Brandy Hill Quarry Expansion: Koala Habitat Plan

FINAL REPORT

Prepared for Hanson Construction Materials Pty Ltd

3February 2023

Biosis offices

NEW SOUTH WALES

Albury
Phone: (02) 6069 9200
Email: albury@biosis.com.au

Newcastle
Phone: (02) 4911 4040
Email: newcastle@biosis.com.au

Sydney
Phone: (02) 9101 8700
Email: sydney@biosis.com.au

Western Sydney
Phone: (02) 9101 8700
Email: sydney@biosis.com.au

Wollongong
Phone: (02) 4201 1090
Email: wollongong@biosis.com.au

VICTORIA

Ballarat
Phone: (03) 5304 4250
Email: ballarat@biosis.com.au

Melbourne
Phone: (03) 8686 4800
Email: melbourne@biosis.com.au

Wangaratta
Phone: (03) 5718 6900
Email: wangaratta@biosis.com.au

Document information

Report to:	Hanson Construction Materials Pty Ltd
Prepared by:	Brooke Corrigan Dr Caragh Heenan
Biosis project no.:	34399
File name:	Brandy Hill Quarry Koala Habitat Plan V3.6
Citation:	Biosis 2021. Brandy Hill Quarry Expansion Koala Habitat Plan. Report for Hanson Construction Materials Pty Ltd. Authors: Corrigan B, Heenan C, Biosis Pty Ltd, Newcastle. Project no. 34399.

Document control

Version	Internal reviewer	Date issued
Draft version 01	Jane Raithby-Veall	19/03/2021
Final Version 01	Tony Cable	25/06/2021
Final Version 02	Mitch Palmer	30/11/2021
Final Version 03.6	Belinda Pignone	03/02/2023

Acknowledgements

Biosis acknowledges the contribution of the following people and organisations in undertaking this study:

- Hanson Construction Materials Pty Ltd: Belinda Pignone.
- Department of the Environment and Energy for access to the Protected Matters Search Tool of the Australian Government.
- NSW Environment, Energy and Science (EES) for access to the BioNet Atlas of NSW Wildlife.
- NSW Department of Primary Industries Fisheries for access to the predicted distribution maps for threatened species and fish communities.

Biosis staff involved in this project were:

- Astrid Mackegard (mapping).
- Mitchell Palmer.
- Tony Cable.

Contents

Tables

Figures

Glossary

BC Act	*NSW Biodiversity Conservation Act 2016*
Biosecurity Act	*Biosecurity Act 2015*
DBH	Diameter at breast height
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPE	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic Information System
LEP	Local Environmental Plan
LGA	Local Government Area
LLS	Local Land Services
NPW Act	*National Parks and Wildlife Act 1974*
NSW	New South Wales
EES	NSW Environment, Energy and Science
PCT	Plant Community Type
study area	The broader area in which the subject land is located, including all direct and indirect impacts.
subject land	The area of direct impact for the proposed development
TEC	Threatened Ecological Community
VEC	Vulnerable Ecological Community
VRZ	Vegetated Riparian Zone
WoNS	Weeds of national significance

1 Introduction

1.1 Project background

Biosis Pty Ltd was commissioned by Hanson Construction Materials Pty Ltd (Hanson) to prepare a Koala Habitat Plan (KHP) to guide the establishment and maintenance of a Koala habitat area intended to mitigate potential impacts to Koala *Phascolarctos cinereus* (Vulnerable, BC Act and EPBC Act) at Brandy Hill Quarry (BHQ) (the study area) construction and operation of the Brandy Hill Quarry Expansion Project (the project).

During assessment of the development application for the project, Hanson committed to establish the Koala habitat area in response to comments and concerns regarding the potential risks associated with the removal of Koala Habitat for the quarry development. This commitment is formalised within EPBC 2015/7453.

The development phase of the project will require the progressive removal of vegetation spread over five stages, covering 55 hectares. The operation of Brandy Hill Quarry will continue over the next 30 years and involve heavy vehicle transport of quarry products. The expansion has been approved, with the prior approved extraction area of 19 hectares to increase by 55 hectares to a total of 74 hectares. Vegetation to be removed has been identified as supporting a low density of Koalas and providing connectivity within the locality.

The project is classified as State Significant Development (SSD) under section 4.36 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), as the development is for the purpose of the extractive industry with extraction of more than 500,000 tonnes of material per annum from a total resource of more than five million tonnes. The project is also declared to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) due to its potential impacts on listed threatened species, including Koala. The potential impacts on such fauna species have been assessed and the project designed to avoid and minimise biodiversity impacts where practicable. Impacts on biodiversity values, such as Koala, are to be managed, mitigated and/or offset under the conditions of consent (EPBC 2015/7453).

Biosis has prepared this KHP to satisfy conditions within Approval – Brandy Hill Rock Quarry Extension, Seaham, Port Stephens NSW (EPBC 2015/7453, 27 October 2020, issued by the Department of Climate Change, Energy, the Environment and Water [DCCEEW, formally Department of Agriculture, Water and the Environment]). Further, the plan conforms to conditions that are relevant to the protection of Koalas during works, as outlined in the State Significant Development (SSD) Consent (SSD-5899, 16 July 2020, issued by the Independent Planning Commission of NSW [the Commission]). This KHP also aligns with the Port Stephens Comprehensive Koala Plan of Management (CKPoM) (Port Stephens Council & Australian Koala Foundation 2002), and all applicable legislation relating to the project.

The approved works involve the removal of 51.63 hectares of habitat (suitable vegetation) for Koala. It is understood that land owned by Hanson and not required for the development of the quarry will be managed under a future Biodiversity Stewardship Site Agreement (BSA). Hanson are also considering a future BSA to cover the Koala habitat area.

1.2 Description of Koala Habitat Plan area

The KHP area is located in the Port Stephens Local Government Area (LGA), approximately 3.5 kilometres west of Seaham and approximately 30 kilometres north of Newcastle Central Business District (**Figure 1**). This falls within the North Coast Koala Management Area (KMA) (OEH 2018) and the Port Stephens Western Koala Management Unit (KMU) (Port Stephens Council & Australian Koala Foundation 2002).

Located on the boundary of the NSW North Coast and Sydney Basin Bioregions the site falls within the Williams River Basin (Hunter catchment). Management considerations are informed by the Hunter Local Land Services (LLS) Management Area on land zoned RU2 Rural Landscape and E3 Environmental Management under the *Port Stephens Local Environmental Plan 2013* (LEP). Regional soil landscape mapping indicates that the study area occurs on the Scone - Gloucester Foothills landscape to the north and Newcastle Coastal Ramp landscape to the south of the Mitchell Landscapes (Mitchell 2002).

The Brandy Hill Quarry is located across 13 lots at 979 Clarence Town Road, Seaham (the study area) in NSW (**Figure 1**). The KHP area is located to the south of the quarry operations between the quarry and Clarence Town Road. It includes the following lots:

- Lot 1 DP264033
- Lot 25 DP1101305
- Lot 2 DP1006516
- Lot 3 DP1006516
- Lot 21 DP752487
- Lot 2 DP737844
- Lot 58 DP752487

Revegetation within the KHP area will establish a habitat corridor that covers 73.8 hectares of land formerly used for grazing interspersed between remnant native vegetation. Once established, it will provide a vegetative corridor for the movement of Koalas and other fauna from the east to west, south of the quarry, ensuring connectivity to the extensive parcel of contiguous remnant native vegetation in the north (**Figure 2**). It is intended that a 100-metre buffer between the southern boundary of the corridor and Clarence Town Road will be maintained as a firebreak to limit bushfires crossing onto the land and to provide separation between the vegetation and the road so that potential conflict between cars and Koala are avoided (**Figure 2**). The establishment of the vegetative corridor will be undertaken in two distinct stages, Stage 1 (between 0-10 years) and Stage 2 (>10 years) and separated into five planting stages (**Figure 2, 3.1** & **3.2**)

The KHP area comprises of partially disturbed native vegetation connected to a larger patch of remnant native vegetation to the north. Surrounding land use is predominantly low-density rural lifestyle which retains large areas of remnant native vegetation therein.

In accordance with the relevant legislation and guidelines (Section 1.3), the preparation of this KHP satisfies the Federal Government approval (EPBC 2015/7453).

Conditional requirements relevant to this plan are outlined in Table 1 and addressed throughout this KHP.

Table 1 Conditions of consent

Reference number	Condition	Related Section
EPBC 2015/7453		
5.a.	Measures for natural regeneration and replanting of at least 73.8 ha of the area to the south of the existing Quarry (marked as Planting Area 1 to Area 5 in Annexure 2) to establish Koala habitat.	Section 6.2.
5.b.	A list of the native flora species to be applied in replanting activities. Replanting must include preferred Koala habitat trees and aim to recreate plant community types in those areas which are to be regenerated and revegetated that is consistent with remnant plant community types.	Appendix 4.
5.c.	A schedule for planting, maintenance and completion of each Planting Area (specified in Annexure 2). Replanting of the area marked as Planting Area 1 must commence within 12 months of approval of the Habitat Plan.	Section 6. Appendix 1.
5.d.	Measures for the management and maintenance of the Planting Areas in Annexure 2, including, the control of pests, weeds and bushfire preparation and mitigation measures.	Section 6.2.
5.e.	The retention of east-west Koala habitat connectivity through a 100 metre vegetated buffer north of the amenity bund (amenity bund is defined in the figures at Appendix 2 of the State development consent) until such time as a suitably qualified person/s has submitted to the Minister confirmation that the Planting Areas would support Koala use and the Minister has approved this confirmation.	Section 3
5.f.	Measures for the long-term monitoring of Koala utilisation in the Planting Areas.	Section 7.
5.g.	Measures for the ongoing protection of the Planting Areas.	Section 7.

1.3 Statutory context

Relevant legislation, recent vegetation mapping and other documentation relevant to the project, includes:

- Approval – Brandy Hill Rock Quarry Extension, Seaham, Port Stephens, NSW (EPBC 2015/7453).
- SSD Consent for Brandy Hill Quarry Expansion Project (SSD-5899).
- *Biodiversity Assessment Report for the Brandy Hill Quarry expansion project* (Biosis Pty Ltd 2019).
- *Brandy Hill Quarry Expansion: Targeted threatened species survey for Koala* (Biosis Pty Ltd 2015).
- *Port Stephens Comprehensive Koala Plan of Management* (CKPoM) (Port Stephens Council & Australian Koala Foundation 2002).
- Brandy Hill Quarry Expansion Environmental Management Strategy (in development)
- Brandy Hill Quarry Expansion Biodiversity and Rehabilitation Plan (in development).
- *Port Stephens Local Environmental Plan 2013*.
- *Port Stephens Development Control Plan 2014*.
- *Lower Hunter Vegetation Mapping* (Parsons Brinckerhoff 2013).

