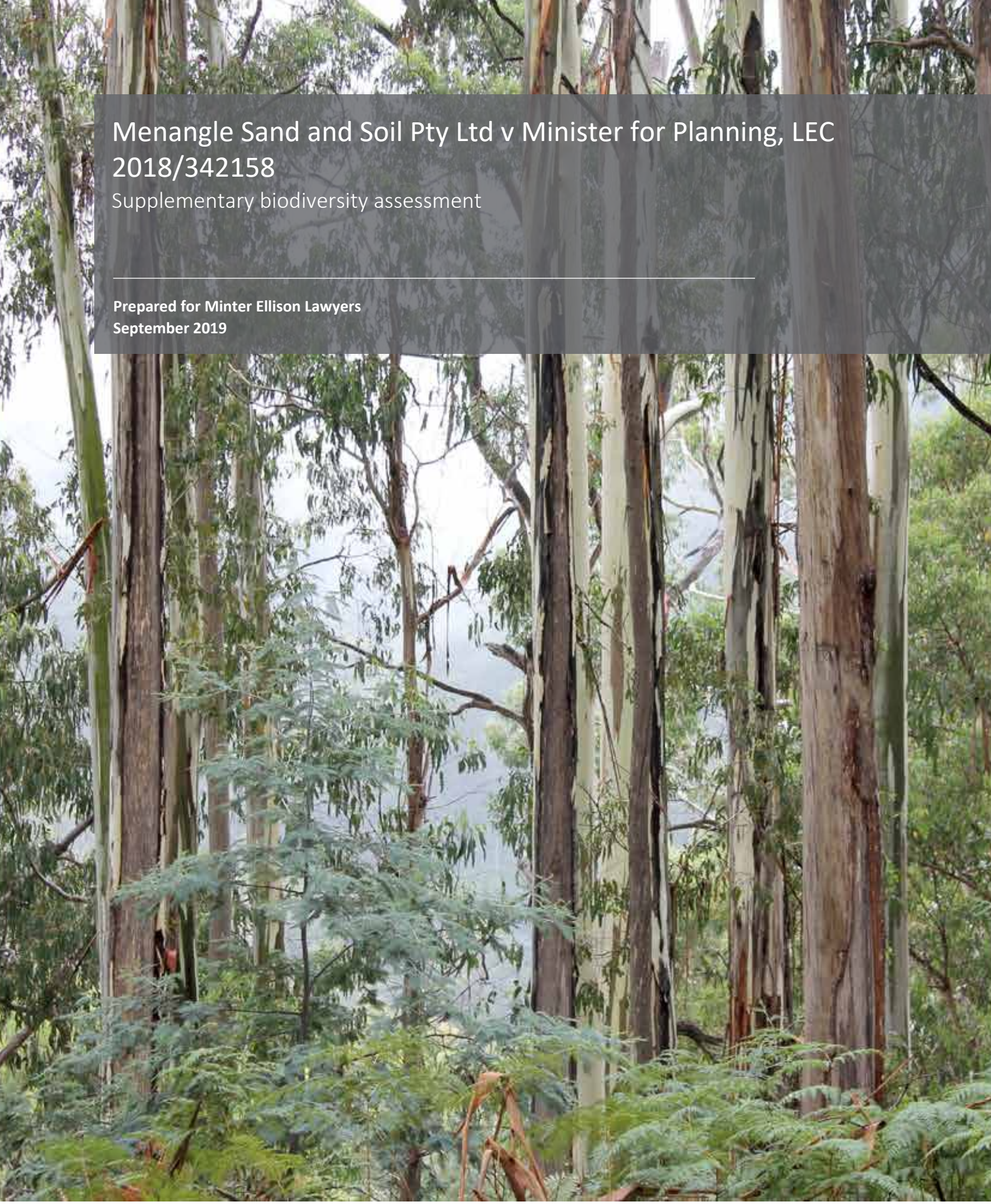
Menangle Sand and Soil Pty Ltd v Minister for Planning, LEC 2018/342158

Supplementary biodiversity assessment

Prepared for Minter Ellison Lawyers
September 2019



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Menangle Sand and Soil Pty Ltd v Minister for Planning, LEC 2018/342158

Supplementary biodiversity assessment

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Minter Ellison Lawyers

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1 Introduction

1.1 Background

The *Menangle Quarry Extension Environmental Assessment* (EMM 2017a) was exhibited in January 2017. The project application was subsequently refused by the Minister for Planning on 25 October 2018. Menangle Sand and Soil Pty Ltd has appealed the refusal through the NSW Land and Environment Court (LEC).

A section 34 conciliation conference was held on 14 June 2019 regarding Menangle Sand and Soil Pty Ltd v Minister for Planning LEC Proceedings (2018/342158), presided by Commissioner Chilcott. During the conference, the respondent (Department of Planning, Industry and Environment (DPIE)) committed to working with the applicant (Menangle Sand and Soil Pty Ltd) to resolve outstanding contentions, and to allow the respondent to provide further information on the environmental impact of the proposal.

1.2 Information requirements

The DPIE requested additional information regarding the Extension Project (the project) in D. Holm's 14 June 2019 letter.

Table 1.1 lists the matters relevant to ecology and biodiversity offsets and outlines how and/or where these requirements have been addressed in this report.

Table 1.1 Ecology and biodiversity offset requirements

Requirement	How/where the requirement has been addressed
4) Ecology requirements	
• Prepare assessments of significance under Part 7a of the *Fisheries Management Act 1994 for the following matters:* – Sydney Hawk Dragonfly (*Austrocordulia leonardi*); – Degradation of riparian vegetation along NSW watercourses (key threatening process, or KTP); – Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams (KTP); – Removal of large woody debris from NSW rivers and streams (KTP).	This requirement has been addressed through the preparation of a separate aquatic assessment by Marine Pollution Research.
• Prepare assessments of significance under Part 7 of the *Biodiversity Conservation Act 2016* for the following matters: – Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (KTP); – Removal of dead wood and dead trees (KTP).	Refer to Chapter 5.
• Based on the assessments above, indicate whether the proposal would have a significant impact on listed threatened species, populations and ecological communities, and whether the proposal would increase the impact of a KTP.	Refer to Chapter 5.

Table 1.1 Ecology and biodiversity offset requirements

Requirement	How/where the requirement has been addressed
• Improve precision of mapping of the River-flat Eucalypt Forest endangered ecological community (EEC) in the Stage 3 area (where warranted) and Stage 8 proposed extraction and restoration (proposed offset) areas, where warranted, to ensure that decisions around impacts and offsets are based on the best available information. This is expected to require further field verification, particularly at the intersection of alluvial and sandstone material.	Refer to Section 2.3 and 3.2.
• Undertake a comparison of the proposed 'swap' areas (ie Stage 3 and part of Stage 8) that comprise River-flat Eucalypt Forest EEC. – Use a recognised method to do this and ensure that the two areas can be ecologically 'valued' to enable a reasonable comparison of their respective ecological value. As part of this, include survey/sampling of large trees (including diameter at breast height and approximate height) and tree hollow size class abundance to enable a comparative assessment of arboreal fauna habitat and the presence of large trees (which are likely to contribute significantly to bank stability). – Prepare a comparative assessment of the ecological value of the Stage 3 area with a suitably sized portion of the Stage 8 area and recommend the size and location of the part of Stage 8 that would be considered as suitably avoided through the non-disturbance of Stage 3.	Refer to Chapter 4.
5) Biodiversity offsets	
• As a result of the above investigations, recommend any changes to the proposed biodiversity offset strategy to ensure an appropriate offset for ecological impacts from the proposed Stage 8 project. Indicate what aspects and proportion of the offset strategy is additional to typical requirements to address the level of uncertainty resulting from the proposed surface disturbance in the restoration areas.	Refer to Chapter 6.

It is noted that responses to matters unrelated to biodiversity has resulted in a redesign of the project footprint. Furthermore, there has been additional consideration given to future weed management within the Stage 8 area in *Menangle Sand and Soil - Weed Management in the Restoration Area* (EMM 2019a).

This report presents and assesses the updated footprint as described in *Menangle Quarry - Amended Extraction Area and Setback* (EMM 2019b) and provides an updated assessment of the ecological outcomes of the amended proposed works. This includes amendments to the proposed biodiversity offsets.

1.3 Purpose of this report

The purpose of this report is to provide additional information that satisfies the information requirements in Table 1.1. It is intended that this supplementary biodiversity assessment is read in conjunction with the *Menangle Quarry Extension Terrestrial Biodiversity Assessment* (EMM 2017b), as the material presented draws on and updates the previous survey and assessment.

2 Method

2.1 Review of previous biodiversity assessment

The vegetation mapping and plot locations in the *Menangle Quarry Extension Terrestrial Biodiversity Assessment* (EMM 2017b) were reviewed. Map shapefiles were imported into ArcGIS Collector for use during field surveys.

2.2 Tree assessment

Tree data was recorded from three locations in the Stage 3 area, and four plots in the Stage 8 area, given its larger comparative size (Figure 2.1)

Where possible, tree data were recorded at the same location as the floristic plots presented in EMM (2017b). Within the Stage 8 area it was not possible to access the prior plot locations, due to very dense weed cover, and alternative locations were visited. It is noted that tree plot 6 is within the extraction area, tree plots 4 and 5 just to the west of the extraction area, and tree plot 7 to the north of the extraction area. Data was recorded from both live and dead trees.

A tree stem size class assessment adapted from the *Biodiversity Assessment Method* (OEH 2017) was conducted at each location. The diameter at breast height (DBH) of each tree was recorded within a 50 x 20 m plot, and trees were classified into the following stem classes:

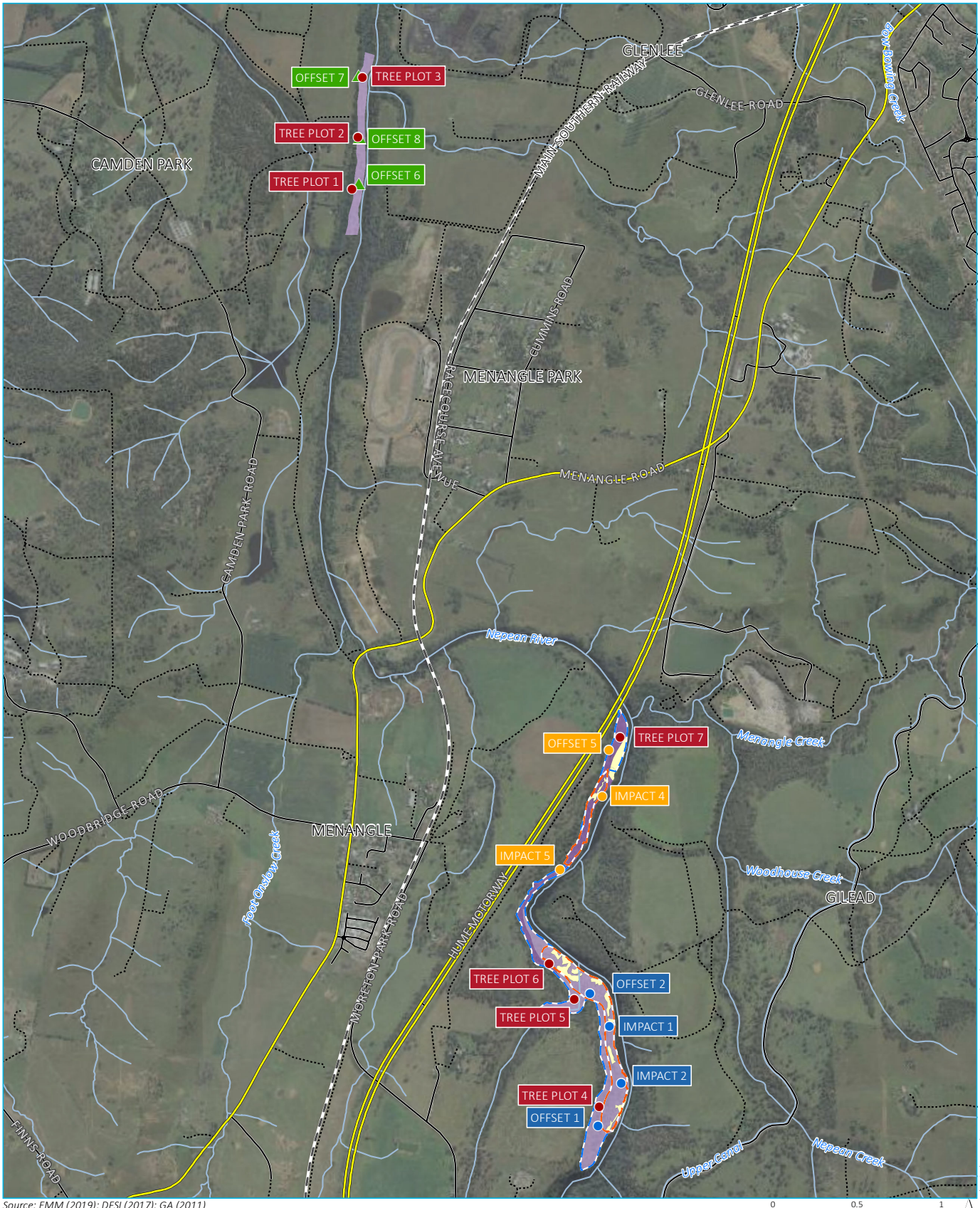
- 30–49.9 cm;
- 50–79.9 cm; and
- 80+ cm.

The number of trees within each stem size class was counted. The low, dense canopy of the exotic trees and shrubs prevented a thorough assessment of the size and quantity of tree hollows in native trees and of tree height. Therefore, hollows were assessed on a presence/absence basis and tree height was approximated based on visual observations.

