (a) above;	4.5
c) establish baseline data for the existing habitat in the proposed Conservation Offset Area;	4.5 and 4.6
d) describe how the proposed Conservation Offset Area would be managed, including long-term measures for: • Feral animal control; • Weed management; • Stock management; and • Bush fire management.	4.7
e) describe how the ecological performance of the Conservation Offset Area would be monitored over time.	4.6

4.2 Aims and Objectives

The aim of the *Conservation Offset Management Plan* is:

- To justify the adequacy of the habitat elements within the conservation offset (see **Figure 2**);
- To maintain the habitat qualities for Brush-tailed Phascogale, Powerful Owl , Koala and *Tetratheca juncea*; and
- To provide management strategies to maintain the ecological integrity of the offset with particular focus on weed, pest, stock and bushfire management.

4.3 Background Information

The Conservation Offset Area is located to the southeast of the Quarry (see **Figure 1**). The Conservation Offset Area is approximately 16 hectares of relatively undisturbed bushland. The offset comprises a number of vegetation communities and habitat types (see **Figure 2**). The purpose of the Conservation Offset Area is to provide an overall improved environmental outcome from the extension of the existing Quarry, by placing a larger area of vegetation/habitat under a formal conservation agreement.

The expansion of the Quarry (Stage 2) involved the clearing of a number of mature trees comprising potential habitat for threatened species known to occur in the local area. Therefore, the main purpose of the Conservation Offset Area is to provide similar habitat near the Quarry with an appropriate level of formal protection for threatened species over the total time of the proposed impact.

The offset has been established within the identified area indicated in **Figure 2**. This area contains mature trees with adequate hollows that provide potential nesting and roosting and suitable foraging habitat for vulnerable (NSW conservation status) fauna species such as Brush-tailed Phascogale, Koala and Powerful Owl, and suitable habitat for the vulnerable plant species *Tetratheca juncea*. This area is approximately 16 hectares in size, compensating for the approved Stage 2 Project (10.8 hectares).

4.4 Flora and Fauna Habitat Attributes to the Offset

The various flora and fauna attributes within the offset area are described below. Overall, the habitat elements and floral assemblage of the offset area is similar to those recorded in the Stage 2 Project area of the Quarry.

Mixed Tall Moist Forest

This community occurs on the sheltered relatively steep south facing slope and major gully of the offset area. It comprises a tall canopy layer with numerous mature trees and a sub-canopy of rainforest species in areas.

Area: 7.5 hectares

Canopy Species*: Eucalyptus propinqua, Eucalyptus microcorys, Corymbia maculata, Eucalyptus siderophloia, Eucalyptus pilularis, Eucalyptus deanii, Eucalyptus paniculata, Syncarpia glomulifera, Eucalyptus acmenoides and Lophostemon confertus.*

Shrubs and small trees: *Rhodamnia rubescens, Guioa semiglauca, Acmena smithii, Indigofera australis, Acacia irrorata, Melaleuca linarifolia and Lantana camara,*

Groundcovers and climbers: *Lomandra longifolia, Glycine clandestina, Oplismenus* spp, *Plectranthus parviflora, Calochlaena dubia, Cissus spp, Cayratia clematidea, Smilax australis, Eustrephus latifolius, Gymnostachys anceps and Rubus Hillii*

Fauna Habitat Attributes:

Hollows: There are a relatively high number of high-quality habitat trees within this offset area. Some of these trees are very large (up to 30m high and 1.5m wide at breast height) and contain numerous hollows and other microhabitat features such as fissures and platforms where leaf litter and bark collects.

Fallen Timber: There is abundant fallen timber in this area of the offset including some large hollow tree trunks as well as numerous large branches. Some of the fallen timber is highly decayed and contains many hollows and fissures.

Rocks/Boulders: There are numerous rocks (10-20cm diameter) and some areas of larger boulders (1m diameter).

Dry Forest

This community occurs on the drier slopes of the offset area with sandy soils. It comprises an open canopy layer with an understorey of sclerophyllous shrubs and grasses. This community was subject to bushfires in 2002.