2 Koala Habitat Plan scope and objectives

2.1 Scope

This KHP will guide the ecological restoration and protection of the southern biodiversity corridor.

The scope of this Koala Habitat Plan (KHP) is to develop a framework for the management of vegetation to be retained, vegetation to be removed, and the ongoing management of weeds and feral animals within the KHP area. The KHP will also outline ongoing management actions required for successful establishment of native plants within the KHP area, and actions to protect the surrounding vegetation from future impact, at least for the period of effect of the EPBC Act approval for the project, i.e., until 31 December 2055

Once vegetation has been established in all five of the planting areas, the maintenance period will actively run for a minimum of 10 years or until the objectives and performance criteria outlined in this KHP are met. Stage 2 will further augment and support general biodiversity outcomes. Ongoing/long-term maintenance will continue at least until December 2055.

2.1.1 Related plans

The KHP sits within the broader environmental management framework provided by the:

- Brandy Hill Expansion Environmental Management Strategy.
- Brandy Hill Expansion Bushfire Management Plan.
- Brandy Hill Expansion Biodiversity and Rehabilitation Management Plan.

2.2 Objectives

The specific objectives for the implementation of this KHP are to:

- Retain and enhance the east-west Koala habitat connectivity.
- Establish an adaptive management framework to drive ecological restoration activities within the southern biodiversity corridor.
- Specify appropriate plant community types and flora species for the corridor.
- Provide methodologies and a decision framework to undertake restoration including:
  - Seed collection
  - Site preparation
  - Planting
  - Direct Seeding
  - Maintenance
  - Weed control
  - Habitat augmentation
- Develop quantitative targets and a system of assessment of the project in relation to those targets.
- Outline function stacking opportunities to improve habitat values for additional fauna species.
- Define success and provide a means to document project progress.

To achieve these outcomes, Hanson will undertake the following:

- Ensure controls and procedures are implemented during construction and operation works to avoid, minimise or manage potential adverse impacts to Koala habitat within and adjacent to the works.
- Ensure appropriate measures are implemented to address the relevant Conditions of Consent, outlined in Table 1.
- Ensure measures are implemented to comply with all relevant legislation and other requirements as described in Section 1.

3 Koala habitat area development

The koala habitat area is proposed to be progressively developed in conjunction with the development of the Quarry. In accordance with Condition 5c of EPBC 2015/7453, Hanson commits to the replanting of the Koala habitat area, beginning with Planting Area 1, commencing within 12 months of the approval of the Koala Habitat Plan. Additionally, in accordance with Condition 5e of EPBC 2015/7453, Hanson commits to ensuring that the east-west Koala habitat connectivity will be retained through a 100-metre vegetated buffer north of the amenity bund until the Koala habitat area has developed sufficiently to support Koala movement, as determined by the Minister (**Figure 2**).

The Koala habitat area has been separated into five planting areas (**Figure 2, 3.1 & 3.2**), with vegetation management active maintenance and ongoing/long-term maintenance described within the KHP to be applied to all five areas/stages. Progressive establishment and replanting would occur over five years with an expected 10-year period required for plants to establish and grow to a size able to support Koala movement. It is therefore proposed that vegetation establishment would occur over a period of 10 to 15 years. This would not conflict with the proposed development of the Quarry and the retention of a corridor in accordance with Condition 5e of EPBC 2015/7453. The initial stage of establishment and replanting would be followed by a second stage of in-fill planting. Following these two stages, each area would be subject to active maintenance, generally involving weed and feral animal controls, replanting of any die back and where necessary, watering and fertilising. Ongoing/long-term maintenance of the area, including fence maintenance and any corrective actions required to reverse impacts to the area, is to occur for the period of effect of the EPBC Act approval for the project, i.e. until 31 December 2055

Table 2 presents an indicative schedule for the replanting activities (years 1 to 10), noting that this schedule is subject to change in response to natural environmental conditions. It is important to recognise that replanting during drought conditions will not occur, however, the quarry development will result in groundwater inflows that can be used for watering of plants within the Koala habitat area. Additionally, ongoing/long-term maintenance of the area isn't included in Table 2 but with encapsulate the active period of the EPBC 2015-7453 consent, that is until 31 December 2055.

Table 2 Schedule for replanting activities – years 1 to 10.

Planting Areas	Year 1	2	3	4	5	6	7	8	9	10
Area 1	Establishment and Phase 1	Phase 2	Active maintenance							
Area 2		Establishment and Phase 1	Phase 2	Active maintenance						
Area 3			Establishment and Phase 1	Phase 2	Active maintenance					
Area 4		`		Establishment and Phase 1	Phase 2	Active maintenance				
Area 5					Establishment and Phase 1	Phase 2	Active Maintenance			

4 Site description

4.1 Field investigation

A flora and fauna site survey of the study area was conducted on 11 to 15 August 2014, with an additional flora assessment undertaken in spring on the 13 and 14 November 2014. Field investigations were undertaken by qualified and experienced ecologists, Ed Cooper, Jane Raithby-Veall, Amy Nelson, Jayne Hanford and Stefan Rose. The study area was surveyed using random meander methods. This involved:

- The identification of native and exotic plant species, according to *Field Guide to the Native Plants of Sydney* (Robinson 2003) and the *Flora of NSW* (Harden 1992, Harden 1993, Harden 2000, Harden 2002) with reference to recent taxonomic changes.
- The identification and mapping of plant communities according to the structural definitions of *Lower Hunter Vegetation Mapping* (Parsons Brinckerhoff 2013).
- Targeted searches for plant species of conservation significance according to the 'random meander' method (Cropper 1993).
- Identifying fauna habitats, assessing their condition and assessing their value to threatened fauna species.
- Observations of animal activity and searches for indirect evidence of fauna (such as scats, nests, burrows, hollows, tracks, scratches and diggings).
- An assessment of the natural resilience of the vegetation of the site.
- Identification of previous and current factors threatening the ecological function and survival of native vegetation within and adjacent to the study area.
- Determination of appropriate rehabilitation and bush regeneration techniques for the native vegetation of the site.

The conservation significance of plant species and plant communities was determined according to:

- *Biodiversity Conservation Act 2016* (and formerly the *Threatened Species Conservation Act 1995*) for significance within NSW.
- EPBC Act for significance within Australia.

4.2 Vegetation communities

Regional vegetation maps and the Biodiversity Assessment Report (Biosis, 2019) indicate the following Plant Community Types (PCTs) best describe vegetation within the KHP:

- PCT 1592 *Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter*.
- PCT 1600 *Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter.*
- PCT 1602 / HU816 *Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter*.
- Disturbed native grassland / exotic grassland.

Spotted Gum - Ironbark – Red Gum - Grey Gum – Grey Box shrub - grass open forest of the Lower Hunter (PCT 1592)

Broadly the canopy is dominated by Spotted Gum *Corymbia maculata*, Narrow-leaved Ironbark *Eucalyptus crebra,* Grey Gum *Eucalyptus punctata* and Grey Box *Eucalyptus moluccana* and to a lesser extent, Red Ironbark *Eucalyptus fibrosa* and Forest Red Gum *Eucalyptus tereticornis.*

Prickly Leaved Paperbark *Melaleuca nodosa* forms dense thickets through some areas. Where canopy has been historically thinned and cleared in some areas, pockets of derived native grasslands are found. The shrub strata contains prickly shrubs such as Prickly Beard-heath *Leucopogon juniperinus*, Gorse Bitter Pea *Daviesia ulicifolia*, Prickly Moses *Acacia ulicifolia* and Native Blackthorn *Bursaria spinosa.* Native understory species include Wiry Panic *Entolasia stricta*, Threeawn Speargrass *Aristida vagans*, Forest Hedgehog Grass *Echinopogon ovatus*, Blady Grass *Imperata cylindrica*, Wallaby Grass *Rytidosperma fulva*, Barbed Wire Grass *Cymbopogon refractus*, Weeping Grass *Microlaena stipoides*, Raspwort *Gonocarpus teucrioides*, Leafy Purple-flag *Patersonia glabrata* Spiny-headed Mat-rush *Lomandra longifolia*, Whiteroot *Pratia purpurascens*, Native Geranium *Geranium solanderi*, Kidney Weed *Dichondra repens*, Goodenia bellidifolia, Germander *Gonocarpus teucrioides* and *Dianella prunina*.

Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter (PCT 1600)

This PCT is characterised by a canopy of Spotted Gum *Corymbia maculata*, Narrow Leaved Ironbark *Eucalyptus crebra*, Grey Box *Eucalyptus moluccana* and, to a lesser extent, Red Ironbark *Eucalyptus fibrosa* and Forest Red Gum *Eucalyptus tereticornis*. The shrub strata included Prickly Beard-heath *Leucopogon juniperinus*, Gorse Bitter Pea *Daviesia ulicifolia*, Prickly Moses *Acacia ulicifolia* and Native Blackthorn *Bursaria spinosa* dominant. Native understory species included Wiry Panic *Entolasia stricta*, Threeawn Speargrass *Aristida vagans*, Forest Hedgehog Grass *Echinopogon ovatus*, Blady Grass *Imperata cylindrica*, Wallaby Grass *Rytidosperma fulva*, Barbed Wire Grass Cymbopogon refractus, Weeping Grass Microlaena stipoides, Raspwort *Gonocarpus teucrioides*, Leafy Purple-flag *Patersonia glabrata* Spiny-headed Mat-rush Lomandra longifolia, Whiteroot *Lobelia purpurascens*, Native Geranium *Geranium solanderi*, Kidney Weed, *Goodenia bellidifolia*, Germander *Gonocarpus teucrioides* and *Dianella prunina*.

Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter (PCT 1602 / HU816)

This PCT is characterised by a canopy of Spotted Gum, Narrow-leaved Ironbark and White Mahogany *Eucalyptus acmenoides*. Other recorded canopy species include White Stringybark *Eucalyptus globoidea*, Sydney Red Gum *Angophora costata*, Red Ironbark and Rough-barked Apple *Angophora floribunda* and Grey Gum *Eucalyptus punctata* and Grey Ironbark *Eucalyptus siderophloia*. This PCT typically has an open understory of shrubs including Prickly Beard-heath, Gorse Bitter Pea, Prickly Moses, Hickory Wattle *Acacia implexa*, Large Mock-olive *Notelaea longifolia*, Native Blackthorn and Coffee Bush *Breynia oblongifolia*. Native herbs, grasses and graminoids recorded include; Wiry Panic, Brown's Lovegrass *Eragrostis brownii*, Blady Grass, Weeping Grass, Wattle Matt-rush *Lomandra filiformis*, Spiny-headed Mat-rush, Stinkweed *Opercularia diphylla*, Pomax *Pomax umbellata*, Thyme Spurge *Phyllanthus hirtellus*, Whiteroot and Kidney Weed *Dichondra repens*.