To establish and compare the value of trees in the Stage 3 and Stage 8 areas, the following factors were considered:

1. The average number of trees greater than 30 cm DBH recorded in the 50 x 20 m plots, converted into trees per hectare.
2. The average number of trees greater than 80 cm DBH recorded in the 50 x 20 m plots, converted into trees per hectare.
3. The average number of hollow-bearing trees for each size class, converted into hollow-bearing trees per hectare.
4. Site value scores from plot data.

The ratio of each factor was calculated (ie Stage 3: Stage 8) to compare values. The individual values for the Stage 3 and Stage 8 areas were summed, and converted to a ratio to enable an overall comparison of the values between the areas.



Source: EMM (2019); DFSI (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

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KEY

- Amended stage 8 - extraction area
- Amended stage 8 - restoration area
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line

Ecological survey locations

- Stage 3 plots
- RFEF (River-Flat Eucalypt Forest) poor condition plots
- RFEF (River-Flat Eucalypt Forest) moderate condition plots
- Tree plot location

- Cleared

Revised plant community type

- River Flat Eucalypt Forest EEC (moderate to good)
- River Flat Eucalypt Forest EEC (low)

Location of tree plots and vegetation plots

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Figure 2.1

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2.3 Vegetation boundary refinements

Ecologists (Katie Diver and Ryl Parker) reviewed the River-flat Eucalypt Forest endangered ecological community (EEC) boundaries mapped in EMM (2017b) for the Stage 3 area and the proposed Stage 8 extraction and restoration (proposed offset) areas via fieldwork conducted on 9 and 10 July 2019. As the eastern extent of River-flat Eucalypt Forest in the Stage 8 extraction area is bounded by the Nepean River, focus was placed on refining the western boundary of the proposed restoration area, at the intersection of alluvial and sandstone material. The entire western boundary of the Stage 8 restoration area was walked.

A change is terminology is noted, with areas previously referred to as "low" condition (EMM 2017b) described and mapped in this report as being in "poor" condition.

Floristic data was collected from ten rapid vegetation points (RVPs) (Figure 2.2), and observations were taken of soil present. The three most common species in each stratum were noted and used to define the boundary between River-flat Eucalypt Forest EEC in the floodplain, and Cumberland Plain Woodland CEEC or Shale/Sandstone Transition Forest EEC upslope of the floodplain.

At the boundary, the main species used to indicate and define the boundaries for the vegetation communities were:

- Cumberland Plain Woodland:
  - Grey Box (*Eucalyptus moluccana*);
  - Narrow-leaved Ironbark (*Eucalyptus crebra*); and
  - Blackthorn (*Bursaria spinosa*).
- River-flat Eucalypt Forest:
  - Bangalay x Sydney Blue Gum (*Eucalyptus bangalay x saligna*)
  - Rough-barked Apple (*Angophora floribunda*);
  - Forest Redgum (*Eucalyptus tereticornis*);
  - River Peppermint (*Eucalyptus elata*); and
  - Grey Myrtle (*Backhousia myrtifolia*).
- Shale/Sandstone Transition Forest:
  - Grey Gum (*Eucalyptus punctata*); and
  - Narrow-leaved Ironbark (*Eucalyptus crebra*).

In addition to the above, the boundary of River-flat Eucalypt Forest adjacent to the bank of the Nepean River within Stage 8 was reviewed and adjusted where necessary using six maps photography at a scale of 1:250.

2.4 Revised impact and offset calculations

The direct impact (ie hectares removed) of River-flat Eucalypt Forest EEC in the Stage 8 extraction area was recalculated based on the amended footprint shown on Figure 2.3. Calculations were performed using a Development (for impacts) and Biobank (for conservation credit generation) site assessments using v4.0 of the

Biobanking calculator. It is noted that as the development is a major project, and thus the 'major project' form of assessment within the Biobanking calculator could have been used. However, the development calculations are the same, except that the major project calculator does not require offsets for endangered ecological community vegetation with a site value score of <17, which did not apply in this instance, and therefore this did not impact upon the credit calculations. The footprint and delineation of the Stage 8 extraction and restoration areas was amended (EMM 2019b) as part of the LEC proceedings. This was informed by the outcomes of the revised geomorphology assessment prepared by Fluvial Systems (2019, test pits at the site and the outcomes of the vegetation boundary mapping. The available land for land-based offsets for the Stage 8 area was re-calculated.

The mapped locations of the vegetation plots were reviewed (Figure 2.1). Because both the vegetation mapping boundaries and the extraction and the restoration area boundaries have changed since the original assessment, the utilisation of the plots for the credit calculations was reviewed. It was found that insufficient plots were available for assessment according to the FBA and Biobanking methods for impact on moderate condition River-flat Eucalypt Forest, and for restoration of poor condition vegetation. The vegetation plots for the stage 8 area were thus grouped into two groups; those within moderate condition vegetation, and those within poor condition vegetation. These groupings were irrespective of whether they were within the impact or restoration area, and this data was used for both impact and restoration area credit generation. Plots were not utilised where they had been identified in the field as being part of Shale/Sandstone Transition Forest, or where they occurred outside of mapped vegetation.

The footprint of impact area (extraction area) and conservation area (offset area) changed as a result of the review of the extraction design requested by DPIE. The plot data utilised was changed to reflect these changes. This inadvertently meant that some plots previously performed within the impact area, changed to being within the offset area. Furthermore, the more detailed vegetation boundary mapping also resulted in one plot location moving outside of the mapped extent of River-flat Eucalypt Forest. In summary, the vegetation plots not utilised were:

- Impact plot 3 – was identified as being located within Shale-Sandstone Transition Forest based on plot notes, and therefore was not utilised;

- Impact plot 6 – was discarded due to vegetation boundary changes, and the GPS point being located outside of the mapped River-flat Eucalypt Forest (or in an ecotone), due to the boundary being moved eastwards after the detailed revision of boundary mapping;

- Offset plot 3 –was not utilised it was located within Shale-Sandstone Transition Forest; and

- Offset plot 4 - was within vegetation to the south which is not proposed to be developed or subject to conservation actions) and therefore was considered to not be from the local area, and was not utilised.

Vegetation plots are used to gather data on the overall condition of the vegetation from a vegetation zone. Merging of plots across the impact and offset zones is considered to be a reasonable assessment approach. Vegetation zones are considered to be "a relatively homogenous area of native vegetation on a development or biobank site that is the same PCT and broad condition state" (OEH 2014). Thus, using plot data from within the respective vegetation zone, irrespective of whether it is within the impact or offset areas, is appropriate as provides the data needed to assess the change (whether impact or gain). This is consistent with the approach under the previous Biodiversity Certification method (OEH 2015), as development and conservation footprints will commonly move in these proposals as footprints are refined, which is consistent with what has happened in this instance.

For the plots within the moderate condition River-flat Eucalypt Forest zone, one (Impact plot 4) is located just outside of the eastern edge of the impact zone, with two (Impact plot 5 and Offset plot 5) located at the western edge of lands to be conserved. The three plots are distributed along the length of the moderate vegetation zone. They are located close to the edges of the vegetation zone, though it is noted that the moderate vegetation zone is quite narrow, and thus their locations are considered reasonable and appropriate. For the poor condition River-flat Eucalypt Forest zone, three plots (Impact plot 1, Impact plot 2, and Offset plot 2) are now located within the revised

extraction area, and one (Offset plot 1) is located within the proposed conservation zone. These plots are distributed along the poor condition vegetation, with all plots located away from edges, and their locations are considered reasonable and appropriate.

Plots conducted within the Stage 3 area were used to assess the vegetation integrity for this area. The plot data utilised is presented in Table 2.1.

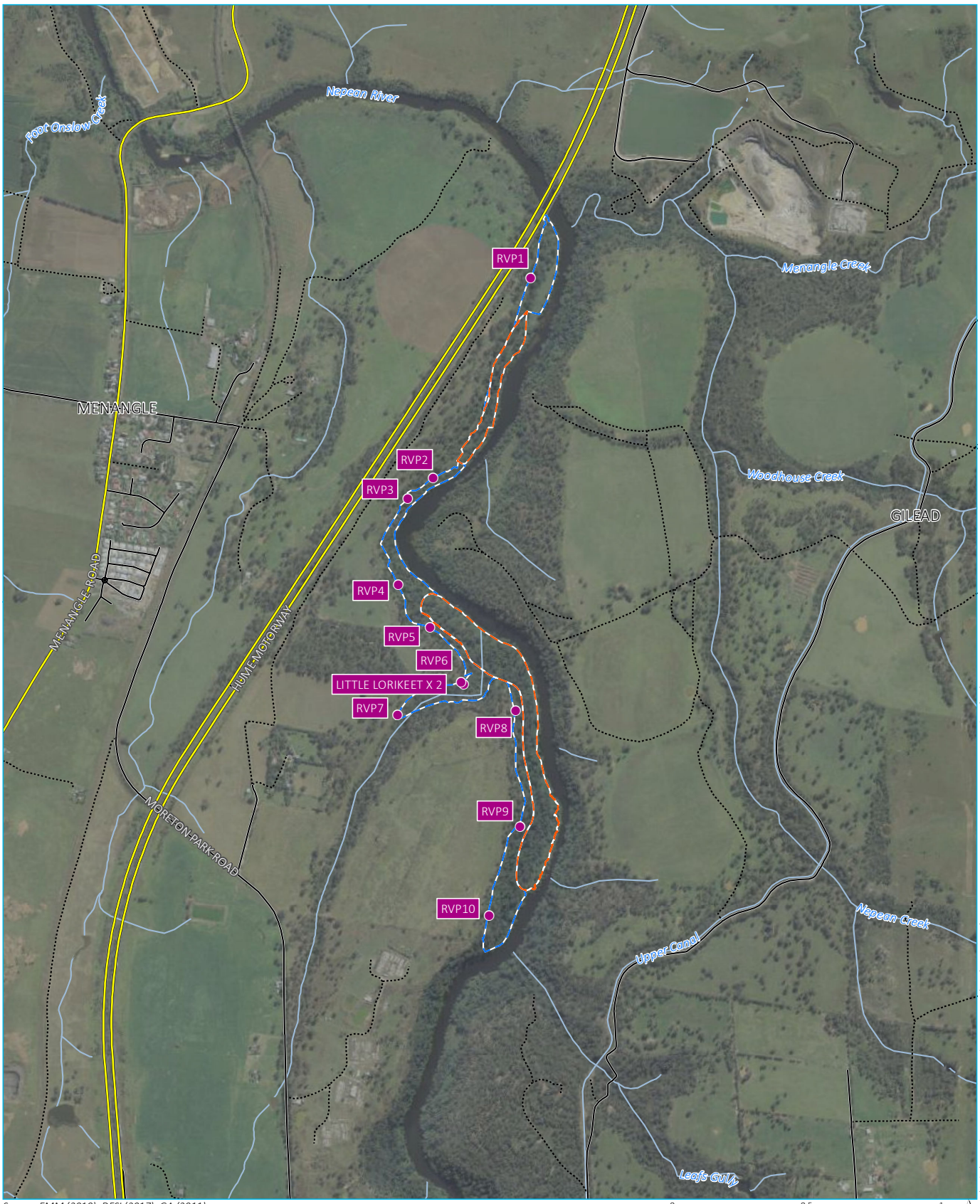
The updated areas and plot data were used to revise the number of residual credits required by the project (following subtraction of the Stage 3 area where the consent will be surrendered).

The credits generated by the Stage 8 restoration area were reviewed in relation to the management works proposed to be conducted, and the value of offset credit generation recalculated based on scores assigned to each attribute (Section 6.3).

Table 2.1 Plot data used

Vegetation Zone and Plot Id	Attributes									
	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL
Stage 8 Moderate										
Impact plot 4	8	4.6	0	40	0	0	50	1	0	10
Impact plot 5	11	9	5.5	100	0	0	100	2	0	5
Offset plot 5	8	20.5	1	20	0	20	70	2	0	12
Stage 8 Poor										
Impact plot 1	8	12	0	0	1	6	12	2	0	20
Impact plot 2	5	4.5	29.5	0	0	0	36	3	0	5
Offset plot 1	7	17.5	10	20	20	0	70	1	0	25
Offset plot 2	3	20	0.5	0	0	0	100	1	0	31
Stage 3										
Offset plot 6	2	10	0	0	0	0	0	1	0	73
Offset plot 7	4	4	2	2	0	0	100	2	0	195
Offset plot 8	3	72	0	0	0	0	100	6	0	95

* NPS = Native plant species, NOS = Native overstorey cover, NGCG = native groundcover grasses, NGCS = native groundcover shrubs, NGCO = native groundcover other, EPC = exotic plant cover, NTH = number of trees with hollows, OR = overstorey regeneration, FL = fallen logs.



Source: EMM (2019); DFSI (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

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KEY

- Amended stage 8 - extraction area
- Amended stage 8 - restoration area
- Rapid vegetation point
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line

Note: Stage 3 tree assessment plots at the same locations as biobanking plots 6, 7 and 8.