Areas: 8.5 hectares

Canopy Species: *Angophora costata* and *Corymbia gummifera* generally dominate the canopy. Other species which may be co-dominate in areas include *Eucalyptu globoidea, Eucalyptus microcorys, Corymbia maculata, Eucalyptus umbra, and Allocasuarina torulosa.*

Shrubs and small trees: *Pultenaea villosa, Persoonia linearis, Pultenaea paleacea, Acacia myrtifolia, Notelaea longifolia, Hibbertia aspera, Pultenaea retusa, Polyscias sambucifolia, Breynia oblongifolia, Davesia ulicifolia and Leptospermum polygalifolium.* Surrounding creeklines the following species are present: *Acacia irrorata, Melaleuca linarifolia and Glochidion ferdinandi.*

Groundcovers and Climbers: *Entolasia stricta, Lomandra obliqua, Imperata cylindrica, Hardenbergia violacea, Lomandra longifolia, Themeda australis, Doryanthes excelsa, Pratia purperascens, Patersonia sericea, Acianthus fornicatus, Caladenia catenata, Tetratheca juncea, Billardieria scandens, Aristida vagans, Brunoniella australis and Dianella caerulea.*

Fauna Habitat Attributes:

Hollows: There are low to moderate hollow numbers in this area as it is relatively young, having been cleared in the past. There are some larger mature trees scattered throughout.

Fallen Timber: There is abundant fallen timber in places, particularly along the drainage lines and flatter areas of this community in the southwest of the offset area. Areas of abundant fallen timber most likely attributable to bushfires. Some of the slopes contain very little fallen timber, however, have abundant boulders and rocks.

Rocks/Boulders: There are numerous rocks (10-20cm diameter) and some areas of larger boulders (1m diameter) on some of the slopes of this area.

4.5 Habitat Suitability of Offset for Threatened Species

4.5.1 Brush-tail Phascogale

Preferred Habitat

Brush-tailed Phascogale is a small Dasyurid marsupial with a tree climbing habit. It typically dens and nests in tree hollows, and forages on the ground, among fallen tree litter and on trees for insects. It is most commonly associated with drier forests and woodlands with an open grassy understorey or plentiful tree litter (fallen branches, etc.).

Preferred habitat is dry sclerophyll open forest and woodlands with sparse ground cover of herbs, grasses and sclerophyllous shrubs where annual rainfall exceeds 500 mm (Triall & Coates, Cuttle 1982, Soderquiest 1994). They are often found in treed habitats which contain rough-barked species preferring open dry foothill forest with little ground cover (DSE, 1997).

Brush-tailed Phascogale require a large number of hollows within their home range as they nest in up to 30 different sites each year (DSE, 1997). Suitable hollows may occur in dead or live trees, with entrance typically 25-40mm wide and lined with leaves and pungent faeces (DSE, 1997). Given Dasyurids typically produce large litters nursery nests for Brush-tailed Phascogale need to be large secure cavities with small openings, however they are also known to utilise nestboxes for shelter and nursery sites (Soderquist *et al*. 1996).

Dead or senescent trees within a landscape are relatively uncommon but appear to be important for Brush-tailed Phascogale who show a preference for using dead or senescent trees for their maternal nest sites (Rhind 2004). However, nest-site choice appears to be influenced not only by hollow availability or proximity to current foraging areas, it is considered likely (Rhind 2004) that social factors such as maintenance and surveillance of territories by visitation or occupation of nest-sites may explain unusual sites within logged areas of their range.

The diet of Brush-tailed Phascogale typically consists of large invertebrates including insects, spiders and centipedes taken mainly gleaned from the trunks and major branches of large trees especially dead branches and rough-barks (Triall & Coates 1993; Soderquist 1995; Scarff *et al.* 1998).

Scarff *et al.* (1998) identified that while their diet is generalised they exhibit preference and selectivity for larger than average prey, especially invertebrates. Therefore, it is likely that the distribution of Phascogale populations is correlated to the richness and abundance of arthropods Recher *et al.* (1996) which are positively related to soil and foliar nutrient levels. A study by van de Ree *et al.* (2001) was able to provide support for this hypothesis by indicating that although home-ranges of Brush-tailed Phascogale within linear remnants were much smaller than average, viable populations were able to utilise linear remnants on high productivity soils, although success was also contributable to the high density of large (DBH>70cm) remnant trees which provided greater foraging area and hollow abundance.