Disturbed native grassland / Exotic grassland

Disturbed native grassland / Exotic grassland within the KHP is dominated by pasture grasses typical of the locality. Some areas also contain a reasonable native groundcover component.

4.3 Koala habitat

The KHP area contains 73.8 hectares of low quality and cleared vegetation which will be improved to provide habitat and connectivity for Koala. Council Koala Habitat Planning Map shows that the study area includes 'Preferred' Koala habitat, 'Link Over Cleared', and 'Link Over Marginal', including 50 metre buffers for 'Marginal' and 'Cleared' (Port Stephens Council & Australian Koala Foundation 2002).

Table 3 highlights important tree species for Koalas within the study area and in the region highlighted by the BAR and the *Port Stephens Council Comprehensive Koala Plan of Management 2002* (CKPoM). This KHP will look to not only restore vegetation communities within the valley, the restoration will include important tree species for the Koala such as Swamp Mahogany *Eucalyptus robusta* and Parramatta Red Gum *Eucalyptus parramattensis* as highlighted by the CKPoM.

Large areas surrounding the study area (total 561 hectares) and adjacent lands, provide high quality habitat for a wide range of birds, reptiles and mammals, including Koala for which this KHP will enhance through easy west connectivity and ecological diversity, within the region.

Table 3 Important tree species for Koalas

Scientific Name	Common Name	Associated PCT (from BAR or reference document)
Eucalyptus robusta	Swamp Mahogany	CKPoM
Eucalyptus parramattensis	Parramatta Red Gum	CKPoM
Eucalyptus tereticornis	Forest Red Gum	1598, 1600, 1718, CKPoM
Eucalyptus paniculata	Grey Ironbark	1602, CKPoM
Eucalyptus crebra	Narrow-leaved Red Ironbark	1600, 1602, 1592, 1718, 1598, CKPoM
Eucalyptus umbra	Bastard White Mahogany	1602, 1598, CKPoM
Corymbia maculata	Spotted Gum	1592, 1602, 1600, 1584, CKPoM
Eucalyptus punctata	Grey Gum	1592,1584, CKPoM
Eucalyptus acmenoides	White Mahogany	1584, 1600, 1602, CKPoM
Casuarina glauca	Swamp Mahogany	1718, CKPoM
Eucalyptus canaliculata	Large-fruited Grey Gum	1602
Eucalyptus globoidea	White Stringybark	1602, 1718
Eucalyptus fibrosa	Red Ironbark	1592, 1600, 1592, 1598
Eucalyptus moluccana	Grey Box	1600
Eucalyptus siderophloia	Northern Grey Ironbark	1600, 1602, 1598

4.4 Priority and environmental weeds

Seven priority weeds for the Hunter LLS region, which includes the Port Stephens LGA, as well as Weeds of National Significance (WoNS) that have been recorded in the Biodiversity Assessment Report (BAR) study area are listed in Table 4, along with their associated Duty (where relevant to the project) (Biosis Pty Ltd 2019). The list below is not exhaustive and baseline weed data including density, distribution and species is to be recorded as a year one milestone prior to on ground works commencing under this KHP.

To prevent biosecurity impacts from occurring as a result of the presence of the above listed priority weeds within the study area, all practical steps will be taken to control and eradicated the weeds from the study area prior to or during vegetation removal.

Table 4 Priority weeds and WoNS recorded within the study area

Scientific name	Common name	General biosecurity duty	WoNS
Chloris gayana	Rhodes Grass	No specific biosecurity duty in NSW, but recognised as a 'Perennial grasses that threaten biodiversity' (DPE 2018).	No
***Cortaderia* sp.**	Pampas Grass	**Regional Recommended Measure** Core infestation area: Port Stephens, Maitland, Cessnock, Lack Macquarie, Newcastle and MidCoast local government areas. Core infestation area: Land managers should mitigate spread from their land. Land managers to reduce impacts from the plant on priority assets.	No
Juncus acutus	Spiny Rush	No specific biosecurity duty in NSW. A tough, tussock-forming perennial rush which can dominate drainage lines and low lying areas. Salt tolerant (Weeds Australia 2011).	No
Lantana camara	Lantana	**General Biosecurity Duty** All plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.	Yes
Olea europaea* subsp. *cuspidata	African Olive	**Regional Recommended Measure** Land managers mitigate the risk of the plant being introduced to their land. Land managers reduce impacts from the plant on priority assets. Land managers prevent spread from their land where feasible.	No
Senecio madagascariensis	Fireweed	General biosecurity duty. No relevant measures with regard to the project.	Yes
Setaria gracilis	Slender Pigeon Grass	No specific biosecurity duty in NSW. An exotic perennial grass which can form dense monocultures which exclude native biodiversity. Particularly aggressive in moist soils.	No

5 Vegetation management

5.1 General approach

This KHP provides the proposed progression of restoration works considering Hanson's long-term commitment to biodiversity management and time frames for the reinstatement of important ecological values. The key to prioritising areas for restoration and the order of which works should be undertaken are the established principles of 'retain, regenerate and revegetate'. Inherent in this approach is the need to work from areas of more resilient bushland to areas of more degraded bushland (DEC 2005, Buchanan 1989).

5.2 Vegetation management zones

The ecological assessment completed by Biosis (2019) has been used to delineate the Vegetation Management Zones to which this Koala Habitat Plan will apply. The delineation of Vegetation Management Zones was determined based on various site attributes identified during the field investigation, including:

- Future land use (retain or remove).
- Plant Community Type.
- Resilience within the overstorey, shrub storey and understorey.
- Level of recruitment of exotic species (including priority weeds and WoNS).

Using these attributes, five management zones have been identified within the KHP area (Table 5). The location and extent of each zone is provided in **Figure 3.1** & **Figure 3.2** with the corresponding summary of the management requirements provided in Section 6.

Table 5 Management zones / Planting Areas

Management zone / Planting Area	Size in hectares	Existing vegetation description
Area 1 (A1)	17.4	West of the access road with remnant PCT 1592 *Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter* and PCT 1602 *Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter*
Area 2 (A2)	11.1	PCT 1592 *Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter*
Area 3a (A3a)	10	West of Deadmans Creek and mapped as PCT 1592 *Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter*
Area 3b (A3b)	6.4	East of Deadmans Creek PCT 1592 *Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter*
Area 4 (A4)	12.9	PCT 1592 *Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter* and PCT 1602 *Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter*
Area 5 (A5)	16.0	PCT 1602 *Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter*

6 Specific management actions

6.1 Construction activities (establishment)

6.1.1 Site inductions

All contractors associated with KHP works are subject to induction to Brandy Hill Quarry and will comply with all directions and procedures related to the operation and its representatives.

6.1.2 Exclusion fencing

The extent of ecologically sensitive areas located adjacent to the operations areas will be shown on site layout maps in the Biodiversity and Rehabilitation Management Plan, and physically delineated on site using protective fencing and signposting where appropriate. Fencing can cause a barrier to movement for Koalas, as outlined in the Koala Protection Plan (Biosis 2021). Fencing is to be maintained along the property boundary and where necessary to protect the lands from disturbance or degrading activities such as recreational four-wheel drive access, dirt bike, mountain bike, camping or firewood collection. The alignment of this fencing is to be in accordance with the Australian Standard *Protection of Trees on Development Sites (AS4970-2009)* and incorporate the relevant tree protection zones for trees and vegetation to be retained.

The fencing will be constructed of, as a minimum, capped star pickets and high visibility para webbing and have appropriate signage stating that it is an environmentally sensitive area to inform and educate construction personnel. Exclusion zones will be clearly marked and labelled on design drawings issued for construction and displayed in prominent places and provided in site inductions. A register of sensitive area maps will be maintained.

No storage of materials or machinery other than those used in landscape restoration is permitted within the KHP area with care taken to avoid the compaction of soils. Rehabilitation works

6.1.3 Seed collection

When native vegetation is lost as a result of project works, revegetation may be necessary to reinstate native vegetation and habitat in the project area. The purpose of revegetation for this project includes:

- Rehabilitation of the quarry site.
- Creating buffer zones around retained native vegetation to protect it from edge effects.
- Creating or maintaining habitat corridors to help facilitate the movement of flora and fauna species.
- Maintaining native seed banks, local provenance of species endemic to the area and genetic diversity.

Time will be allocated to seed collection to allow for seasonal variations in seed production. Depending on timing, this can include collecting seed up to 12 months in advance of revegetation works. Seed collection will support local genetic diversity and propagation by preserving material that would otherwise be lost from the expansion area. Seed collection for the KHP is managed under wider expansion environmental management. Collection of seed from the adjoining retained vegetation will support restoration for the site as a whole. Seed collection methods are provided in Appendix 2.

Seed collection is to be carried out in accordance with the Florabank Guidelines, by experienced and licenced seed collectors/ecologists. Seed collection from a Threatened Ecological Community also requires a licence under the NSW *National Parks and Wildlife Act 1974*.

The management of seed collection contractors will involve the following:

- Engage contractor to collect all available seed from expansion footprint prior to clearing.
- Include cleaning, processing and agreed storage provision for the extent of the contract.
- Integrate with seed strategy for the operations restoration plan.

6.1.4 Weed management

The proposed works have the potential to introduce and promote weeds and pathogens in the development footprint as well as in the surrounding area. Environmental weeds are exotic species considered either a high risk of dispersing and becoming established in adjacent native vegetation or have the potential to cause significant ecological harm. Recommended methods for control of environmental weeds recorded on site, along with priority species, are outlined in Appendix 3. The described weed management actions outlined within the KHP are applicable to all planting areas (planting area 1 to 5).

6.1.5 Natural regeneration

Encouraging the natural regeneration of pre-existing vegetation is an effective form of site restoration to support and capitalise on:

- Seeds and propagules existing within the seed bank.
- Local provenance species adapted to the environmental conditions in the area.
- Re-establishment of the community will follow natural patterns of re-colonisation and succession.
- Soil fauna, fungal and microbial populations that are essential to a healthy plant growing environment are already present. Or can be encouraged by enhancing or repairing abiotic conditions within the site.

Some practical and cost-effective management actions that can be used to encourage natural regrowth and regeneration include:

- Disturbing the soil surface
- Managing weed infestations
- Creating canopy gaps
- Watering

The applicability of any of the above management actions will be dependent on the pre-existing vegetation and local conditions. Natural regeneration and encouragement of natural regrowth will be most effective in areas immediately adjacent to remnant native vegetation and drainage lines. Appropriate monitoring and management of this zone must be carried out as actions such as soil disturbance and canopy gaps may also result in the establishment of weed populations. The described natural regeneration actions outlined within the KHP are applicable to all planting areas (planting area 1 to 5).