Rapid vegetation points for vegetation boundary assessment

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Figure 2.2

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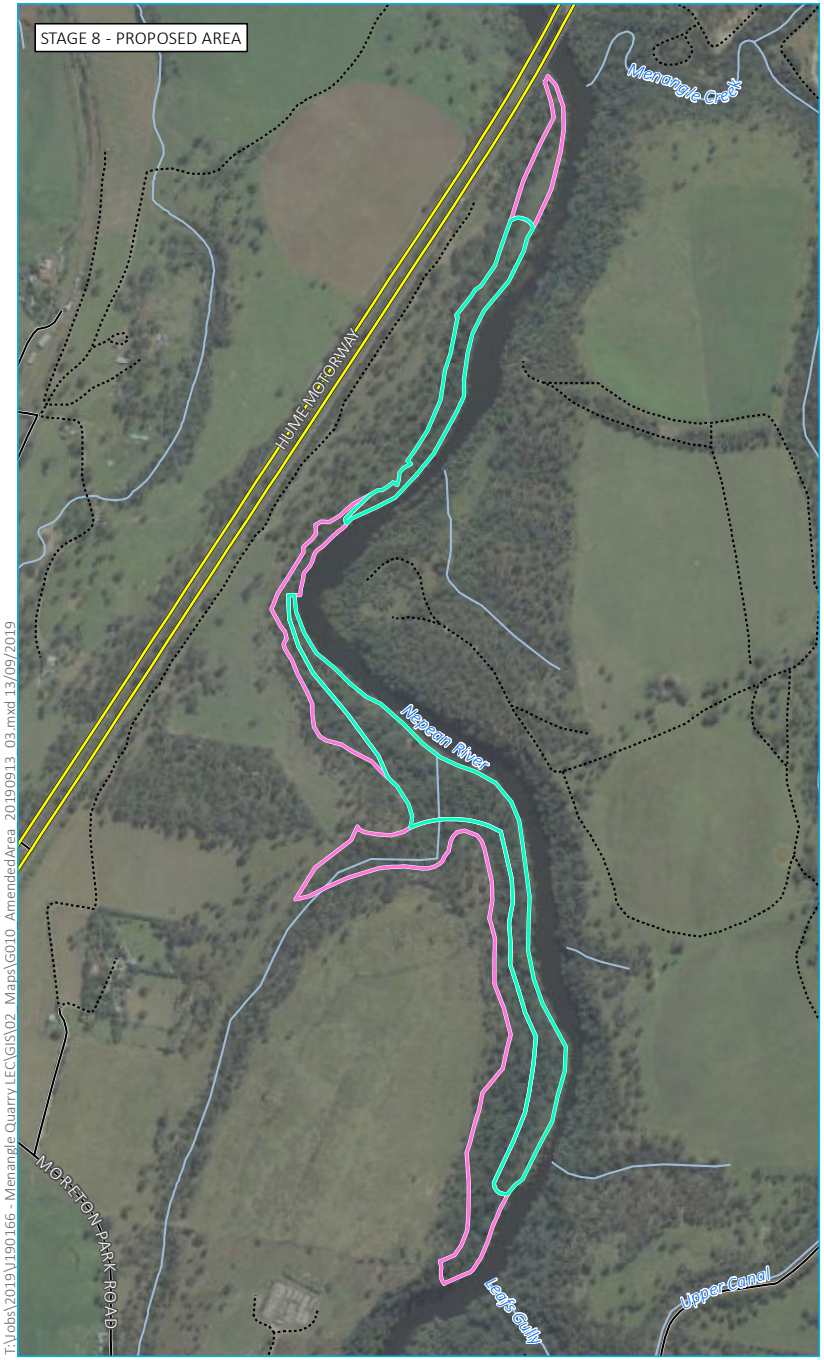

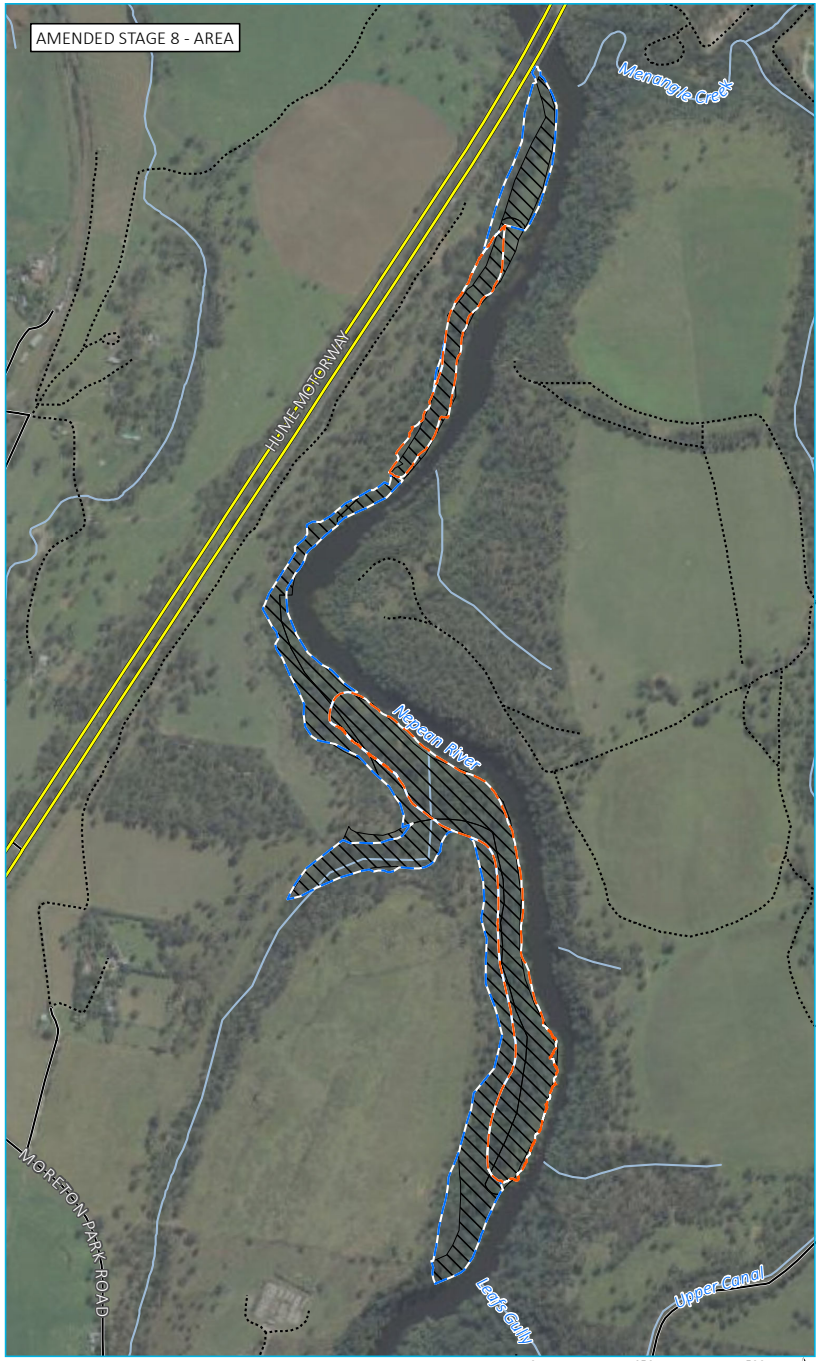

KEY

- Stage 8 - Proposed extraction area
- Stage 8 - Proposed restoration area
- Amended stage 8 - extraction area
- Amended stage 8 - restoration area
- Previous restoration and extraction area
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line

Note: Adjustments to the riverbank boundary made using six maps photography at a scale of 1:250. It is noted that there are variations in the extent of aerial photography at the larger scale shown on this figure

T:\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps\G010_AmendedArea_20190913_03.mxd 13/09/2019

Source: EMM (2019); DFSI (2017); GA (2011)

0 250 500 m

GDA 1994 MGA Zone 56

N

Amended stage 8 extraction and restoration area

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Figure 2.3

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3 Results

3.1 Tree assessment

The height of all trees was estimated to range between 40 to 50 m with both the Stage 3 and Stage 8 area (both impact and offset areas) consistently, while most hollows were estimated to be 10 cm diameter or greater (noting that the BBAM definition of a hollow was utilised, ie with hollows with a minimum entrance width of 5 cm and appears to have depth (ie you cannot see solid wood beyond the entrance), and at least 1 m above ground level are counted).

Photographs from each tree assessment plot are shown in Table 3.1. In many photographs the presence of large trees is obscured by the thick understorey weed cover.

Table 3.1 Tree plots

Tree plot #	Photograph at transect end
1	

Table 3.1 Tree plots

Tree plot #	Photograph at transect end
2	
3	

Table 3.1 Tree plots

Tree plot #	Photograph at transect end
4	
5	

Table 3.1 Tree plots

Tree plot #	Photograph at transect end
6	
7	

Table 3.2 presents the tree assessment results, comprising the DBH of trees within each stem size class, and the trees containing hollows within each stem size class. The site value scores have been added from plot data collected during the *Menangle Quarry Extension Biodiversity Assessment* (EMM 2017b). Initially, the mean average for each of these parameters was provided in Table 3.2. The ecology expert engaged by the Department of Planning, Travis Peake (Umwelt), suggested that a median average may be more appropriate. A median average identifies the point where half of the numbers are above and below it, and can avoid bias from large or small outlier data points. The median average is also presented in Table 3.2. Given the number of data points (three tree plots within Stage 3, and four tree plots within Stage 8), it is considered that the mean is the most appropriate average.

Travis Peake questioned whether the number of hollow bearing trees could have been underestimated. It is noted that tree plot 7, from the Stage 8 area, had the highest number of hollow bearing trees, despite being located the furthest from the extraction area (within the offset area). There is a mean average of 2 hollow bearing trees per plot, based on a total of 8 hollow bearing trees (all in trees >80 cm DBH) recorded across 4 plots (Table 3.2). This can be compared with data for hollow bearing trees from the site value plots which for the moderate vegetation zone which had an average of 1.67 hollow bearing trees per plot (values of 1, 2, and 2), and 1.75 hollow bearing trees per plot (values of 2, 3, 1, and 1) within poor condition vegetation (Table 2.1). Thus, the data is consistent in identifying that the number of hollow bearing within the Stage 8 area is lower than within the Stage 3 area.

Table 3.2 Tree assessment results

Stage	Tree Plot	Stem size class (cm)				Trees containing hollows in each stem size class (cm)				Site value score
		30-49.9	50-79.9	80+	Total	30-49.9	50-79.9	80+	Total	
3	1	0	2	4	6	1	2	4	7	41.15
3	2	0	3	2	5	0	3	2	5	
3	3	2	4	6	12	2	3	4	9	
	Subtotal	**2**	**9**	**12**	**23**	**3**	**8**	**10**	**21**	
3	**Mean /ha ***	**6.7**	**30**	**40**	**76.7**	**10**	**26.7**	**33.3**	**70**	
	Median /ha *	**0**	**30**	**40**	**60**	**10**	**30**	**40**	**70**	
8	4	0	0	7	7	0	0	0	0	32.64
8	5	1	2	3	6	0	0	3	3	
8	6	0	0	2	2	0	0	1	1	
8	7	0	2	6	8	0	0	4	4	
	Subtotal	**1**	**4**	**18**	**23**	**0**	**0**	**8**	**8**	
8	**Mean /ha ***	**2.5**	**10**	**45**	**57.5**	**0**	**0**	**20**	**20**	
	Median /ha *	**0**	**10**	**45**	**65**	**0**	**0**	**20**	**20**	

* Number of trees converted to average number of trees per hectare by determining the average number of trees per plot and multiplying by 10 to convert to trees per hectare as a 50m by 20m plot covers 0.1 hectare.

3.2 Vegetation boundary refinements

The results of the rapid vegetation points are provided in Table 3.3. In the Stage 8 area, the boundary of the River-flat Eucalypt Forest in the northern restoration area was extended further west as it had been previously underestimated. The boundary of River-flat Eucalypt Forest was moved further east or south (ie reduced area) in the central restoration area, with several amendments made in the east and west in the southern restoration area. The boundaries of River-flat Eucalypt Forest in the Stage 3 area were found to be correct and were not amended as no other vegetation communities occur in this area. The revised boundaries of River-flat Eucalypt Forest are shown in Figure 3.1.