A detailed study of Brush-tailed Phascogale diet (Scarff *et al.* 1998) also found evidence of nectar feeding. The fact that four mature females utilised the same source indicated that flowers were a valuable food source given that females usually occur in intrasexually exclusive home ranges (Soderquist and Ealey 1994; Rhind 1998; van der Ree 2001). Studies at three locations report extended bouts of nectar feeding by Brush-tailed Phascogale (Goldingay, 2000) suggesting that nectar feeding may provide an important carbohydrate resource. Soderquist (1995 cited in Scarff *et al*. 1998) reports that much higher levels of nectar use are recorded in Eastern Australia although not all eucalypt flowers are used equally.

Habitat in the Conservation Offset Area

Nesting / Roosting

There are a high number of hollows within the Tall Moist Forest suitable for the nesting and roosting behaviour of Brush-tailed Phascogale. There are many large trees that are likely to provide suitable nursery sites with large secure cavities with small openings. The Dry Forest contains low to moderate numbers of hollows which may be important for Brush-tailed Phascogale particularly when foraging in these areas of the offset.

Foraging

There is a diversity of tree and shrub species within the offset which provide nectar, which (as referenced above) may provide an important food resource for Brush-tailed Phascogale in the local area. Many invertebrates that also utilise these nectar and pollen resources are likely to be eaten by Brush-tailed Phascogale. The larger trees within the Tall Moist Forest provide a variety of microhabitats for invertebrates such as dead branches and rough bark providing foraging areas for Brush-tailed Phascogale. The higher nutrient levels of the volcanic soils of the Tall Moist Forest is likely to positively influence the abundance of larger invertebrates favoured by Brush-tailed Phascogale. The high abundance of fallen timber in areas is also likely to provide suitable foraging for invertebrates and possible nesting and roosting sites for Brush-tailed Phascogale. Areas of the Dry Forest are also likely to provide some foraging opportunities.

Conclusion

Core habitat elements for Brush-tailed Phascogale are present within the Conservation Offset Area, considering the presence of large mature trees with high hollow numbers, a variety of suitable foraging resources and relatively high nutrient soils.

4.5.2 Koala

Preferred Habitat

Notwithstanding the definitive appearance of this species, observations of the free-ranging Koalas can be difficult. This is in part due to the cryptic nature of the species and the large and almost exclusive home ranges that individuals occupy; 100 hectares plus (White 1999). The species is identified as a species in decline and there are many complex factors that limit free-ranging Koala populations, including food tree preferences, history of disturbance and Chlamydia infection, all of which make longer-term population trends of many populations difficult to predict (Phillips 2000).

Evidence of tree use by Koalas and, therefore, the presence of Koalas is generally determined by faecal pellet counts and scratches on trees “possible Koala scratches”. Studies conducted by Phillips (2000) in the Port Stephens local government area showed that 10 Eucalyptus species and 9 species of non-eucalypt were utilised by Koalas in that area.

The following tree species which are used by Koalas are present in the conservation offset area:

- Grey Gum (*Eucalyptus punctata or E. propinqua*);
- Tallowwood (*Eucalyptus microcorys*);

- Blackbutt (*Eucalyptus pilularis*);
- Spotted Gum (*Corymbia maculata*);
- Grey Ironbark (*Eucalyptus paniculata*);
- Broad – leaved White Mahogany (*Eucalyptus umbra*);
- Red Bloodwood (*Corymbia gummifera*);
- White Mahogany (*Eucalyptus acmenioides*);
- Red Mahogany (*Eucalyptus resinifera*); and
- Smooth Barked Apple (*Angophora costata*).

Habitat in the Conservation Offset Area

Nesting / Roosting

Koalas have no specific nesting or roosting habitat requirements.

Foraging

The foraging habitat present for Koalas within the conservation offset includes a range of preferred and supplementary feed trees. Of the 19 species of trees identified by Phillips as being utilised by Koalas, 10 occur within the conservation offset. The higher nutrient soils present within the Tall Moist Forest and along the drainage lines of the Dry Forest of the conservation offset are likely to provide higher foliar nutrient levels favourable for Koalas (Phillips, 2000).

Conclusion

The Conservation Offset Area is likely to provide habitat elements for Koala, considering the abundance of suitable feed trees and the presence of higher nutrient volcanic soils.

4.5.3 Powerful Owl

Preferred Habitat

Powerful Owl is the largest of Australia's owls. It feeds on large arboreal mammals, megabats, and other fauna captured in trees. It forages mostly in open forests and typically roosts in tall trees in dark moist gullies. It nests in a very large hollow, typically in large tree in a moist gully. Pairs maintain and hunt throughout a home range that may be up to 1000 ha.