6.1.6 Infill planting and revegetation

Active revegetation is required in all planting areas (A1-A5). Infill planting and active revegetation are to be undertaken in general accordance with the specifications outlined below. The species list for infill planting and active revegetation is provided in Appendix 4, this has been prepared based on years of assessment, for the project by Biosis, the Company's restoration experience as well as guidance provided in the CKPoM. The species selection is deliberately intended to encourage the development of Koala habitat. The recommended

planting list is based on species that are characteristic of Lower Hunter Spotted Gum Ironbark community variations recorded in the study area. Additionally they are species that are easily propagated and established from readily available local provenance seed.

Active revegetation will, where possible, be carried out in a manner that avoids structured plantings in straight lines and achieves a more randomised pattern.

All plants to be installed as part of the required revegetation works are to be either as hikos and/or enviro-cells sized pots. Advanced stock are not to be used for rehabilitation purposes and do not compensate for multiple plantings within the KHP area. A recommended species list and percentage of species per stratum is provided in Appendix 4, this has been prepared based on years of assessment for the project, restoration experience, as well as guidance of the CKPoM.

The selective stratums of canopy (overstorey) and understorey are to be installed during Stage 1 of the revegetation program. This stage, to be implemented over a ten year period, is to undertaken in three distinct phases being:

- Establishment and site preparation (Year 1).
- Canopy and mid storey installation (Year 2).
- Replacement supplementary planting, active maintenance and long-term maintenance (Ongoing).

All planted specimens within Stage 1 are to be installed with a biodegradable planter bag (with two bamboo stakes), mulched with a native tree woodchip mulch (tub ground mulch is an appropriate substitute if required) and a slow native release fertiliser. Plants to be initially watered once installed with a nitrogen-based fertiliser e.g. Seasol® to reduce plant stress, increase plant survival rates and eliminate the effects of nitrogen drawdown derived by the decomposition of the required mulch. Details of the required actions per phase are provided as Table 11.

Stage 2 of the vegetation program will aim to consolidate the successes of Stage 1 and is to focus on the establishment a native ground story stratum. This stage is to commence at the completion Stage 1. Details of the required actions per phase are provided as Table 11.

Management actions to be undertaken during Stage 2 will include:

- Control, with scope to eliminate all environmental and NSW priority weed species.
- Installation of a variety of native grass and forb species.
- Supplementary revegetation (where required) to maintain a continued canopy with the corridor.

The described active revegetation actions outlined within the KHP are applicable to all planting areas (planting area 1 to 5).

6.1.7 Plant numbers and densities

Koalas prefer habitat that includes (DPE 2020, McAlpine et al. 2007, Mitchell 2015):

- At least 30 % of total canopy trees that are preferred food trees. Between 40 to 60 % of the landscape will be native forest or woodland for a one kilometre radius around where koalas occur.
- Non-eucalypt trees and shrubs for shelter and other behavioural purposes.
- Water nearby to provide trees with higher leaf moisture and water to drink.
- A minimum habitat patch size of 2 hectares, although larger than 50 to 100 hectares is preferable to support a sustainable population with connectivity to other habitat patches.

The following is a guide to inform the revegetation densities (DPE 2021a, DPE 2020), numbers are indicative and can be adjusted through documented reasoning where natural regeneration or existing trees support a lower volume including supplementary inter-planting (i.e. Increasing the density of koala food species within an area):

- Trees are be installed at a rate of 1 plant/ 10 square metres in areas with no pre-existing canopy.
- Shrubs are be installed at a rate 1 plant/10 square metres in areas with no pre-existing canopy or shrub layer. Plantings can be grouped at higher densities (2-5 metres apart) and do not need to be distributed evenly within the planting area.
- Grasses and groundcovers are to be installed at a rate of 1 to 6 plants per square metre (or as appropriate as determined by a restoration consultant) (Stage 2) (DPE 2021a).

The proposed planting numbers per management zone are provided in Table 6.

Table 6 Stage 1 Planting numbers

Zone	hectares	Trees	Shrubs	Total
Area 1 (A1)	17.4	17,400	17,400	34,800
Area 2 (A2)	11.1	11,100	11,000	22,000
Area 3a (A3a)	10	10,000	10,000	20,000
Area 3b (A3b)	6.4	6,400	6,400	12,800
Area 4 (A4)	12.9	12,900	12,900	25,800
Area 5 (A5)	16.0	16,000	16,000	32,000
Total				**147,400**

An estimated 147,400 plants are to be installed as part of the initial KHP works (**Figure 3.1 & 3.2**). In the event of plant loss, replacement is required until target stem densities of established plants per hectare are met. It is recommended that a total of 294,800 plants be included in the project planning schedule to allow for 1:1 replacement over a 10 year period (Table 10). Stage 2 densities will be determined during a comprehensive plan review and future planning at the completion of Stage 1 to meet ecosystem structure targets relative to the conditions on ground at that future time. Assisted natural regeneration and direct seeding techniques will accelerate the restoration process and reduce the requirement for supplementary planting in Stage 2.

The described planting numbers and densities outlined within the KHP (indicated in Table 6) are applicable to all planting areas (planting area 1 to 5).

6.1.8 Fertilising

At the time of planting fertiliser is be applied to each plant in the form of a native slow release product with an N: P: K ratio similar to that of 21.8: 0.7: 7.2. Water crystals are to be included in all areas except those with high year round moisture content i.e. creek lines or seeps below dams. A combination soil conditioner and water retention product such as Terraform is recommended.

The described plant fertiliser actions outlined within the KHP are applicable to all planting areas (planting area 1 to 5).

6.1.9 Watering

Watering of the supplementary planting works will be undertaken to support establishment and survival of the plantings in order to meet restoration goals. Watering is to abide by any local authority water restrictions or guidelines. Water sourced from dams or other onsite storage will avoid evaporative dams or dams low in the landscape during extended dry periods as these can have elevated sodium levels toxic or problematic to plants. Electric conductivity water tests will be undertaken if there is cause for concern prior to utilising the water sources. Salt content of dams are subject to changes in weather patterns and rainfall.

All plants are to be watered prior to planting, so that the substrate within the pots and root system is uniformly hydrated. This is best achieved through routine appropriate watering in the lead up to planting. If plants and media have dried or shown signs of water stress submerging trays in water until air ceases to escape or saturation is achieved. This will rehydrate the plant and provide adequate moisture to reduce transplant shock.

Where possible plants are to be watered in on the day of planting to settle soil around the root ball and remove voids which would otherwise increase the rate of moisture loss around the plant. Watering in will take place no more than 24-48 hours post planting. Rainfall is not a substitute for watering in, which is one of the key factors in survival rates in restoration projects.

During the three-to-six-month establishment period, the frequency of watering to achieve plant establishment will depend on the prevailing climatic conditions at the time of planting and thereafter. Watering is to be frequent enough to maintain adequate soil moisture to prevent water stress and repressed growth during establishment. Planting will be timed to avoid the hottest periods of summer where new tubestock will be most vulnerable to rapid loss of soil moisture at a rate not easily compensated for by watering. During these periods rapid evaporation and water on leaves during very hot days can cause scorching and stress on young plants not yet resilient enough to survive harsh conditions.

During the establishment phase the following watering program is recommended (dependent on weather) (Table 7).

Table 7 Watering program

Weeks 1 - 8	Months 2 - 4	Months 5 - 6
Once a week	Once a fortnight	Once a month

The frequency of watering will be gradually reduced as the plantings mature and it is anticipated that after a period of 4 to 6 months the planting will be sufficiently established such that supplementary watering will no longer be required.

Planting areas are to be monitored during the active maintenance period to ensure that climatic conditions are not affecting the newly planted tube stock. If climate or environmental conditions are affecting the tube stock a watering program can be reinstated pending the approval by the environmental manager.

Temporary water systems can greatly reduce the manual labour involved in watering individual plants from trailer or ute mounted systems by hand. Automatic systems can take many forms, generally involving a storage which can be filled in bulk to support a drip or sprinkler system gravity fed or pressurised via a pump.

Automatic watering systems can be highly effective in encouraging areas of natural regeneration to establish more rapidly or provide support during challenging summer conditions when used appropriately.

The described watering actions outlined within the KHP are applicable to all planting areas (planting area 1 to 5).

6.1.10 Pest control

Predation by native macropods, introduced herbivores (rabbits and hares), insect pests and infection caused by plant diseases/pathogens can have an adverse effect on the establishment of plantings by defoliating, damaging, removing or killing young plants. To minimise the loss of plants through predation and/or disease, all new plantings will be protected by:

- Use of black plastic rigid mesh tree guards, which would be reused on new plantings once the initial planted specimens mature.
- Use of corflute tree guards of an appropriate size, which are long-lasting and reusable on new plantings.
- Temporary exclusion fencing of larger areas or where initial trials indicate that the efficacy of using individual tree guards is low.

The described pest control actions outlined within the KHP are applicable to all planting areas (planting area 1 to 5).

6.1.11 Bushfire management

A 100-metre buffer between the southern boundary of the habitat corridor and Clarence Town Road will be established and maintained as a firebreak to limit bushfires crossing into the planting areas (A1-A5), consistent with the Brandy Hill Expansion Bushfire Management Plan. An evacuation plan is in place covering fire risk to site personnel.

6.2 Maintenance

Maintenance works are split between active and ongoing maintenance periods. Active maintenance works will commence following the implementation of weed control and revegetation activities and will continue for a period of up to 10 years for Stage 1 and five years for Stage 2 from commencement of the KHP. It is anticipated that the maintenance activities will occur bi-monthly for the duration of the habitat establishment. Ongoing / long-term maintenance will be involve regular monitoring, weed control, fence maintenance and repair

All maintenance works outlined and described within the KHP are applicable to all planting areas (planting area 1 to 5). Required works and indicative effort are outlined in Table 8.

