Biodiversity Assessment Report: Proposal ID: 0099/2016/3605MP

Flatrock Rd Mundamia – proposed landfill extension of West Nowra Recycling & Waste Facility

The purpose of this Biodiversity Assessment Report is to detail the Ecosystem and Species Credits for the project as generated by the Biobank Calculator

Environmental Planning and Assessment Unit, Environmental Services Section, Shoalhaven City Council 2017

Executive Summary

Shoalhaven City Council's (Council) Environmental Assessment Unit has completed a Biodiversity Impact Assessment (Assessment) of the proposed extension of West Nowra Recycling & Waste Facility (State Significant Development – reference SDD15_7187), to be sited at Flatrock Road Mundamia (Lot 1 DP 1104402). The 14.52ha site is currently completely covered in native vegetation.

The Secretary of the NSW Department of Planning and Environment (DP&E) Environmental Assessment Requirements (SEARs) required the Assessment to be undertaken using the Framework for Biodiversity Assessment Methodology (FBAM) by an accredited Biobank Assessor (Accredited Biobank Assessor number 0099)

The proposal was assessed using the FBA methodology based on a site footprint area of 9.87ha being cleared and utilised with areas outside of the proposal retained as a vegetated visual amenity buffer and potential Biobank site.

Vegetation surveys within the native vegetation identified one Plant Community Type (PCT 1082 with Biometric reference SR594; Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion) to be cleared. The Assessment calculated the total loss of this vegetation would require the retirement of 719 ecosystem credits.

One other PCT with Biometric reference SR549; Grey Gum Blue-leaved Stringybark open forest on gorge slopes occurs over a small portion of the site outside the area to be cleared. The vegetation across the site is in moderate to good condition with with an estimated 27 hollow-bearing trees per hectare providing known and potential habitat for a number of threatened fauna species (GHD, 2014).

Targeted surveys (conducted under Scientific Licence SL100128 and Animal Research Authority TRIM13/3758) were also conducted for threatened species identified in the SEARs and the Biobank Assessment process. One "species credit" threatened flora species (Nowra Heath Myrtle *Triplarina nowraensis*) is known from the site but is outside the area to be impacted. Previous studies have identified two "species credit" threatened fauna species; Squirrel Glider and Eastern Pygmy-possum utilising the habitat of the site with the loss of 9.87ha of this habitat requiring the retirement of 217 Squirrel Glider species credits and 197 Eastern Pygmy-possum credits. Five other "ecosystem" threatened fauna species are definitely known from the site (Powerful Owl, Yellow-bellied Glider, Grey-headed Flying Fox, Eastern Bentwing Bat and Glossy Black-cockatoo), detected during 2014 -15 surveys or previous surveys, with a number of probable detections of other threatened microchiropteran bat species (Eastern False Pipistrelle, Greater Broad-nosed Bat and Large-eared Pied Bat). These detections (and additional targeted surveys from March – July 2017) have guided mitigation with measures recommended to mitigate and confine impacts to the subject site.

Council is currently proposing several offset options for consideration. One option is to Biobank the residue of the subject land to provide for some of the credits needed in addition to the purchase and retirement of the required credits. An Expression of Interest for the required ecosystem credits failed to attract the required credits.

Another option is to retire credits is the use of "supplementary measures" on a parcel of Council owned land at Huskisson, approximately 22km to the south east of Mundamia. The Huskisson site is 72.36ha with 55.29ha available for an offset worth 669 ecosystem credits (to be verified by the NSW Office of Environment & Heritage - OEH) for vegetation that is more valuable (in terms of percent cleared and strategic location) than the vegetation to be cleared. The site also contains a confirmed Eastern Pygmy-possum (EPP) population worth 333 credits, Eastern Bristlebird habitat worth 100 credits (species credits to be verified by OEH) and habitat for Green & Golden Bell Frog (subject of ongoing assessment).

Finding Squirrel Glider credits are the subject of surveys and negotiations with Council endeavouring to find credits on council land but credits are currently available on the credit market though it is an option to Biobank the remaining area of the subject lot (4.65ha) to protect remaining EPP and Squirrel Glider habitat, each worth 33 species credits (to be verified by OEH).

Full details of the assessment process as per the FBA methodology are in sections 3 to 11 of this report with the Biobank credit report from the Biobank calculator provided in Appendix 1.

Table of Contents

1 Introduction

Shoalhaven City Council (Council) proposes to extend the existing landfilling operation at the West Nowra Recycling & Waste Facility (Facility) which has been identified as a Major Project (State Significant Development – reference SDD15_7187, incorrectly identified as SDD15_7187 in the OEH SEARs) under the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act). An application for a Major Project must be accompanied by an Environmental Impact Statement (EIS). Council received the Secretary of the Department of Planning and Environment (DP&E) Environmental Assessment Requirements (SEARs) (Reference SDD15_7187) in August 2016 for this proposal.

This Biodiversity Assessment Report (BAR) has been prepared to meet the requirements of the SEARs and "*Appendix 7: Reporting requirements for the FBA",* of the Framework for Biodiversity Assessment (FBA), NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014a). The assessment and Biodiversity Assessment Report (BAR) has been produced by an accredited Biobanking Assessor who is also an employee of Shoalhaven City Council.

Assessor Name: Michael Smith

Assessor Number: 0099

Calculator Version: Biobanking Credit Calculator Version 2.0

2 Proposed Major Project Description and site justification

This BAR is for a proposed Major Project development being the extension of the existing Facility to be operated by Shoalhaven City Council at Flatrock Road Mundamia (Lot 1 DP 1104402), approximately 5km west of Nowra on the South Coast of NSW (Figure 2).

A plan of the proposed footprint with direct and indirect impact zones is depicted in Figure 1. Of the project footprint area (9.94ha) approximately 0.07ha is on land already approved to be cleared on the existing landfill site (on Lot 1 DP 870268 and Lot 1 DP 847203). The proposed extension to the Facility will utilise approximately 9.87ha of the subject land (14.52ha) which is the area assessed under the FBA (Figure 3). It is envisaged indirect impacts will be contained within the subject site.

The subject land is identified as Lot 1 in DP 1104402 (Flatrock Road Mundamia) and is depicted in Figure 2 below.

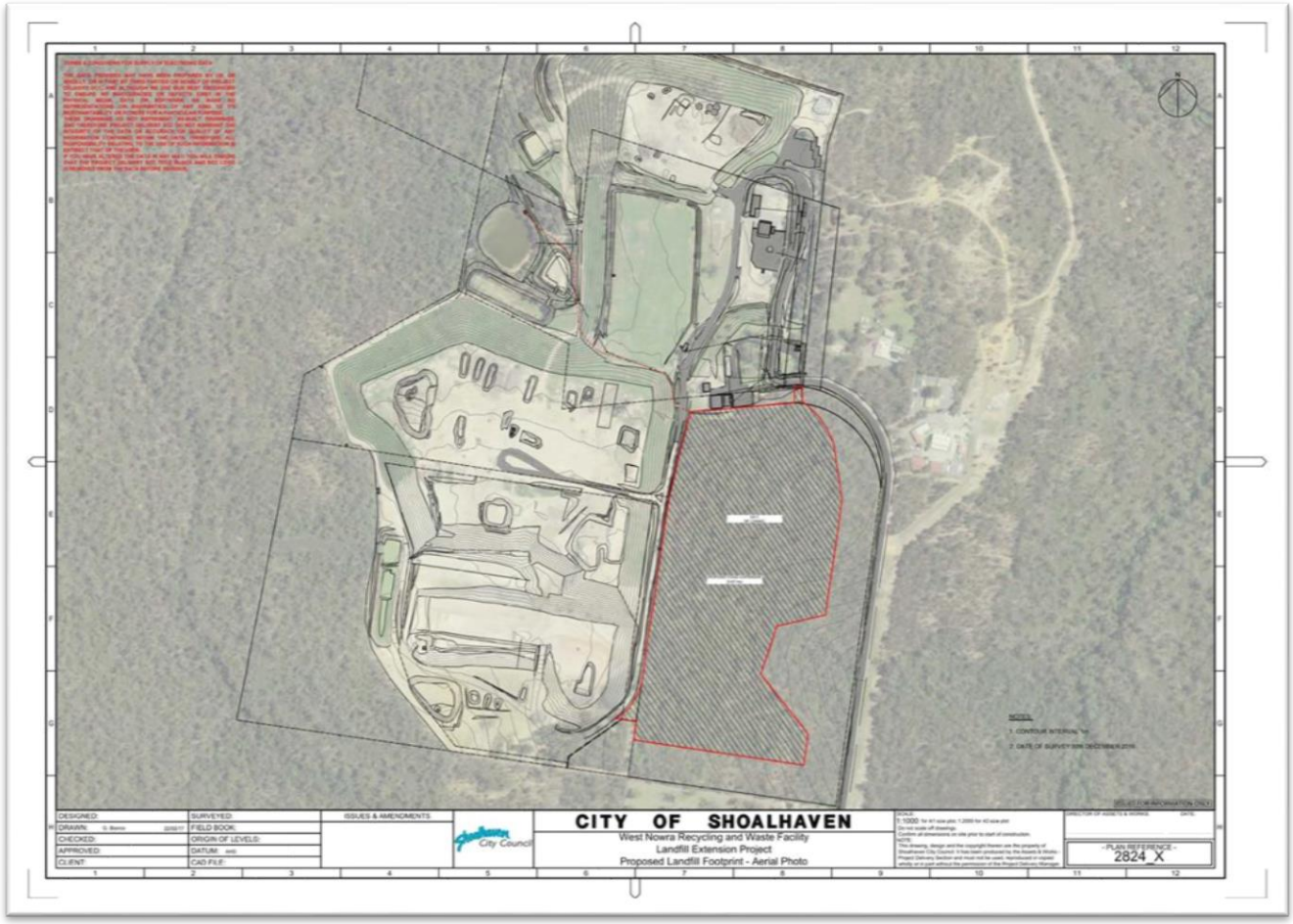


Figure 1 – Project footprint over Lot 1 DP 1104402 (proposed Development Area subject to FBA, and over Lot 1 DP 870268 and Lot 1 DP 847203 (existing landfill site)

Figure 2 – Subject land and boundary

Currently the site is undeveloped and completely covered in native vegetation Figure 2.

Figure 3 – Development footprint

The subject site adjoins cleared land to the west being the existing West Nowra landfill Facility, cleared private rural land to the south, with Flatrock Road adjoining the eastern and northern boundaries of the site. Under the Biobank connectivity rules Flatrock Road doesn't form a break in connectivity being less than 100m wide. A small triangular section of native vegetation has been retained to the southwest on the existing Facility land to maintain connectivity from the site to Bamarang Nature Reserve to the south-west. It is proposed as part of the mitigation measures to enhance connectivity to the east of the subject site, where the Squirrel Glider has also been detected, by installing wildlife rope bridges over Flatrock Road with permanent monitoring cameras to monitor their use by wildlife.

The greater surrounding landscape is dominated by intact bushland in moderate to good condition with some rural properties, roads and power line easements, a NSW National Parks & Wildlife Service depot, the Shoalhaven River to the north, and areas of historic disturbance (Figure 3 & Figure 4).

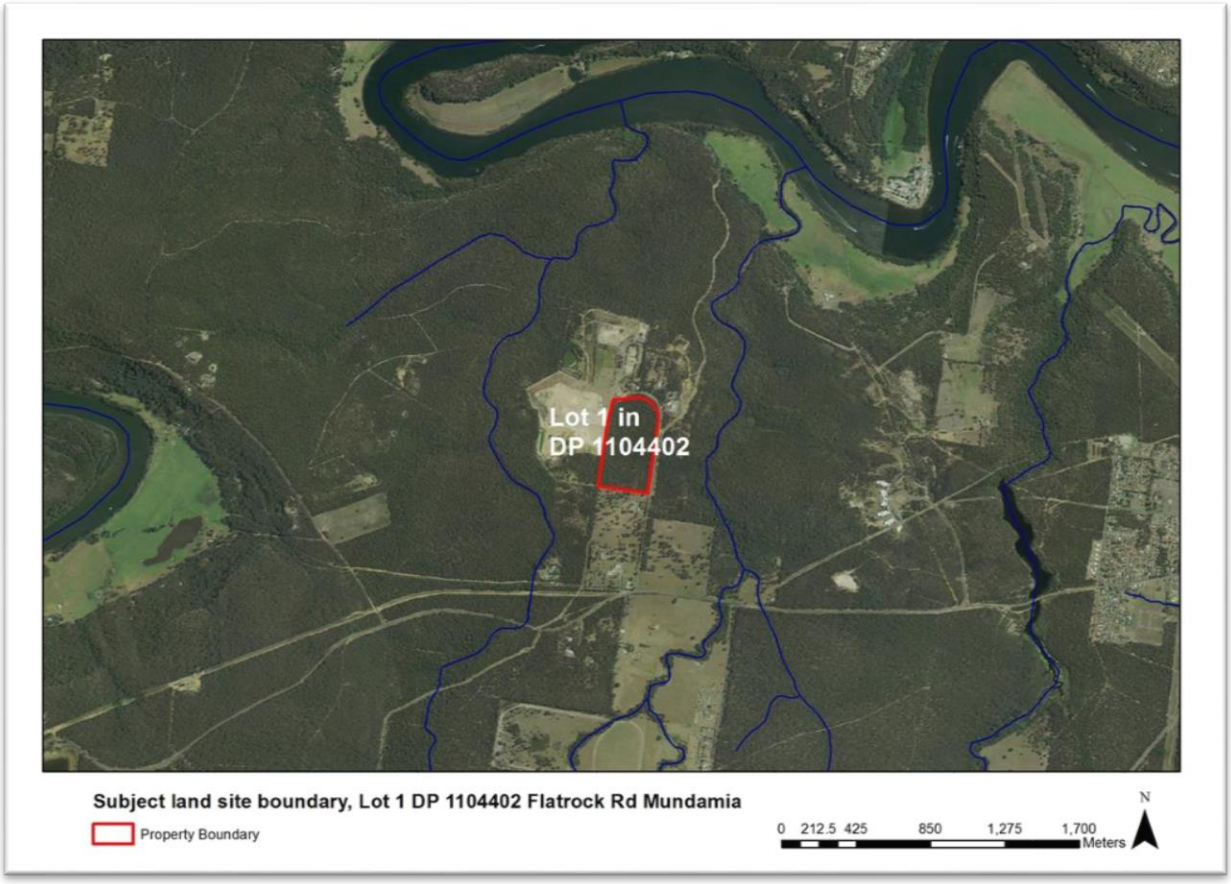


Figure 4 – Subject site and surrounding landscape

3 Landscape features

3.1 IBRA bioregion and subregions, NSW landscape region and area (ha)

The subject site is within the Sydney Basin bioregion and the Ettrema IBRA subregion (OEH Bionet mapping accessed August 2015) (Figure 5). The subject site is within the Mitchell landscape; Nowra – Durras Coastal Slopes (Figure 6).

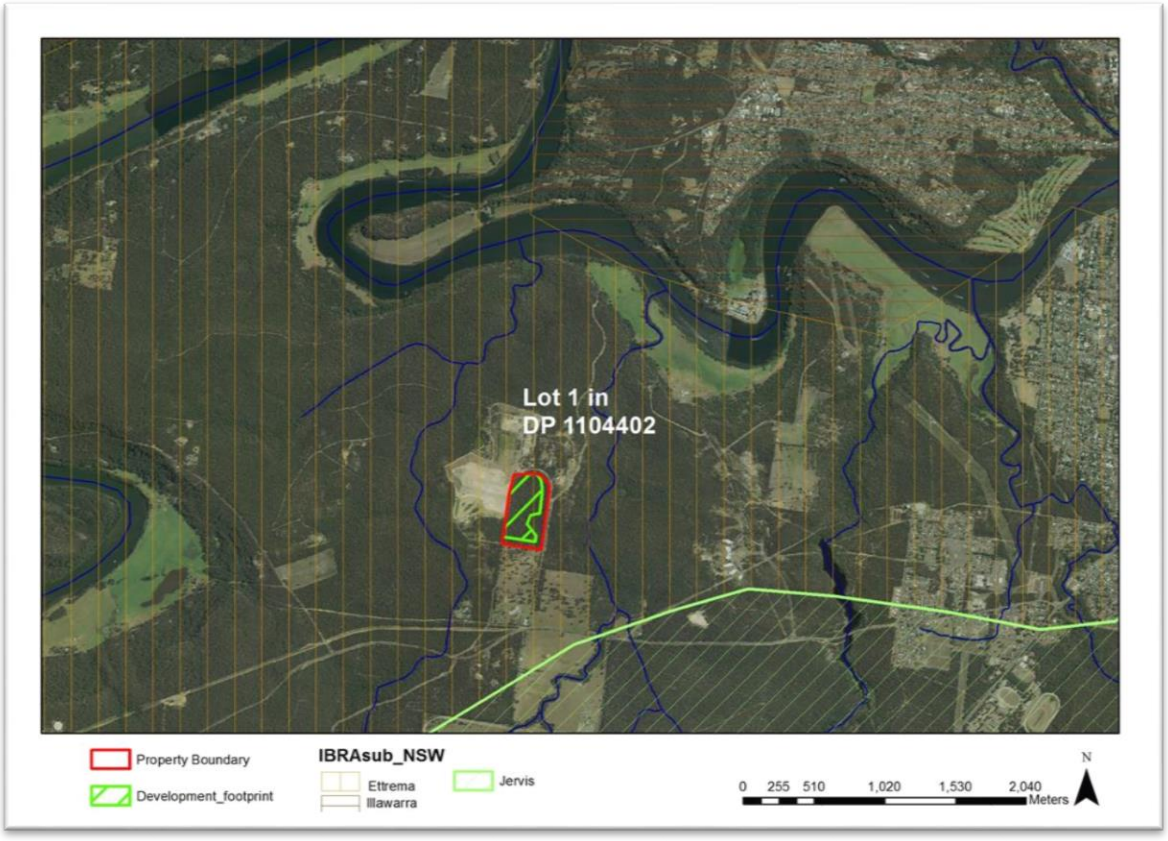


Figure 5 – IBRA subregions and development site

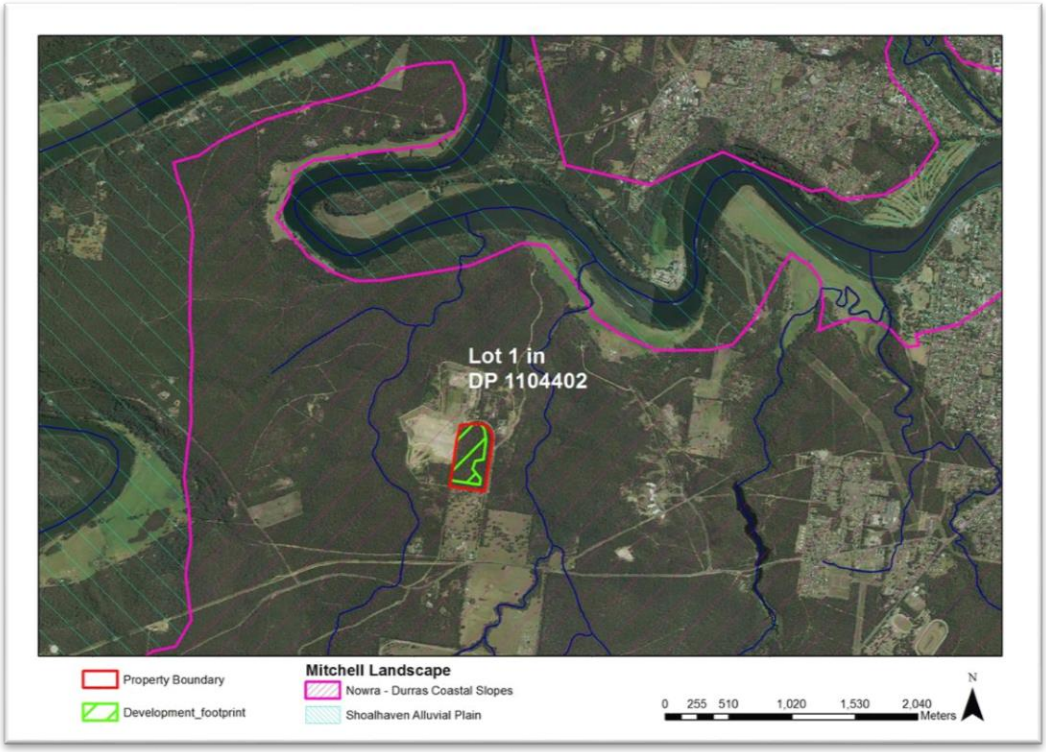


Figure 6 – Mitchell landscapes and the development site

3.2 Native vegetation extent in the 1000ha outer assessment circle

The area of native vegetation before development is depicted in Figure 7. The area was calculated using ArcGIS software and totalled 804.80ha (76-80% native vegetation cover class). After development the area of native vegetation remains within the same native vegetation class despite being reduced by 9.87ha down to 794.93ha.