Habitat in the Conservation Offset Area

Nesting / Roosting

There are many large hollow bearing trees within the Tall Moist Forest that contain large vertical spout hollows which may provide suitable nesting habitat for Powerful Owls. The dense canopy within the major gully also provides suitable roosting habitat for Powerful Owls.

Foraging

There is likely to be a high abundance of prey for Powerful Owls. The major prey species of the Powerful Owl in the local area includes Brush-tailed possum, Grey-headed Flying Fox, Squirrel Glider, Sugar Glider and Brush-tailed Phascogale. These species are present in the local area, and the Conservation Offset Area provides suitable habitat for these prey species

Conclusion

Core habitat elements are present for Powerful Owl including large hollows and a dark moist gully suitable for nesting and roosting and the highly likely presence of abundant prey within the Conservation Offset Area and surrounding areas of remnant vegetation.

4.5.4 Tetratheca juncea

The *Tetratheca juncea* subpopulations detailed in the original Environmental Impact Statement for the Quarry have been substantially impacted from bushfire, although some plant clumps were recorded in recent searches, dense areas of larger post-colonising shrubs including *Leptospermum sp., Pultanea villosa, and Acacia myrtifolia* seemed to have largely out-competed *Tetratheca juncea* in these populations (RPS, 2008).

Preferred Habitat

The majority of *Tetratheca juncea* populations occur on predominantly low nutrient soils with a dense understorey of grasses (NPWS 2000). It is often found in association with Red Bloodwood (*Corymbia gummifera*) dominated vegetation communities, within which Smooth-barked Apple (*Angophora costata*) or Scribbly Gum (*Eucalyptus haemastoma*) are co-dominant, with a dense understorey of herbs, forbs, grass trees and grasses (Landenberger, 2003). *Tetratheca juncea* displays a preference for cooler southern aspects (161–240°) along ridges although it can be found on any aspect or slope and generally prefers sites with good drainage and low moisture levels (NPWS 2000).

Habitat in the Conservation Offset Area

Tetratheca juncea was recorded in the Conservation Offset Area within areas of the Dry Forest (see **Figure 2**). The size of the population in the offset has not been accurately detailed, however, is likely to range from 20-100+ plants, the size of the population will be accurately detailed in monitoring studies. The Dry Forest area (see **Figure 2**) provides suitable habitat for *Tetratheca juncea,* where it was recorded on a south-southwest facing slope in grassy understorey with rocks and boulders present.

Conclusion

The Conservation Offset Area contains suitable habitat for *Tetratheca juncea*. Areas where plant clumps were found in the Conservation Offset Area have suitable areas of habitat surrounding in which the population could expand.

4.6 Monitoring

4.6.1 Prior to 2011 Monitoring

Threatened fauna monitoring was undertaken within the Conservation Offset Area and the remnant vegetation present on site, to allow for appropriate identification and assessment of trends over time. Furthermore, monitoring of threatened fauna species throughout the site was undertaken to provide a more holistic indication of the target species distribution.

The three focus fauna species targeted during surveys were Brush-tailed Phascogale, Koala and Powerful Owl.

During the 2007/08 baseline survey a series of fauna survey locations were established throughout the site. These locations were utilised throughout the subsequent annual monitoring periods.

Diurnal Koala Habitat Searches

During the 2007/08 annual monitoring period, seven Koala Spot Assessment Technique (SAT) plot locations were selected. SAT plot locations were selected where a State Environmental Planning Policy No. 44 (SEPP 44) Schedule. Two food tree species were identified at a density greater than 15 percent. At each SAT plot a centre tree was selected that either:

- Had a Koala present;
- Had Koala scats at the base;
- Had scratches indicative of Koalas; or
- Was a Koala feed tree species as per SEPP 44.

Within each SAT plot, the closest 30 trees (greater than 20cm diameter at breast height) to the centre tree were searched for Koala activity such as:

- Koala individuals;
- Koala scats; and
- Koala scratches.

Due to the presence of other arboreal mammals such as the Common Brushtail Possum, the identification of scratches on tree trunks as belonging to either koalas or other arboreal mammals is problematic. Where large scratches of similar size and shape to koala scratches were identified, they were noted as ‘possible’ Koala scratches.