Table 8 Indicative maintenance works summary

Maintenance activity	Minimum effort	Frequency	Responsibility
Spot spraying of annual and perennial weeds	Two person days, Monthly	Quarterly in cooler months, monthly in warmer months	Land manager/bush regeneration contractor
Checking and repairing tree guards	One person day, 5 times per year	Bi-annually	Land manager
Watering	As required	Only during excessively hot periods of summer	Land manager/bush regeneration contractor
Replacement planting of tubestock	As required	Annual checks and planting	Land manager/bush regeneration contractor

7 Management actions and Performance Criteria

Table 9 Vegetation management actions and performance criteria

Management action	Management zone / planting area	Responsibility	Task / performance criteria	Timing
Define management boundary and install signage	All zones / planting area 1 to 5	Restoration Contractor and Environmental Manager	Install signage and delineate management boundaries. Where this is within existing boundary fences fencing is only required where there is a risk from operations areas or multi-purpose access tracks. Management boundaries can be delineated through natural materials such as reclaimed logs and rocks where appropriate i.e. Adjoining bushfire management areas The Koala Habitat Corridor - both retained and rehabilitated (see Figure 1 & Appendix 1 Figure 2) is to be clearly delineated within environmental management area maps and described as a 'non disturbance area' within operational plans.	• Prior to expansion earthworks.
Bush regeneration (primary and secondary weed control)	All zones / planting area 1 to 5	Restoration Contractor and Environmental Manager	Weed control works are to include the following actions: • Treat weeds listed in 4.4 and those documented in baseline surveys as per best practice guidelines under the direction of the Restoration Contractor. • Define the edge of the KHP area through weed removal along the northern and southern property boundaries. • Secondary treatments are to be ongoing as required following completion of primary treatment works. • Commencement of maintenance works will occur once mature exotic species have been reduced to 5% Projected Foliage Cover (PFC). This is expected to be 12 weeks (3 months) after commencement of primary weed control works. • All mature priority weeds/WoNS are to be successfully treated within the KHP area prior to commencement of the maintenance period.	• From the outset of vegetation management program. • As specified adjacent.

Management action	Management zone / planting area	Responsibility	Task / performance criteria	Timing
Planting Program	All zones / planting area 1 to 5	Restoration Contractor and Environmental Manager	Planting program as determined annually • All installed plants are to be propagated from locally appropriate seed, and selected from the list for contained in Appendix 4 of this KHP (or as determined by a suitably qualified restoration contractor in keeping with the aims and outcomes of this plan). • Year 1 works will target areas which need minimal planting preparation such as weed control or soil preparation and augment existing native regeneration. • Planting density to be consistent with those prescribed in Section 6.2.5 (noting that a staged approach to restoration goals are acceptable subject to documented decision frameworks and adaptive management plans)	• Annually from Year 1
Planting maintenance	All zones / planting area 1 to 5	Restoration Contractor and Environmental Manager	• Installed plantings are to be maintained with key elements of water, prevention of predation and suppression of smothering weeds. • There will be a maximum loss of 20% of the original planting numbers for an individual species. • A minimum of 80% survivorship for each species is to be maintained. • Replacement planting is to be carried out throughout the maintenance period to sustain the 80% survival rate at the completion of the maintenance period. • Losses of greater than 20% of originally installed plantings will have the maintenance period extended until survival rates have been achieved.	• Minimum weekly watering as per section 6.2.7. • Watering visits to continue as required to plant establishment. • Weed removal as required to the completion of the maintenance period.
Weed Maintenance	All zones / planting area 1 to 5	Restoration Contractor and Environmental Manager	• All mature priority weeds are to be successfully treated prior to commencement of maintenance period. • Seedlings of priority species are to be continually suppressed to a level of <5% Projected Foliage Cover (PFC) where they occur in the seed bank below mature specimens, and <2% PFC across remainder of the KHP area.	• The maintenance period will run following successful secondary weed control and/or installation of final plantings (whichever is later) until the

Management action	Management zone / planting area	Responsibility	Task / performance criteria	Timing
			• Works to be undertaken utilising best practice bush regeneration techniques. • Less than 5% exotic species PFC to be achieved over the KHP area after 12 months of maintenance works. • Continual suppression at <5% for the remaining maintenance period.	completion of the KHP.
Ongoing/long-term Maintenance	All zones / planting area 1 to 5	Environmental Manager	• When completion criteria of planting and active maintenance are met, and the program is considered complete, ongoing management and maintenance is to be incorporated under the operations environmental management strategy. • The Koala Habitat Corridor is to be clearly delineated within environmental management area maps and described as a 'non disturbance area' within operational plans. • Seedlings of priority species are to be continually suppressed to a level of <2% Protected Foliage Cover (PFC) across the KHP area. • Continual suppression of exotic species at <5% PFC across the KHP area. • Fence maintenance to be carried out, when required i.e. any damage to fences is repaired • Annual monitoring of rehabilitation areas by a suitably qualified bush regeneration specialist or ecologists. Plots established and monitored in accordance with the NSW Biodiversity Assessment Method.	• For the life of the Quarry • For the period of effect of the approval (December 2055).

Table 10 Management actions - Monitoring

Management action	Specification / Requirement
Ecological Monitoring Framework	Ecological Monitoring is to be undertaken by a qualified bush regeneration, ecology or environmental management professional. Monitoring surveys will assess the success of weed removal, plant growth and natural regeneration, and will be undertaken as follows: • Prior to commencement of works to gather baseline data. • Followed by annual monitoring and reporting. • Vegetation monitoring reports are to be prepared every twelve months for the period of effect of the approval (December 2055). • Achievement of performance criteria will be updated in each preceding report as milestones are achieved. • These reports are to be submitted to the industry regulator. The restoration zones / planting areas 1 to 5 (as established) will be monitored in terms of vegetation condition and the achievement of performance criteria. Monitoring activities are to include: • Establishing a minimum of six photo-points in representative locations. • Compile initial and on-going weed density maps. • Assessment of weed control works including priority and woody weed control, and weed density surrounding plantings, via monitoring techniques such as weed density mapping, and quadrat / transect surveys. • Identification and assessment of any natural regeneration of native plant species. • Certification of local provenance plantings prior to installation. • Assessment of the success rate of plantings and assessment of plant replacement requirements, and convey any need to BR contractor. • Assessment of the site for evidence of herbivory and erosion. Monitoring works will also provide the following certifications to the proponent / project manager, and then on to the regulator: • Certification that the planting stock/collected seeds (including initial and replacement plantings/seeds) is of local provenance as evidenced by the supplying nursery or bush regeneration contractor, and at the required densities. • Certification of commencement of maintenance period, i.e. all primary secondary and revegetation works have been completed to acceptable standards. • Final certification that the targets of the vegetation management works have been achieved. Monitoring of koala utilisation within the planted areas will be undertaken as follows: • Annual remotely piloted aircraft systems (RPASs) or drone surveys utilising thermal imaging technology within planted areas. This survey methodology has been identified as an efficient method to directly survey koalas, comparative to

Management action	Specification / Requirement
	spotlighting and the Spot Assessment Technique (Witt et al. 2020, Phillips & Callaghan 2011). Drone surveys are also recognised as a feasible and cost-effective new technology for estimating Koala densities in the *NSW Koala Monitoring Framework* (DPE 2021b). • RPAS/drone surveys are to be undertaken by qualified experienced personnel, preferably during the cooler parts of the day and cooler months, to increase chance of detection, as outlined in Box 3 of the *NSW Koala Monitoring Framework* (DPE 2021b). • The primary objective of the planted koala habitat areas is to ensure the existing koala population does not experience a decline as a result of the proposed quarry extension. The secondary objective is to increase koala habitat availability within the locality. Koala utilisation will be used to measure the effectiveness of the planted areas in satisfying these objectives, with the baseline population/activity levels to be determined through surveys supporting the project's Environmental Impact Statement (EIS). • Ongoing monitoring of Koala utilisation within the planted areas will be undertaken for the period of effect of the approval (December 2055).

Table 11 Timing of Vegetation management actions, monitoring management actions and performance criteria

Management Action	Timeframe								
	Prior to commencement of works (2023)	Year 1 (2023)	Year 2 (2024)	Year 3 (2025)	Year 4 (2026)	Year 5 (2027)	Year 5 – 10 (2028 – 2033)	Year 10-15 (2034 – 2039)	Year 15-30 (2040 – 2055)
Gather baseline data	■								
Ecological monitoring of rehabilitation areas (site wide, inc. vegetation monitoring of the KHP, weed monitoring) as described in Table 10		■	■	■	■	■	■	■	■
Certification – planting stock/collected seeds are of local provenance		■	■	■	■	■			
Certification – commencement of maintenance period (both active and ongoing/long-term)			■	■	■	■	■	■	■
Certification – targets of vegetation management works have been achieved							■		
Active Koala monitoring utilising RPAS/drone surveys, as described in Table 10			■	■	■	■			
Ongoing monitoring of Koala, as described within the Koala Protection Plan and Rehabilitation and Biodiversity Management Plan							■	■	■

8 Schedule of works

The KHP will be undertaken in general accordance with the schedule of works provided below and the relevant specifications provided. The schedule of works is applicable to all planting areas (planting area 1 to 5), as they are established. The responsibility for completing the actions within the schedule of works will be attributed to the principal bush regeneration contractor that is engaged to complete the work.

Post year 10 works will be ongoing/long-term maintenance for the period of effect of the approval, being December 2055, pending outcomes of actions described in Table 11. Achievement of performance criteria for the schedule of works will be monitored and updated in each preceding annual monitoring report as milestones are achieved. Finally, the five-year milestone review with be a major review of the plan and schedule for the new five year cycle, which will include an update to the action plan below.

Table 12 Action plan for vegetation management inc. Active Maintenance (Years 1 to 10)

Actions	Timeframe						
	Pre-construction	Year 1	Year 2	Year 3	Year 4	Year 5	Year 5 - 10
Engage licensed seed collectors & pre-expansion clearance collection							
Baseline condition report and preparation of a two-year schedule of works based on site and climatic conditions							
Engage nursery for plant propagation							
Stockpile logs and rocks from expansion to augment ground habitat							
Seed collection							
Remove rubbish or debris from priority restoration area							
Primary weed control							
Ground preparation (slashing, deep ripping, mulch)							
Habitat augmentation (reclaimed logs, rocks etc)							
Planting Program							
Active and ongoing maintenance							
Photo point monitoring and annual reporting							
Five year milestone review (major review of plan and schedule next 5 year cycle)						Review	

9 Adaptive management

An adaptive management approach is to be employed in respect of the works forming part of this KHP. An adaptive management approach involves an integrated process of monitoring, reviewing and then responding to the health and condition of the plantings within planting areas 1 to 5 as well as the status of the weed species to identify any alterations to the design and maintenance of works that may be required to ensure the objectives of the KHP are achieved.

For example, option of plantings or seeds, application rates for fertiliser and the watering schedule should be flexible in responding to the health and vigour of the habitat and changing climatic conditions. Monitoring the habitat will also allow for a review of the selected species to enable changes in the species composition of the supplementary planting/seed dispersion if it is determined that a particular species or stock sourced from a certain location is not performing adequately. The supplementary planting species, planting densities and planting patterns nominated within this KHP may be subject to change and review if certain species are unavailable or are performing inadequately. The weed control works are also to be reviewed and appropriate changes implemented accordingly, if required. By example, if the nominated weed suppression schedule is not achieving the Performance Indicators specified, the frequency of weed suppression activities will be increased accordingly.