The percentage Native Vegetation Score from the Biobank Calculator is 1.00.

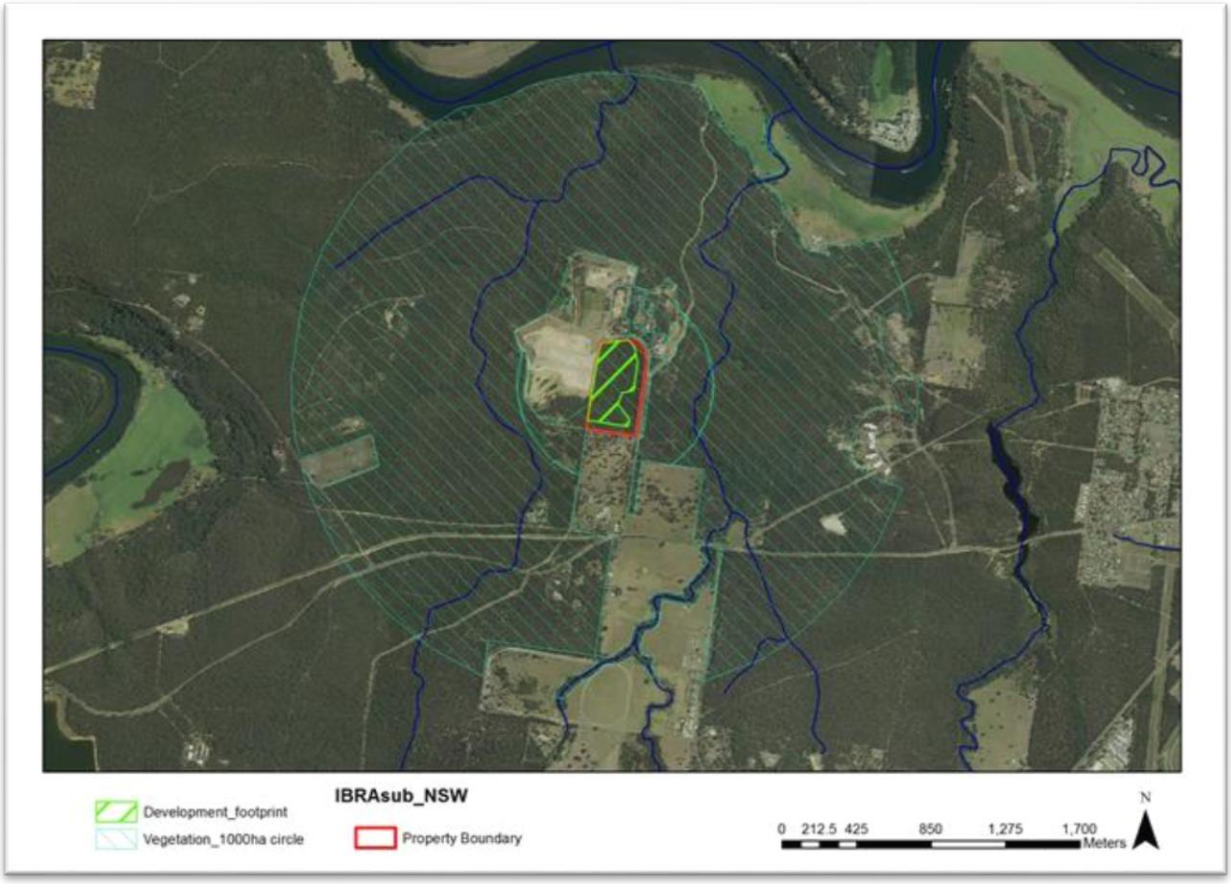


Figure 7 – 1000ha Assessment Circle containing 804.8ha of native vegetation

3.3 Cleared areas

The subject site (14.52ha) is completely vegetated with native vegetation in "moderate to good" condition (refer to Figure 2) with only minor disturbance to vegetation around the fence line.

Areas within the existing landfill site adjoining the subject property, most notably adjoining the south-west corner, are depicted as covered in native vegetation but have not been included as native vegetation within the 1000ha circle because they have since been cleared or can be cleared under existing approvals.

3.4 Rivers and streams classified according to stream order

There are no rivers or streams within or immediately adjoining the subject site. The subject site is within the catchment of, and within approximately 400 to 500m from Cabbage Tree Creek which flows into the Shoalhaven River approximately 1.5km to the north (Figure 8).

3.5 Wetlands within, adjacent to and downstream of the site

There are no SEPP14 Wetlands within 10km of the subject site (Shoalhaven City Council, GIS accessed August 2015).

There are no other important wetlands and local wetlands adjacent to or downstream of the subject site (Figure 8).

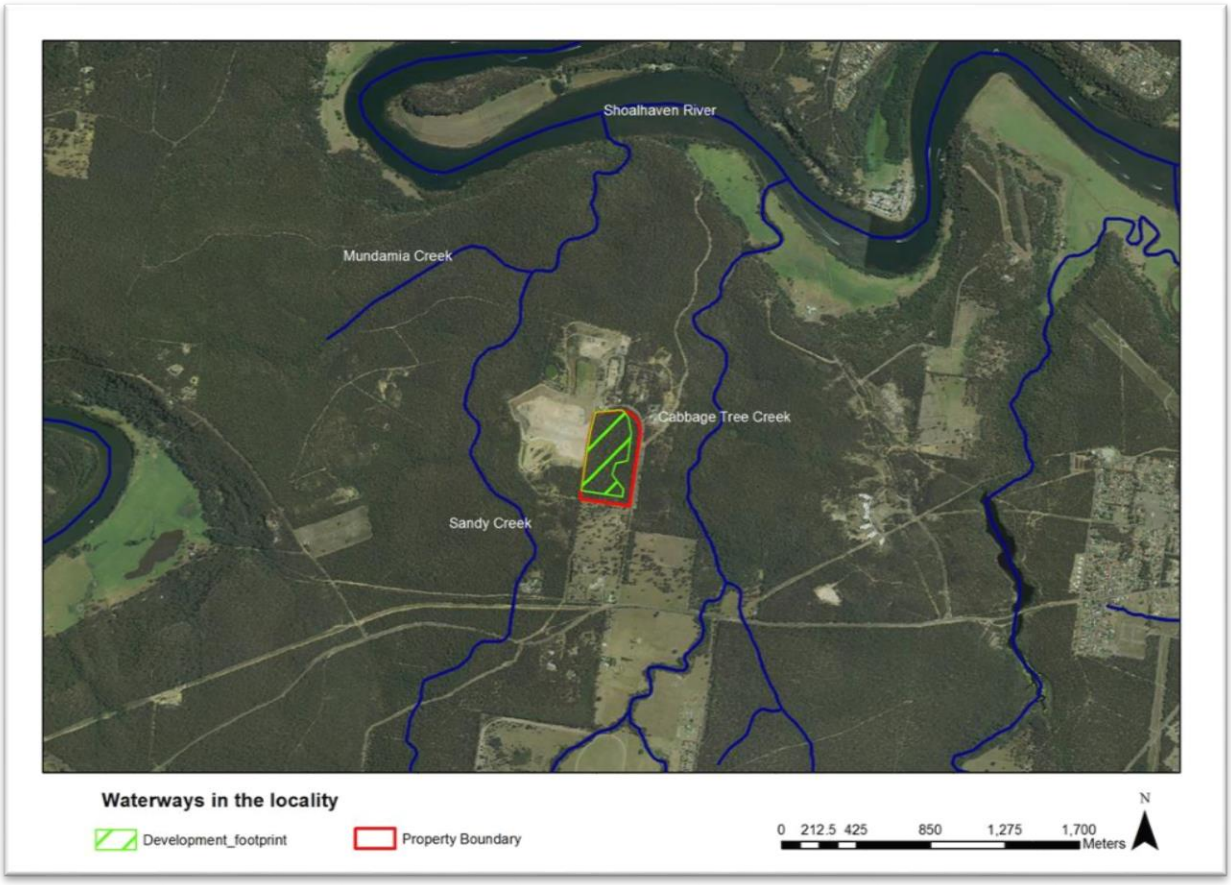


Figure 8 – Waterways around the development site and locality

3.6 Landscape value components

The subject site is approximately rectangular in shape (refer to Figure 2), that is, site-based, for the purpose of calculating a landscape score.

3.6.1 Percent native vegetation cover in the landscape (development site)

The subject site is 14.52 and is covered in native vegetation and is included in the 804.80ha (76-80% native vegetation cover class) within the 1000ha assessment circle. After development the area of native vegetation remains within the same class despite being reduced by 9.87ha down to 794.85ha (Figure 7).

In terms of the 100ha assessment circle, there is 52.71ha of native vegetation before development (51 – 55% native vegetation cover class) which is reduced to 42.84ha after development (41 - 45% native vegetation cover - Figure 9). The Biobank Calculator gives a Percentage Native Cover Score of 1.00

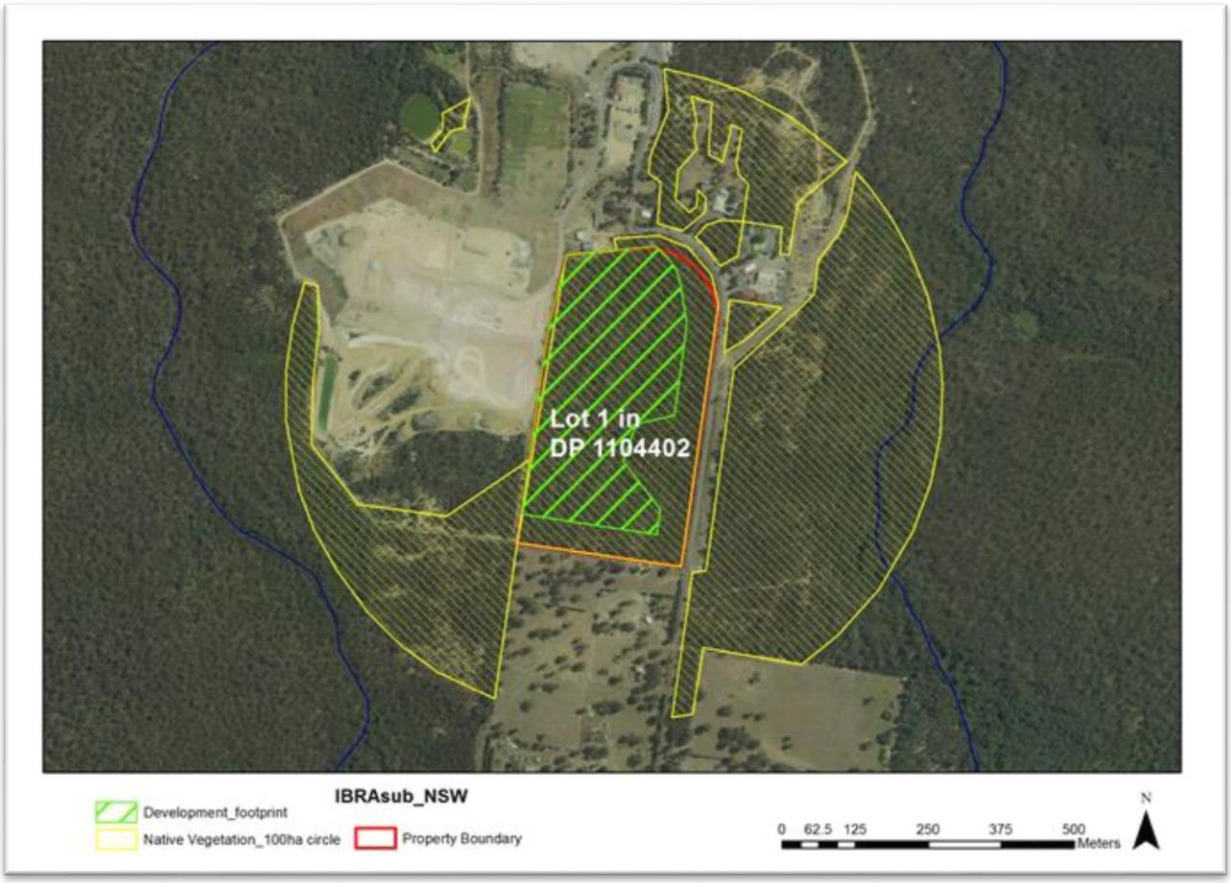


Figure 9 – 100ha Assessment circle with 52.7ha of native vegetation

3.6.2 Connectivity value (development site)

Connectivity, as per the FBA, is >100m-500m wide before development reducing to >30m-100m after development (refer to Figure 3) which gives a Connectivity Value of 8.

3.6.3 Patch size (development site)

Patch size, as per the FBA, is greater than 200ha (refer to Figure 2) which gives a Patch Size Score of 12.

3.6.4 Area to perimeter ratio (development site)

Not applicable, subject site and development are not classified as linear as per the FBA.

3.6.5 Strategic location of Major Project site

The subject site is not within;

a) An area of land identified as part of a state significant biodiversity link in a plan approved by the Chief Executive OEH, or

b) The riparian buffer area of a third order stream or higher, an important wetland or an estuarine area.

The subject site is identified as being within a regional biodiversity habitat corridor (Shoalhaven Local Environment Plan 2014) on the Shoalhaven City Council GIS (Figure 10) and South Coast Regional Conservation Plan (DECCW, 2010). However for the purposes of the FBA, these are not identified as a regional biodiversity link and therefore a site based connectivity assessment is required.

Figure 10 – Regional Biodiversity Habitat Corridor highlight pale green (Shoalhaven LEP 2014)

3.6.6 Landscape value score

The landscape value score produced using the Biobank calculator is 21.00.

4 Native Vegetation

4.1 Plant communities identified within the development site

Two plant community types (PCT) were identified within the subject land; Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion (PCT 1082 with Biometric Veg type Code SR594) and PCT with Biometric reference SR549; Grey Gum Blue-leaved Stringybark open forest on gorge slopes. These PCT were identified following a review of existing mapping (refer to the paragraphs below) and a rapid visual assessment of the site and surrounding areas as well as analysis of data from three vegetation plots within the SR594 PCT and one from within the SR549 PCT (Figure 11). As SR549 is outside of the development footprint and not impacted the data from the plot was only used to verify the identity of the PCT. The assessment and calculation of biodiversity credits is based on the impact of the development on SR594 only.

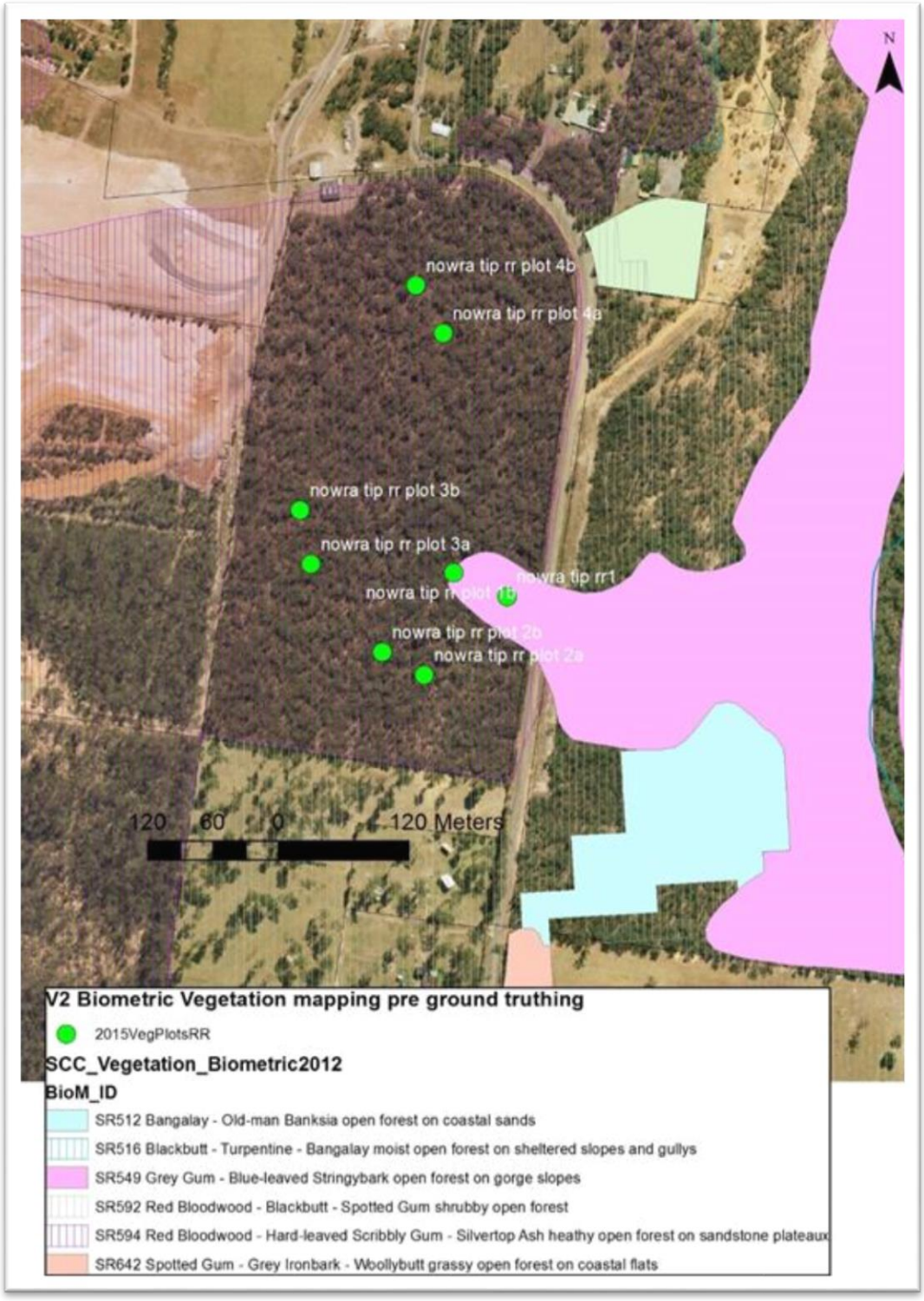


Figure 11 – vegetation plot locations over existing biometric vegetation mapping

Vegetation Class

Dry Sclerophyll Forests (shrubby sub-formation) – Sydney Coastal Dry Sclerophyll Forests.