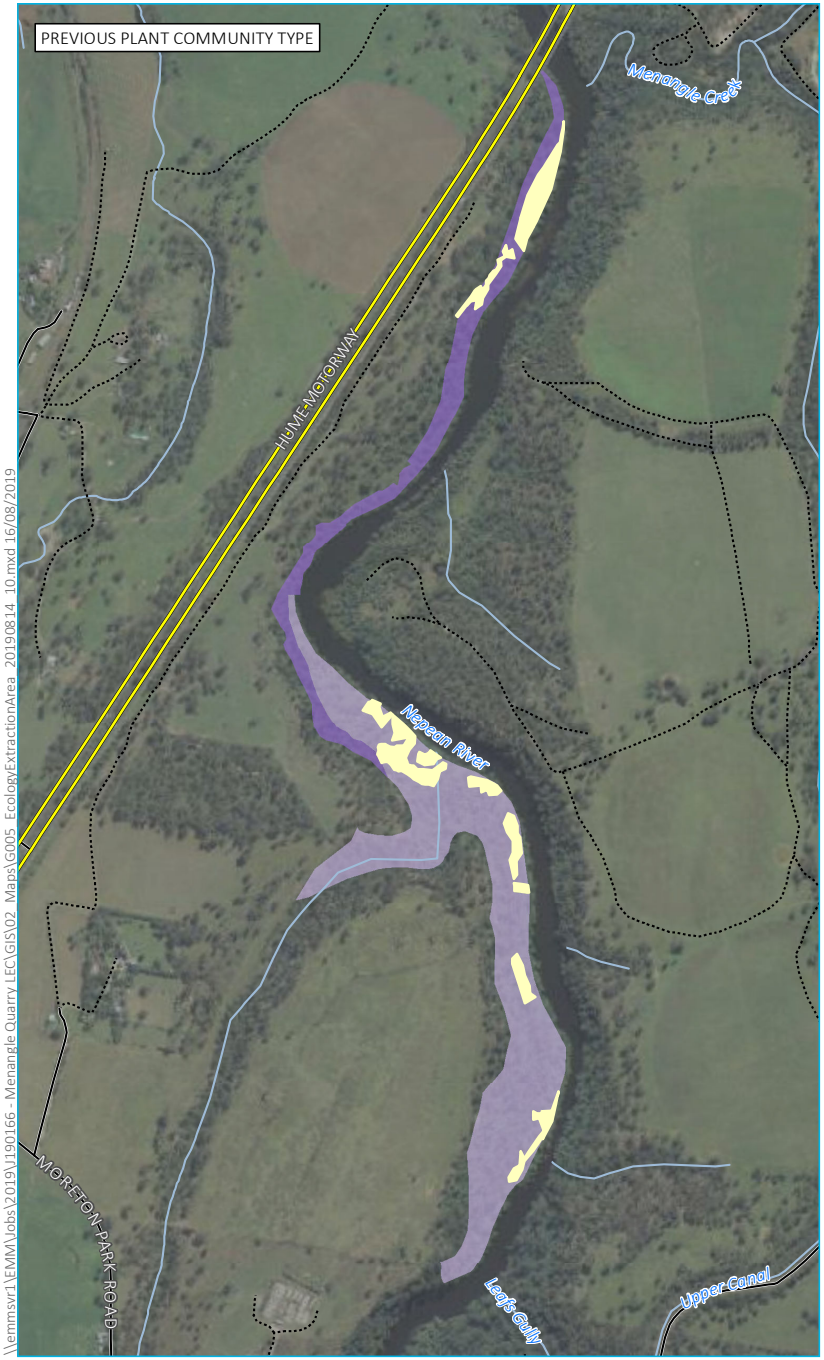
Table 3.3 Rapid vegetation point results

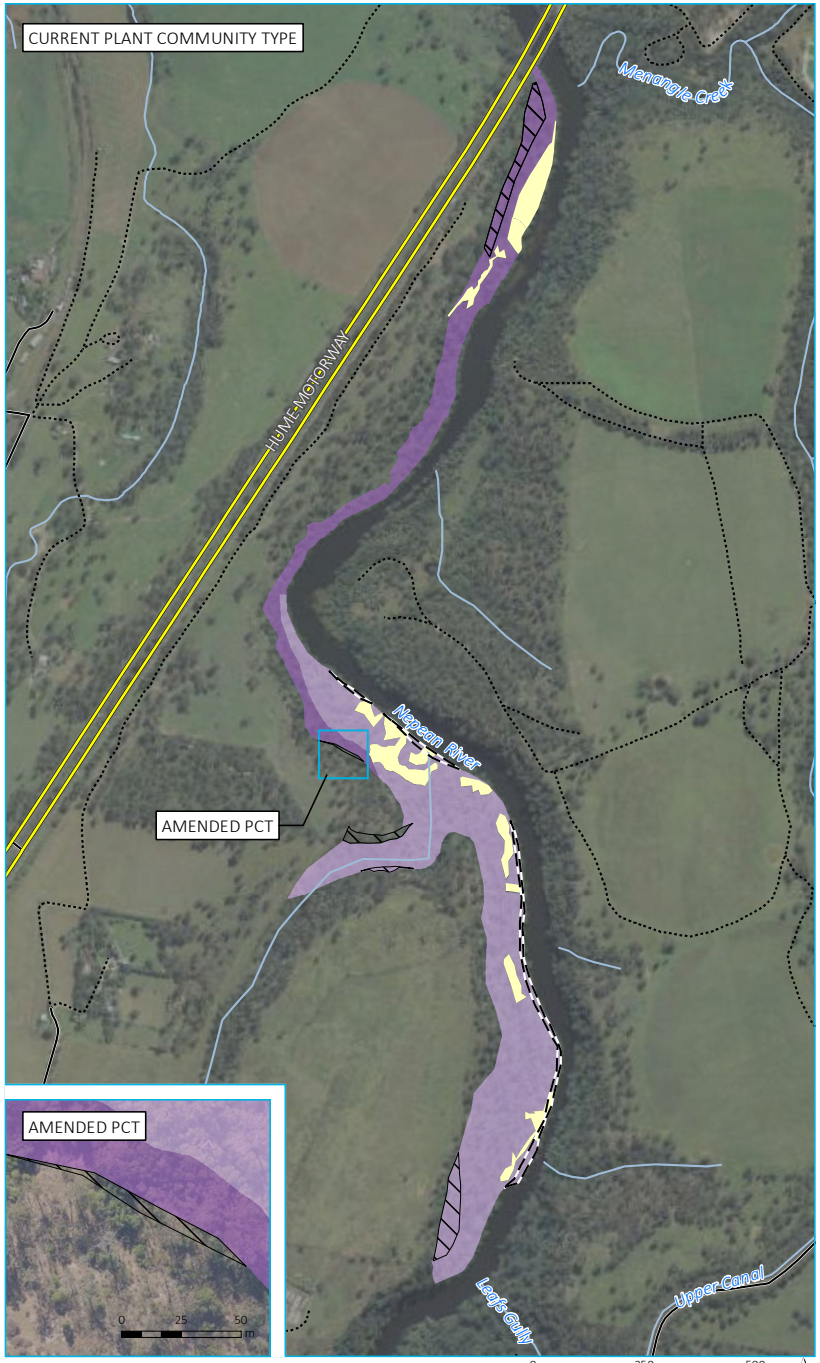
RVP #	Dominant Canopy	Dominant understorey (including climbers)	Dominant ground	Soil
1	Bangalay x Sydney Blue Gum (*Eucalyptus bangalay x saligna*) and Kurrajong (*Brachychiton populneus*)	Coast Myall (*Acacia binervia*), Coffee Bush (*Breynia oblongifolia*), African Boxthorn (*Lycium ferocissimum**), Lantana (*Lantana camara**)	Kikuyu (*Pennisetum clandestinum**), Slender Bamboo Grass (*Austrostipa verticillata*), Saltbush (*Einadia sp.*), Fireweed (*Senecio madagascariensis**), Australian Waterbuttons (*Cotula australis*)	Sandy loam with loose material that can be packed together
2	River Peppermint (*Eucalyptus elata*), Grey Myrtle (*Backhousia myrtifolia*)	Lantana*, Dodder-laurel (*Cassytha pubescens*)	Weeping Grass (*Microlaena stipoides*), Slender Bamboo Grass, Catsear (*Hypochaeris radicata**)	Same as RVP1
3	Forest Redgum (*Eucalyptus tereticornis*), Rough-barked Apple (*Angophora floribunda*)	Coast Myall, Grey Myrtle, Lantana*	Australian Waterbuttons, Weeping Grass, Slender Bamboo Grass, Fireweed*, Saltbush	Same as RVP1
4	Rough-barked Apple	Grey Myrtle, Lantana*, Broad-leaf Privet (*Ligustrum lucidum**)	Saltbush, Panic Veldt Grass (*Ehrharta erecta**), Maidenhair Fern (*Adiantum aethiopicum*)	Loose, with a sandy component
5	Forest Redgum, River Peppermint	Wild Olive (*Olea europaea**), Broad-leaf Privet*	Panic Veldt Grass*, Panic Grass (*Entolasia sp.*), Weeping Grass	Loose, with a sandy component
6	Rough-barked Apple, Forest Redgum	Grey Myrtle, Dodder-laurel	Nodding Blue Lily (*Stypandra glauca*), Saltbush, Wattle Mat Rush (*Lomandra filiformis*)	Only rocks and mulch; no soil
7	Rough-barked Apple	Grey Myrtle	Slender Bamboo Grass, Weeping Grass, Rock Fern (*Cheilanthes sp.*), Little Spurflower (*Plectranthus parviflorus*)	Not visible from cliffline
8	Bangalay x Sydney Blue Gum, Figtree (*Ficus sp.*), She Oak (*Casuarina glauca*), Wattle (*Acacia sp.*)	Sweet Bursaria (*Bursaria spinosa*), Lantana*, Dodder-laurel	Not visible, due to access from cliff	Not visible from cliffline
9	River Peppermint, She Oak, Rough-barked Apple	Lantana*, Grey Myrtle, Dodder-laurel	Saltbush	Not visible from cliffline
10	Rough-barked Apple, River Peppermint, She Oak	Broad-leaved Privet*, Lantana*, Grey Myrtle, Dodder-laurel	Unknown as covered by Lantana	Not visible from cliffline

* Denotes exotic plant species.

3.3 Opportunistic records

A pair of Little Lorikeets was opportunistically observed in the central restoration area during the rapid vegetation point survey (Figure 2.2). Little Lorikeets are listed as a vulnerable species under the NSW *Biodiversity Conservation Act 2016* (BC Act). An impact assessment is provided for this species in Section 5.3. In terms of biodiversity offsets, this species is included under the ecosystem credit assessment, which combines both vegetation and associated predicted threatened species values as the Little Lorikeet is classified as an ecosystem credit species.





KEY

- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Amended PCT area
- Amended riverbank

Plant community type

- River Flat Eucalypt Forest EEC (moderate)
- River Flat Eucalypt Forest EEC (Poor)

Note: Adjustments to the riverbank boundary made using six maps photography at a scale of 1:250. It is noted that there are variations in the extent of aerial photography at the larger scale shown on this figure

0 250 500 m

GDA 1994 MGA Zone 56

N

Source: EMM (2019); DFSI (2017); GA (2011)

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Revised vegetation mapping

Menangle Quarry Extension
Figure 3.1

EMM
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4 Value comparison of Stage 3 and Stage 8 areas

4.1 Value factors

Value factors (Section 2.2 and 3.1) are compared in Table 4.1 for Stage 3 and Stage 8 areas.

Table 4.1 Comparison of value factors

Analysis method	Trees >30 cm DBH/ha			Trees >80 cm DBH/ha			Hollows/ha			Site value score		
	Stage 3	Stage 8	Ratio	Stage 3	Stage 8	Ratio	Stage 3	Stage 8	Ratio	Stage 3	Stage 8	Ratio
Mean	76.7	57.5	1.3	40	45	0.9	70	20	3.5	41.1	Poor: 32.64	1.26
											Moderate: 31.42	1.31
Median	60	65	0.92	40	45	0.9	70	20	3.5	41.1	Poor: 32.64	1.26
											Moderate: 31.42	1.31

The Stage 3 area has higher values than Stage 8 for average trees >30 cm DBH/ha, and average hollows/ha. In particular, the Stage 3 area has a much higher average hollows per hectare (ratio of 3.5). The Stage 3 area has a slightly lower score for average trees >80 cm DBH/ha (ratio of 0.9).

The one item of difference between the mean and median averages is for the tree>30 cm DBH per hectare. In this instance, the median results in a lower score assigned to the Stage 3 area, and a higher score assigned to the Stage 8 area.

4.2 Overall value

The comparative value of the Stage 3 and Stage 8 areas was determined by summing the results for individual factors measured (Table 4.2). It is noted that the two factors trees >30 cm DBH and >80 cm DBH do involve some duplication of the trees which are >80 cm DBH. However, it is noted that removing this duplication this would further increase the overall ratio from surrendering the approval to clear the Stage 3 area, as the number of trees <80 cm DBH were higher in Stage 3 area compared to Stage 8 area. On this basis, overall, the Stage 3 area is 1.47 times higher value than the Stage 8 area based on mean values, or 1.30 times higher value than the Stage 8 area based on using median values (Table 4.2).

The ‘swap’ is proposed from the poor condition vegetation. It is noted that in this instance the value of the poor and moderate condition site value scores are flipped from where they would be intuitively be expected. That is, the site value score of the vegetation zone mapped as ‘poor’ has a site value score of 32.64, and the vegetation zone mapped as ‘moderate’ has a site value score of 31.42, which is slightly lower than the vegetation mapped as poor, even though visually it mapped as being in worse condition due to extremely dense weed cover.

It is noted that the ‘flipping’ of scores can occur with the methodology because each of the ten attributes are assigned an integer score of 0, 1, 2 or 3, and it depends how plot data results compares to benchmark values for a vegetation community (ie. the chance placement of plots can influence the attribute and overall scores). Further, despite the use of the terminology of moderate and poor to describe the two vegetation zones, it indicates that the two vegetation zones are in an overall similar ecological state, with degradation due to past disturbance and significant weed levels.

Therefore, it is appropriate to include the proposed land swap to reduce the impact of the Stage 8 restoration area, via surrender of the approval to clear and extract from the Stage 3 area. Despite the overall value of the surrender found to be worth considerably more than a 1:1 surrender, it is proposed that a 1:1 ratio surrender is used which is a reduction in impact of 5.68 ha. It is proposed that the 1:1 surrender occur from the poor condition vegetation zone, as this is the area that is considered to be most similar to the Stage 3 area. The finding that the Stage 3 area are worth a higher ratio value than 1:1 will more than outweigh the difference is site value scores between the poor (32.64) and moderate (31.42) vegetation zones within the Stage 8 area.