It is important to note that any changes will comply with the aims of this KHP and any licensing or approval conditions issued before implementation.

In such an event that causes unexpected impacts on planting areas i.e. disease or uncontrolled bushfire, the adaptive management approach allows the update and change of management actions to establish appropriate corrective actions in light of an unexpected impact. Additionally, the maintenance and continued upkeep of the habitat area will be for the period of effect of the approval, being December 2055.

References

Biosis 2021. *Brandy Hill Quarry Expansion Koala Protection Plan*, Report for Hanson Construction Materials Pty Ltd. Authors: Heenan C, Biosis Pty Ltd, Newcastle. Project no. 34399.

Biosis Pty Ltd 2015. *Brandy Hill Quarry Expansion: Targeted threatened species survey for Koala*, Report for Hanson. Author: Corden, C. Biosis Pty Ltd, Sydney Office. Project no. 19323., Sydney Office.

Biosis Pty Ltd 2019. *Brandy Hill Quarry Expansion-Biodiversity Assessment Report*, Newcastle Office.

Buchanan R 1989. *Bush regeneration: recovering Australian landscapes*, TAFE NSW, Sydney.

Cropper S 1993. *Management of Endangered Plants*, CSIRO Publications Victoria, Melbourne, Victoria.

DEC 2005. *Recovering bushland on the Cumberland Plain: Best practice guidelines for the management and restoration of bushland*, Burton R (ed.), New South Wales Government Department of Environment and Conservation (NSW), Sydney, N.S.W.

DPI 2018. *New South Wales Weed Control Handbook - A Guide to Weed Control in Non-crop, Aquatic and Bushland Situations*, 7th edn, New South Wales Department of Primary Industries.

DPE 2018. *Introduced grasses*, *NSW Department of Planning and Environment*, accessed 16 March 2021, http://www.environment.nsw.gov.au/topics/animals-and-plants/pest-animals-and-weeds/weeds/widespread-weeds/introduced-grasses.

DPE 2020. *Koala Habitat Revegetation Guidelines - A Practical Guide to Identify, Connect and Revegetate Koala Habitat in New South Wales*, Department of Planning & Environment, Parramatta, NSW.

DPE 2021a. *Revegetating Koala Habitat - Central Coast Koala Management Area*, *Revegetating Koala Habitat - Central Coast Koala Management Area*, accessed 10 March 2021, https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/programs-legislation-and-framework/nsw-koala-strategy/local-government-resources-for-koala-conservation/central-coast-koala-management-area.

DPE 2021b. *NSW Koala Monitoring Framework*, Environment, Energy and Science. Department of Planning and Environment. Parramatta, NSW. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/nsw-koala-monitoring-framework-210261.pdf.

Harden GJ 1992. *Flora of New South Wales*, NSW University Press, Kensington, NSW.

Harden GJ 1993. *Flora of New South Wales*, NSW University Press, Kensington, NSW.

Harden GJ 2000. *Flora of New South Wales*, Revised Edition, NSW University Press, Kensington, NSW.

Harden GJ 2002. *Flora of New South Wales*, Revised Edition, NSW University Press, Kensington.

McAlpine C, Rhodes J, Peterson A, Possingham H, Callaghan J, Curran T, & Lunney D 2007. *Planning Guidelines for Koala Conservation and Recovery: A Guide to Best Planning Practice*, https://espace.library.uq.edu.au/view/UQ:124088.

Mitchell D 2015. *Australian Koala Foundation National Koala Tree Planting List, Australian Koala Foundation*, Australian Koala Foundation, www.savethekoala.com/about-koalas/trees-koalas.

Mitchell P 2002. *NSW (Mitchell) Landscapes*, Department of Environment and Climate Change NSW, Hurstville NSW.

OEH 2011.' Seed Collecting' *in*, *Conservation Management Notes*, NSW office of Environment and Heritage.

OEH 2018. *A Review of Koala Tree Use Across New South Wales*, Office of Environment and Heritage.

Parsons Brinckerhoff 2013. Lower Hunter Vegetation Mapping, 2013. VIS_ID 4513, accessed 2 December 2019, https://data.gov.au/dataset/ds-nsw-3e36fe58-9302-4d08-8858-b19895154aab/details?q=.

Phillips S & Callaghan J 2011. 'The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas Phascolarctos cinereus', *Australian Zoologist*, 35, 3.

Port Stephens Council & Australian Koala Foundation 2002. Port Stephens Council Comprehensive Koala Plan of Management (CKPoM).

Ralph M 1993. *Seed Collection of Australian Native Plants – For Revegetation, Tree Planting and Direct Seeding*, Bushland Horticulture, Fitzroy.

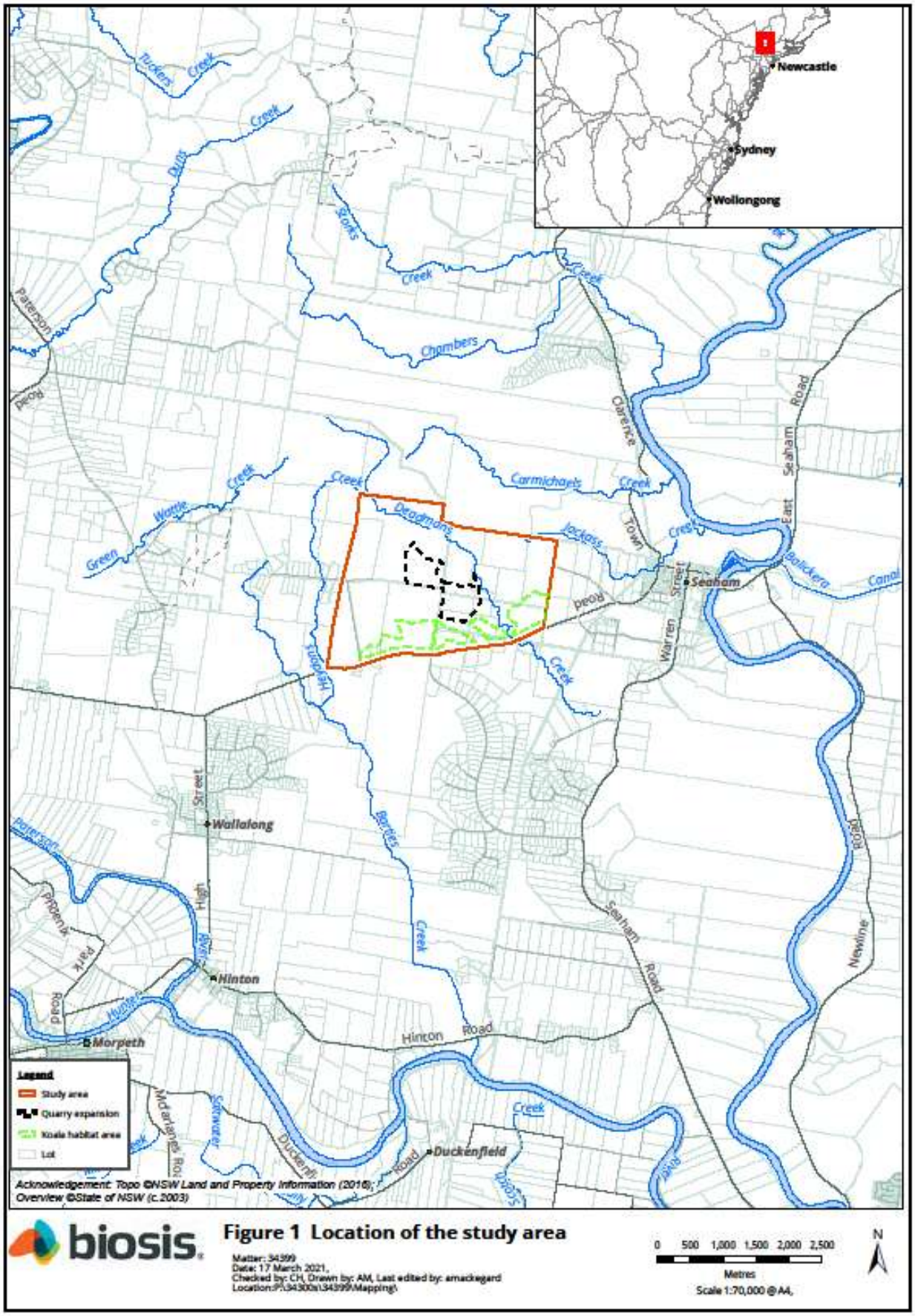
Robinson L 2003. *Field Guide to the Native Plants of Sydney*, 3rd edn, Kangaroo Press, Sydney.

Weeds Australia 2011. *Juncus acutus subsp. acutus | WEEDS AUSTRALIA - profiles*, accessed 16 March 2021, https://profiles.ala.org.au/opus/weeds-australia/profile/Juncus%20acutus%20subsp.%20acutus.

Witt RR, Beranek CT, Howell LG, Ryan SA, Clulow J, Jordan NR, Denholm B, & Roff A 2020. '*Real-time drone derived thermal imagery outperforms traditional survey methods for an arboreal forest mammal*', *PLoS ONE*, 15, 11.