Vegetation Type

(PCT 1082 with Biometric Veg type Code SR594) Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion

Area (ha) for each vegetation type

For the subject site (14.52ha), native vegetation identified as Biometric Veg type Code SR594 covers 14.04ha with SR549 covering the remaining 0.48ha. Only SR594 is impacted by the proposal.

Species relied upon for identification of vegetation type and relative abundance

Species in bold are listed as characteristic species for SR594 in OEH, 2013. The over-storey in the three plots contained 4 species; ***E. sclerophylla****, **Corymbia gummifera,** Eucalyptus eugenioides,* and *E. punctata,* with no one species dominating.

Mid-storey plants from the plots; ***Banksia spinulosa,*** *Hakea sericea, H. dactyloides,* ***Lambertia formosa*** *and* ***Petrophile pedunculata****. L.formosa* is particularly dominant with the *H.sericea* and *B.spinulosa*.

Ground cover (shrubs <1m and grasses) from the plots; ***Entolasia stricta*****,** *E. marginata, Echinopogon caespitosus, Imperata cylinderica, Themeda australis, Microlaena stipoides, Platylobium formosum, Pratia purpurascens, Goodenia hederacea, Lepidosperma laterale,* ***Lomandra obliqua****, Lomandra filiformis, Pteridium esculentum, Lindsaea linearis, Smilax glyciphylla, Violacea hederacea, Micrantheum ericoides,* ***Patersonia sericea****, Lomandra multiflora, Aristida vagans, Panicum simile, Opercularia hispida, Dillwynia retorta, Hypericum gramineum, Cryptostylis subulata,* and *Xanthorrhoea resinifera.*

The mapped occurrence of **SR549** on the subject land is at the start of the drainage line that flows (through a pipe after rain only) under Flatrock Road to adjoin Cabbage Tree Creek. OEH (2013) describes the community as occurring “on the rocky slopes of the Ettrema, Shoalhaven, Danjera and Yarramunmun Gorges where sediments underlying the Sydney Basin are exposed”. Cabbage Tree Creek flows through a gorge with the mapped occurrence on the subject land (upstream of the gorge) likely to be an ecotone between SR549 and SR594. Given the small area of SR549 mapped, and the one plot of data collected from this area and no plot data collected from the main area mapped on the eastern side of Flatrock Road, confidence in the identification of this community is low. Given that SR549 is not to be directly

impacted or requires the retirement of credits for the proposal, an incorrect identification of this community will not impact on the credit calculation of this assessment.

The species used to identify SR549 were, in the canopy, *Eucalyptus sclerophylla, Corymbia gummifera* and ***E.globoidea****.* Mid-storey species were *Leptospermum rotundifolium, Banksia spinulosa, Hakea sericea, H. dactyloides, Dillwynia retorta, Acacia ulicifolia*, and *Lambertia Formosa.* Ground cover (shrubs <1m and grasses) species were; *Entolasia stricta, Anisopogon avenaceus, Echinopogon casespitosus, Lepidosperma laterale, L. filiformis, Patersonia sericea,* and *Xanthorrhoea resinifera.*

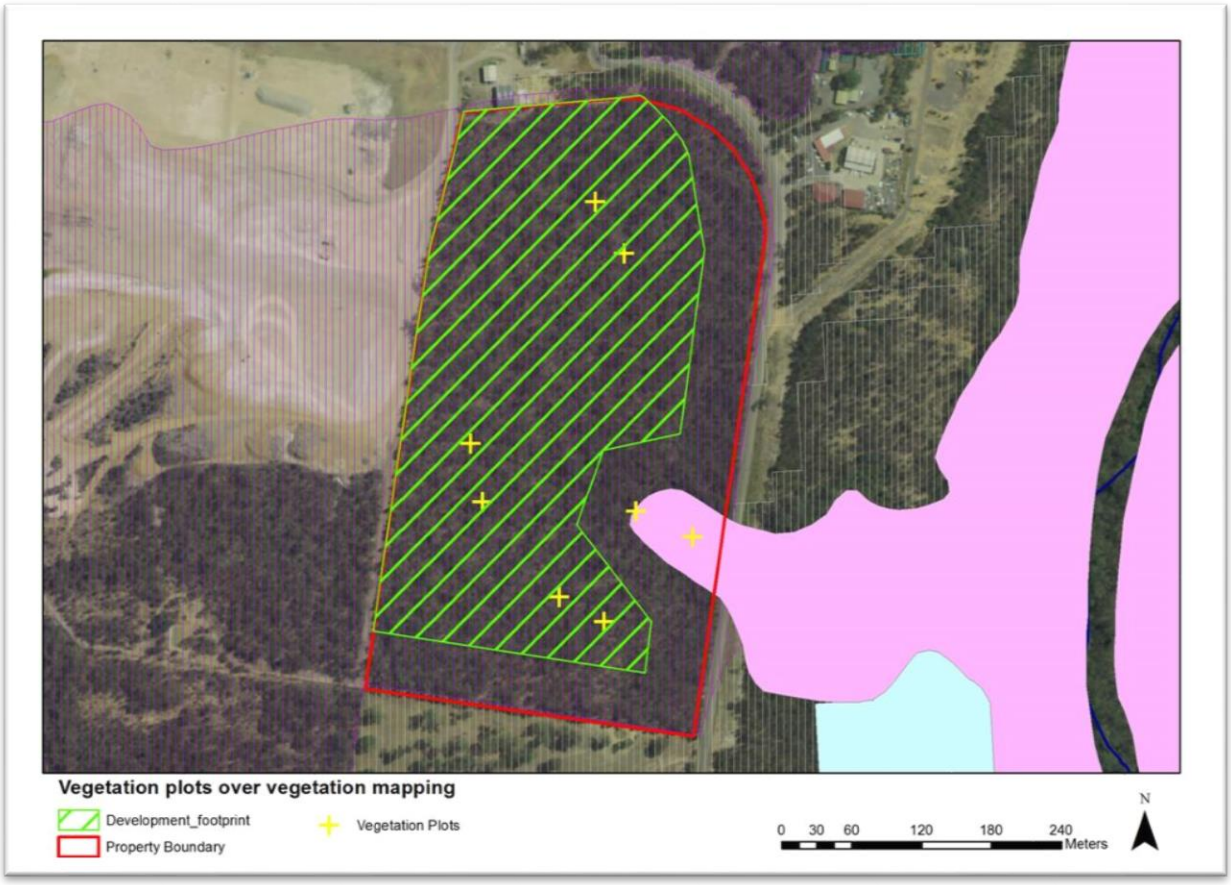


Figure 12 – Vegetation Plots (20mx50m) locations

Justification of evidence used to identify a PCT

Prior to collecting vegetation plot data on site, the existing Biometric Vegetation Mapping (OEH, 2013) was reviewed. The mapping (Figure 11) depicted two vegetation communities as occurring on the subject site; SR549 and SR594.

The existing Biometric Vegetation Mapping "incorporates several different vegetation classifications and 'perceived' user accuracies to develop a Biometric vegetation map" (OEH, 2013). The vegetation mapping unit SR594 (Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin) contains a number of vegetation subtypes from the Council vegetation mapping project (Mills, 2000); SCL-GUM (Scribbly Gum – Bloodwood Woodland / Open Woodland), SCL-CAS (Scribbly Gum – Casuarina Forest), SIE-GUM (Silvertop Ash – Bloodwood Forest) and CON-GUM (Yertchuk – Bloodwood Woodland). This vegetation mapping requires ground truthing in many areas following aerial photo interpretation and a limited number of vegetation plots to create the original map. The same is likely for SR549; Grey Gum – Blue-leaved Stringybark open forest on gorge slopes.

Within the subject site, surveys of the site have identified areas where the vegetation changes to match the descriptions of subtypes in Mills (2000). Red Bloodwood is common over the majority of the site stands of Casuarina (*Allocasuarina littoralis*) along the eastern and southern eastern portions of the site. The majority of the site contains "a heathy understorey" dominated by *Lambertia formosa* and *Hakea sericea*.

In terms of the landscape position, the subject site matches that for the SR594 PCT in the Biometrics being on the sandstone plateaux between the gorges of Cabbage Tree to the east and Sandy Creek to the west. The site is at the lower and eastern end of the Shoalhaven River approximately 5km from where the river enters the coastal floodplain before entering the sea.

For SR549, the PCT is described as occurring on the "dry upper slopes of rocky gorges between 400m and 850m". It includes related vegetation types DSFp11 in Tozer et al (2010) and PUN-AGG Grey Bum – Stringybark Forest/Woodland in Mills (2000). Whilst the subject site is at an elevation of between 40-50m above sea level (Shoalhaven City Council GIS mapping layers) and below that described in the Biometrics, the landscape description of PUN-AGG in Mills matches with the subject site and nearby being within a "fringing community of the sandstone gullies around Nowra". "The abundance and often dominance of *E. punctata* is characteristic of the community" and is evident along Cabbage Tree Creek immediately to the east.

EEC status

Neither of SR594 or SR549 are vegetation communities listed as Endangered Ecological Communities (OEH, 2013).

Estimate of percent cleared value of PCT

It is estimated 20% of both SR594 and SR549 have been cleared since European settlement (OEH, 2013).

4.2 Description of vegetation zones within the development site

Condition class and sub category

Only one vegetation zone occurs on the subject land within the proposed development footprint; (SR594) Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion. The development zone covers 9.87ha of the 14.52ha subject site.

The condition before development was assessed as being within Benchmark with no native vegetation after development within the development footprint.

Vegetation on the subject site, outside the development footprint, has been subjected to a small amount of historic disturbance but is within “benchmark” at the “good” end of “moderate to good”. A small number of trees have been cleared with old weathered stumps observed in a number of locations and vegetation in the south east corner of the site appears to have been cleared in the distant past during some minor quarrying.

Area of each vegetation zone

SR594 covers 14.04ha of the subject land and is the only PCT directly affected by the proposal with the area to be cleared (one vegetation zone) equating to 9.87ha. An area of 4.17ha of this PCT will be retained within a vegetation buffer surrounding the proposed landfill extension screening the site from Flatrock Road.

SR549 is outside the area affected by the proposal and covers 0.48ha of the subject land.

Survey effort (number of plots)

Data from 3 plots was used to identify the SR594 PCT with the Biobanking Assessment Methodology 2014 specifying 3 plots per 4-20ha (vegetation zone area).

One plot was used to identify the mapped occurrence of SR549 PCT with the Biobanking Assessment Methodology 2014 specifying 1 plot per 2ha for areas up to 4ha. SR549 covers 0.45ha of the subject land.

4.3 Local Data

Not applicable. Plots were surveyed in each of the two predicted mapping vegetation types with the analysed plot data used to confirm the two vegetation communities on the subject site.

5 Credit Report and Data Sheets

Copies of the credit report is provided in Appendix 1 – Biodiversity Credit Report with the Biobanking Calculator calculating 719 Ecosystem Credits are required for the clearing of 9.87ha of SR594 Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin bioregion.

The 9.87ha is also known habitat for two “species credit” threatened fauna species being Squirrel Glider which generates a requirement for 217 credits and Eastern Pygmy-possum which generates a requirement for 197 credits to be retired before the proposal can proceed.

6 Threatened Species requiring survey

Threatened species requiring survey or / and assessment have been identified through;

- The SEARs. Project specific species requiring survey or / and assessment are reproduced from the SEARs (Table 1).
- The Biobank Calculator (Table 2)
- Previous recent biodiversity surveys on the subject site and existing Bionet threatened species records (Table 3).

Table 1 – Project specific species from the SEARS requiring targeted survey

Attachment B – Project Specific Requirements

A. Impacts on the following species will require further consideration and provision of the information specified in s9.2 of the Framework for Biodiversity Assessment:

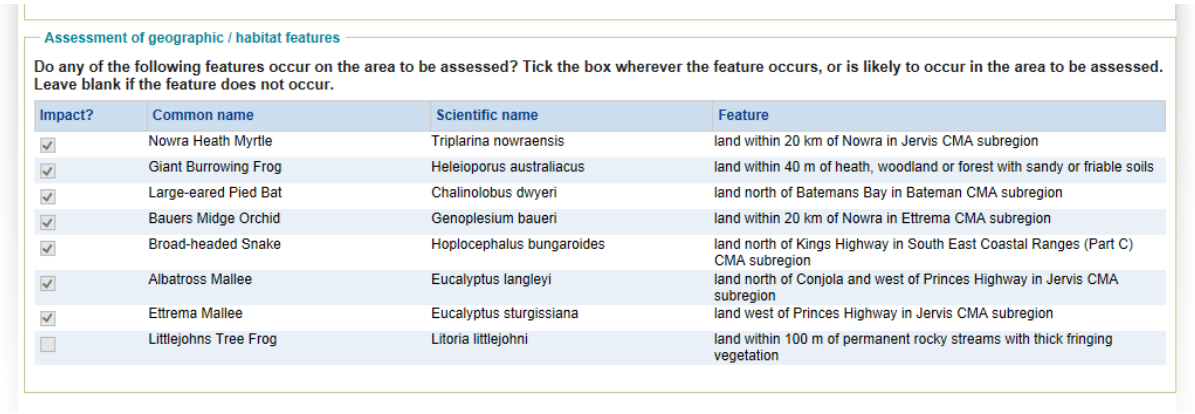
- *Acacia bynoeana*
- *Gallium australe*
- *Melaleuca deanei*
- *Triplarina nowraensis*
- *Hibbertia stricta subsp. Furcatula*
- *Calochilus pulchellus*
- *Pterostylis ventricosa*
- *Pterostylis vernalis*
- *Genoplesium baueri*
- *Cryptostylis hunteriana*

B. Surveys for all species must include targeted searches in all habitat (including marginal habitat) on the subject site.

C. Surveys for orchids must undertake consecutive/parallel 5m wide transects covering all potential habitat (including marginal habitat) on the subject site. Surveys must involve walking along each transect searching for the species, and must be undertaken during the species' flowering season. Flowering season must be confirmed by survey of flowering at known reference sites.

Table 2 – Biobank calculator geographic / habitat features and species requiring survey

RRP assessment of geographic / habitat features



Assessment of geographic / habitat features

Do any of the following features occur on the area to be assessed? Tick the box wherever the feature occurs, or is likely to occur in the area to be assessed. Leave blank if the feature does not occur.

Impact?	Common name	Scientific name	Feature
☑	Nowra Heath Myrtle	Triplarina nowraensis	land within 20 km of Nowra in Jervis CMA subregion
☑	Giant Burrowing Frog	Heleioporus australiacus	land within 40 m of heath, woodland or forest with sandy or friable soils
☑	Large-eared Pied Bat	Chalinolobus dwyeri	land north of Batemans Bay in Bateman CMA subregion
☑	Bauers Midge Orchid	Genoplesium baueri	land within 20 km of Nowra in Ettrema CMA subregion
☑	Broad-headed Snake	Hoplocephalus bungaroides	land north of Kings Highway in South East Coastal Ranges (Part C) CMA subregion
☑	Albatross Mallee	Eucalyptus langleyi	land north of Conjola and west of Princes Highway in Jervis CMA subregion
☑	Ettrema Mallee	Eucalyptus sturgissiana	land west of Princes Highway in Jervis CMA subregion
☐	Littlejohns Tree Frog	Litoria littlejohni	land within 100 m of permanent rocky streams with thick fringing vegetation

Go to predicted threatened species

Survey time matrix

Common name	Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bauers Midge Orchid	Genoplesium baueri		Yes	Yes									
Broad-headed Snake	Hoplocephalus bungaroides			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Bynoes Wattle	Acacia bynoeana	Yes	Yes	Yes						Yes	Yes	Yes	Yes
Deanes Paperbark	Melaleuca deanei	Yes	Yes										Yes
Eastern Pygmy-possum	Cercartetus nanus												
Giant Burrowing Frog	Heleioporus australiacus	Yes	Yes	Yes	Yes	Yes				Yes	Yes	Yes	Yes
Hibbertia puberula	Hibbertia puberula	Yes	Yes							Yes	Yes	Yes	Yes
Hibbertia stricta subsp. furcatula	Hibbertia stricta subsp. furcatula	Yes								Yes	Yes	Yes	Yes
Koala	Phascolarctos cinereus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Large-eared Pied Bat	Chalinolobus dwyeri	Yes	Yes	Yes	Yes					Yes	Yes	Yes	Yes
Nowra Heath Myrtle	Triplarina nowraensis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pretty Beard Orchid	Calochilus pulchellus										Yes	Yes	
Regent Honeyeater	Anthochaera phrygia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3 – Threatened records within 10km of the subject land sourced from Bionet accessed January 2016.

Scientific Name	**Common Name**	**Number of records**
Heleioporus australiacus	Giant Burrowing Frog	4
Litoria aurea	Green and Golden Bell Frog	234
Botaurus poiciloptilus	Australasian Bittern	5
Chelonia mydas	Green Turtle	2
Hoplocephalus bungaroides	Broad-headed Snake	2
Stictonetta naevosa	Freckled Duck	3
Ixobrychus flavicollis	Black Bittern	3
Hieraaetus morphnoides	Little Eagle	1

Lophoictinia isura	Square-tailed Kite	22
Pandion cristatus	Eastern Osprey	2
Burhinus grallarius	Bush Stone-curlew	2
Thinornis rubricollis	Hooded Plover	1
Rostratula australis	Australian Painted Snipe	1
Calyptorhynchus lathami	Glossy Black-Cockatoo	237
Callocephalon fimbriatum	Gang-gang Cockatoo	12
Glossopsitta pusilla	Little Lorikeet	2
Neophema pulchella	Turquoise Parrot	1
Ninox strenua	Powerful Owl	19
Tyto novaehollandiae	Masked Owl	2
Tyto tenebricosa	Sooty Owl	2
Dasyurus maculatus	Spotted-tail Quoll	7
Epthianura albifrons	White-fronted Chat	3
Daphoenositta chrysoptera	Varied Sittella	12
Petroica boodang	Scarlet Robin	4
Phascolarctos cinereus	Koala	3
Cercartetus nanus	Eastern Pygmy-possum	6
Petaurus australis	Yellow-bellied Glider	255
Potorous tridactylus	Long-nosed Potoroo	1
Pteropus poliocephalus	Grey-headed Flying-fox	36
Petrogale penicillata	Brush-tailed Rock-wallaby	4
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	3
Mormopterus norfolkensis	Eastern Freetail-bat	4
Chalinolobus dwyeri	Large-eared Pied Bat	2
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	13

Myotis macropus	Southern Myotis	1
Scoteanax rueppellii	Greater Broad-nosed Bat	5
Arctocephalus pusillus doriferus	Australian Fur-seal	1
Hibbertia puberula		1
Hibbertia stricta subsp. furcatula		2
Acacia bynoeana	Bynoe's Wattle	5
Acacia pubescens	Downy Wattle	1
Eucalyptus langleyi	Albatross Mallee	20
Eucalyptus sturgissiana	Ettrema Mallee	1
Melaleuca deanei	Deane's Paperbark	2
Syzygium paniculatum	Magenta Lilly Pilly	1
Triplarina nowraensis	Nowra Heath Myrtle	325
Cryptostylis hunteriana	Leafless Tongue Orchid	4
Genoplesium baueri	Bauer's Midge Orchid	9
Pterostylis ventricosa		1
Pterostylis gibbosa	Illawarra Greenhood	62
Pterostylis vernalis		15
Galium australe	Tangled Bedstraw	1
Zieria baeuerlenii	Bomaderry Zieria	16
Zieria tuberculata	Warty Zieria	1
Solanum celatum		8

In addition to species listed as requiring targeted surveys in the Biobanking calculator and in the SEARs, the list of threatened species recorded within 10km (Table 3) was reviewed against the habitat requirements for each species and those habitat requirements available on the subject site. Based on these requirements, no additional "species credit" threatened species were identified for targeted surveys. Only the Squirrel Glider and Eastern Pygmy-possum, both recorded on the subject site in 2014, were listed as a species requiring to be offset due to the loss of habitat as a result of the proposed development.