Hair Tube Sampling

Hair tube sampling was undertaken across the site to target the Brush-tailed Phascogale. Each typical hair tube transect consisted of 10 hair funnels (Faunatech design) spaced 10-20m apart. One atypical hair tube transect consisting of only 3 hair funnels was also set within a small area of vegetation (Transect 5). Each hair funnel was mounted on a tree trunk, approximately 2- 2.5m above the ground. Hair tubes were baited with a mixture of rolled oats, peanut butter and honey and left active for a period of 10 nights, totalling 630 hair tube trap nights within the site (in 2011 period).

Call Playback

Call playback of pre-recorded Powerful Owl calls was broadcast in an effort to elicit vocal responses from the species and/or to attract an owl to the playback site. The calls were broadcast through an amplification system (loud hailer) designed to project the sound for up to 1km under still night conditions. The call was broadcast for at least five minutes, followed by five minutes of listening, and stationary spotlighting (RPS, 2008). Following the final broadcast and listening the surrounding area was spotlighted on foot.

During the 2008/09 survey and the 2009/10 survey, call playback for Masked Owl, Sooty Owl and Barking Owl was also undertaken. During the 2008/09 survey Masked Owl calls were played at all sites, with Sooty Owl calls played within appropriate wet habitats and Barking Owl calls within dry woodland habitat.

Spotlighting

Spotlighting was undertaken over four nights (during the 2008/09 survey) within the site to target three key species (Brush-tailed Phascogale, Koala and Powerful Owl). Each spotlighting transect was traversed each night by two people resulting in a total of 16 person hours of spotlighting.

Incidental observations

Opportunistic sightings of secondary indications (scratches, scats, diggings, tracks etc.) of targeted fauna were noted. Such indicators included:

- Distinctive scats left by mammals;
- Scratch marks made by various types of arboreal animals;
- Scats consistent with Koalas;
- Chewed *Allocasuarina ssp*. cones indicative of feeding by Glossy Black Cockatoos; and
- Whitewash, regurgitation pellets and prey remains from owls.

4.6.2 2011 - 2019 Monitoring

Schedule 3 Condition 22 e) from DA 265-10-2004 states the *Conservation Offset Management Plan* must describe how the ecological performance of the Conservation Offset Area would be monitored over time. The commitment to monitor ecological performance two-yearly is outlined in the *Flora and Fauna Management Plan*.

Annual ecological monitoring was completed for the four years (prior to 2011) and has indicated minimal change in species composition. In the AEMR which covered the period of 1 August 2010 – 15 January 2012, the cover letter and the text of the document outlined HQPL's proposal to reduce monitoring frequency from annually to every five years. HQPL received no feedback regarding this proposed approach. In the 2012 and 2013 AEMR's HQPL again requested feedback from the DPIE regarding the proposed approach to reduce the ecological monitoring frequency.

Flora and fauna monitoring results have shown that the site is having minimal impacts on the surrounding ecological community.

4.6.3 2020 Monitoring

Two yearly flora and fauna monitoring in Remnant Vegetation and the Conservation Offset Area, as required under Schedule 3 Condition 23, (implementation and performance of the *Flora and Fauna Management Plan* and *Conservation Offset Strategy*), of the Development Consent (DA 265/10/2004) will occur in 2020. Ecological monitoring is scheduled for the flowering period (August – December 2020) for optimum results. Fauna monitoring is scheduled for the summer months when most fauna species are generally active.

Ecologists engaged by HQPL have advised the following surveys will be undertaken within the Conservation Offset Area:

- 2 Ecological monitoring plots (20x20m);
- 2 *Tetratheca juncea* monitoring plots (5x5m);
- 1 Koala plot (Spot Assessment Technique);
- 2 Remote camera monitoring transects (4 remote cameras per transect), RC6 and RC7 (refer to **Figure 3**). Cameras will be active for 10 days/nights;
- 1 Owl Call play-back transect. Pre-recorded owl calls will be broadcast for periods of 5 minutes with 5 minutes listening time. Owl calls will generally be broadcast prior to spotlighting;
- 1 Spotlighting transect. Spotlighting will be undertaken for a total of approximately 16 hours for two personnel across the remnant and Conservation Offset Area targeting the Brush-tailed Phascogale, Koala and Powerful Owl; and
- 1 Anabat survey. Each Anabat will be active on two nights for 1 hour on each night.