Appendices

Appendix 1 Figures


Newcastle
Sydney
Wollongong
Tuckers Creek
Dunns Creek
Stoms Creek
Paterson
Chambers Creek
Clarence Creek
Seaham Road
Carmichaels Creek
Deadmans Creek
Jackass Town Creek
Seaham East
Balickera Canal
Green Wattle Creek
Seaham
Warren Street
Hexham Creek
Wallalong
Barnes Creek
Phoenix Park Road
High Street
Hinton
Morpeth
Hinton Road
Seaham Road
Newline Road
Duckenfield
Legend
Study area
Quarry expansion
Koala habitat area
Lot
Acknowledgement: Topo ©NSW Land and Property Information (2016); Overview ©State of NSW (c.2003)
biosis
Figure 1 Location of the study area
Matter: 34399
Date: 17 March 2021,
Checked by: CH, Drawn by: AM, Last edited by: amackegard
Location:P:\34300s\34399\Mapping\
0 500 1,000 1,500 2,000 2,500
Metres
Scale 1:70,000 @ A4,
N

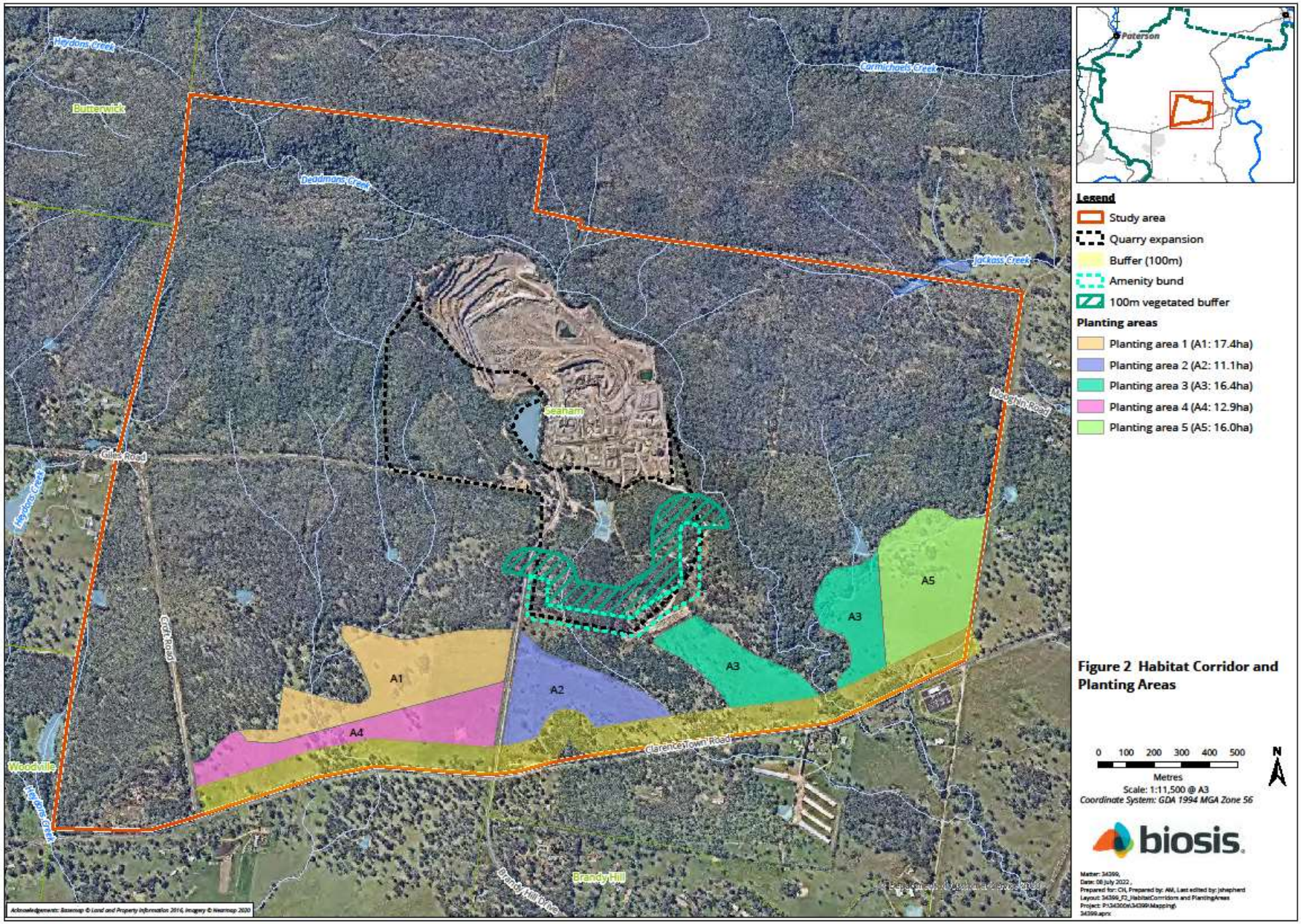


Figure 2 Habitat Corridor and Planting Areas

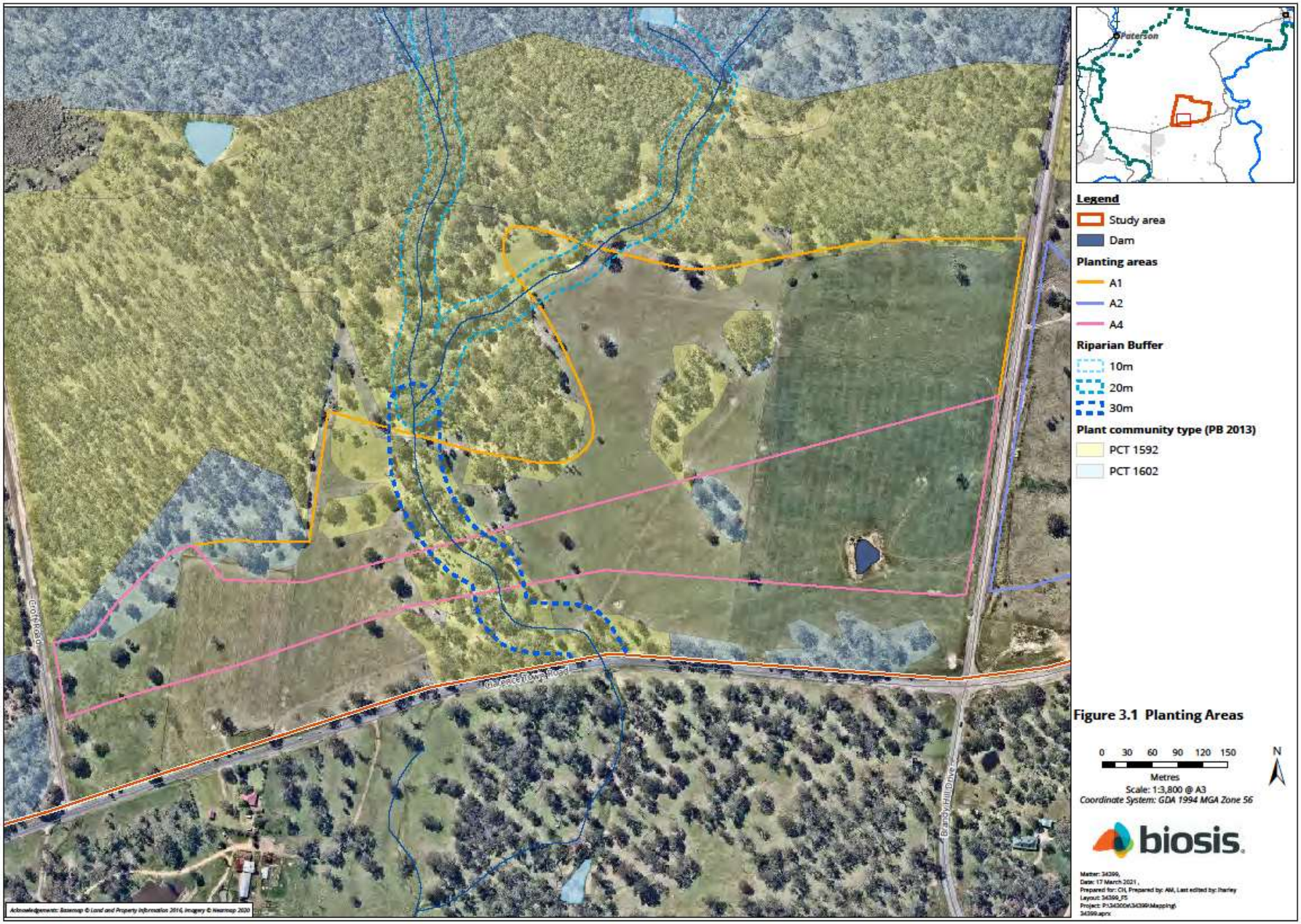
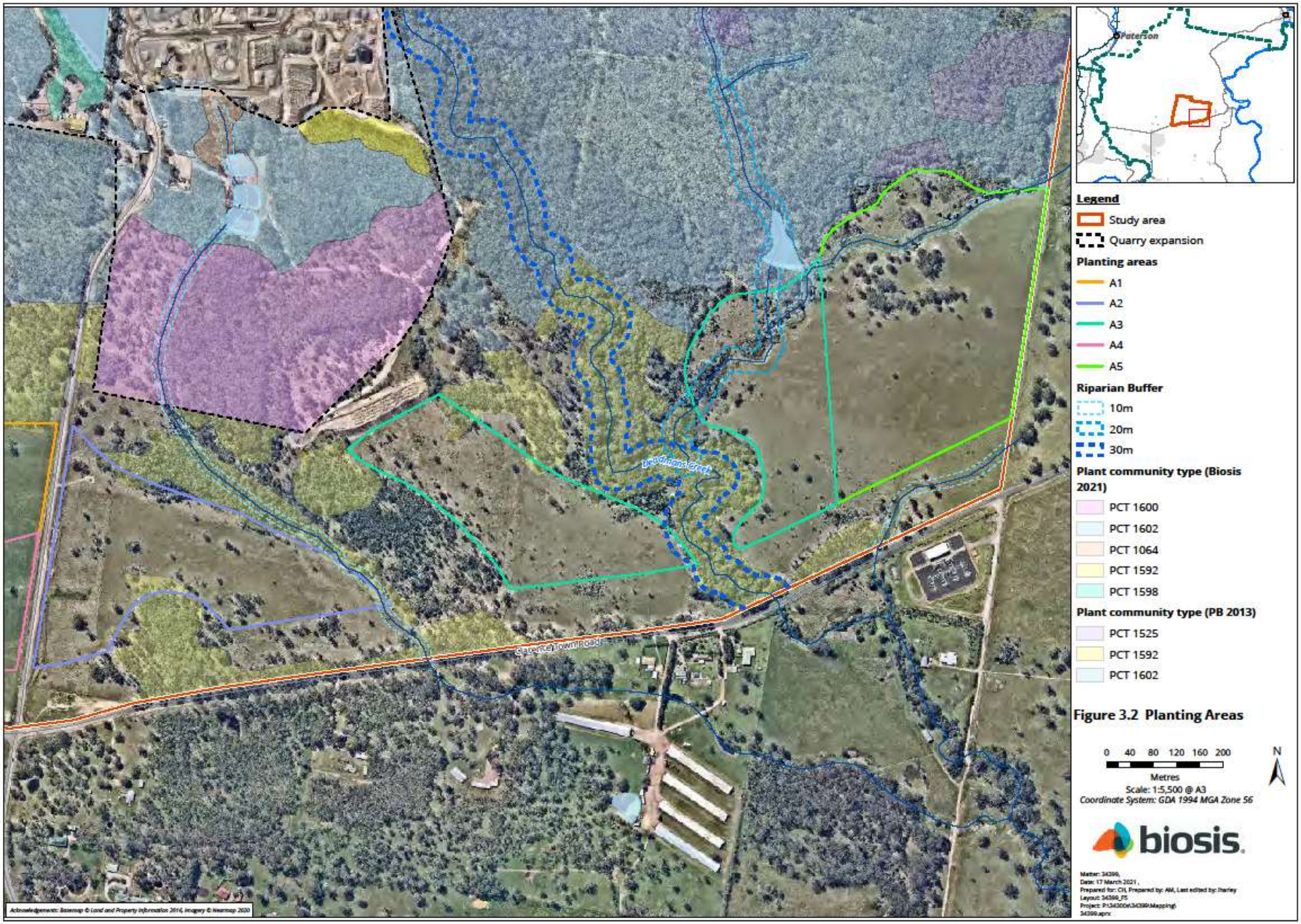