Section 8.3 of the Framework for Biodiversity requires a demonstration of "avoidance and minimisation of direct impacts on biodiversity values" on Plant Community Types that contain threatened species habitat and areas that contain habitat for vulnerable, endangered or critically endangered threatened species or populations. A number of threatened species, both ecosystem and species credit species, have previously been identified on the subject land during surveys (Hyder 2007, GHD 2013 and SCC 2014). These species are mostly hollow dependent with the Illawarra Regional Operations Group of the NSW Office of Environment & Heritage advising targeted hollow bearing trees surveys are required across the site to determine if breeding, roosting or denning trees are found on the subject land with such trees requiring a buffer of 100m for breeding sites and 50m of roosting and den trees. Species the subject of targeted additional hollow-bearing tree surveys are; Powerful Owl, Masked Owl, Yellow-bellied and Squirrel Glider.

7 Threatened flora species, survey methods and results

Previous studies

A number of previous environmental studies of the subject land, dating back to 2007, were reviewed to give an historical timeline of surveys and results on the site over a number of seasons by different ecologists. The details of these surveys, timing, and results are referred to throughout the following sections relating to specific species. The results of these surveys have not been relied upon, however, to conclude a species requiring survey under FBA does not inhabit the subject land, rather they support any conclusions under this assessment where species were not detected or habitat was assessed to be unsuitable.

These studies are;

- Threatened Biodiversity Survey and Assessment – West Nowra by Hyder Consulting (June 2007). Survey and report of the subject land commissioned by Shoalhaven City Council.
- West Nowra Resource Recovery Park EIS Flora and Fauna Impact Assessment by GHD (February 2014). Survey and report commissioned by Shoalhaven City Council for withdrawn State Development Application (Council reference RA14/1003) over the subject land.
- Targeted threatened species surveys by Shoalhaven City Council Threatened Species Officers from December 2013 to November 2015 over the subject land to provide data for the withdrawn development application (Council reference RA14/1003) as well as the current proposal.

Additional targeted surveys and expert reports for the FBA assessment

A number of additional targeted surveys were conducted by Shoalhaven City Council staff (Environmental Assessment Officers and support staff working under Scientific Licence SL10028). Targeted fauna surveys of selected hollow-bearing trees were conducted from 27 March 2017 through to 20 June 2017 looking to identify breeding, roosting and den trees for threatened species previously detected across the subject land by Hyder (2007), GHD (2013) and SCC (2014). Surveys involved two ecologists and two support staff traversing the subject land identifying and recording the locations

of trees with hollows assessed as being suitable for use by large forest owls and threatened gliding possums. In all 70 hollow-bearing trees were identified for targeted surveys with the locations depicted in Figure 13. In addition to the locations, the height of each tree was obtained using a Nixon Forestry Pro tree measuring instrument, and recorded along with the tree species and the number of hollows (Appendix 4).

It is likely there are more hollow-bearing trees than was recorded with not all hollows being visible from the ground. Some hollows or trees were not recorded due to the hollow being too shallow when viewed through binoculars. Trees with only small hollows (generally less than 10cm in diameter) unsuitable for large forest owls and threatened gliders were generally not included in the inventory. In all 18 person hours was spent identifying hollow-bearing trees across the subject land.

Targeted surveys of the hollow-bearing trees were conducted over 9 nights commencing on Monday 27 March 2017 through to 20 June 2017 (60.75 hours in total). Details of the weather conditions of the survey are provided in Table 7 with the number of surveyors, trees surveyed and the results displayed in Table 8. The surveys involved surveyors (up to 4 each night) being in position approximately half an hour before sunset, positioned so they could keep watch on up to 3 hollows to observe and record animals leaving or entering hollows, and staying in position until one hour after sunset. Each surveyor had a pair of binoculars and Led Lenzer head torch to aid in observing the hollows. The results of the survey are provided immediately after Table 8. The location of the subject site and its surrounds along with prevailing conditions means fauna utilising the hollows could have been missed due to a number of factors; not all hollows could be watched at one time, sometimes breezy conditions hampered observing hollows, and intruding noise from the adjoining operating Landfill facility with methane fuelled generator, nearby roads, RSPCA animal shelter, and farms could have masked the calls of owls and gliders.

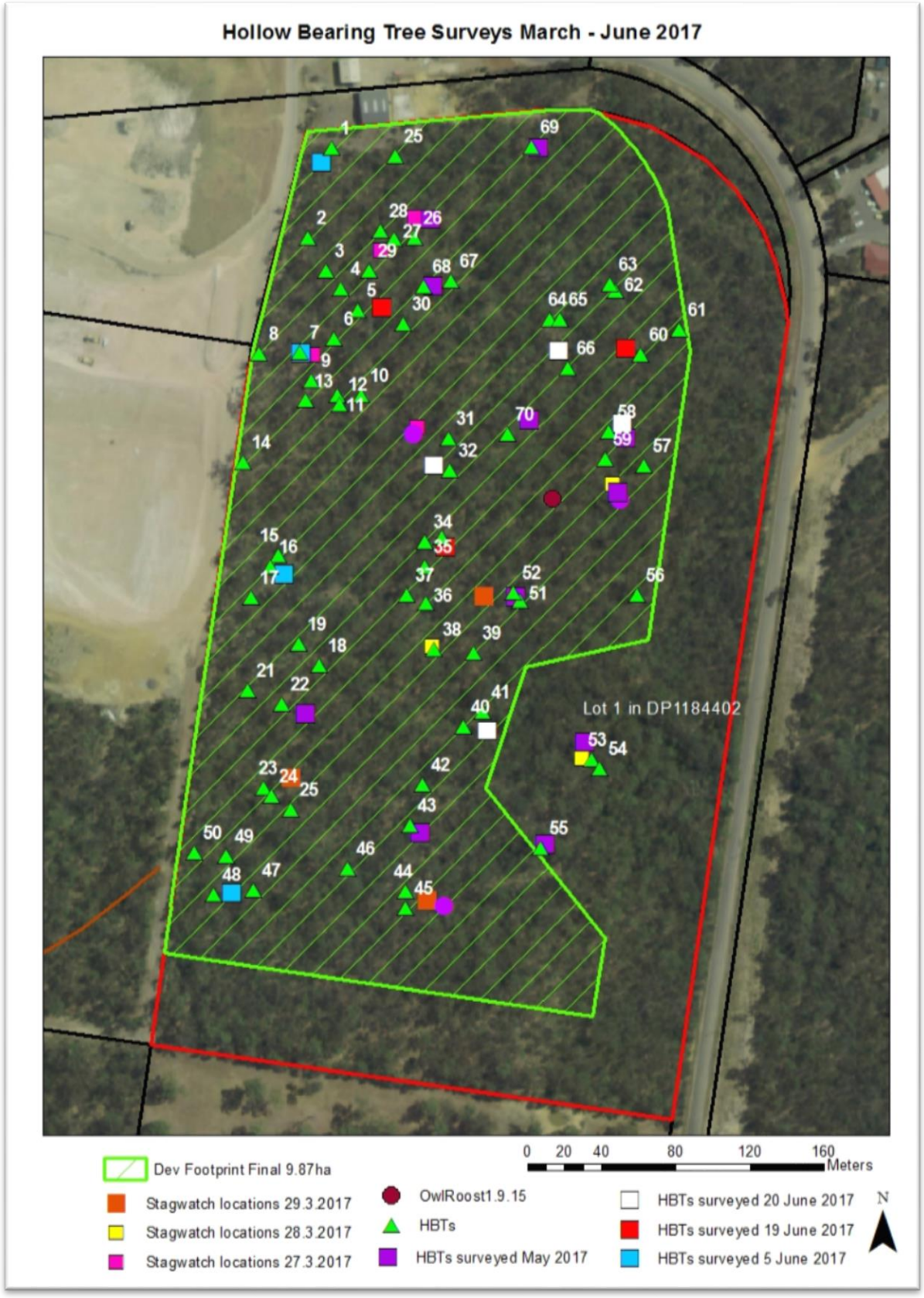


Figure 13 - Additional targeted hollow-bearing tree (HBT) survey locations and effort

Details of specific surveys for threatened plants are provided in the sections for each species with a recognised orchid expert (Mr Alan Stephenson) engaged to assess the likelihood or otherwise of several orchid species occurring on the site.

Vegetation plots and targeted threatened flora species surveys were conducted on the 25 and 26 November 2015. The species targeted were the two Hibbertia species (*Hibbertia puberula* & *Hibbertia stricta subsp. furcatula*), *Galium australe, Acacia bynoeana,* and *Melaleuca deanei.* A portion of the subject land was also surveyed on 15 September 2015 (Figure 14).

Figure 14 – Targeted flora survey transects and results 15 September 2015

Albatross Mallee (Eucalyptus langleyi)

This species is identified for consideration using the Biobanking Calculator.

Profile

The Albatross Mallee grows to 6 m tall, with smooth, grey, green or pink bark that sheds in ribbons. The juvenile leaves are broadly oval-shaped and glossy green in colour. The large, glossy, green adult leaves are lance-shaped and up to 18 cm long by 4 cm wide. The buds are club-shaped and have a hemispherical cap. The flowers grow at the end of a flattened stalk. The fruits are hemispherical or urn-shaped, ribbed with enclosed valves. It is found in mallee shrubland on poorly-drained, shallow, sandy soils on sandstone (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10298).

Survey methods and notes

The species is predicted to potentially occur on the subject site based on a number of records within 10km including a population north of the Shoalhaven River in Bomaderry Creek Reserve. It is not listed in the SEARS but is identified as a potential species for consideration based on the geographic and habitat features check list in the BBAM tool.

The potential for species to occur on the subject land based on the habitat requirements described in the species profile and the author's knowledge of known sites for the species was assessed during a 2 hour targeted search of the subject site on 15 September 2015. Numerous other targeted surveys on the site (Table 5) for other threatened species, including installing pitfall traps, confirmed that suitable habitat (shallow sandy soils on sandstone) is not found anywhere on the site.

Habitat on site, results and potential impacts

Vegetation on the subject site is from the Dry Sclerophyll Forests class (Keith, 2004) as opposed to the mallee shrubland habitat required for the species. The 15 September 2015 targeted survey did not detect the species. No suitable habitat as described in the species profile was found on the subject site. The species will not be directly or indirectly impacted by the proposal.

The non-detection of the species is consistent with the findings of Hyder (2007) and GHD (2014).

Ettrema Mallee (Eucalyptus sturgissiana)

This species is identified for consideration using the Biobanking Calculator.

Profile

The Ettrema Mallee grows to 5 m tall. It has smooth grey to brown bark that sheds in strips. Unusually, the adult leaves are paired, slender (to 12 cm by 1.5 cm) and glossy green on both sides. The buds are stalkless, blue-green and to 7 mm long by 4 mm wide. The flowers are in clusters of seven, and are held on a flattened stalk. The fruits are bell-shaped, up to 7 mm long and 7 mm wide. The Ettrema Mallee is mostly restricted to the Northern Budawang Range in Morton National Park, with a few occurrences on the nearby coastal plain. Usually grows as an emergent in low shrub-heath. Grows on sandy, swampy soils (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10318).

Survey methods and notes

The species is predicted to potentially occur on the subject site based on a number of records within 10km mostly to the south and at slightly higher elevations.

Surveys for threatened plants including Ettrema Mallee were conducted on the subject site on 15 September 2015 around the top of the drainage line where there could have be potential habitat. Two surveyors spent approximately 2 hours in this portion of the site (Figure 14) looking for potential habitat and the species. Both surveyors carried hand-held GPS units to record the survey transect. One GPS unit failed so not all areas covered are depicted in Figure 14.

The potential for species to occur on the subject land based on the habitat requirements described in the species profile and the author's knowledge of known sites for the species was assessed during a 2 hour targeted search of the subject site on 15 September 2015. Numerous other targeted surveys of the site for other threatened species (flora and fauna), including installing pitfall traps, confirmed that suitable habitat (shallow sandy soils on sandstone) is not found anywhere on the site.

Habitat on site, results and potential impacts

Vegetation on the subject site is from the Dry Sclerophyll Forests class (Keith, 2004) as opposed to low shrub-heath on sandy swampy soils recognised as habitat for the species. The 15 September 2015 targeted survey and other surveys did not detect the species. With no suitable habitat as described in the species profile found on the subject site the species will not be directly or indirectly impacted by the proposal.

The non-detection of the species is consistent with the findings of Hyder (2007) and GHD (2014).

Bynoe's Wattle (Acacia bynoeana)

This species is identified in the SEARs as an additional species for consideration as well as being listed using the Biobanking Calculator.

Profile

Bynoe's Wattle is a semi-prostrate shrub to a metre high. The phyllodes ('leaves') are shiny, stiff and narrow, 1.5 - 5 cm long and 1 - 3 mm wide. The single flower heads, on short hairy stems, appear anytime from September to March. Its seedpods are mature from September to January. The hairy branchlets distinguish the species from the similar and more common Three-veined Wattle (*Acacia trinervata)*. It occurs in heath or dry sclerophyll forest on sandy soils and seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated over storey species include Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leaved Apple (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10006).

Survey methods and notes

Surveys for threatened plants including Bynoe's Wattle were conducted on the subject site on 15 September 2015 within the survey period specified in the survey time matrix. Two surveyors walked over the site (Figure 14) looking for potential habitat and the species from 10am to 12:30pm (5 hours of survey effort). Both surveyors carried hand-held GPS units to record the survey transect. One GPS unit failed so not all areas covered are depicted in Figure 14.

This species was also surveyed for on 25 and 26 November 2015 by two experienced botanists who also undertook vegetation plot surveys.

Habitat on site, results and potential impacts

Potential habitat, as described in the species profile above is not found on the subject site, with the soil not being the required "sandy' substrate. Based on the species not being detected during the 15 September 2015 and 25-26 November 2015 surveys, it is unlikely Bynoe's Wattle occurs on the site and viable local populations of the species will not be directly or indirectly impacted by the proposal.

The non-detection of the species is consistent with the findings of Hyder (2007) and GHD (2014).

Nowra Heath Myrtle (Triplarina nowraensis)

This species is identified in the SEARs as an additional species for consideration as well as being listed using the Biobanking Calculator.

Profile

Nowra Heath Myrtle is a small, erect shrub to 5 m tall. The branchlets have a grey, scaly bark. The small paired leaves are blunt-tipped with the broadest part above the middle. Leaves are only 5 mm long by 1.7 mm wide. They have a row of large oil dots on either side of the mid-rib and are highly aromatic when crushed. The tea-tree flowers are creamy-white and occur in pairs. The fruits are hemispherical and wrinkled. There are five known populations of Nowra Heath Myrtle. Three of these form a cluster to the immediate west of Nowra. A fourth, much smaller population is found 18km south-west of Nowra in the Boolijong Creek Valley. The fifth population is located north of the Shoalhaven River on the plateau above Bundanon. Nowra Heath Myrtle occurs on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone. The sites are often either treeless or have a very open tree canopy due to the impeded drainage (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10813).

Survey methods and notes

Surveys for threatened plants were conducted on the subject site on 15 September 2015 within the survey period specified in the survey time matrix. Two surveyors walked areas of known Nowra Heath Myrtle habitat and further west along and around the shallow drainage line. Both surveyors carried hand-held GPS units to record the survey transect. One GPS unit failed so not all areas covered are depicted. The location of all specimens observed were recorded with the working GPS (Figure 14).

Habitat on site, results and potential impacts

This species is known to occur on the subject site (refer Figure 14) with 83 plants detected. The plants occur at the start of a shallow drainage line that flows to the east and into Cabbage Tree Creek and away from the subject site.

The area where the specimens are found is outside the development footprint and buffered from the development by a minimum distance of 50m with a naturally vegetated area to be

retained to screen the landfill from Flatrock Road. The buffer distance of 50m, discussed and negotiated with the Illawarra Regional Operations Group of the NSW Office of Environment, should enable the species to remain viable on the subject land (David Bain OEH pers comm).

Bauer's Midge Orchid (Genoplesium baueri)

This species is identified in the SEARs as an additional species for consideration as well as being listed using the Biobanking Calculator.

Profile

A terrestrial orchid 6-15 cm high, fleshy, brittle, yellowish-green or reddish. Inflorescence sparse, 1-3 cm long, 1-6-flowered. Flowers approximately 15 mm across, green and red or wholly reddish. Dorsal sepal approximately 3.5 mm long, 4 mm wide; lateral sepals linear to lanceolate, 9-10 mm long, approximately 1.5 mm wide, widely divergent. Petals approximately 3 mm long, 1.5 mm wide, striped. Labellum approximately 4 mm long, approximately 2.5 mm wide, margins incurved; callus raised, of 2 linear, curved lobes extending about halfway to the labellum apex. Currently the species is known from just over 200 plants across 13 sites. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Grows in dry sclerophyll forest and moss gardens over sandstone. Flowers February to March (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10875).

Genoplesium baueri Shoalhaven profile

Genoplesium baueri (Brittle Midge Orchid) is a highly localised terrestrial "midge" orchid known from 5 sites in the Shoalhaven Local Government Area. Its preferred habitat is open forest, shrubby forest in well-drained sandy and gravelly soil (A. Stephenson, 2011). Within this macro habitat, the species' micro habitat requirements are open patches in forest or woodland with a sparse shrub layer and little to no leaf litter (pers. Comm. with Alan Stephenson).

Survey Methods

Prior to surveys of the subject land, a Council Environmental Assessment Officer met with recognised local orchid expert Mr Alan Stephenson at a reference site within Bomaderry Creek bushland on Thursday 11 February 2016. *Genoplesium baueri* was flowering at the reference site (Photo 1).

Photo 1 – Genoplesium baueri flowering at Bomaderry Creek bushland reference site 11.2.2016

The species micro habitat requirements as described above were observed and discussed with specimens at the reference site growing in open patches with little leaf litter (Photo 2).

Photo 2 – Genoplesium baueri habitat at Bomaderry Creek bushland reference site 11.2.2016

The reference site is approximately 5km to NNE of the subject land in what was visually assessed as being a similar vegetation community.

Surveys for *G.baueri* at the subject site were conducted on Thursday 18 February 2016 and Monday 22 February 2016. Prior to commencing the survey, the three staff (one Environmental Assessment Officer and two experienced Botanists visited the reference site at Bomaderry Creek bushland on Thursday 18 February 2016 to familiarise themselves with the species and its habitat.

Surveys at the subject site involved searches of suitable potential habitat (open patches with sparse shrub layer and leaf litter Photo 3) with the three surveyors walking in parallel transects where the vegetation allowed. Two hand-held GPS units were carried by two surveyors to give an indicative map of the areas surveyed (Figure 15). Areas with dense shrubs or areas where the leaf litter was relatively deep (Photo 4) was discussed on site with Alan Stephenson (OEH approved Orchid expert) and assessed as being unsuitable habitat. These areas were not surveyed which leaves only a relatively small area of potential habitat on the subject site.

Photo 3 – potential habitat surveyed at subject site

Survey effort in hours for Thursday 18 February 2016 was 13.5 person hours (3 x 4.5 hours).