Location of plots, surveys and transects are detailed in **Figure 2** and **Figure 3**. Details of survey methodology for ecological and *Tetratheca juncea* monitoring for both the remnant vegetation and Conservation Offset Area are detailed in **Section 3.4.1** and **3.4.4** respectively.

Note *Grevillea parviflora subsp. Parviflora* will not be monitored within the Conservation Offset Area at the present time but will be monitored within the remnant vegetation areas (see **Section 3.4.2**).

4.7 Management in Conservation Offset Area

Feral Animal Control

Feral animals are monitored through opportunistic sightings of scats, targeting feral cats, goats, rabbits, dogs and foxes. Evidence of feral animals are recorded during ecological surveys.

If there is evidence of feral animals in the area, the most appropriate methods will be employed to control each species. Control methods may include trapping animals and getting them euthanized and/or poisonous baits.

HQPL strives to work with local community groups (such as the Bulahdelah District Pest Animal Control) in an effort to combat the spread of pest species and the damaging impact they have on native flora and fauna.

Weed Management

Weeds are not abundant in the Conservation Offset Area and are mainly restricted to some minor *Lantana camara* infestations within areas of the Tall Moist Forest, which will be controlled and monitored overtime. These infestations will be controlled through methods detailed in **Section 2.7**.

Stock Management

There should be no stock within the Conservation Offset Area.

Any unplanned stock will be monitored through opportunistic sightings of scats, targeting cattle and goats. No evidence suggesting the presence of stock has been found in the offset and it is unlikely to be a significant problem in the future. If evidence is found to suggest the presence of stock in the offset, a number of management options can be implemented including liaison with local landholders who have stock which may be entering the offset area and/or the offset could be fenced to exclude any local stock.

Bush Fire Management

Management of bush fire within the offset is needed to limit impacts of bushfires to mesic vegetation (habitat with a well-balanced supply of moisture) sensitive to fire present within areas of the Tall Moist Forest and to control fuel loads below residential dwellings on the eastern side of the offset. Bush fire management will be undertaken in consultation with NSW Rural Fire Service (RFS).

Hazard reduction burn would only be undertaken where there are heavy fuels that could support an uncontrolled fire. The NSW RFS will be consulted to determine the most appropriate method of assessing the fuel load and the level of fuel load that would warrant a hazard reduction burn.

Any hazard reduction burning will be undertaken in consultation with the relevant authorities and in accordance with the NSW RFS Standards for Low Intensity Bush Fire Hazard Reduction Burning.

5 Reporting and Reviewing

An assessment of flora and fauna management will be included within the Annual Environmental Management Report (AEMR) to be submitted to the DPIE annually, in accordance with Condition 23 of DA 265-10-2004.

This management plan will be reviewed at a minimum of every five (5) years to assess its effectiveness.

6 Responsibilities

Environmental responsibilities associated with this *Flora and Fauna Management Plan* for Karuah Quarry personnel are outlined below in **Table 5**.

Table 5 Roles and Responsibilities

Personnel	Responsibilities
Quarry Manager	Implementation of this Plan
Environmental Officer	Coordinate the flora and fauna monitoring requirements of this plan. Evaluate and report monitoring results as required. Coordinate Flora and Fauna related incident investigations and reporting as required by legislation and internal standards and guidelines. Assist with the review of this plan.
All employees and contractors	Comply with all requirements of this *Flora and Fauna Management Plan.* Report all potential environmental incidents to the Environmental Officer and Quarry Manager immediately. Seek approval from the Environmental Officer and Quarry Manager prior to making changes to infrastructure/processes which may result in increased Flora and Fauna impacts.

7 References

2004 Environmental Impact Statement, *Application for an existing Hard Rock Quarry*, prepared by Asquith and deWitt Pty Ltd.