Table 4.2 Overall value of Stage 3 and Stage 8 areas

Factor	Mean Values			Median Values		
	Stage 3	Stage 8	Ratio	Stage 3	Stage 8	Ratio
Average trees >30 cm DBH/ha	76.7	57.5	1.33	60	65	0.92
Average trees >80 cm DBH/ha	40	45	0.89	40	45	0.89
Average hollow bearing trees/ha	70	20	3.50	70	20	3.50
Site value score	41.15	32.64	1.26	41.15	32.64	1.26
Overall sum and ratio value	227.85	155.14	1.47	211.15	162.64	1.30

5 Impact assessment

5.1 Direct impact

Following revision of the Stage 8 extraction area, the project will impact up to 11.0 ha of River-flat Eucalypt Forest. This assumes that all of the trees in the horizontal setback area will be cleared; however, it is now proposed to retain these trees (EMM 2019b). Surrender of the approval to quarry in the Stage 3 area, at a 1:1 ratio, will reduce this impact by 5.68 ha (refer to Section 4.2), making the total additional loss of River-flat Eucalypt Forest to 5.32 ha.

The revised areas of direct impact on River-flat Eucalypt Forest is shown in Figure 5.1, together with revised proposed restoration areas.

Sections 5.2 and 5.3 respectively below provide discussion of key threatening processes identified by DPIE for consideration, and update assessments of significance for threatened communities and species. The lower 1:1 reduction for surrender of the Stage 3 lands has been utilised for the purposes of the impact assessments.

5.2 Key threatening processes

This section provides discussion of the two key threatening processes specifically identified by DPIE for consideration (Table 1.1). It is noted that two other key threatening processes are also considered relevant and were already considered in EMM (2017b), and are considered in the assessments of significance, and are:

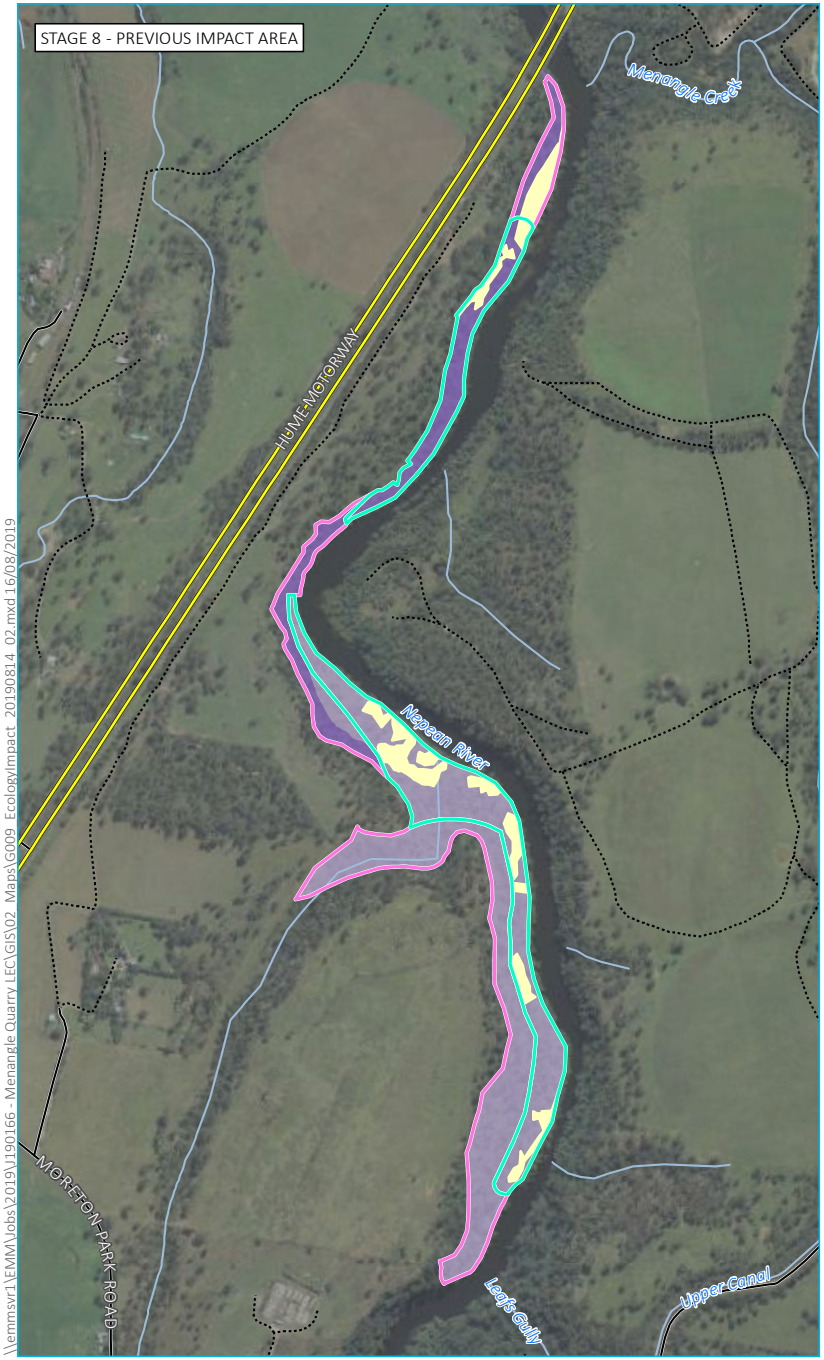
- The 'clearing of native vegetation' and fragmentation, with the destruction of one or more strata layers within a stand of native vegetation; and
- The 'loss of hollow-bearing trees'.

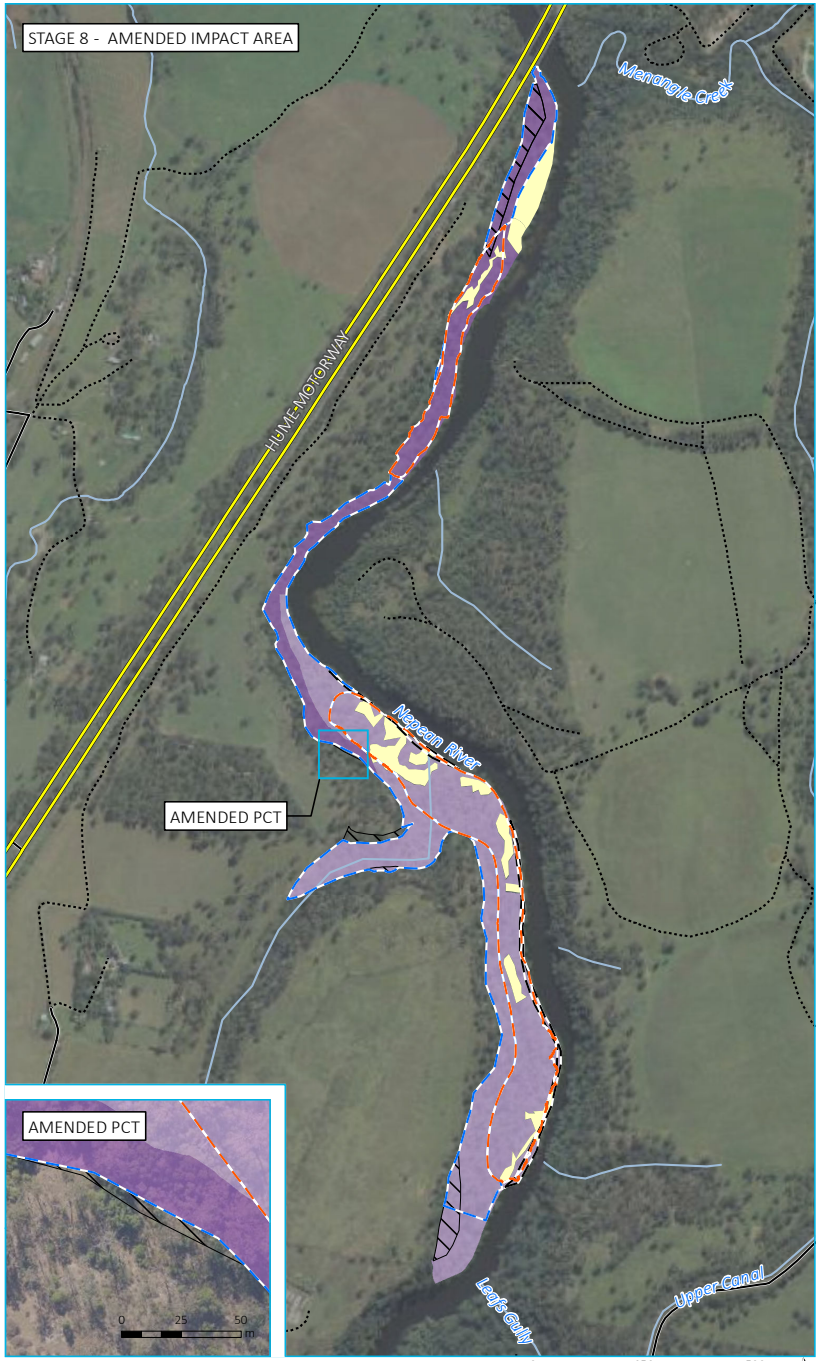
5.2.1 Alteration to natural flow regimes of rivers and streams and their floodplains and wetlands

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a factor contributing to loss of biological diversity and ecological function in aquatic ecosystems, including floodplains. Alteration to natural flow regimes can occur through reducing or increasing flows, altering seasonality of flows, changing the frequency, duration, magnitude, timing, predictability and variability of flow events, altering surface and subsurface water levels and changing the rate of rise or fall of water levels (NSWSC 2002).

Riparian zones can be altered as a result of change in flow patterns both from the catchment and along the length of the river. Such change in flows to and from floodplains can lead to bank erosion, reduced nutrient filtering capacity and changes to stream behaviour (NSWSC 2002).

The flow regime of the Menangle River is described in detail in Section 6.3 in Menangle Quarry Extension Response to *DoI Water Comments of 21 February 2018* (EMM 2018). The main channel of the Nepean River is lower than 64 mAHD and the water level remains in this channel over 99% of the time. The water flow will be unaffected by the proposed extraction activities when the river water level is in the main river channel, as the bank containing the channel will be left in situ during the proposed extraction works.





KEY

- Stage 8 - Proposed extraction area
- Stage 8 - Proposed restoration area
- Amended stage 8 - extraction area
- Amended stage 8 - restoration area
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Amended PCT area
- Amended riverbank

Plant community type

- River Flat Eucalypt Forest EEC (moderate)
- River Flat Eucalypt Forest EEC (Poor)

Note: Adjustments to the riverbank boundary made using six maps photography at a scale of 1:250. It is noted that there are variations in the extent of aerial photography at the larger scale shown on this figure

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Source: EMM (2019); DFSI (2017); GA (2011)

0 250 500 m

GDA 1994 MGA Zone 56

N

Revised direct impact on River-flat Eucalpyt Forest

Menangle Quarry extension
Figure 5.1

EMM
creating opportunities

The proposed works will not extract water, or directly alter the non-flood flow regime of the Nepean River. Floods with a level higher than 64 mAHD, with a flow that exceeds the capacity of the main river channel (approximately 100 m^3/s), will overtop the in situ bank adjacent to the extraction area where it is graded (EMM 2019b). Parts of the restoration areas will be inundated during floods. The water velocity in the extracted areas will be reduced compared to the velocities experienced currently due to the increased flow area available (Advisian 2018).

The proposal has adjusted how the lower riverbank and setbacks will be treated, which is discussed in EMM (2019b). In summary, there will be weed treatment of the lower riverbank, which will consist of the "cut and paint" method of weed treatment for large woody weeds so that the root mass is retained and continues to stabilise the soil. The proposal will now retain native trees (>0.1 m DBH) within the lower riverbank and the adjacent setback.

The quarry has operated based on this previous 10 m setback buffer since at least 1990 and this setback has successfully prevented scouring of the bank during operations. We understand that the setback was required by the Department of Water Resources based on the 1%-ile flow of the Nepean River, 100 m^3/s, which cause a water level of 63.4 mAHD, allowing an approximately 0.6 m freeboard safety margin to the crest of the bank. Retaining the existing vegetation on the riverbank further stabilises the bank from erosion. There is no evidence of significant erosion of the banks from floods in the proposed extraction areas.

In consideration of the above, it is considered that the project will not alter the natural flow regime of the Nepean River or its floodplain.

5.2.2 Removal of dead wood and dead trees

The removal of dead wood and dead trees includes: the removal of forest and woodland waste left after timber harvesting, collecting fallen timber for firewood, burning on site, mulching on site, the removal of fallen branches and litter as general tidying up, and the removal of standing dead trees.

Dead wood and dead trees provide essential habitat for a wide variety of native animals and are important to the functioning of many ecosystems. The removal of dead wood can have a range of environmental consequences, including the loss of habitat (as they often contain hollows used for shelter by animals), disruption of ecosystem process and soil erosion.

Removal of dead old trees (either standing or on the ground) results in the loss of important habitat such as hollows and decaying wood for a wide variety of vertebrates, invertebrates and microbial species (NSWSC 2003).

Standing dead trees comprise a component of the extraction and restoration areas. During tree plots in the restoration area, some dead trees were observed as being present. Many contained hollows, which was visually noted as being consistent with the extraction area. Fallen timber is also present in the extraction area, though recorded as from 5 to 31 m in length within plots in the Stage 8 area (Table 2.1), which is well below the benchmark of 50 m or greater woody debris per plot.

The impact of removing dead trees, logs and woody debris from the extraction area represents a permanent impact that will increase the impact of this KTP within the extraction area. Two actions are proposed to mitigate these impacts, namely:

1. The creation of additional nesting resources by either placing nestboxes in the restoration area or the creation of artificial hollows using a chainsaw in trees currently present (Rueegger 2017).