Survey effort in hours for Monday 22 February 2016 was 6 person hours (3 x 2 hours – council staff) with an additional 1 hour by Alan Stephenson.

Photo 4 – unsuitable habitat at the subject site not surveyed

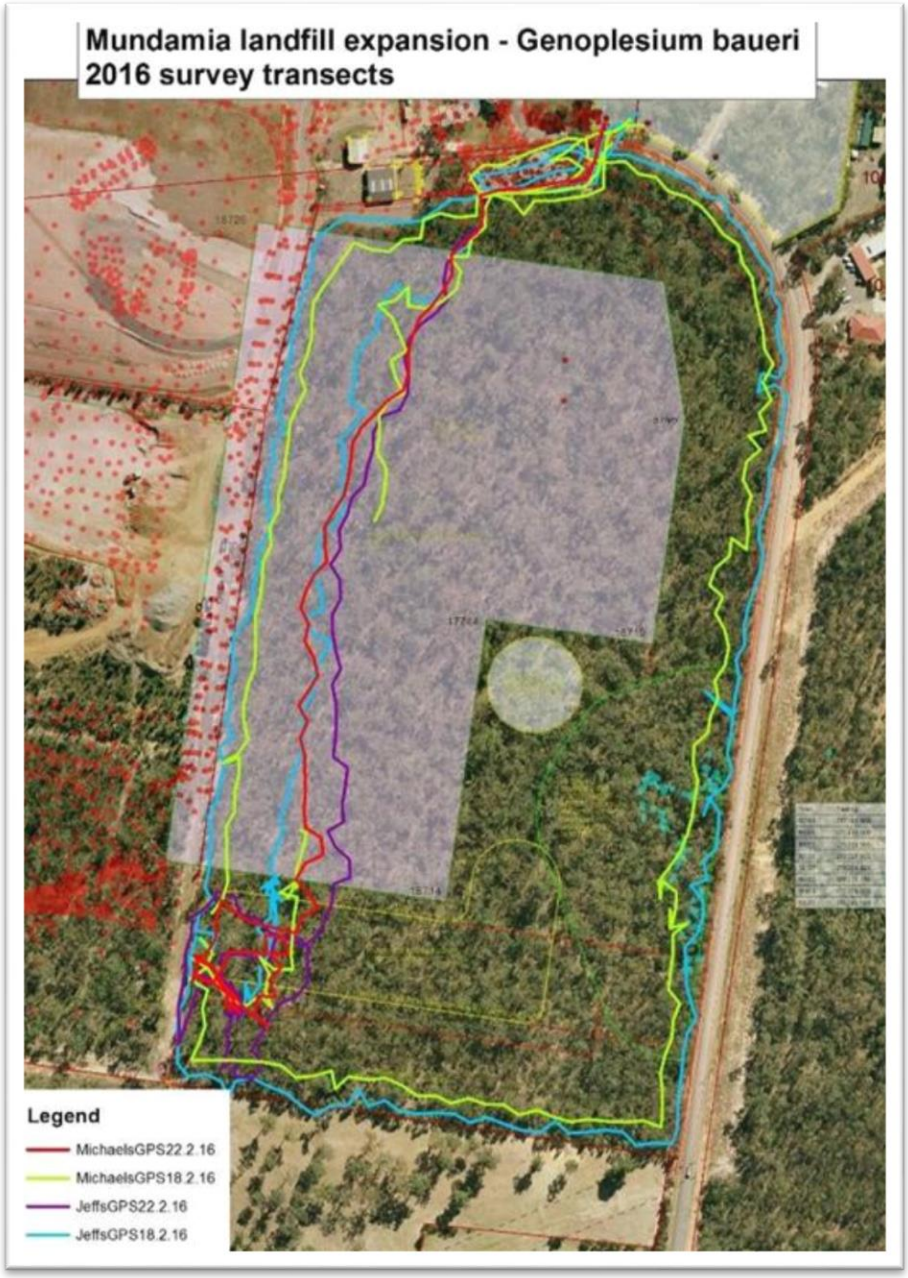


Figure 15 – GPS track of *Genoplesium baueri* surveys 2016

Results

The areas surveyed as recorded by the hand-held GPS are depicted in Figure 15.

On the Thursday 18 February 2016 survey a number of terrestrial orchids and one epiphytic orchid were detected; *Cryptostylis subulata* (leaves and old flowers), *C. erecta* (leaves only), *Dipodium variegatum* (flowering), *Corunastylis woollsii* (flowering), *Corunastylis apostasioides* (flowering) and *Cymbidium suave* (plants in stumps and hollows). Photos of the *Corunastylis* flowers were taken and sent to Alan Stephenson to confirm the species identification.

On the Monday 22 February 2016 survey, Alan Stephenson joined council staff to review live specimens photographed and sent to him for identification. No new species were identified and Mr Stephenson confirmed much of the site is unsuitable for *Genoplesium baueri* with the *Corunastylis woollsii* the most common midge orchid found in the area.

No Genoplesium baueri were detected with much of the site containing unsuitable habitat.

The non-detection of the species is consistent with the Hyder 2007 survey results.

Pretty Beard Orchid (Calochilus pulchellus)

This species is identified in the SEARs as an additional species for consideration as well as being listed using the Biobanking Calculator.

Profile

Calochilus pulchellus is a terrestrial herb with a single upright sublinear leaf which sheaths the flowering stem briefly at the base; the leaf is fully developed at flowering time. The flowering stems are 200-300 mm tall, bearing 1-5 flowers on pedicels 6-12 mm long. The flowers last for 2-4 days and are 25-30 mm long by approximately 20 mm wide; the sepals and petals are a pale green or greenish yellow with darker reddish longitudinal striations and the labellum hairs are a coppery red. Fruits have not yet been observed. *Calochilus pulchellus* is similar to *C. grandiflorus*.

It is known from the Sydney Basin Bioregion, where a total of less than 30 adult plants have been recorded in three sites over a range of 40 km on the South Coast of NSW, at altitudes from 20-560 m above sea level.

All currently known sites are within the Shoalhaven Local Government Area. The life cycle of *C. pulchellus* is typical for temperate zone members of the genus, with the leaf emerging from a subterranean tuber in mid-winter, and flowering occurring from late October to late November, with only one or two flowers open at a time and each flower lasting only 2-4 days. The plant dies back to tubers in later summer. It is likely that additional scattered individuals and small colonies exist within the area of occurrence.

At Vincentia the species grows in low Scribbly Gum dominated woodland with a low wet heath understorey. The soil is sandy loam overlying sandstone. In Booderee National Park it grows in a tall heathy association. In Morton National Park on the Little Forest Plateau it occurs in

low heath among scattered clumps of emergent eucalypts and Banksia in shallow coarse white sand over sandstone, in a near-escarpment area subject to strong orographic precipitation (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20092).

The species was not detected by GHD (2014) with surveys by Hyder (2007) outside the known flowering time.

Expert report

The subject site was inspected by the recognised local orchid expert Mr Alan Stephenson on Sunday 13 September 2015 to assess the habitat potential for *Calochilus pulchellus.* Mr Alan Stephenson is the author of the book "Orchid species of the Shoalhaven, NSW Australia". Mr. Stephenson did not find any suitable habitat for the species on the subject land and his report is provided in full in Appendix 2.

Potential impacts

In the absence of suitable habitat for the species there are no potential direct and indirect impacts likely from the proposal.

Leafless Tongue Orchid (Cryptostylis hunteriana)

This species is identified in the SEARs as an additional species for consideration.

Profile

The Leafless Tongue Orchid has no leaf. It produces an upright flower-stem to 45 cm tall, bearing 5 to 10 flowers between November and February. It has small narrow green sepals and petals to 22 mm long, but is dominated by an erect narrow very hairy 'tongue' (the labellum). This is up to 33 mm long, maroon along the margins and at the widened tip, and with a black central band. All other tongue orchids have leaves; most have a downward pointing labellum.

It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites).

Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in

woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*) (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10187).

Survey methods and notes

Targeted surveys for this species were conducted during the 2013/14 flowering period. Prior to the survey of the subject land a known local reference site on Turpentine Road Tomerong was checked (on 2 December 2013) to confirm that *Cryptostylis hunteriana* was in flower and detectable during the survey. Twenty-four specimens were observed flowering at the reference site. Surveys conducted on the subject land took place on the 2-3 December 2013 (38.5 person hours) and 16 December 2013 (21.5 person hours).

The surveys involved between three to five surveyors (with two hand-held GPS) walking in parallel (where the terrain allowed) approximately 5 metres apart actively searching for specimens of the target species. The search area is depicted in Figure 16.

Habitat on site, results and potential impacts

No individuals of the Leafless Tongue Orchid were detected on Lot 1 DP 1104402.

A range of other orchid species were detected and identified. They occurred in abundant numbers across the site. Detected species were: *Cryptostylis subulata* (Cow Orchid), *Cryptostylis erecta* (Bonnet Orchid), *Cryptostylis leptochila* (Spotted Tongue Orchid*), Cymbidium suave* (snake orchid), *Dipodium variegatum* (common Hyacinth Orchid) and *Calochilus gracillimus* (Slender Beard Orchid).

Whilst the site contains what appears to be suitable habitat, given the species has not been detected on or near the site when known local reference sites contained flowering specimens, it is concluded the species does not occur on the subject land. Based on these results there are unlikely to be direct or indirect impacts arising from the proposal.

The species was not detected at the end of the known flowering period (February) by Hyder (2007), with surveys by GHD (2014) outside the known flowering time.

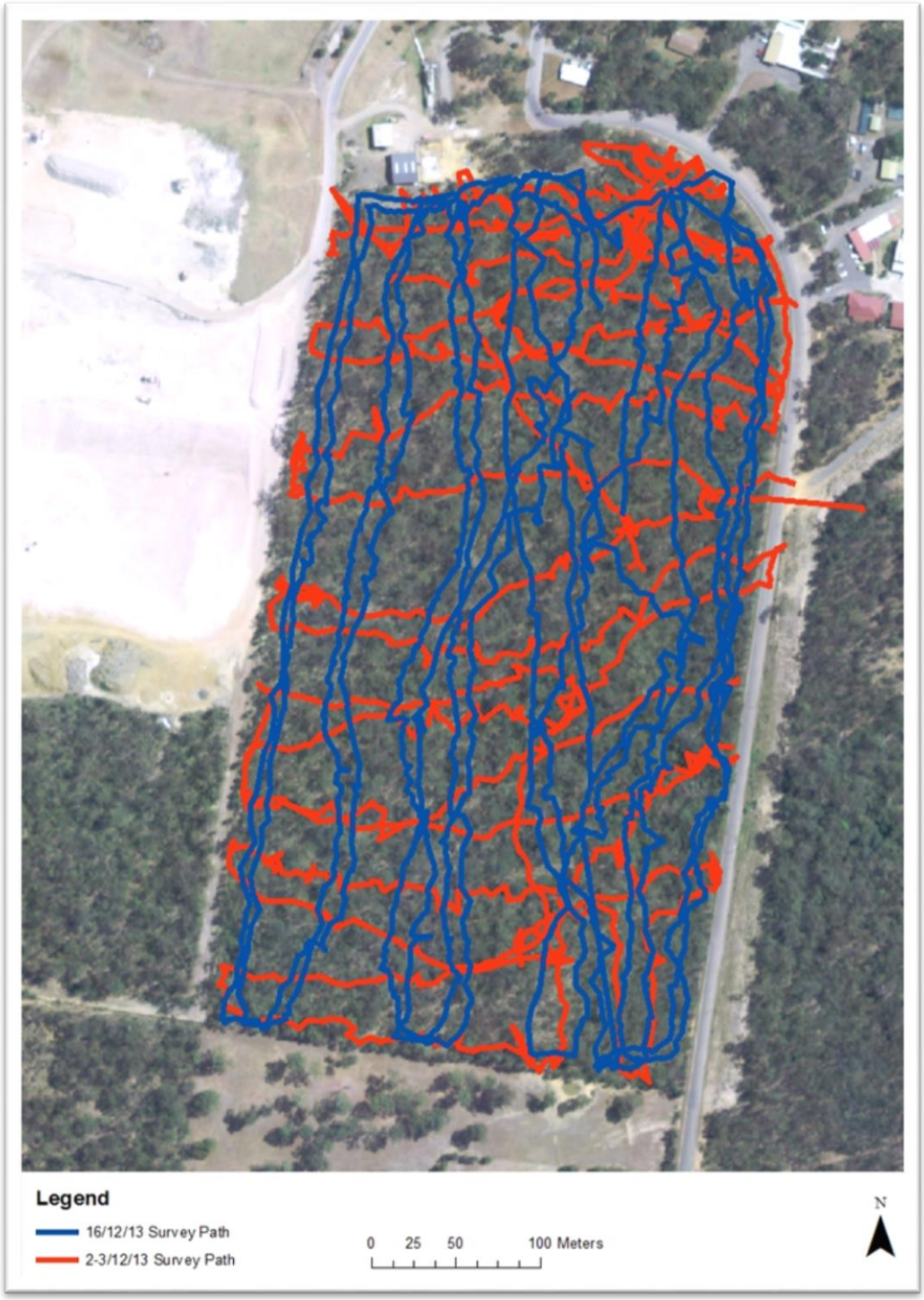


Figure 16 – *Cryptostylis hunteriana* survey transects

Pterostylis ventricosa

This species is identified in the SEARs as an additional species for consideration.

Profile

Pterostylis ventricosa is a perennial terrestrial orchid. The 8-30 cm tall flowering stem emerges from an underground tuber and produces 1 to 6 flowers at the top. The flowers are between 10-13 mm long and 4.5-5.5 mm wide. They are quite bulbous and greener at the base merging to bright red-brown at the flower tips. A leaf rosette of 4 to 9, 3-12 mm long, dark green leaves emerges around the same time as the flowering stem.

Pterostylis ventricosa is known from one population at St Georges Basin and three populations at Sussex Inlet, south of Nowra on the NSW south coast. Surveys carried out at various times between 2007 to 2010 estimate a total population of about 1,200 plants. The two largest populations, one at St Georges Basin and one at Sussex Inlet, are located on estates of private land. Two smaller populations, comprising a total of less than 10% of the known plants, are within Conjola National Park.

The species occurs in several habitats. Predominantly in more open areas of tall coastal eucalypt forest often dominated by one or more of the following tree species:- Turpentine, Spotted Gum, Grey Ironbark, Blackbutt, White Stringybark, Scribbly Gum and Sydney Peppermint. Often favours more open areas such as along powerline easements and on road verges where the tree over storey has been removed or thinned. Grows in a range of groundcover types, including moderately dense low heath, open sedges and grasses, leaf litter, and mosses on outcropping rock. Soil type ranges from moisture-retentive grey silty loams to grey sandy loams. Sometimes found in skeletal soils on sandstone rock shelves (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20162).

Survey methods and notes

Shoalhaven City Council engaged local orchid expert Alan Stephenson to inspect the subject for potential habitat for the species and provide an expert report.

Habitat on site, results and potential impacts

Alan Stephenson concluded the subject site does not have suitable habitat for the species.

The species was not detected during February and March surveys by Hyder (2007) with surveys by GHD (2014) outside the known flowering time.

Pterostylis vernalis

This species is identified in the SEARs as an additional species for consideration.

Profile

Pterostylis vernalis is a perennial terrestrial orchid with flowering stems 10-20 cm tall. The stems arise from an underground tuber. 1-2 basal leaf rosettes are produced per plant and these are usually present at flowering. 3-7 leaves, each on a stalk 3-12 mm long, form each rosette; the leaf blades are ovate, 5-15 mm long, 4-10 mm wide, dark green; the leaf edges are straight and the leaf tips are pointed. Flower stalks slender, wiry, producing 1-4 flowers at the top, each flower borne on a thin stalk 1-9 mm long. Flowers moderately spaced, facing inwards, 1-3 open at once, 8-10 mm long, 4-4.5 mm wide, bulbous, green proximally with a prominent white patch towards the base of the hood (galea), dark brown to blackish distally; hood slightly inflated at the base, erect before curving forwards in a semi-circle; dorsal sepal slightly longer than the petals, the distal parts of the dorsal sepal and petals strongly scabrous. Dorsal sepal ovate-lanceolate when flattened, 12-15 mm long, 6-9 mm wide, inflated at the base then tapered distally, boldly striped, acute to apiculate, dorsal surface scabrous. Lateral sepals erect, closely embracing the hood; prominently striped; the tips just reaching the top of the hood. Petals oblong 9-11 mm long, approximately 3 mm wide, strongly falcate, white with brown stripes and markings. Labellum erect, not readily visible, straight or slightly curved forwards near the apex, white with a brown central stripe and brown margins. Labellum blade elliptical to obovate, 3-4 mm long, 1.5-1.7 mm wide, obtuse to truncate. Callus a raised central reddish ridge approximately 0.3 mm across. Column 4-5 mm long, curved away from the ovary, erect, green and white. Column wings approximately 1.3 mm long; inner margins adorned sparsely with short white cilia; mid-section approximately 0.6 mm long, dark green. Anther approximately 0.8 mm long, obtuse. Pollinia narrowly linear, approximately 1.3 mm long, yellow, mealy. The fruit are erect, narrowly obovoid capsules 10-13 mm long, 4-5 mm wide, borne on stalks to 10 mm long.

Pterostylis vernalis is only known from the Nowra area on the NSW south coast. There are five known populations located to the west and south-west of Nowra. Four are within a few kilometres of each other, and one is located approximately 18 km to the south-west. The total population is approximately 450-500 known individuals. The four northern populations may have once been considered as one population covering an area of approximately 3 km^2.

Most known *Pterostylis vernalis* plants are located on land not reserved for conservation purposes. The exceptions are the southern-most population which is located in Jerrawangala National Park, and a part of one of the northern populations, which is located in Triplarina Nature Reserve.

Pterostylis vernalis grows in open sites in shallow soil over sandstone sheets, in heath and heathy forest. The distribution of the plants throughout its range is naturally patchy as the species is restricted to sections of rock shelf where there is only a thin layer of soil over the rock shelf and where these sites are subject to particular hydrological conditions.

Pterostylis vernalis is a seasonal perennial which is present above ground in the cooler months between late autumn until it sets seed in late spring. The above ground parts then wither and the plants persist as a dormant tuber underground over summer. *Pterostylis vernalis* is distinguished from other species of *Pterostylis* by the emergence of the rosettes before the development of the inflorescence. *Pterostylis vernalis* is the only *Pterostylis* species in the vicinity of Nowra that flowers in spring (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20163).

Survey methods and notes

Shoalhaven City Council engaged local orchid expert Alan Stephenson to inspect the subject for potential habitat for the species and provide an expert report.

Habitat on site, results and potential impacts

Alan Stephenson concluded the subject site does not have suitable habitat for the species.

The species was not detected by GHD (2014) with surveys by Hyder (2007) outside the known flowering time.

Hibbertia puberula

This species is identified in the SEARs as an additional species for consideration as well as being listed using the Biobanking Calculator.

Profile

Shrublets with few spreading but ultimately wiry branches up to 30 cm long, sparsely branched, pubescent, often becoming hairless. Leaves oblong-lanceolate to almost linear, 3 - 6 mm long, 0.8 - 1.4 mm wide, acute, sometimes becoming obtuse, abruptly constricted into petiole. Flowers yellow, single or rarely in a cluster of up to three. Outer calyx lanceolate to ovate with strongly recurved margins and a distinctly raised central ridge near the apex, strigose or hirsute to rarely puberulous. Inner calyx broadly elliptic to oblong ovate, with innermost two acute to - cuspidate above broad membranous margins, hirsute to strigose, rarely pubescent along the central ridge, becoming smaller to glabrous towards the margins. Stamens (9-)10-14(-18), with anthers 1.3 - 2.1mm long. Recent work on this species and its relatives have shown it to be widespread, but never common. It extends from Wollemi National Park south to Morton National Park and the south coast near Nowra. Habitats are typically dry sclerophyll woodland communities, although heaths are also occupied. Flowering time is October to December, sometimes into January (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10402).