Aussie Bee Website (1997-2003) Australian Native Bee Research Centre, North Richmond NSW Australia http://www.zeta.org.au/~anbrc/reedbees.html

Bartier, F.V., Gross, C.L., Mulligan, D.R., Bellairs, S.M., & Bowen, D. (2001*) Understanding the biology and ecology of vulnerable plant species: A case study with Tetratheca juncea occurring over coal leases, ACARP Project C8012. A report prepared for Australian Coal Research, June 2001.*

Braun-Blanquet, J. (1982), *Plant Sociology*: *The Study of Plant Communities.*

Close, DC and Davidson, NJ. (2002) *Revegetation to combat tree decline in the Midlands and Derwent Valley Lowlands of Tasmania: Practies for improved plant establishment. Ecological Management and Restoration. Vol. 4, No. 1, April 2002.*

Coleby, D. (2003) *Use of salvaged bush soil and brush matting to restore quarry sites at Sublime Point, Leura, NSW. Ecological Management and Restoration. Vol. 4, No. 3, December 2003. Blackwell Science.*

Cuttle, P. (1982) *Life history strategy of the dasyurid marsupial Phascogale tapoatafa. In Carnivorous marsupials: 13-22. Archer, M. (Ed). Sydney: Royal Zoological Society of New South Wales and Surrey Beatty.*

Davies, R and Christie, J (2001) *Rehabilitating Western Sydney's bushland: Processes needed for sustained recovery. Ecological Management and Restoration. Vol. 2, No. 3, December 2001. Blackwell Science*.

Debus, S.J.S. and Chafer, C.J. (1994). *The Powerful Owl Ninox strenua in New South Wales. Australian Birds, 28(Supp.) (Oct.): S21-S38.*

Department of Housing (2004) *Managing Urban Stormwater: Soils and Construction Manual*.

Department of Sustainability and Environment (1997) Action Statement No. 79 – Brush-tailed Phascogale Phascogale tapoatafa.

Department of Natural Resources and Environment, Victoria. Accessed 4 March 2004: http://www.dpi.vic.gov.au/dse/nrenpa.nsf/FID/-5D76E9BCEB75ED2B4A2567FA0001ABAF?OpenDocument

Driscoll, C. (2003). *Pollination ecology of Tetratheca juncea (Tremandraceae) finding the pollinators. Cunninghamia (2003) 8(1): 133-140.*

Ellis. W. A. H., Melzer. A., Carrick. F. N. and Hasegawa. M. (2002). *Tree use, diet and home range of the koala (Phascolarctos cinereus) at Blair Athol, central Queensland. Wildlife Research 29: 303-311.*

Ellis. W. A. H., Melzer. A., Carrick. F. N. and Hasegawa. M. (2002). *Tree use, diet and home range of the koala (Phascolarctos cinereus) at Blair Athol, central Queensland. Wildlife Research 29: 303-311.*

Ellis. W. A., Hale. P. T. and Carrick.F. (2002) *Breeding dynamics of koalas in open woodlands. Wildlife Research 29: 19–25 35.*

Garnett, S. (1992) Powerful Owl. pp.113-114 in: Garnett, S. (ed.) *'Threatened and Extinct Birds of Australia'.* (R.A.O.U. and A.N.P.W.S. : Melbourne).

Gibbons, P. & Lindenmayer, D. (2002). *Tree Hollows and Wildlife Management in Australia*. CSIRO Publishing, Collingwood, Victoria.

Goldingay, R.L. (2000) *Small dasyurid marsupials – are they effective pollinators? Australian Journal of Zoology, 48: 597–606 Greening Australia Victoria Incorporated.*

(2003) *Revegetation Techniques: A guide for establishing native vegetation in Victoria*. Greening Australia Victoria.

GSS Environmental (2014), *Environmental Monitoring Plan for Hard Rock Quarry*, Karuah.

GSS Environmental (2014), *Environmental Management Strategy for Hard Rock Quarry*, Karuah.

HWR Ecological (December 2005), *Flora and Fauna Management Plan.*

HWR Ecological (December 2008), *Flora and Fauna Management Plan.*

HWR Ecological Flora & Fauna – *Bushfire – Aquatic – Wetland – Management – Monitoring.*

HWR ecological Flora & Fauna – *Bushfire – Aquatic – Wetland – Management – Monitoring.*

Landenberger, D. (2003) *Relationship between vegetation communities and Tetratheca juncea a threatened plant. Unpublished honours thesis prepared for the University of Newcastle.*

Mortlock W. (1998) Florabank Model Code of Practice. Florabank

National Parks and Wildlife Service (2000) Threatened Species Information – Tetratheca juncea. Department of Environment and Conservation (NSW).

NSW Scientific Committee (2004) Tetratheca juncea (a shrub) vulnerable species listing. Department of Environment and Conservation (NSW).