2. Retaining woody debris and logs from the extraction area and restoration area, and placing these resources into the offset area, extraction area, and lower riverbank. The active placement of logs and woody debris at least 0.10 m in diameter and greater than 0.5 m in length in a configuration that reflects natural systems, such that for restoration lands that there is overall ≥500 m of woody debris per hectare for the current moderate and poor condition lands, and ≥100 m of woody debris per hectare for the

current cleared lands. Further, for the extraction and lower riverbank zones also placement of ≥100 m of woody debris per hectare.

These actions will mitigate and reduce the impact from the loss of these resources and the impact of the KTP within the extraction area. It is also noted that these impacts are considered and quantified as part of the Biobanking method, through the hollow bearing tree and the log attributes.

5.3 Impact on listed threatened species and communities

Assessments of significance completed for the *Menangle Quarry Extension Biodiversity Assessment* (EMM 2017b) were completed using the former provisions under Section 5A of the *Environmental Planning and Assessment Act 1979,* or seven-part test. These tests were revised into the current assessment format defined in Section 7.3 of the BC Act, and now assess the KTPs, as described in Section 5.2.

Section 7.3 of the BC Act provides the criteria that must be considered in the assessment of the significance of potential impacts on relevant threatened communities or species. As the legislation has changed, and at the request of DPIE, assessments have been completed under the BC Act using the following five questions:

1. *In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.* (hereafter referred to as 'Life cycle of threatened species')

2. *In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:*

    a) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or*

    b) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.* (hereafter 'EEC extent and modification)

3. *In relation to the habitat of a threatened species or ecological community:*

    a) *the extent to which habitat is likely to be removed or modified as a result of the proposed development or action;*

    b) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or action;*

    c) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.* (hereafter 'habitat removal, fragmentation, isolation and importance')

4. *Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).* (hereafter 'critical habitat')

5. *Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of, a key threatening process.* (hereafter 'key threatening processes')

The following assessments of significance have been undertaken.

5.3.1 River-flat Eucalypt Forest and Shale Sandstone Transition Forest

River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregion is listed as an EEC under the BC Act and has been recorded within the riparian corridor. On the northern portion of the Stage 8 area, this EEC remains as a large patch of contiguous forest in good condition. In the southern portion of the Stage 8 area, this EEC remains as a semi-continuous patch in poor condition interspersed with cleared areas.

Shale Sandstone Transition Forest in the Sydney Basin Bioregion is listed as a critically endangered ecological community (CEEC) under the BC Act. On the southern part of the Stage 8 area, this CEEC is present as a small patch to the west of River-flat Eucalypt Forest.

An assessment of significance has been completed in accordance with Section 7.3 of the BC Act to assess the impact of the project on the two communities (Table 5.1).

Table 5.1 Assessment of significance for threatened ecological communities

Criteria	Discussion
1. Life cycle of threatened species	This question refers to threatened species, therefore is not relevant to this assessment.
2. EEC extent and modification	River-flat Eucalypt Forest is now restricted to less than 30% of its original extent. This community occupies 27 ha in the locality (ie within 5 km of the Stage 8 area). This community is present in the northern and southern Stage 8 area. In the northern area, it occupies a contiguous corridor of overall moderate to good condition. In the southern area, it occupies a semi-continuous corridor in poor condition and is interspersed with cleared land. Up to 11.00 ha of River-flat Eucalypt Forest will be directly impacted by the quarry, and the clearing of 5.68 ha will be avoided by not extracting the Stage 3 area (the replacement area). Therefore, up to 5.32 ha, comprising 2.35 ha in moderate to good condition and 2.97 ha in poor condition, will be cleared. This assumes that all of the trees in the horizontal setback area will be cleared; however, it is now proposed to retain these trees (EMM 2019b). This 5.32 ha represents 19.7% of this EEC community in the locality, but only approximately 0.09% of the 5,313 ha of the current extent of this EEC within the Cumberland Plain (DECCW 2010). The shrub layer of the River-flat Eucalypt Forest is dominated by invasive weeds including Large and Small-leaved Privet and Lantana, which are currently preventing the regeneration of the mature canopy eucalypts. Although mature trees will be removed, large areas of weed infestation and weed-infested soils will also be removed to allow for the re-establishment of native vegetation using species representative of River-flat Eucalypt Forest. Clearing of the River-flat Eucalypt Forest will occur in stages, with the maximum extent of the cleared (un-rehabilitated) extraction area being only 1 ha at any one time. Rehabilitation with representative species of River-flat Eucalypt Forest will occur in these 1 ha blocks following extraction completion. Employing the staged approach to clearing and rehabilitation and noting the success of previous rehabilitation efforts at the quarry, the project is not expected to have an adverse effect on the community such that its local extinction risk is increased. Shale Sandstone Transition Forest is now restricted to 22.6% of its original extent. This community occupies 33 ha in the locality. The clearing of this community has been avoided through the design and therefore no direct impacts will occur. The project will remove large areas of weed infestation and weed-infested soil that may cause invasion in the adjacent Shale Sandstone Transition Forest. Accordingly, the project will aim to have a positive impact on the adjacent Shale Sandstone Transition Forest through reduced competition with invasive weed species.

Table 5.1 Assessment of significance for threatened ecological communities

Criteria	Discussion
3. Habitat removal, fragmentation, isolation and importance	The project would remove up to 11.00 ha and avoid the approved clearing of 5.68 ha of River-flat Eucalypt Forest, resulting in a residual clearing area of up to 5.32 ha. The impact will be minimised through progressive clearing and rehabilitation, with only 1 ha cleared at a time. Given the progressive clearing and rehabilitation of the River-flat Eucalypt Forest, fragmentation and isolation impacts are considered unlikely. The shrub layer of the River-flat Eucalypt Forest in the Stage 8 area is heavily infested with invasive weeds which is preventing natural regeneration of the canopy eucalypts from occurring. Although mature trees will be removed for the project, a large infestation of weeds and weed-infested soil will also be removed, providing an opportunity to restore the community to better condition in the long-term as the planted eucalypts mature in the rehabilitation area. Shale Sandstone Transition Forest will not be directly impacted by the project and therefore no vegetation clearing, fragmentation or isolation will occur. Shale Sandstone Transition Forest is a CEEC and therefore all remaining patches of the community are important to its survival.
4. Areas of outstanding biodiversity value	Areas of outstanding biodiversity value do not occur in the project area.
5. Key threatening processes	The project represents three key threatening processes, namely: • the 'clearing of native vegetation' and fragmentation, with the destruction of one or more strata layers within a stand of native vegetation; • the 'loss of hollow-bearing trees'; • the 'removal of dead wood and dead trees'; • the 'alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands'. These key threatening processes will be minimised through progressive clearing and rehabilitation, the installation of hollows in the adjacent restoration areas, and relocation of fallen and/or felled timber into the restoration area, and extraction area once extraction works are finished in an area.
Conclusions	The project is unlikely to have a significant impact on these threatened ecological communities as: • the approval to extract resource from Stage 3 is proposed to be surrendered, which will decrease the total impact on the community. The further work undertaken as part of this report has identified that the Stage 3 lands is of higher value on a number of attributes, and therefore is a reasonable exchange for the poor condition vegetation in the Stage 8 extraction area; • the River-flat Eucalypt Forest will be progressively cleared and rehabilitated in 1 ha areas which will reduce the amount of impact at any one point in time, with extraction progressing over 13–15 years; • large areas of weed infestation and weed-infested soils within the restoration area, extraction area, and lower riverbank will be removed and managed for long-term ecological outcomes, improving the future condition and viability of the community in the locality; and • the clearing of Shale Sandstone Transition Forest has been avoided through the design, and the western boundary mapping where the ecotone between the River-flat Eucalypt Forest and Shale Sandstone Transition Forest occurs has been further refined and confirmed from works undertaken to support this report.

5.3.2 Threatened woodland birds: Dusky Woodswallow (*Artamus cyanopterus cyanopterus*) and Little Lorikeet (*Glossopsitta pusilla*)

The Dusky Woodswallow is listed as a vulnerable species under the BC Act and has been recorded in the study area. The Dusky Woodswallow inhabits woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. This species has been recorded numerous times in the locality.

The Little Lorikeet is listed as a vulnerable species under the BC Act and was recorded opportunistically in the Stage 8 restoration area. The Little Lorikeet can be found in eucalyptus forest and nest in proximity to feeding areas. Foraging and breeding habitat is present in the Stage 8 area on the site in remnant eucalypt woodland.

An assessment of significance has been completed in accordance with Section 7.3 of the BC Act to assess the impact of the project on threatened woodland birds (Table 5.2).

Table 5.2 Assessment of significance for threatened woodland birds

Criteria	Discussion
1. Life cycle of threatened species	The project will not affect breeding habitat for the Dusky Woodswallow as the majority of breeding records for this species, as well as presence records within the breeding period, occur on the western slopes of the Great Dividing Range. A pair of Little Lorikeets were recorded in the Stage 8 restoration area, but not in the extraction area. Although potential breeding and foraging habitat is present in the extraction area, potential habitat to be removed for the project is unlikely to affect the life cycle of the species given the alternative and higher quality habitat to be retained adjacent to the Stage 8 area, and along the Nepean River in the locality.
2. EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
3. Habitat removal, fragmentation, isolation and importance	Up to 11.00 ha of potential foraging habitat for the Little Lorikeet and Dusky Woodswallow will be removed for the project. This is not expected to impact these species as the Little Lorikeet is a highly nomadic species that migrates in response to eucalypt flowering events and the Dusky Woodswallow utilises a range of habitat types including disturbed vegetation. Clearing will not fragment nor isolate potential habitat for either species. Additionally, clearing will be staged, and progressive rehabilitation will occur, leaving a maximum disturbance area of 1 ha at any one time.
4. Areas of outstanding biodiversity value	Areas of outstanding biodiversity value do not occur in the project area.
5. Key threatening processes	The project represents one key threatening process relevant to the Dusky Woodswallow and Little Lorikeet, namely the 'clearing of native vegetation', with the destruction of one or more strata layers within a stand of native vegetation. This key threatening process will be minimised through progressive clearing and rehabilitation.
Conclusions	The project will not have a significant impact on threatened woodland birds as: • staged clearing and progressive rehabilitation will occur; and • the species are nomadic and/or habitat generalists with alternate habitat widely available in the locality.

5.3.3 Little Eagle (*Hieraaetus morphnoides*)

The Little Eagle is listed as a vulnerable species under the BC Act and was not recorded in the study area. The Little Eagle occupies open eucalypt forest in open country and nests in tall living trees. Potential hunting habitat is present in the exotic grassland in the study area and potential breeding habitat is present in the remnant eucalypt woodland and exotic grassland.

An assessment of significance has been completed in accordance with Section 7.3 of the BC Act to assess the impact of the project on the Little Eagle (Table 5.3).

Table 5.3 Assessment of significance criteria for the Little Eagle

Criteria	Discussion
1. Life cycle of threatened species	No evidence of Little Eagles or their nests was recorded during targeted surveys. Therefore, the species is considered unlikely to breed in the Stage 8 area and their life cycle is unlikely to be affected by the project.
2. EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
3. Habitat removal, fragmentation, isolation and importance	The project will remove up to 11.00 ha of potential habitat for the Little Eagle. The removal of potential Little Eagle habitat is not expected to impact the species such that a decline would occur in local populations. This is due to the species high degree of mobility and the suitable alternative habitat widely available in the locality. The project will not fragment habitat for the species as vegetation in the riparian corridor, north and south of the Stage 8 area will be retained. Additionally, vegetation clearing will be staged, with the disturbance areas progressively rehabilitated following the completion of extraction.
4. Areas of outstanding biodiversity value	Areas of outstanding biodiversity value do not occur in the project area.
5. Key threatening processes	The project represents two key threatening process relevant to the Little Eagle, namely the 'clearing of native vegetation' and fragmentation, with the destruction of one or more strata layers within a stand of native vegetation and the 'removal of dead wood and dead trees'. These key threatening processes will be minimised through progressive clearing and rehabilitation.
Conclusions	The project is unlikely to have a significant impact on the Little Eagle as: • no known breeding habitat will be removed; • a small part of their larger hunting range will be removed; • the species is highly mobile and can access alternative habitats in the locality; and • clearing will be undertaken in stages, and the disturbance area will be progressively rehabilitated.

5.3.4 Barking Owl (*Ninox connivens*) Masked Owl (*Tyto novaehollandiae*) and Powerful Owl (*Ninox strenua*)

The Barking Owl is listed as a vulnerable species under the BC Act and has not been recorded in the Stage 8 area. It inhabits woodland and forest, including fragmented remnants and partially cleared farmland. It roosts in shaded tree and shrub foliage. It requires very large, permanent territories between 2,000 to 6,000 hectares.

The Masked Owl is listed as a vulnerable species under the BC Act and has not been recorded in the Stage 8 area. The species lives in dry eucalypt forests and woodlands but often hunts along the edges of forests, including roadsides. Pairs have a large home-range of 500 to 1,000 hectares and the species roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.

The Powerful Owl is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. The species is a habitat generalist, occupying a range of vegetation types including woodland, forest and even rainforest. Potential breeding habitat is present in the large hollows along the unnamed creek in the Stage 8 area. Limited hunting habitat is present in the remnant eucalypt woodland throughout the Stage 8 area.

An assessment of significance has been completed in accordance with Section 7.3 of the BC Act to assess the impact of the project on the Masked Owl and Powerful Owl (Table 5.4).