Survey methods and notes

Surveys for threatened plants, including *Hibbertia puberula,* were conducted on the subject site on 15 September 2015 and on 25 and 26 November 2015, within the survey period specified in the survey time matrix. Two surveyors walked over a portion of the site (Figure 14) in the September 2015 survey. Both surveyors carried hand-held GPS units to record the survey transect. One GPS unit failed so not all areas covered are depicted.

The 25-26 November 2015 survey covered the majority of the site and was conducted in conjunction with vegetation plot surveys by two experienced botanists.

Habitat on site, results and potential impacts

No specimens were observed during the surveyors and with the generalised description in the profile the site does represent potential heathy understorey habitat in theory. In the absence of detections it is concluded the species will not be impacted by the proposal.

The species was not detected by GHD (2014) with surveys by Hyder (2007) outside the known flowering time.

Hibbertia stricta subsp. furcatula

This species is identified in the SEARs as an additional species for consideration as well as being listed using the Biobanking Calculator.

Profile

Hibbertia stricta subsp. *furcatula* is a small shrub growing to 1.3 m in height and up to 70 cm wide. It is usually upright in habit, and is densely covered with hairs on the branchlets, flowers, and less densely on the leaves. Leaves are alternate, linear, 7 - 15 mm long, 0.5 - 0.8 mm wide, and are unevenly spaced and often appearing somewhat whorled. The subspecies is identified by fine forked fascicled hairs along the centre of the upper surface of the leaves. Flowers are solitary, mostly on short lateral branchlets growing from the end of the stalk. There are 6 to 8 stamens with 0.5 - 0.7 mm long filaments and the anthers are 2 - 3 mm long. There are two carpels that are 0.8 - 1 mm long. It is known to occur in two populations, one in the southern outskirts of Sydney, and one near Nowra. Habitat of the South Coast population is poorly recorded, but appears to be dry sclerophyll forest or woodland associations in sandy soils over sandstone with flowering occurring from winter to summer (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20078).

Survey methods and notes

Surveys for threatened plants including *Hibbertia stricta subsp. furcatula* were conducted on the subject site on 15 September 2015 and on 25-26 November 2015 within the survey period specified in the survey time matrix. Two surveyors walked over a portion of the site (Figure 14) in the September 2015 survey. Both surveyors carried hand-held GPS units to record the survey transect. One GPS unit failed so not all areas covered are depicted.

The 25-26 November 2015 survey covered the majority of the site and was conducted in conjunction with vegetation plot surveys by two experienced botanists.

Habitat on site, results and potential impacts

There is one record for the target species approximately 400m to the northeast of the subject land. The record (for 2 plants) comes from an area that has been disturbed and within the same Plant Community Type. Based on this record the subject site represents potential habitat.

No specimens were observed during the surveys but given the proximity of the nearby records the site does represent potential habitat in theory. In the absence of detections it is concluded the species will not be impacted by the proposal.

The species was not detected by GHD (2014) with surveys by Hyder (2007) outside the known flowering time.

Tangled Bedstraw (Galium australe)

This species is identified in the SEARs as an additional species for consideration.

Profile

Tangled Bedstraw is a straggling and inter-twining herb with weak, hairy stems to 60 cm long. The leaves are in whorls of four; each is up to 12 mm long by 4 mm wide. One to seven small (about 2 mm long) white flowers occur on stalks to 12 mm long. Fruits are about 1.5 mm long with numerous hooked hairs. Tangled Bedstraw is widespread in Victoria and Tasmania and is also found in South Australia (and ACT land in Jervis Bay). Following a taxonomic revision, many recent records in NSW have been re-determined as other species. Tangled Bedstraw has been recorded historically in the Nowra (Colymea) and Narooma areas and is extant in Nadgee Nature Reserve, south of Eden. Records in the Sydney area are yet to be confirmed. Most flowering collections have been made in late spring to early autumn. In NSW (and ACT land in Jervis Bay), Tangled Bedstraw has been recorded in Turpentine forest and coastal Acacia shrubland (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10336).

Survey methods and notes

Surveys for threatened plants including Tangled Bedstraw were conducted on the subject site on 15 September 2015 and on 25 and 26 November 2015 within the survey period specified in the survey time matrix. Two surveyors walked over a portion of the site (Figure 14) in the September 2015 survey. Both surveyors carried hand-held GPS units to record the survey transect. One GPS unit failed so not all areas covered are depicted.

The 25-26 November 2015 survey covered the majority of the site and was conducted in conjunction with vegetation plot surveys by two experienced botanists.

Habitat on site, results and potential impacts

Tangled Bedstraw was not detected during the survey with no suitable habitat observed. In the absence of the species and habitat it is unlikely the species will be directly or indirectly impacted by the proposal.

The species was not detected by GHD (2014) or Hyder (2007).

Deane's Paperbark (Melaleuca deanei)

This species is identified in the SEARs as an additional species for consideration.

Profile

Deane's Paperbark is a shrub to 3 m high with fibrous, flaky bark. New stems are furry and white, though the mature stems are hairless. The smooth leaves are not paired. They are narrow, to 25 mm long and 6 mm wide, with pointed tips. The many white flowers form spikes to 6 cm long, on a furry stem. The five petals are less than 5 mm long; each is paired with a bundle of 17 - 28 stamens. The woody fruits are barrel-shaped, to 7 mm in diameter. Deane's Paperbark occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively with more isolated occurrences in the Blue Mountains, Wollemi National Park, Yalwal (west of Nowra) and the lower Hawkesbury River area. The species occurs mostly in ridgetop woodland, with only 5% of sites in heath on sandstone. Flowers appear in summer (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10515).

Survey methods and notes

Surveys for threatened plants including Deane's Paperbark were conducted on the subject site on 15 September 2015 and on 25-26 November 2015 within the survey period specified in the survey time matrix. Two surveyors walked over a portion of the site (Figure 14) in the September 2015 survey. Both surveyors carried hand-held GPS units to record the survey transect. One GPS unit failed so not all areas covered are depicted.

The 25-26 November 2015 survey covered the majority of the site and was conducted in conjunction with vegetation plot surveys by two experienced botanists.

Habitat on site, results and potential impacts

No suitable habitat was observed and Deane's Paperbark was not detected during the survey. It is unlikely the species will be directly or indirectly impacted based on these findings.

The species was not detected by GHD (2014) or Hyder (2007).

8 Threatened fauna species, habitats and survey methods

The biobank calculator predicted a number of threatened fauna species as occurring on the site with the Masked Owl the species with the highest credit requirement. Seven Species Credit fauna species are identified as requiring targeted surveys;

- Broad-headed Snake
- Eastern Pygmy-possum
- Giant Burrowing Frog
- Koala
- Large-eared Pied Bat
- Eastern Bentwing Bat
- Regent Honeyeater

Fauna surveys on the site have been conducted on the subject site in recent times starting from 8-11 October 2013 through to 23 and 28 January 2014 (GHD, 2014). Fauna surveys have also been conducted back in 2007 (Hyder, 2007). As a result of these surveys, eleven threatened fauna species have been detected on site by way of:

- feeding signs and direct / or observation (GHD, SCC, Hyder) for Yellow-bellied Glider, Squirrel Glider, Glossy Black-cockatoo, Powerful Owl, Masked Owl (probable), and Grey-headed Flying-Fox during diurnal surveys and nocturnal spotlighting transects.
- pitfall surveys and spotlighting (Eastern Pygmy-possum).
- Analysis of Anabat echolocation calls (Eastern Bentwing Bat, Eastern False Pipistrelle -probable record - Anabat, Greater Broad-nosed Bat - probable record - Anabat, and Large-eared Pied Bat - probable record – Anabat.

The number of threatened fauna species is not surprising given the high number of hollow-bearing trees (HBT), with hollows of varying sizes, detected on the site. GHD (2014) estimated the site contains 27 HBT per hectare. Of these species, Squirrel Glider is a species credit species and has been added to the Biobank Calculator as a species impacted by the proposal.

Individual targeted survey methods are discussed for each credit species identified in the Biobanking calculator as species requiring survey.

For the purposes of calculating biodiversity credits, Powerful and Masked Owl, Yellow-bellied Glider, Glossy-black Cockatoo, Eastern Bentwing-bat (in the absence of breeding habitat),

Eastern False Pipistrelle, Greater Broad-nosed Bat and Grey-headed Flying-fox are not "species credit" fauna species and therefore do not require credits to be retired.

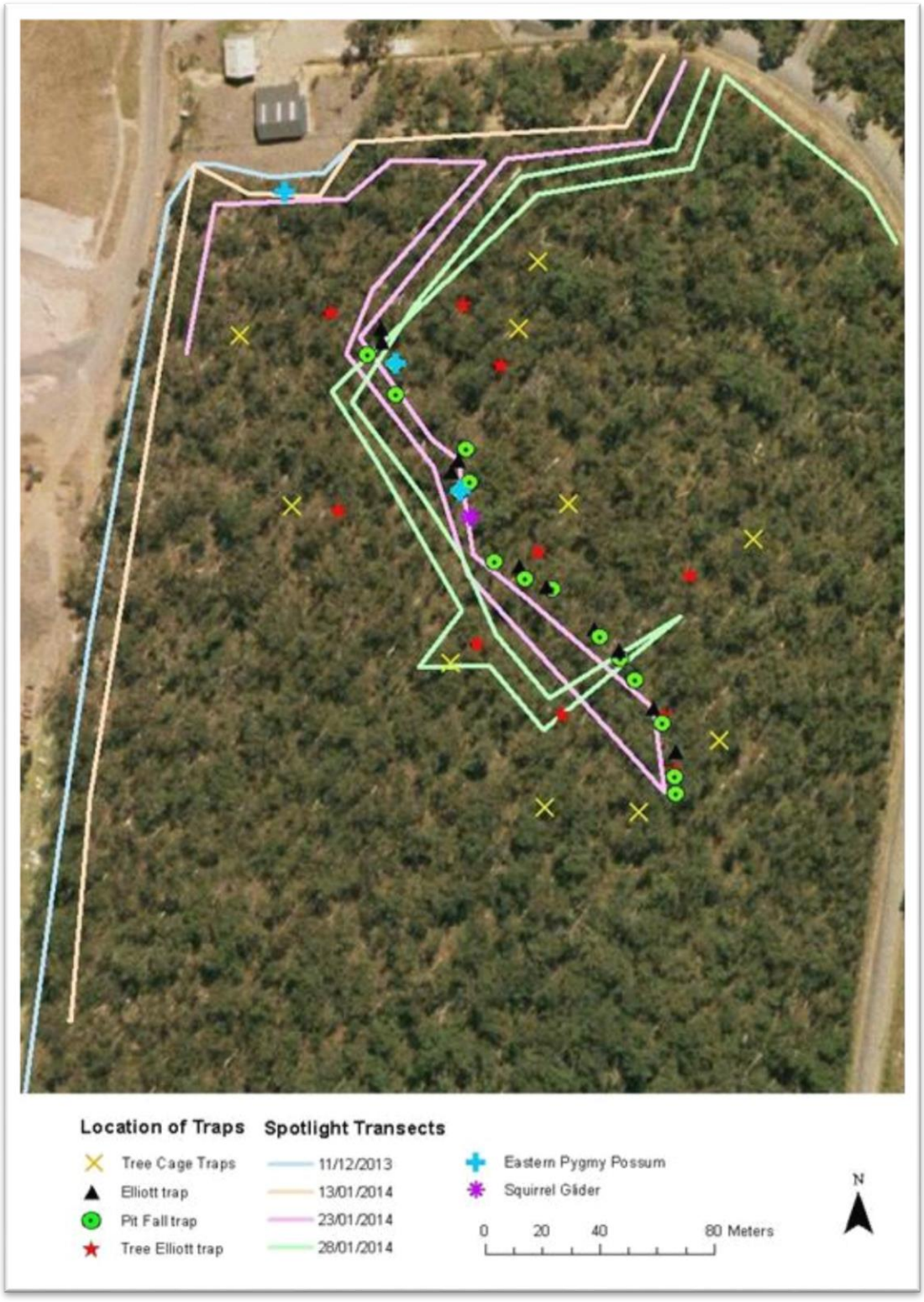


Figure 17 – fauna survey locations by method and threatened species detection locations

Table 4 – Survey techniques effort and dates for GHD 2013

Date	Survey type	Survey Method	Effort
8-11 October 2013	Detailed survey	Habitat assessments	1 person over 2 days
		Biobanking plot-transects	7 plot-transects
		Targeted flora search	1 person over 8 hours (subject site) 1 person over 4 hours (study area)
		Anabats	2 anabats over 3 nights
		Call playback	3 nights (3 person-hours)
		Spotlighting	3 nights (6 person-hours)
		Bird surveys	3 mornings (3 person-hours)
		Opportunistic surveys	4 days
10 -31 October 2013	Detailed survey	Cameras	2 units for 3 weeks
31 October -1 November 2013	Follow-up survey	Call playback	1 night (1 person-hour)
		Spotlighting	1 night (2 person-hours)
		Birds	1 morning (1 person-hour)
		Koala spot assessments	2 sites
		Targeted flora search (*Triplarina nowraensis* and spring-flowering orchids)	1 person over 3 hours (subject site) 1 person over 1 hour (study area)

Table 5 – Survey techniques effort and dates for Shoalhaven City Council (SCC) 2013 and 2014

Date	Survey type	Survey Method	Effort
2-3 December 2013	Targeted *Cryptostylis hunteriana* survey	Parallel transects of the study area	38.5 person-hours
16 December 2013	Targeted *Cryptostylis hunteriana* survey	Parallel transects of the study area	21.5 person-hours
9-13 December 2013	Detailed survey	Pitfall trapping	15 traps over four nights (60 trap nights)
		Elliot A traps (ground)	10 traps over 4 nights (40 trap nights)
		Elliot B/cage traps (tree)	10 traps over 4 nights (40 trap nights)
		Spotlighting	3.5 person-hours on one night (11 December 2013)
13-17 January 2014	Detailed survey	Pitfall trapping	15 traps over four nights (60 trap-nights)
		Elliot A traps (ground)	10 traps over 4 nights (40 trap-nights)
		Elliot B/cage traps (tree)	10 traps over 4 nights (40 trap-nights)
		Spotlighting and call playback	4 person-hours on one night (13 January 2013)
23 January 2014	Follow-up survey	Spotlighting, stag-watching and call playback	4 person-hours
28 January 2014	Follow-up survey	Spotlighting, stag-watching and call playback	5 person-hours

Table 6 – Survey methods and effort (Hyder 2007)

Date	Survey type	Survey methods	Effort
17 & 20 February 2007	Site inspection	Establish sites for quadrats and transects	Two days
		Identification of plant communities	Two days
		Identify threatened flora	Two days
		Opportunistic fauna surveys	Two days
19-22 March 2007	Detailed survey	Elliot A traps (ground)	25 for three nights
		Elliot B traps (ground)	25 for three nights
		Cage traps	10 traps for three nights
		Harp Trap	1 trap for three nights
		Anabat recordings	1 unit for three nights
		Spotlighting	Three nights
		Call playback for owls, gliders and Koala	Three nights
		Bird survey	Two mornings
7-8 May 2007	Follow-up survey	Spotlighting	Two nights
		Call playback	Two nights
		Bird surveys	Two mornings

9 Results: Targeted Threatened Fauna Species

Broad-headed Snake (Hoplocephalus bungaroides)

This species is identified for consideration using the Biobanking Calculator.

Profile

The Broad-headed Snake is largely confined to Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and Shoalhaven groups, within the coast and ranges in an area within approximately 250 km of Sydney. The species is described as nocturnal and shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. It moves from the sandstone rocks to shelters in crevices or hollows in large trees within 500m of escarpments in summer. Feeds mostly on geckos and small skinks; will also eat frogs and small mammals occasionally. Females produce four to 12 live young from January to March, which is a relatively low level of fecundity (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10413)

Survey notes

Whilst there are some small cliff lines along the lower reaches of Cabbage Tree Creek approximately 500m to the east of the subject site, the closest escarpments are approximately 1km away to the north along the Shoalhaven River. Whilst there are numerous hollow-bearing trees found on the subject land no Broad-headed Snakes were detected during 2007, 2013 and 2014 summer spotlighting surveys, a time when the species could potentially be found on the subject site.

Habitat on site, results and potential impacts

Given the distance from escarpments and the lack of rock habitat on the subject site, it is unlikely the species occurs there or would be impacted by the proposal. The species has not been detected during 3 nights of spotlight surveys in 2007 (Hyder) and 16.5 hours of spotlight surveys over 3 nights in the summer 2013 and 2014 (SCC).

Eastern Pygmy-possum (Cercartetus nanus)

This species is identified for consideration using the Biobanking Calculator.

Profile

Eastern Pygmy-possums are tiny (15 to 43 grams) active climbers, with almost bare, prehensile (capable of curling and gripping) tails, and big, forward-pointing ears. They are light-brown above and white below. Adults have a head and body length between 70 - 110

mm and a tail length between 75 - 105 mm. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks. Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10155.

Survey notes, detections, habitat on site and impacts

This species has been detected (10 December 2013 and 15 January 2014) on the subject land in targeted pitfall trap surveys (Photo 5 - 2 captures) and once during a nocturnal spotlight survey (Photo 6) on 23 January 2014. The land contains resources such as numerous tree hollows, nectar producing trees such as Red Bloodwoods, a mid-canopy with Acacias, and dense understory of shrubs (*Bankia spinulosa* and *Lambertia formosa*). The shrub layer thins out in the south-east corner but it is likely the entire subject land is utilised by the species. The proposed development will permanently remove 9.87ha of the this habitat but will not sever connectivity to other known habitat approximately 2km to the south-west, where the species was detected during targeted pitfall trapping surveys on 12 February 2014. Based on these detections and the habitat available, EPP has been added to the Biobank Calculator as a species to be affected by the proposal via the direct loss of 9.87ha of known habitat. This loss will require the retirement of 197 EPP species credits with the EPP habitat polygon depicted in Figure 19.

Measures are proposed in section 10 to mitigate the impact of the clearing on species.

Figure 18 – confirmed EPP and Squirrel Glider records from 2013 and 2014

Photo 5 – Pitfall trap (night of 10 December 2013) captured EPP

Photo 6 – EPP observed in Red Bloodwood on 23 January 2014 during spotlighting

Giant Burrowing Frog (*Heleioporus australiacus*)

This species is identified for consideration using the Biobanking Calculator.

Profile

The Giant Burrowing Frog is a large, rotund, slow-moving frog that grows to about 10 cm long. It is a powerfully built species with muscular hind limbs and enlarged tubercles on the feet well suited to burrowing. It is found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. It spends more than 95% of its time in non-breeding habitat in areas up to 300 m from breeding sites. Whilst in non-breeding habitat it burrows below the soil surface or in the leaf litter. Individual frogs occupy a series of burrow sites, some of which are used repeatedly. The home ranges of both sexes appear to be non-overlapping suggesting exclusivity of non-breeding habitat. Home ranges are approximately 0.04 ha in size. Individuals move into the breeding site either immediately before or following heavy rain and occupy these sites for up to 10 days. Most individuals will not attempt to breed every year. Breeding habitat of this species is generally soaks or pools within first or second order streams. They are also commonly recorded from 'hanging swamp' seepage lines and where small pools form from the collected water (OEH Threatened Species profile. http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10398)

Survey notes

No targeted surveys have been conducted due to a lack of suitable habitat and the species has not been detected opportunistically.