Payne R.J., Stevenson D. And Wellington R. (2002), *A Standardised Method for Counting Black-eyed Susan Populations. A Technical Note.*

Phillips, S., Callaghan, J., and Thompson, V. (2000), *The tree species preferences of koalas (Phascolarctos cinereus) inhabiting forest and woodland communities on Quaternary deposits in the Port Stephens area, New South Wales. Wildlife Research.*

Phillips. S, Callaghan. J, Thompson,V. (2000).*The tree species preferences of koalas (Phascolarctos cinereus) inhabiting forest and woodland communities on Quaternary deposits in the Port Stephens area, New South Wales. Wildlife Research 27(1): 1-10.*

Phillips. S, Callaghan. J. (2000). *Tree species preferences of koalas (Phascolarctos cinereus) in the Campbelltown area south-west of Sydney, New South Wales. Wildlife Research 27: 509-516*

Quin, D. G. (1995) *population ecology of the Squirrel Glider (Petaurus norfolcensis) and the Sugar glider (Petaurus breviceps) (Masupialia: Petauridae) at Limeburners Creek, at the central North Coast of New South Wales. Wildlife Research 22: 471–505*

Rhind, S.G. (1996) *Habitat tree requirements and the effects of removal during logging on the marsupial Brush-Tailed Phascogale (Phascogale tapoatafa) in Western Australia. The Western Australian Naturalist Vol. 21 no.1 pp 1-22. 36.*

Rhind, S.G. (2004) *Direct impacts of logging and forest management on the brush-tailed phascogale and other arboreal marsupials in a jarrah forest of Western Australia. In Lunney, D.: Conservation of Auatralia's Forest Fauna. Royal Zoological Society of NSW, Sydney.*

Recher, H. F., Majer, J. D., and Ganesh, S. (1996). *Eucalypts, arthropods, and birds: on the relation between foliar nutrients and species richness. Forest Ecology and Management 85: 177–195.*

RPS (2008), *Annual Ecological Monitoring Report.*

RPS (2008a), *Flora and Fauna Management Plan – Amendment.*

RPS (2011), *Annual Ecological Monitoring Report – Karuah Quarry.*

Scarff, F.R., Rhind, S.G. and Bradley, J.S. (1998) *Diet and foraging behaviour of brush-tailed phascogales (Phascogale tapoatafa) in the jarrah forest of south-western Australia. Wildlife Research, 25: 511ñ526.*

Soderquiest, T.R. (1993) *Maternal strategies of Phascogale tapoatafa (Marsupialia: Dasyuridae). I. Breeding seasonality and maternal investment. Australian Journal of Zoology, 41: 549-566.*

Soderquist, T. (1995) *Brush-tailed Phascogale Phascogale tapoatafa. In R. Strahan (Ed) The Mammals of Australia. Reed Books, Chatswood.*

Soderquist, T.R. and Ealey, L. (1994) *Social interactions and mating strategies of a solitary carnivorous marsupial, Phascogale tapoatafa, in the wild. Wildlife Research, 21: 527-42.*

Soderquist, T.R., Triall, B.J., Faris, F. and Beasley, K. (1996) *Using nest boxes to survey for the brush-tailed phascogale Phascogale tapoatafa. Victorian Naturalist, 113: 256-261.*

Thomson, VP. and Leishman MR. (2004) *Survival of native plants of Hawkesbury Sandstone communities with additional nutrients: effect of plant age and habitat. Australian Journal of Botany. Vol. 52 No. 2. CSIRO Publishing.*

Triall, B.J. and Coates, T.D. (1993) *Field observations on the brush-tailed phascogale Phascogale tapoatafa (MARSUPIALIA: DASYURIDAE). Australian Mammology, 16: 61-65.*

Van der Ree, R., Soderquist, T.R., and Bennett, A.F. (2001) *Home-range use by the brush-tailed phascogale (Phascogale tapoatafa) (Marsupialia) in high-quality, spatially limited habitat. Wildlife Research, 28: 517–525.*

White, N. A., and Kunst, N. D. (1990). *Aspects of the ecology of the koala in southeastern Queensland. In Biology of the Koala. (A. K. Lee, K. A. Handasyde and G. D. Sanson, eds.) pp. 109–116, Surrey Beatty: Sydney.*

White, N.A. (1999). *Ecology of the Koala (Phascolarctos cinereus) in rural Southeast Queensland, Australia. Wildlife Research 26(6) 731-744.*

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628