Table 5.4 Assessment of significance for the Barking Owl, Masked Owl and Powerful Owl

Criteria	Discussion
1. Life cycle of threatened species	No evidence of owl nesting was recorded during the surveys. Additionally, the species were not recorded. Therefore, the habitat to be removed along the Nepean River only represents potential breeding habitat for the Barking Owl, Masked Owl and Powerful Owl only. The habitat to be removed for the project represents what is likely to be a small part of a large hunting range for the three species along the Nepean River. This habitat will be progressively removed and restored in 1 ha areas as part of the project. The removal of this habitat is unlikely to have an adverse impact on the lifecycle of this species as no known breeding habitat is being removed, and hunting habitat is available in the wider locality, along the Nepean River.
2. EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
3. Habitat removal, fragmentation, isolation and importance	Up to 11.00 ha of potential breeding and hunting habitat will be progressively removed and rehabilitated for the project. In addition, the loss of 5.68 ha of potential breeding and hunting habitat will be avoided by not extracting the approved Stage 3 area. This habitat occurs as a continuous corridor along the river, therefore, the removal of discrete parts of this habitat prior to rehabilitation is unlikely to have adverse impacts on prey availability for the species. The Barking Owl, Masked Owl and Powerful Owls also have very large home ranges, therefore have the ability to utilise alternative habitat locations.
4. Areas of outstanding biodiversity value	Areas of outstanding biodiversity value do not occur in the project area.
5. Key threatening processes	The project represents three key threatening processes relevant to the forest owls, namely the 'clearing of native vegetation', with the destruction of one or more strata layers within a stand of native vegetation, the 'loss of hollow-bearing trees' and the 'removal of dead wood and dead trees'. These key threatening processes relevant to forest owls will be minimised through progressive clearing and rehabilitation and the installation of next boxes in the adjacent restoration areas.
Conclusions	The project will not have a significant impact on the Barking Owl, Powerful Owl and Masked Owl as: • no known roosting or nesting habitat will be removed; • staged clearing and progressive rehabilitation will occur; and • they are highly mobile species with a large home range.

5.3.5 Cave dependant microbats: Large Bentwing Bat (*Miniopterus orianae oceanensis*), Large-eared Pied Bat (*Chalinolobus dwyeri)* and Little Bentwing Bat (*Miniopterus australis*)

The Eastern Bentwing Bat is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. It is found in a range of habitats including wet and dry sclerophyll forest, open woodland, *Melaleuca* forests and grasslands. Foraging habitat is present along the riparian corridor in the Stage 8 area. Breeding or roosting habitat is absent from the Stage 8 area.

The Large-eared Pied Bat is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. It is found in well-timbered areas containing gullies. Foraging habitat is present along the riparian corridor in the Stage 8 area.

The Little Bentwing Bat is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. It is generally found in well-timbered areas. Foraging habitat is present along the riparian corridor in the Stage 8 area. Breeding and roosting habitat is absent from the site.

An assessment of significance has been completed in accordance with Section 7.3 of the BC Act to assess the impact of the project on these cave dependant microbats (Table 5.5).

Table 5.5 Assessment of significance for cave dependent microbats

Criteria	Discussion
1. Life cycle of threatened species	The Eastern Bentwing Bat, Little Bentwing Bat and Large-eared Pied Bat require specialised caves for breeding, which are absent from the site. Foraging habitat is available in the riparian corridor some of which will be removed for the project. Sandstone overhangs may provide shelter (non-breeding) habitat for these cave-dwelling bat species. Project noise may temporarily disturb roosting bats, however, only part of the Stage 8 area will be affected at any one time. Therefore, the project is unlikely to adversely affect the life cycle of these species such that viable local populations are placed at risk of extinction.
2. EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
3. Habitat removal, fragmentation, isolation and importance	The project will not remove any breeding or roosting habitat for the Eastern Bentwing Bat, Large-eared Pied Bat and Little Bentwing Bat. However sub-optimal foraging habitat in the exotic grassland areas and River-flat Eucalypt Forest will be removed. The sub-optimal habitat being removed is not important to these species as the shrub layer of the remnant woodland highly weed infested and cluttered which would make hunting difficult for these species. Optimal foraging, breeding and roosting habitat is available nearby in the west within the Woronora Special Area and Dharawal Nature Reserve. The Eastern Bentwing Bat, Little Bentwing Bat and Large-eared Pied Bat are all highly mobile species and a small loss of potential foraging habitat from future development will not impact on the habitat connectivity for the species.
4. Areas of outstanding biodiversity value	Areas of outstanding biodiversity value do not occur in the project area.
5. Key threatening processes	The project represents one key threatening process relevant to cave-dependent microbats, namely, the 'clearing of native vegetation' and fragmentation, with the destruction of one or more strata layers within a stand of native vegetation. This key threatening process will be minimised through progressive clearing and rehabilitation.
Conclusions	The project will not have a significant impact on these threatened cave dependant microbats as: • breeding and roosting habitat will not be removed; • only sub-optimal foraging habitat will be removed; and • they are highly mobile species with access to higher quality foraging habitat in the wider locality.

5.3.6 Threatened hollow dependant microbats: Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Coastal Free-tailed Bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*) and Southern Myotis (*Myotis macropus*)

The Eastern Coastal Free-tailed Bat is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. The Eastern Coastal Free-tailed Bat occurs in dry sclerophyll forest, woodland, swamp forest and mangrove forests east of the Great Dividing Range. Potential roosting and breeding habitat is present in hollow trees within remnant woodland. Potential foraging habitat is present in the canopies of remnant woodland.

The Eastern False Pipistrelle is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. The Eastern False Pipistrelle prefers moist habitats, with trees taller than 20 m. Potential roosting, breeding and foraging habitat are available in eucalypt hollows in the riparian corridor within the Stage 8 area.

The Greater Broad-nosed Bat is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. The Greater Broad-nosed Bat is most commonly found in tall wet forest. Potential roosting, breeding and foraging habitat is available in eucalypt hollows in the riparian corridor within the Stage 8 area.

The Yellow-bellied Sheathtail-bat is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. The Yellow-bellied Sheathtail-bat roosts singly or in groups of up to six, in tree hollows and forages in most habitats across its very wide range, with and without trees.

The Southern Myotis is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. The Southern Myotis is a microbat that roosts in groups of 10–15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. The species forages over streams and pools catching insects and small fish by raking their feet across the water surface.

An assessment of significance has been completed in accordance with Section 7.3 of the BC Act to assess the impact of the project on these threatened hollow dependant microbats (Table 5.6).

Table 5.6 Assessment of significance for threatened hollow dependent microbats

Criteria	Discussion
1. Life cycle of threatened species	Hollow-bearing trees containing potential breeding and roosting habitat for the Eastern Coastal Free-tailed Bat, Yellow-bellied Sheathtail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Southern Myotis will be removed for the project. Tree clearing will occur in stages for the project, with a maximum disturbance area of 1 ha at any one time. Staged clearing will allow the retention of potential breeding habitats in the Stage 8 area until such time that clearing is required. In addition, nest boxes will be erected in the restoration areas prior to clearing to compensate for the loss of hollow-bearing trees. The proposed action is unlikely to adversely affect the species life cycles such that viable local populations are placed at risk of extinction.
2. EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
3. Habitat removal, fragmentation, isolation and importance	Up to 11.00 ha of potential breeding and foraging habitat will be removed in the Stage 8 area for threatened hollow dependent bats. In addition, the loss of 5.68 ha of similar habitat will be avoided by not extracting the Stage 3 area. This habitat is considered to be sub-optimal given the infestation of invasive weeds that clutter the shrub layer, making flight and hunting difficult for the species. Impacts will be minimised through staged clearing, progressive rehabilitation and the placement of nest boxes in the proposed restoration area. Given the staged clearing and progressive rehabilitation, the habitat of these species is unlikely to be fragmented or isolated. The species is highly mobile and capable of accessing alternative habitats along the Nepean River corridor.
4. Areas of outstanding biodiversity value	Areas of outstanding biodiversity value do not occur in the project area.
5. Key threatening processes	The project represents three key threatening processes relevant to impacts on hollow-dependent microbats, namely the 'clearing of native vegetation' and fragmentation, with the destruction of one or more strata layers within a stand of native vegetation, the 'loss of hollow-bearing trees' and 'the removal of dead wood and dead trees'. These key threatening processes will be minimised through progressive clearing and rehabilitation and the installation of next boxes in the adjacent restoration areas.
Conclusions	The project is unlikely to have a significant impact on threatened hollow dependant microbats as: • the potential habitat is sub-optimal; • the species are highly mobile; • the impacts of the project on the species will be minimised through staged clearing, progressive rehabilitation and the placement of nest boxes in the proposed restoration area.

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

The Grey-headed Flying-fox is listed as a vulnerable species under the BC Act and has been recorded in the Stage 8 area. The Grey-headed Flying-fox is known to inhabit rainforest, forest and woodlands, heaths and swamps, as well as urban gardens where there is an abundance of nectar and pollen. The Stage 8 area provides potential foraging habitat in the canopy of scattered flowering eucalypt trees. Breeding and roosting habitat is absent within the Stage 8 area.

An assessment of significance has been completed in accordance with Section 7.3 of the BC Act to assess the impact of the project on the Grey-headed Flying-fox (Table 5.7).

Table 5.7 Assessment of significance for Grey-headed Flying-fox

Criteria	Discussion
1. Life cycle of threatened species	Potential foraging habitat for the Grey-headed Flying Fox is available in the canopies of eucalyptus trees to be removed, where they may forage on the nectar and flowers. No roosting or breeding habitat is present for this species within the Stage 8 area, therefore the most important parts of the species lifecycle will not be impacted by the project. The removal of foraging habitat in the Stage 8 area will cause a minor reduction in foraging habitat for this species. However, it is unlikely to affect the foraging lifecycle of this species due to the abundance of other eucalypt and flowering feed trees in the wider locality including Woronora Special Area, Dharawal Nature Reserve and vegetation along the Nepean River.
2. EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
3. Habitat removal, fragmentation, isolation and importance	Roosting and breeding habitat is absent from the Stage 8 area, and therefore will not be removed for the project. Up to 11.00 ha of potential Grey-headed Flying-fox foraging habitat for these species will be removed from the Stage 8 area. This potential foraging habitat will be removed in stages and progressively rehabilitated, minimising the project's impacts on foraging habitat availability. Suitable foraging habitat is also present in the proposed restoration area and larger national parks and nature reserves in the locality. Additionally, the loss of 5.68 ha of similar habitat will be avoided by not extracting the Stage 3 area. Therefore, the project is unlikely to adversely affect the species life cycle such that a viable local population of the species will be placed at risk of extinction.
4. Areas of outstanding biodiversity value	Areas of outstanding biodiversity value do not occur in the project area.
5. Key threatening processes	The project represents one key threatening process relevant to the Grey-headed Flying-fox, namely the 'clearing of native vegetation', with the destruction of one or more strata layers within a stand of native vegetation. This key threatening process will be minimised through progressive clearing and rehabilitation.
Conclusions	The project is unlikely to have a significant impact on the Grey-headed Flying-fox as: • breeding habitat is absent from Stage 8 area; • impacts on potential foraging habitat will be minimised through staged clearing, progressive rehabilitation and avoidance of clearing the Stage 3 area.

6 Biodiversity offset strategy

6.1 Revised credit calculations

The extraction footprint has been revised (EMM 2019b). This section provides details of the updated areas and calculations. Details of the areas used for the original proposal, and the revised areas used for the purpose of updated credit calculations for this assessment are provided in Table 6.1. It is noted that the area calculations have changed due to refinements to vegetation mapping boundaries (Section 3.2), and subsequent amendments to both extraction and restoration area boundaries (Section 2.4).

Table 6.1 Credit calculation areas

Vegetation zone	Biometric vegetation type (BVT)	Original area (ha)	Revised area (ha)
Reduction of impact via surrender of Stage 3 consent			
2 Poor	HN526	5.68 (1:1 reduction)	1.1 multiplier (despite being found to be worth a higher value reduction): 5.68
Impact (loss)			
1 Moderate	HN526	2.79	2.35
2 Poor	HN526	7.86 (prior to subtraction of 5.68 for Stage 3)	8.65 (prior to subtraction of 5.68 or 8.41 for Stage 3)
Cleared	-	-	2.22
Total		10.81 (vegetated area only)	13.22
Offset (gain)			
1 Moderate	HN526	2.99	4.39
2 Poor	HN526	9.66	9.62
3 Cleared	HN526	Not identified	0.84
Total		12.65	14.85
Rehabilitation of extraction area and bank			
1 Moderate	HN526	-	0.47 (Lower riverbank)
2 Poor	HN526	-	0.21 (Lower riverbank)
3 Cleared	HN526	10.81	12.86

6.2 Impact assessment

The number of credits required was recalculated for the revised direct extraction area as presented in Table 6.2.

Table 6.2 Ecosystem credit impact calculations

Vegetation Zone	Biometric Vegetation Type (BVT)	Impact area (ha)	Loss in site value score	Credits required
Impact (loss)				
1 Moderate	HN526	2.35	31.42	67
2 Poor (prior to reduction from surrender of Stage 3)	HN526	8.65	32.64	255
Reduction of impact to "poor" condition vegetation via surrender of Stage 3 consent				
2 Poor (using 1:1)	HN526	8.65 – 5.68 = 2.97	32.64	87
Total (after surrender of Stage 3 using 1:1 ratio)				154

For the Stage 3 subtraction, EMM's view remains that the degree of impact should be assessed after the subtraction of the surrender of the Stage 3 consent, which is still proposed. However, to provide clarity, the impact assessment calculations are provided for the entire Stage 8 extraction area. Then the value of the Stage 3 subtraction has been provided, based on the originally proposed 1:1 reduction, despite the finding from Chapter 4 that the surrender of this consent would be worth a higher deduction.