Habitat on site, results and potential impacts

The subject site is flat and contains only one shallow drainage line towards the south-east corner but no pools (ephemeral or permanent) for potential breeding sites. The drainage line outside the area proposed to be cleared and buffered by a minimum distance of 50m. The closest potential breeding habitat is approximately 400m away to the east along Cabbage Tree Creek though no assessment of the suitability of this watercourse for the species has been conducted. The nearest record for the species is within Bomaderry Creek Reserve, approximately 5km north and on the other side of the Shoalhaven River.

It is likely the subject site only represents marginal foraging habitat at best for the species though the soils of the site are not friable. Given no Giant Burrowing Frogs have been detected within 5km of the subject land, and the lack of suitable habitat on the subject land, it is unlikely the proposal will impact the species. The species is therefore not considered to require an offset.

Squirrel Glider (Petaurus norfolcensis)

This "credit species" species has been detected on the subject site during spotlighting on 23 January 2014 as well as immediately to the southeast on eastern side of Flatrock Road opposite the subject site by GHD in 2013. Photos of the animals were sent to Ross Goldingay by GHD for confirmation the animals were Squirrel Gliders (pers comm with Kirsten Crosby of GHD) with the subsequent SCC record also confirmed by OEH (Matt Cameron – accountable officer) following quarantining of the record.

Profile

Adult Squirrel Gliders have a head and body length of about 20 cm. They have blue-grey to brown-grey fur above, white on the belly and the end third of the tail is black. There is a dark stripe from between the eyes to the mid-back and the tail is soft and bushy averaging about 27 cm in length. Squirrel Gliders are up to twice the size of Sugar Gliders, their facial markings are more distinct and they nest in bowl-shaped, leaf lined nests in tree hollows. Squirrel Gliders are also less vocal than Sugar Gliders. The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. Inhabits Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia mid-storey. Lives in family groups of a single adult male, one or more adult females and offspring. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of *Acacia* gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10604).

Survey notes

This species was observed on subject land during spotlight surveys on 23 January 2014 (Photo 7 & 8). A Squirrel Glider was also observed approximately 200m away on land immediately to the southeast in mid 2013.

The species was targeted with arboreal trapping but no animals were captured.

Habitat on site, results and potential impacts

Suitable habitat with numerous hollow-bearing trees and foraging signs (sap feeding incisions on the main trunks of Red Bloodwood *Corymbia gummifera* and Grey Gum *Eucalyptus punctata* on the subject land and immediate surrounds) is found across the subject land. The species is hollow-dependant and its diet varies seasonally with Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein, all available on the subject site seasonally.

The threatened species profile database lists Squirrel Glider as a species that can withstand loss (with no area specified). The threatened species polygon (section 6.5.1.14 of the FBAM) for the Squirrel Glider is depicted in (Figure 19) which equates to the “development footprint” (9.87ha).

Based on the detections on the subject land and nearby, and the habitat available, Squirrel Glider has been added to the Biobank Calculator as a species to be affected by the proposal via the direct loss of 9.87ha of known habitat. This loss will require the retirement of 217 Squirrel Glider species credits.

Photo 7 & Photo 8 – Squirrel Glider observed during SCC spotlight survey on the subject land

Measures are proposed in section 10 to reduce and mitigate the impact of the clearing on species.

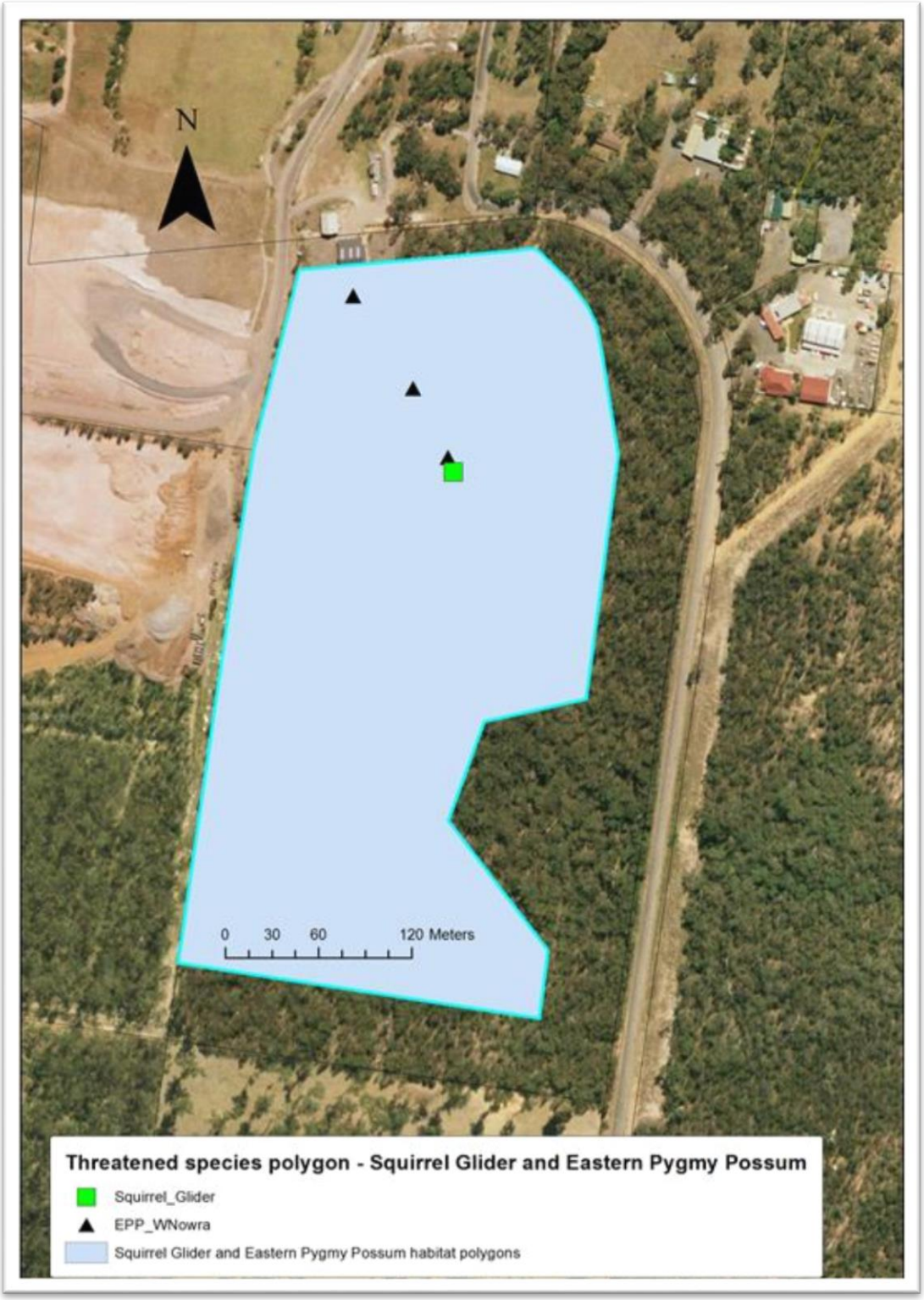


Figure 19 – Threatened Species Polygon

Koala (Phascolarctos cinereus)

This species is identified for consideration using the Biobanking Calculator.

Profile

The Koala is an arboreal marsupial with fur ranging from grey to brown above, and is white below. It has large furry ears, a prominent black nose and no tail. It spends most of its time in trees and has long, sharp claws, adapted for climbing. Adult males weigh 6 - 12 kg and adult females weigh 5 - 8 kg. During breeding, males advertise with loud snarling coughs and bellows. The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. It was briefly historically abundant in the 1890s in the Bega District on the south coast of NSW, although not elsewhere, but it now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands. Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Inactive for most of the day, feeding and moving mostly at night. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10616).

Survey notes

Koala spot assessments were conducted in two locations on the subject land by GHD on 31 October 2013 and 1 November 2013 (GHD, 2014). A number of surveys applicable to detecting koala, including spotlighting and dusk stag-watching surveys, have been conducted on the subject land (Hyder, 2007 & GHD, 2014). In addition, the vegetation on site has been studied to identify the PCT, tree hollows, trap locations, and during diurnal bird surveys.

Habitat on site, results and potential impacts

GHD (2014) found no primary or secondary feed trees of the Koala (*Phascolarctos cinereus*) as listed for the 'south coast' management area (DECC 2008) are present at the site. One supplementary feed tree species, White Stringybark, is present though Grey Gum (*E. punctata*), which is listed as feed tree species under SEPP 44 (Koala Habitat Protection NSW schedule of feed tree species) is scattered across the site. No Koala scats were recorded during the GHD surveys, and no Koalas observed/heard during numerous diurnal and nocturnal surveys (GHD 2014, Hyder 2007 & SCC 2014/15). Koalas may occur in the study

area on occasion when moving between areas of better quality foraging habitat. Koalas are unlikely to reside or breed in the study area due to the lack of primary and secondary feed trees. Given these considerations, the study area does not represent core Koala habitat as defined under SEPP 44. No koalas were detected on the subject site and if the species does occur in the locality, they are unlikely to be impacted beyond the loss of 9.87ha of non-core potential foraging habitat.

Large-eared Pied Bat (Chalinolobus dwyeri)

This species is identified for consideration using the Biobanking Calculator.

Profile

A small to medium-sized bat with long, prominent ears and glossy black fur. The lower body has broad white fringes running under the wings and tail-membrane, meeting in a V-shape in the pubic area. This species is one of the wattled bats, with small lobes of skin between the ears and corner of the mouth.

Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years.

Found in well-timbered areas containing gullies.

The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy.

Likely to hibernate through the coolest months.

It is uncertain whether mating occurs early in winter or in spring (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10157).

Survey methods and notes

GHD (2014) conducted microchiropteran bat surveys using Anabat echolocation recording at 7 locations across the site and nearby (within 100m) between 8 October 2013 to 1 November 2013. Three locations were within the proposed development footprint.

Hyder (2007) also conducted targeted microbat surveys (3 nights) in March 2007 using Anabat, harp trapping and roost searches.

Habitat on site, results and potential impacts

Based on the profile description above the subject site provides potential foraging habitat for Long-eared Pied Bats with potential roosting and breeding available along the escarpment cliffs along the Shoalhaven River and the lower reaches of Flatrock Creek to the north and east respectively approximately 1 to 1.5km away.

Long-eared Pied Bat was detected to the north of the subject site ("probable" confidence rating) by GHD with an Anabat.

Large-eared Pied Bat has been added to the calculator as a species probably recorded on the site but breeding habitat is not impacted by the proposed development. It is noted the species can either be an ecosystem or species credit species depending on whether breeding habit (known caves and escarpments) is to be impacted. The species is therefore treated as an ecosystem species in the Biobank Calculation.

Eastern Bentwing-bat (Miniopterus schreibersii subsp. oceanensis)

This species is identified for consideration based on GHD (2014) Anabat survey detections along Flatrock Road.

Profile

The Eastern Bentwing-bat has chocolate to reddish-brown fur on its back and slightly lighter coloured fur on its belly. It has a short snout and a high 'domed' head with short round ears. The wing membranes attach to the ankle, not to the base of the toe. The last bone of the third finger is much longer than the other finger-bones giving the "bent wing" appearance. It weighs up to 20 grams, has a head and body length of about 6 cm and a wingspan of 30 - 35 cm. Eastern Bentwing-bats occur along the east and north-west coasts of Australia.

Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.

They form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia. Breeding or roosting colonies can number from 100 to 150,000 individuals.

Hunt in forested areas, catching moths and other flying insects above the tree tops (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10534).

Survey methods and notes

GHD (2014) conducted microchiropteran bat surveys using Anabat echolocation recording at 7 locations across the site and nearby (within 100m) between 8 October 2013 to 1 November 2013. Three locations were within the proposed development footprint.

Hyder (2007) also conducted targeted microbat surveys (3 nights) in March 2007 using Anabat, harp trapping and roost searches.

Habitat on site, results and potential impacts

Based on the species profile notes and the survey results, the subject site provides foraging habitat only with no breeding habitat (caves) available.

The species was detected with an Anabat with a confidence rating of "definite" by GHD along Flatrock Road.

Eastern Bentwing-bat has been added to the calculator as a species recorded nearby and likely to use the site for foraging but breeding habitat is not impacted by the proposed development. It is noted the species can either be an ecosystem or species credit species depending on whether breeding habit (known caves) or foraging habitat (forests within 300km of the breeding sites) is to be impacted. The species is therefore treated as an ecosystem species in the Biobank Calculation.

Regent Honeyeater (Anthochaera Phrygia)

This species is identified for consideration using the Biobanking Calculator.

Profile

The Regent Honeyeater is a striking and distinctive, medium-sized, black and yellow honeyeater with a sturdy, curved bill. Adults weigh 35 - 50 grams, are 20 - 24 cm long and have a wing-span of 30 cm. Its head, neck, throat, upper breast and bill are black and the back and lower breast are pale lemon in colour with a black scalloped pattern. Its flight and tail feathers are edged with bright yellow. There is a characteristic patch of dark pink or cream-coloured facial-skin around the eye. Sexes are similar, though males are larger, darker and have larger patch of bare facial-skin. The call is a soft metallic bell-like song; birds are most vocal in non-breeding season. It has recently been placed in the genus *Anthochaera* along with the wattlebirds, and was formerly known by the name *Xanthomyza phrygia.* The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Once recorded between Adelaide and the central coast of Queensland, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests (OEH Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10841).

Survey notes

In terms of survey methodology, the OEH threatened species website contains a link to the Australian Government's "Survey guidelines for Australia's threatened birds". The survey guidelines provide further habitat notes; "mostly occurs in box-ironbark eucalypt associations. Prefers the wettest, most fertile sites within these associations such as along creek flats, broad river valleys and foothills. In New South Wales, riparian forests of river oak with needle-leaf mistletoe are also important for feeding and breeding. At times of food shortage, uses other woodland types and wet lowland coastal forest dominated by swamp mahogany *E. robusta* or spotted gum *Corymbia maculata*" (Commonwealth of Australia, 2010).

The Australian Government's survey guidelines recommend for areas less than 50ha, 20 hours of survey effort over 10 days, stating the birds are conspicuous in the breeding season (mostly September to November) and less so at other times.

Habitat on site, results and potential impacts

Habitat on site, based on the notes in the survey guidelines, is not optimal. Red Bloodwoods (*Corymbia gummifera*) on site provide potential occasional woodland foraging habitat when flowering (late summer to autumn). Hyder (2007), GHD (2014) and Council's Environmental Assessment Officers (2014/15) recorded bird species whilst conducting a range of surveys, including targeted morning bird surveys on 8 occasions. Given the subject site is not within one of the three known breeding areas mentioned in the OEH profile, or on the inland slopes of Great Dividing Range, Hunter Valley or Central Coast of NSW (preferred and known habitat), the survey effort and timing is considered adequate, particularly given the area proposed to be cleared (9.87ha) in relation to the distances the species is known to cover (up to 580km. Birdlife Australia website accessed 17 August 2015).

No Regent Honeyeaters were detected. Given the species is now listed as Critically Endangered with low numbers it is not surprising the species was not detected. It is unlikely the species occurs on the subject site or in the locality or would be impacted by the proposal.

Targeted hollow-bearing tree surveys in 2017

In order to demonstrate "avoidance and minimisation of direct impacts on biodiversity values" targeted hollow-bearing tree surveys were conducted from 27 March 2017 to 20 June 2017 (9 nights) using the survey methods described in section 7. Specifically, targeted surveys focused on Large Forest Owls (breeding and roosting habitat), Yellow-bellied and Squirrel Gliders (den trees) following discussions with the OEH Illawarra Regional Operation Group.

The DEC (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (working draft),* provide guidance on the detectability of large forest owls with the number of sampling sessions required to find each species to a level of 90% probability when the species was known to be present on a site. Of these, 7 and 9 sampling sessions are required for both powerful owl and masked owl respectively to be detected with a 90% probability. Based on the 9 surveys conducted for the targeted surveys compared to the guidelines, the survey effort suggests a very high probably that if species of large forest owl were on the site during the known breeding season for powerful owl and most likely breeding season for masked owl they would have been detected.

Weather conditions details during the surveys are provided in - Weather conditions during 2017 HBT surveys. Trees (number) surveyed and surveyor details are provided in HBT survey results table.

Table 7 - Weather conditions during 2017 HBT surveys

Survey date	Survey times	Temp at start of survey	Wind	Moon and cloud
27.3.17	6:30-8:30PM	260C	SE 7km/hr	No moon 0/8 cloud cover
28.3.17	6:30-8PM	20.200C	SE 6km/hr	No moon 8/8 cloud cover
29.3.17	6:30-8:20PM	24.20C	calm	No moon 0/8 cloud cover
24.5.17	4:45-6:45PM	180C	NW 12km/hr	No moon, 0/8 cloud cover
25.5.17	4:45-6:30PM	160C	calm	No moon, 0/8 cloud cover
29.5.17	4:30-6:30PM	140C	Light westerly	No moon visible, 0/8 cloud cover
5.6.17	4:30-6:30PM	140C	Calm	5/8 moon visible, 1/8 cloud cover
19.6.17	4:15-6:15PM	160C	Calm	No moon visible, 0/8 cloud cover
20.6.17	4:15-6:15PM	160C	Calm	No moon visible, 0/8 cloud cover

Table 8 - HBT survey results

Date	Tree #	Surveyor	Fauna detected using hollow
27.3.17	25-29	Elizabeth Dixon and Ramona Schwarzwalder	None entering or exiting hollows – Microbats nearby
27.3.17	6-9, 13, 31-32	Michael Smith and Madlen Deja	None entering or exiting hollows – Microbats nearby
28.3.17	57-59	Nikki Hunter	None entering or exiting hollows – observed Microbats and 1xSugar Glider nearby
28.3.17	53-54	Elizabeth Dixon	None entering or exiting hollows – observed 2xSugar glider nearby
28.3.17	36-39	Michael Smith	None entering or exiting hollows – observed Microbats nearby
29.3.17	44-45	Nikki Hunter	None entering or exiting hollows – 1xAntechinus observed running down the tree and 2xSugar gliders heard calling nearby
29.3.17	23-25	Elizabeth Dixon	None entering or exiting hollows
29.3.17	51-52	Michael Smith	None entering or exiting hollows – observed Microbats and 1xSugar glider nearby

24.5.17	57-59	Megan Birmingham	None entering or exiting hollows – observed 1xBrushtail Possum nearby
24.5.17	30, 67-68	Michael Smith	None entering or exiting hollows
24.5.17	51-52	Elizabeth Dixon	None entering or exiting hollows
25.5.17	18-22	Megan Birmingham	None entering or exiting hollows
25.5.17	42-43	Michael Smith	None entering or exiting hollows
25.5.17	26-29, 69	Nikki Hunter and Steve Hunter	None entering or exiting hollows
29.5.17	53-54	Megan Birmingham	None entering or exiting hollows – 1xSugar glider observed nearby
29.5.17	70	Michael Smith	None entering or exiting hollows
29.5.17	55	Elizabeth Dixon	None entering or exiting hollows
29.5.17	57-59	Suyeom Kim	None entering or exiting hollows
5.6.17	15-17	Megan Birmingham	None entering or exiting hollows
5.6.17	1-2, 25	Michael Smith	None entering or exiting hollows

5.6.17	57-59	Elizabeth Dixon	None entering or exiting hollows
5.6.17	7-13	Angela Jenkins	None entering or exiting hollows
19.6.17	3-6, 30	Megan Birmingham	None entering or exiting hollows
19.6.17	34-38	Michael Smith	None entering or exiting hollows
19.6.17	60-61	Elizabeth Dixon	None entering or exiting hollows
20.6.17	64-66	Megan Birmingham	None entering or exiting hollows
20.6.17	40-41	Michael Smith	None entering or exiting hollows
20.6.17	57-59	Elizabeth Dixon	None entering or exiting hollows
20.6.17	31-32, 70	Nikki Hunter	None entering or exiting hollows

Habitat on site, results and discussion

Habitat

Approximately 70 hollow-bearing trees were targeted for survey. Some hollows appeared perfect for large forest owls (Figure 20) and both Powerful Owl (Hyder 2007) and Masked Owl (probable detection by GHD 2012) had been observed on the subject land though no nest sites had been detected. Numerous hollows suitable for Yellow-bellied Glider and Squirrel Glider are also found across the site.