Figure 3.1 Planting Areas


Paterson
Legend
Study area
Quarry expansion
Planting areas
A1
A2
A3
A4
A5
Riparian Buffer
10m
20m
30m
Plant community type (Biosis 2021)
PCT 1600
PCT 1602
PCT 1064
PCT 1592
PCT 1598
Plant community type (PB 2013)
PCT 1525
PCT 1592
PCT 1602
Figure 3.2 Planting Areas
0 40 80 120 160 200
Metres
Scale: 1:5,500 @ A3
Coordinate System: GDA 1994 MGA Zone 56
N
biosis
Gresleys Town Road
Acknowledgements: Basemap © Land and Property Information 2016, Imagery © Nearmap 2020

Appendix 2 Seed collection and propagation methods

Seed collection methods

To minimise negative impacts associated with seed collection, no more than 10% of the total seed available at the site (and from individual plants) should be collected in any one year (Ralph 1993). However, this is not applicable in the project footprint where all native vegetation is to be cleared. If seed is collected from adjoining retained areas however, the 10% rule applies. General considerations for seed collection include:

- Ensure seed is collected from as many individual plants as possible to maximise genetic diversity.
- Ensure seed is collected from stands or groups of plants rather than isolated plants, even if they carry large amounts of seed.
- Neighbouring plants are likely to be related so ensure that seed is collected from plants across the entire area.
- Approximately equal amounts of seed from each plant are to be collected.
- Ensure seed is collected from various parts of the plant (not just those easily accessible).
- Label each batch of seed collected with:
  - Species.
  - Location.
  - Date collected and collector's name.
  - Number of plants collected from.
  - Details on position in the landscape, percentage of seed ripe, soil type, and other relevant details.

Seed can be collected from tall trees by utilising fallen limbs and branches, or using a long-handled pruner. Seed on small trees and shrubs can be collected using secateurs or pruners, hand-picked, or the branches hand-stripped. A drop-sheet or tarpaulin under the plant can be used to catch fallen seeds and fruit when branches are shaken. For species which release their seed very quickly upon ripening (such as wattles and bush-peas), it may be worthwhile to tie paper bags or nylon stockings around the branches before the seed pods ripen (OEH 2011).

Timing of seed collection

Timing of seed collection is a critical consideration. Timing is mostly dependant on when the seed matures for each species and how long the seed remains on the plant after maturity. The peak seed collection period in NSW usually occurs from October to December. Although seed ripens generally the same time each year, seasonal variations and local climatic factors and conditions can lead to variations in timing from year to year (Ralph 1993).

Key indications of seed maturity include:

- Colour changes of fruits, seed heads or cones.
- Seed or fruit hardness.
- Dryness of fruits.
- Ease of removal.

- Opening of fruits.

Another consideration of seed collection is that many plants flower over a long period of time and therefore contain seeds of varying maturity. It is important to only collect the mature seed and a second or third visit to the plant may be required to allow time for all seed to mature.

Propagation

A nursery, local to the KHP area will be sourced at least 6 months to 12 months prior to construction and provided with the proposed planting list in Table 12, so that seed can be sourced and propagated for revegetation works on site. Seed collection will follow the procedure outline above.

All plants shall be true to scheduled nomenclature, well formed, hardened off and disease free nursery stock.

They shall be container grown in potting soil with a firmly established root system but with no large roots growing out of the container. No plant shall be pot bound.

The condition of plant stock should encourage future growth that is strong and typical of the species. Correct nursery/growing practices shall help ensure the long-term health and viability of the plant stock on site after planting.

The Bush Regeneration Contractor shall allow for an independent Horticultural certification of all stock prior to delivery to site that confirms the following:

- Stock is disease free and healthy.
- Rootball has adequately grown into the container appropriate to the specified size.
- Stock shows no evidence of spirally, being pot bound, or other undesired outcomes of growth at the nursery.

Appendix 3 Weed management measures

General weed management measures that will be undertaken prior to and during revegetation works:

- Use a range of weed management methods such as slashing or mowing (physical and mechanical control) as well as a range of herbicides (to avoid herbicide resistance).
- Mow/slash areas infested with weeds before they seed (avoiding native vegetation).
- Employ appropriate vehicle hygiene such as:
  - Clean machinery, vehicles and footwear before moving to a new location.
  - Securely cover loads of weed-contaminated material.
  - Dispose of weed contaminated soil at an appropriate waste management facility.
  - Remove weeds immediately and dispose of without stockpiling.
  - Separate weeds from native vegetation to be mulched – do not use weeds for mulch.
  - Minimise soil disturbance in weed infested areas.

Weed control methods adopted in the implementation of this KHP are based on a combination of the current site management, bush regeneration industry standards and botanical knowledge of the weeds. Techniques and methods recommended in following sections such as 'hand weeding' are described in detail in various publications such as *Recovering Bushland on the Cumberland Plain: Best practice guidelines for the management and restoration of bushland* (DEC 2005).The publication *New South Wales Weed Control Handbook: A guide to weed control in non-crop, aquatic and bushland situations, 7th Edition* (DPI 2018) provides descriptions on general and standard weed control methods.

Application of herbicide during weed control works will depend on species targeted and the growing situation. For example the selection of a herbicide and the application method for a particular species or class of plant will be determined by factors such as the degree of infestation of target species, limiting damage to off target native flora and preventing herbicides entering waterways. The DPI (2018) document cited above can be referred to as guide for specific herbicides, record keeping and herbicide application techniques.

Use of herbicides must be according to the NSW *Pesticides Act 1999*, Material Safety Data Sheets and labelling instructions for specific trade name herbicides and off label use permits registered with the APVMA. The use of herbicide as part of this KHP will be limited to direct application to cut stumps and spot spraying. Any contractors using herbicides on the site must be trained and appropriately qualified to do so (ChemCert Level 2 or equivalent for subordinates and ChemCert Level 3 or equivalent for supervisors).

Slashing can be used to prevent weeds from flowering and setting seed. This method can be undertaken with a tractor and slashing implement or by using a hand held brush cutter (DPI 2018). In addition DEC (2005) have highlighted that slashing or mowing can also be used in bushland areas (with grassy native understorey) as an initial or holding treatment to reduce weed mass. This allows for more efficient follow up as fast growing reshooting weeds can be spot sprayed with herbicide among areas of native grasses and herbs. DEC (2005) also suggest that to effectively control exotic annual herbs and grasses, mowing or slashing must be done at least monthly in summer (possibly more frequently if conditions are warm and wet and weed growth is accelerated). For perennial weeds which mature in mid to late summer, mowing or slashing can be reduced to two to three times each season, with the final treatment being applied late in the season ideally before fruit

ripens and seed becomes viable (DEC, 2005). Further simple techniques for reducing the potential for assisting the dispersal of weed species as a result of slashing are to:

- Slash from areas of dominated by native species to more degraded areas dominated by introduced species.
- Shake or wash down slashing implements in disturbed and managed areas prior to use in more intact areas.

In summary it is recommended that a combination of reducing the height and number of occasions slashing occurs and appropriate weed hygiene protocols be implemented.

Appendix 4 Recommended planting species list

The following canopy species list is consistent with vegetation types which occur onsite and are known to provide habitat and/or food for Koala (Table 3). Understory species are consistent with Spotted Gum / Grey Gum / Red Gum / Grey Box vegetation as described within this plan and the BAR. Species included below are known to be compatible with restoration works such as seed collection and propagation, while species likely to self-colonise (such as fruit bearing shrubs dispersed by birds and mammals) are largely omitted.

The recommended planting list in Table 12 is not exclusive and can be augmented with species recorded in the BAR or onsite by a qualified restoration ecologist. Key communities that have guided this list include; VZ1 (PCT1600), VZ2 (PCT1602) and VZ4 (PCT1592) as well as regional documents such as the *Port Stephens Comprehensive Koala Plan of Management 2002*.

Table 13 Recommended species planting list

Species name	Common name	Percentage of mix per strata
Overtstorey (Core)		
Eucalyptus tereticornis	Forest Red Gum	20
Eucalyptus parramattensis	Parramatta Red Gum	15
Eucalyptus robusta	Swamp Mahogany	15
Eucalyptus acmenoides	White Mahogany	15
Eucalyptus punctata	Grey Gum	10
Eucalyptus crebra	Narrow-leaved Ironbark	10
Corymbia maculata	Spotted Gum	5
Eucalyptus umbra	Broad-leaved White Mahogany	5
Casuarina glauca	Swamp Oak	5
Overstorey (supplementary)		
Eucalyptus umbra	Bastard White Mahogany	2-5
Eucalyptus canaliculata	Large-fruited Grey Gum	2-5
Eucalyptus globoidea	White Stringybark	2-5
Eucalyptus paniculata	Grey Ironbark	2-5
Allocasuarina torulosa	Forest Oak	2-5
Mid-storey		
Acacia falcata	Sickle Wattle	5 - 10
Acacia implexa	Hickory Wattle	5 - 10
Acacia irrorata	Green Wattle	5 - 10
Acacia longifolia	Sydney golden wattle	5 - 10

Acacia ulicifolia	Prickly Moses	5 - 10
Breynia oblongifolia	Coffee Bush	5 - 10
Bursaria spinosa	Blackthorn	5 - 10
Daviesia ulicifolia	Gorse Bitter Pea	5 - 10
Leucopogon juniperinus	Prickly Beard-heath	5 - 10
Maytenus silvestris	Narrow-leaved Orangebark	5 - 10
Melaleuca nodosa	Ball Honey-myrtle	5 - 10
Melaleuca styphelioides	Prickly-leaved Tea Tree	5 - 10
Understory		
Aristida vagans	Three-awn Speargrass	20 - 60
Cymbopogon refractus	Barbed Wire Grass	20 - 60
Dianella caerulea* var. *producta	Blue Flax-lilly	5 - 10
Echinopogon ovatus		20 - 60
Entolasia stricta	Wiry Panic	20 - 60
Gahnia aspera	Rough Saw-sedge	5 - 10
Lepidosperma laterale	Variable Sword-sedge	5 - 10
Lomandra confertifolia	Mat-rush	5 - 10
Lomandra filiformis	Wattle Mat-rush	5 - 10
Lomandra longifolia	Spiny-headed Mat-rush	5 - 10
Lomandra multiflora	Many-flowered Mat-rush	5 - 10
Themeda triandra	Kangaroo Grass	20 - 60
Rytidosperma fulva	Wallaby Grass	20 - 60