The total number of credits required is 154 credits, based on the surrender of the Stage 3 lands based on a 1:1 ratio.

It is noted that all trees within the horizontal setback zone (which is about 2 ha of the 13 ha of the extraction area) will be retained. Details are provided in EMM (2019b). However, as survey of the trees to be retained is not available, the biodiversity impact assessment assumes that all land within the extraction area will be completely cleared.

6.3 Scores assigned to gains at restoration site

The assignment of scores to vegetation zones to be managed within the restoration areas has been reviewed and is presented in Table 6.3. For each of the three vegetation zones (moderate, poor and cleared), the current site value scores, standard predicted future score, and adopted future score for credit calculations is presented, along with management actions proposed to achieve those scores, or rationale for the selected score are presented.

It is noted that the proposed weed management (EMM 2019a) would be expected to deliver a much larger gain for the exotic plant cover attribute where there is currently a score of zero, however, the credit calculator did not allow entry of a higher score for this attribute, and thus the default was used.

Table 6.3 Restoration area future site values

Attribute	HN526 benchmarks	Management zone attribute score (0, 1, 2, or 3)			Score with standard management actions			Adopted future score (with the proposed management outcomes)*			Notes on relevant management measures to deliver proposed site value gain and rationale for selected future score
		Moderate	Poor	Cleared	Moderate	Poor	Cleared	Moderate	Poor	Cleared	
Native plant species richness	≥24	1	1	0	1.5	1.5	0.5	2	2	1	To achieve this at least 50% of the native plant species richness benchmark must be achieved (ie at least 12 species from the nominated PCT in this instance). Planting or seed distribution will establish, after topsoil removal, a minimum of 12 different native species consistent with River-flat Eucalypt Forest. A higher species diversity is to be planted or broadcast, in case some native species do not readily establish.
Native over-storey cover	27.5–32.5	1	1	0	2	2	1	2	2	1	No change from the standard increases are proposed.
Native mid-storey cover	21–31	1	1	0	2	2	1	1	1	1	Current score retained for moderate condition zone. This is because the mid-storey will be removed with stripping the topsoil. Revegetation will occur, but due to the time required for new native groundcover to establish, the score is not being allowed to increase. For the poor and cleared zones condition zones the attribute score was put to a score of 1, to reflect revegetation that will occur.
Native ground cover (grasses)	24.45–30.45	1	1	0	2	2	1	2	2	1	For moderate condition zone, as above for native mid-storey attribute, whereby current score is retained and not allowed to increase. For poor and cleared, score allowed to increase to 1 (maximum allowed by tool) to reflect planting and management.
Native ground cover (shrubs)	0 - 10	3	3	3	3	3	3	3	3	3	This attribute will be within benchmark in a completely cleared state. Nonetheless, some shrubs will be planted or established via seed at a low density.
Native ground cover (other)	24.45 – 30.45	1	0	0	2	1	1	1	1	1	As above for native mid-storey attribute.

Table 6.3 Restoration area future site values

Attribute	HN526 benchmarks	Management zone attribute score (0, 1, 2, or 3)			Score with standard management actions			Adopted future score (with the proposed management outcomes)*			Notes on relevant management measures to deliver proposed site value gain and rationale for selected future score
		Moderate	Poor	Cleared	Moderate	Poor	Cleared	Moderate	Poor	Cleared	
Exotic plant cover (calculated as percentage of total ground and mid-storey cover)	0	0	1	0	0.5	1.5	3	0.5	2	0.5	No increase from default is permitted in the online BBAM assessment tool where a vegetation zone has a current score of zero, despite significantly higher achievements expected than the default values. Increase to a value of 2 for the poor zone the exotic plant cover must achieve <33% as a percentage of total ground and midstorey cover. Significant weed management actions are proposed, and thus this increase from the default gain is proposed for the poor condition vegetation zone.
Number of trees with hollows	≥1	3	3	0	3	3	0	3	3	0	For moderate and poor condition no change, as the attribute is already within benchmark (3/3). No change for cleared, as the trees will be absent (except within the bank zone).
Proportion of over-storey species occurring as regeneration	1	0	0	0	0.5	0.5	0.5	0.5	0.5	0.5	To achieve the increase to 1 it must be demonstrated that >25% of over-storey species for the PCT are naturally regenerating. As the site is dominated by one tree species (Bangalay x Botryoides) it is considered that this would be difficult to demonstrate, and thus the default increase has been accepted.

Table 6.3 Restoration area future site values

Attribute	HN526 benchmarks	Management zone attribute score (0, 1, 2, or 3)			Score with standard management actions			Adopted future score (with the proposed management outcomes)*			Notes on relevant management measures to deliver proposed site value gain and rationale for selected future score
		Moderate	Poor	Cleared	Moderate	Poor	Cleared	Moderate	Poor	Cleared	
Total length of fallen logs	≥50	1	1	0	1.5	1.5	0	2	2	0.5	For this attribute, it is identified that the active placement of logs brought onto the vegetation zone and placed in a configuration that reflects natural systems can be used as habitat augmentation. This will be used in the offset area, as there will be a ready supply of woody debris and logs from the trees removed from the extraction area, as well as available machinery. BBAM does not provide guidance on thresholds to be reached to increase a score from 1 to 2 for the moderate condition zone. For both moderate and poor zones it is proposed that 100% of the benchmark will be achieved, such that 50 m of coarse woody debris that is at least 0.1 m in diameter and greater than 0.5 m is achieved per BBAM plot of 50 m by 20 m (0.1 ha). Or, that there is overall 500 m of woody debris per hectare of offset lands. For the cleared lands the maximum permitted by the tool is to rise to 0.5. Again, BBAM does not provide guidance on the values to be achieved for a score of 0.5, however it is proposed that 20% of the benchmark is achieved, noting that a score of 1 would be achieving >10 to <50% of benchmark. In practice this will mean 10 m of coarse woody debris per BBAM plot for the cleared lands.
Site Value Score	-	Current value = 31.42	Current value = 32.64	Current value = 1.56	Default value = 48.61	Default value = 50.0	Default value = 13.72	Future value = 48.70	Future value = 53.39	Future value = 17.62	

* Management scores derived using guidance in Appendix 7 of BBAM.

6.4 Credit generation calculations

The value of the restoration areas was calculated, based on management of the updated restoration areas, and utilising the adopted future attribute scores as identified in Section 6.3, and is presented in Table 6.4. In total, the proposed restoration lands will generate the equivalent of 163 credits for River-flat Eucalypt Forest (HN526).

No additional 'averted loss' was included in the site gain calculations, as the lands will not be established as formal Biobanking (or Stewardship) sites, though the proposed covenant and approach to site management seek to emulate these outcomes as closely as possible. It is noted that the lands are zoned as RU1 Primary Production under *Wollondilly Local Environment Plan 2011*. As such, for the offset site credit generation under Biobanking calculations the vegetation could have been considered to be native vegetation that has a high risk of decline in site value score, which could have allowed greater credit generation.

In addition, calculations were made of the potential for both the extraction area and lower bank to also generate credits, assuming management in the same way as for cleared lands in the restoration area, and identified that this management would be worth an additional further 137 credits (Table 6.4)

Table 6.4 Ecosystem credit generation calculations

Vegetation Zone	Biometric Vegetation Type (BVT)	Area (ha)	Current site value score	Future site value score	Gain in site value score	Credits generated
Offset areas (gain)						
1 Moderate	HN526	4.39	31.42	48.70	17.28	46
2 Poor	HN526	9.62	32.64	53.39	20.75	109
Cleared	HN526	0.84	1.56 **	17.62	16.06	8
						163
Rehabilitation (gain)						
3 Cleared	HN526	12.86	1.56 **	17.62	16.06	130
4 Lower bank *	HN526	0.68	1.56 **	17.62	16.06	7
Total		28.39				137

* The lower bank area has been treated for the purpose of credit calculations as being rehabilitated from a cleared state as no plots were available for this zone. It is noted that there is a total of 0.47 ha moderate and 0.21 ha poor condition vegetation.

** Site value score starts above zero as the 'Native ground cover (shrubs)' attribute for HN526 has a benchmark value of 0–10% cover. Therefore, in a completely cleared state this particular attribute is considered to be within benchmark, and thus generates a score.

Overall, to mitigate the risk of the Stage 8 offset lands not achieving the intended outcomes, the following has been applied:

- The surrender of the Stage 3 consent, at a 1:1 deduction from the impact on the poor condition vegetation is proposed, despite higher ratios being identified as relevant (Chapter 4).
- The modification of the proposed gain from standard increases within the offset lands, depending on the context and the management proposed. Specifically, for the midstorey cover and groundcover (other) attributes are not being allowed to go above a value of 1, even though the default increase for these attributes where the current value is 1 is an increase to a score of 2. For the exotic plant cover the tool also

does not allow entry of increase above the default increase to 0.5 where the current score is zero (moderate and cleared zones), even though the management approach proposed will address the current extreme weed load, and is it is considered that a much higher performance will occur than that predicted, in terms of reducing weed cover.

- Not seeking additional gains from the averted loss component due to the native vegetation being at a high risk of decline due to the RU1 zoning.

- The generation of additional credits beyond that required (a total of 154 credits required, with 163 credits generated, which is a surplus of 9 credits).

Additional further actions to mitigate risk are also proposed under section 6.5 below.

6.5 Proposed positive management measures

The management of the revised restoration area, which would also be the biodiversity offset for the project, would be carried out to align with the staged extraction and would include:

- Surrender the approval to extract the Stage 3 area will immediately protect 5.68 ha of River-flat eucalypt forest. This will allow vegetation clearing in the Stage 8A and for extraction to start. In turn, this will provide a pit void in which to bury weed-infested soil and woody weeds removed from northern parts of the restoration area.

- Establishment of a positive covenant on title under s88b or s88e of the NSW *Conveyancing Act 1919*. The covenant should identify that ecological management of the restoration lands is required, and identify that management is to be performed as per the management plan for the site (yet to be prepared), with funds for management coming from the trust fund.

- A similar positive covenant on title may also be established for the extraction lands if required, though noting that this could not occur until extraction is complete.

- A vegetation management plan will be prepared (see EMM 2019a).

- Initially, signage will be installed every 50 m (on posts or trees) along the boundaries of the restoration area to delineate the restoration areas.

- Nestboxes or hollows will be created in the whole of the restoration area in the Year 1 of the extension project. Hollow creation would be by using a chainsaw in large trees as per Rueegger 2017. A total of 106 nestboxes or tree hollows will be placed or created, based on loss of an estimated average loss of 20 hollow bearing trees per hectare across 5.32 ha of impact in the extraction area.

- Weed infested soil will be stripped from the restoration area by Menangle Sand and Soil to eliminate most weeds (see EMM 2019a). This stripping would occur progressively as the extraction area progresses.

- Following the removal of weed infested soil, a wire fence will be installed along the boundary between the extraction areas and the restoration areas. Gates will be installed to control access.

- Native seeds consistent with River-flat Eucalypt Forest will be broadcast in the restoration area as soon as the soil weed seedbank has been removed, to establish a minimum of 12 different native species (of all types) consistent with River-flat Eucalypt Forest.

- The active placement of logs and woody debris at least 10 cm in diameter and greater than 0.5 m in length in a configuration that reflects natural systems, such that for restoration lands that there is overall ≥500 m per ha of woody debris per hectare for the current moderate and poor condition lands, and ≥100 m per ha of woody debris per hectare for the current cleared lands. Further, for the extraction and lower riverbank zones also placement of ≥100 m per ha of woody debris per hectare.

- There will be ongoing weed control by a full-time rehabilitation specialist hired by Menangle Sand and Soil.

- Ecological burns will be undertaken in accordance with the vegetation management plan.

- Rabbit and fox control programs in the Stage 8 area from Year 2 will contribute to broader control programs. It is noted that due to these actions are only likely to be effective if broader control programs in the local region occurring.

- There will be annual inspections by an appropriately qualified ecologist on the condition of the restoration areas. The findings and actions undertaken during the year will be reported to DPIE, and to Council.

Menangle Sand and Soil will establish a trust account to ensure that restoration area management costs can be met in-line with Biobanking requirements. The total amount in the trust will be based on the measures listed above and it will be established before the commencement of extraction. Nominally payments will be made into the Trust fund in four stages through the life of the Extension Project, associated with the progression of the clearing areas, with provision made for the management of each part of the restoration area preceding clearing in the extraction/rehabilitation area.

7 Conclusion

In summary, this supplementary biodiversity assessments has found:

- The impact area has been calculated as requiring 154 ecosystem credits. This is based on using a 1:1 reduction in impact area for poor condition vegetation from surrender of the Stage 3 consent, whereas it was found that the reduction for surrender of the Stage 3 would be worth a larger deduction of 1:1.3 or 1:1.47 depending on the calculation method utilised.

- The management of the proposed offset lands have been identified as generating 163 credits. This is a surplus of 9 credits to the extraction area impacts.

In addition to the above, the following additional actions are proposed that are in addition to the offset requirements calculated using a 1:1 reduction for the Stage 3 consent:

- The retention of all trees in the horizontal setback area within the extraction area – however the horizontal setback area not been treated as a different management zone, and therefore the credit impact assessment is conservative and would be reduced further should these outcomes be taken into consideration.

- The cleared extraction areas will be rehabilitated and would be worth 130 credits.

- The lower bank area will be also be rehabilitated and would be worth an additional 7 credits.

In summary the ecological gains, based on the Biobanking method, are considered to be greater than the impacts for the proposed extraction project.

References

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