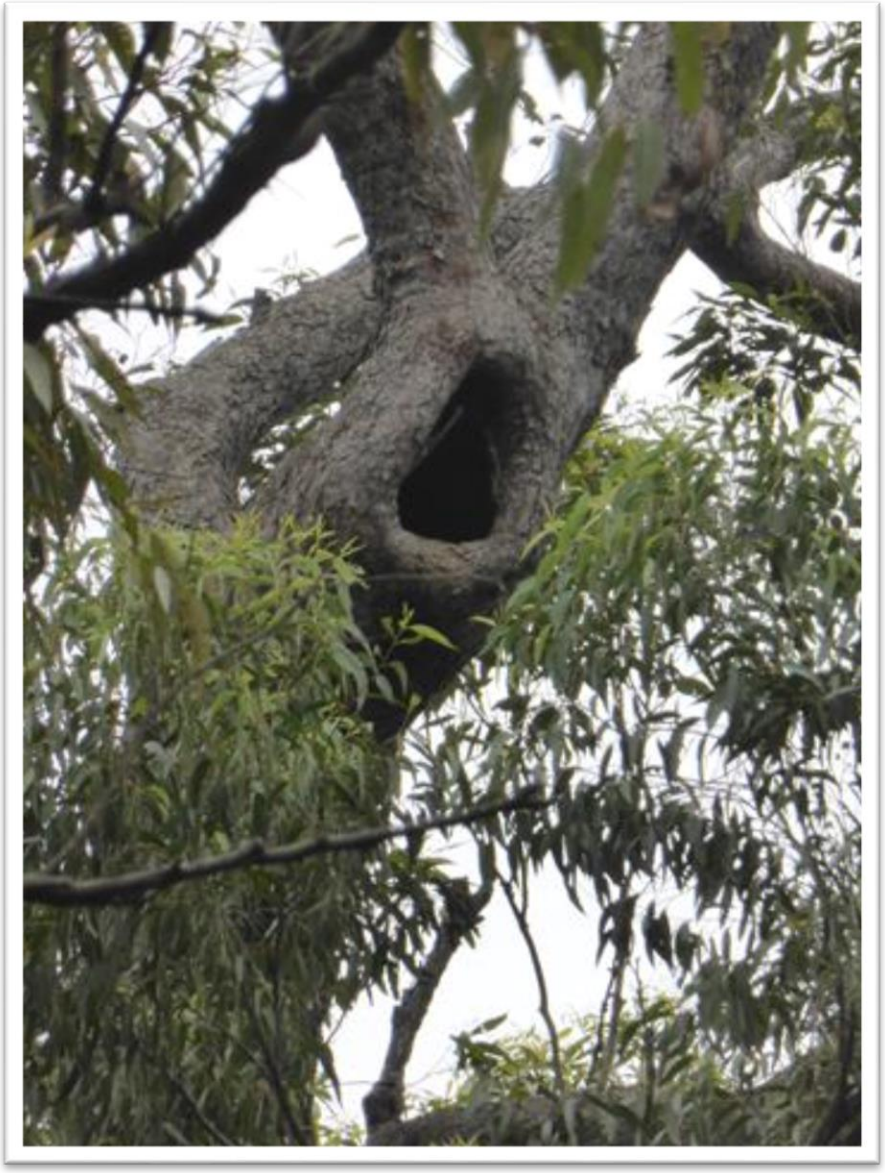


Figure 20 Large hollow potentially suitable for large forest owls on the subject site

Results

A **Powerful Owl** was heard calling at dusk and into the early evening by the four staff surveying, an estimated 500m to the east of the subject site near Cabbage Tree Creek, on Monday 5 June 2017. The Cabbage Tree Creek gully area east of Flatrock Road contains numerous large trees in a gully approximately 300m from Flatrock Road. Given the Powerful Owl has been detected previously on the subject site on two occasions (Hyder 2007 – observed on the edge of the site beside Flatrock Road and SCC on 1 September 2015 found likely powerful owl whitewash and pellets below a tree – refer to Figure 13 for location) it is likely the subject site and proposed development area is part of the home range for a resident pair. No nest sites were detected on the subject site despite 60.75 hours of targeted

survey of trees hollows, nocturnal observations and listening for calling owls over 9 occasions from 27 March to 20 June 2017. Based on these latest and previous findings, the impact of the proposed development is restricted to the loss of almost 10ha of foraging and occasional roosting habitat.

A **Masked Owl** was tentatively identified on the edge of Flatrock Road on the subject site previously by GHD (2013). The species was not detected utilising hollows during the recent targeted surveys on the site. Based on the possible detection of the species by GHD on the subject land, and the habitat on and around the site, the impact of the proposed development is restricted to the loss of almost 10ha of foraging and potential nesting and roosting habitat.

No **Sooty Owls** were detected on the subject site and based on the usual roosting and nesting habitat preferences for the species (rainforest as well as tall moist eucalypt forest with very large tree-hollows for nesting – OEH Sooty Owl Profile accessed July 2017) it is unlikely Sooty Owl would utilise the subject site.

Yellow-bellied (YBG) and Squirrel Gliders have been detected on the subject property by Hyder (2007) (YBG) and SCC (Squirrel Glider) (2014). There are grey gums (*Eucalyptus punctata*) and red bloodwoods (*Corymbia gummifera*) scattered across the site that provide sap and nectar resources. No den trees have been identified on the site though it is probable hollows on the site are utilised by both species at least from time to time. Squirrel gliders have small home ranges (3 to 5ha) but require abundant trees (OEH website species profile, accessed 17 July 2017) and have been detected on two occasions on and close to the site (GHD, 2013 & SCC 2014). YBG are known to utilise up to 13 den trees within their large home ranges (20-85ha – NPWS, 2003). The lack of detection during the targeted surveys is discussed below but whilst it is likely tree hollows on the subject land are utilised by YBG and Squirrel Glider on occasion specific tree hollows could not be identified.

Discussion

At the beginning of the targeted surveys in March 2017 it was apparent, compared to March 2014 when numerous Grey-headed Flying-fox, numerous Sugar Gliders, a Squirrel Glider and an Eastern Pygmy-possum were detected spotlighting, that the Red Bloodwood trees (*Corymbia gummifera*) were having a poor flowering season with very few trees observed to be flowering. Probably due to the lack of nectar (and therefore insects), Sugar Gliders during the 2017 surveys were observed to be feeding on Acacia sap and the seeds of *Allocasuarina littoralis* (Figure 21). Whether the lack of nectar on the site leads to a reduction in animal

numbers compared to years when nectar is abundant is open to debate but it appeared the density of arboreal fauna on the site during 2017 surveys was much reduced. Further survey and analyse of results would be required to confirm this but the perceived lack of fauna during 2017 compared to 2013/2014 highlights the importance of multiple studies over longer time spans than is usually possible for individual development proposal assessments.

Figure 21 Sugar glider feeding on *Allocasuarina littoralis* seeds 29 March 2017

10 Direct and indirect impacts and mitigation measures

In selecting the subject site, Shoalhaven City Council has taken all reasonable measures to avoid and minimise direct and indirect impacts to the biodiversity values of the locality, bearing in mind that the proposal is an extension to the existing landfill facility that is restricted by government regulations in relation to alternative methods of waste disposal, land zonings, existing urban development, land availability and the existing landfill site.

10.1 Potential alternatives to landfill

In terms of potential alternatives to negate the need for an extension of the existing landfill at West Nowra, Shoalhaven City Council has recently received an approval for a Resource Recovery Park to be a constructed at 114 Flatrock Road Mundamia, adjoining the existing the landfill site and opposite the subject land (State Significant Development – reference SDD 15_7015). Council's Waste Services Unit has estimated the Resource Recovery Park will remove up to an estimated 60% of currently generated waste but disposal of the remaining waste will still require an extension to the existing landfill development.

Alternatives, such as Energy from Waste solutions (gasification, pyrolysis, plasma arc and incineration), have been previously proposed to deal with Sydney's waste and reduce the pressure on existing landfill sites but the majority of the waste stream, across NSW, is not currently eligible waste fuel (EPA, 2015).

If NSW / Australia aimed to match the world's best example (Sweden's waste to energy system - http://www.avfallsverige.se/), it could potentially have only 4% of waste going to landfill which would significantly reduce the need for landfill sites in the Shoalhaven and produce energy at the same time.

10.2 Potential alternate landfill sites

Extension of the existing landfill site has been identified as a viable option by Council with the number of potential new sites within the Shoalhaven Local Government Area (LGA) being limited. Potential new sites would require a larger area of land clearing and therefore have greater direct impacts with a new site requiring a total minimum land area of 40ha (section 1.4, page 5 of Locale Consulting, 2014) to accommodate stock piling areas, infrastructure such as roads and buildings, and buffers. The proposed extension at West Nowra would make use of the existing infrastructure and therefore have a direct impact

footprint at least a quarter of the size when compared to the area required to establish a new landfill elsewhere in the Shoalhaven.

The Locale Consulting (2014) study identified and then looked at the suitability of 11 sites within the Shoalhaven LGA, including the subject site, for landfill sites for putrescible waste. Of these sites, four sites, including the subject site, were considered suitable for further investigation after taking into consideration other planning and licencing requirements such as land zoning, access, topography etc.

The three other sites and environmental attributes are described below.

10.2.1 Alternative site at South Nowra

Locale Consulting (2014) identified a site at South Nowra on Crown and privately owned land as the “preferred site”. It is zoned RU2 – Rural Landscape where landfill sites are permitted. The lots are identified as Lot 7314 DP1163622, Lot 7-8 DP1154597, and Lot 4 DP1092381 totalling approximately 290ha (Figure 22).

Figure 22 Identified potential alternative site at South Nowra with creeks and 40m buffer

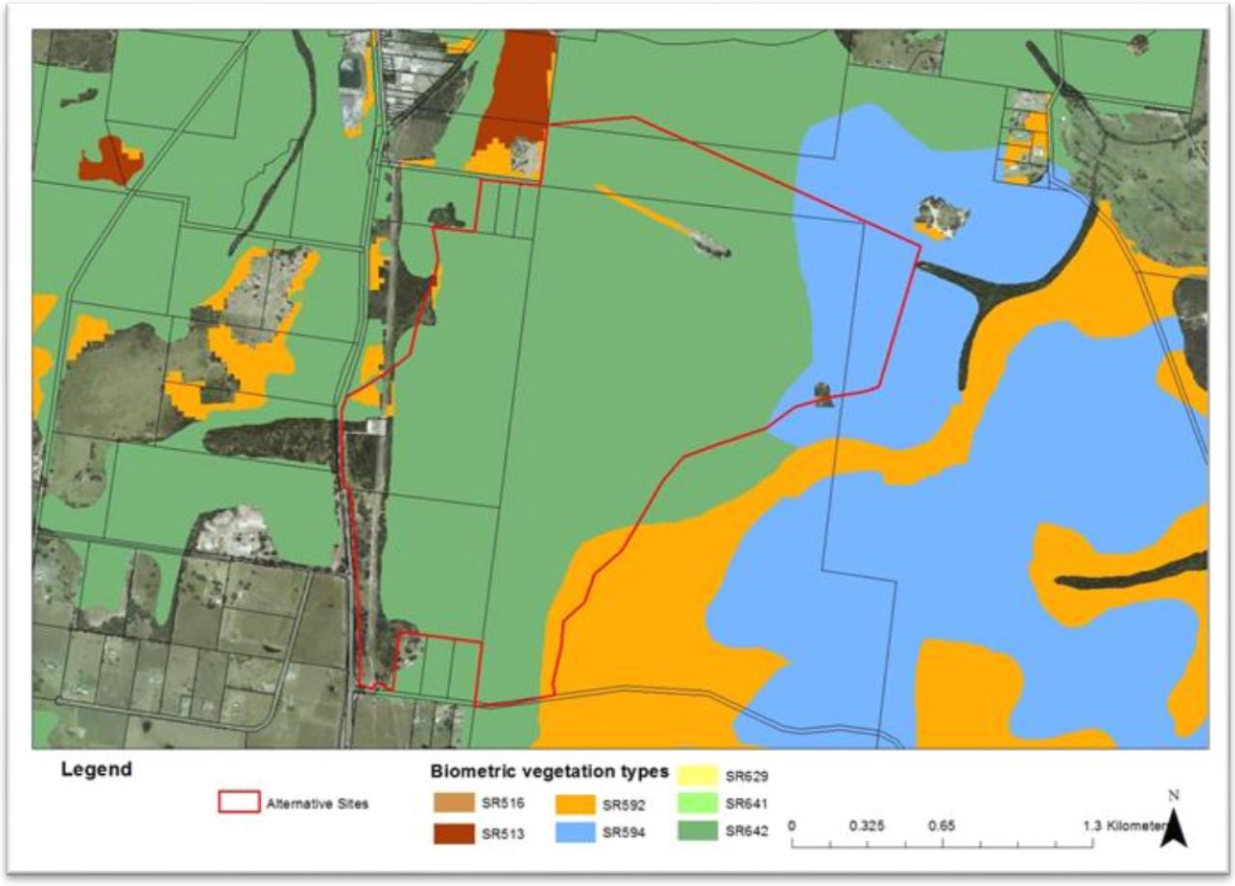


Figure 23 Identified potential alternative site at South Nowra with Biometric Vegetation mapping overlain

An on-ground assessment of the privately owned portions was not permissible and an analysis of Shoalhaven City Council's GIS layers identified a number of creeks on the site that significantly reduce the area of land potentially available for a landfill site. In addition to the water courses, the majority of the vegetation on the site has been mapped (OEH, 2013) as "Spotted Gum – Grey Ironbark – Woollybutt grassy open forest on coastal flats, southern Sydney Basin and South East Corner" (Biometric ID: SR642 Figure 23) with an estimated 35% of this vegetation type having been cleared (OEH, 2013) compared to 20% cleared for the SR594 vegetation type identified on the proposed development site at Flatrock Road Mundamia. Based on cleared percentages alone, the vegetation on the alternative site at South Nowra is more valuable with 40ha required to be cleared compared to 10ha at Flatrock Road Mundamia.

Another constraint to this site is the existence of Rifle Range, around which is required a significant buffer for safety reasons.

10.2.2 Alternative site at Blackbutt Range Road Tomerong

The possible alternative site at Blackbutt Range Road Tomerong, being the RU2 – Rural Landscape zoned portions of UPN – 116486, Lot 26, 30, 48, 53 in DP755965, is privately owned or Forestry Land and approximately 420ha.

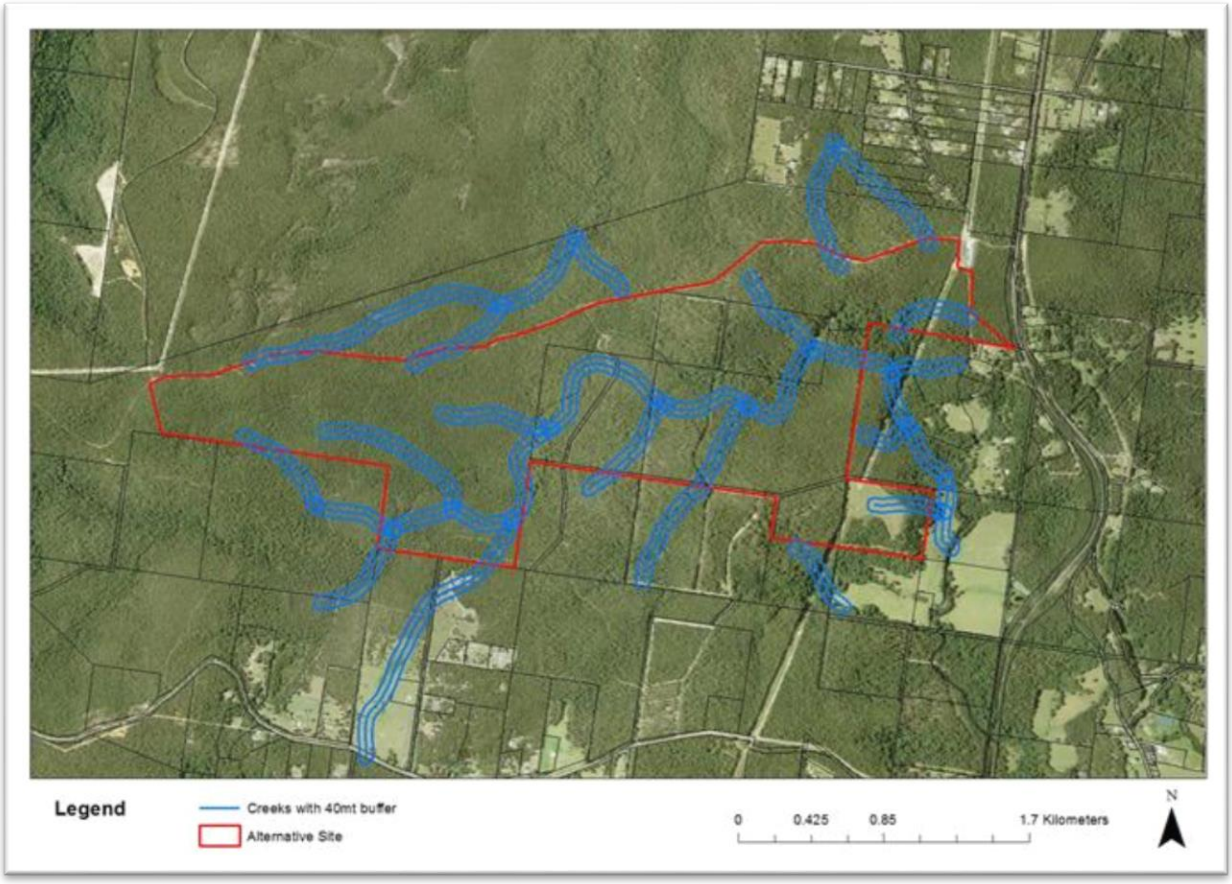


Figure 24 Identified potential alternative site off Blackbutt Range Road Tomerong with creeks and 40m buffer

An on-ground assessment of the privately owned portions was not permissible and an analysis of Shoalhaven City Council's GIS layers identified a number of creeks and gullies (Figure 24) on the site that significantly reduce the area of land potentially available for a landfill site. The site contains a mix a vegetation types (Figure 25) due to the significant changes in elevation associated with the creek gullies and surrounding ridges and plateaus. Forty hectares would have to be cleared on this alternative site compared to 10ha at Flatrock Road Mundamia.

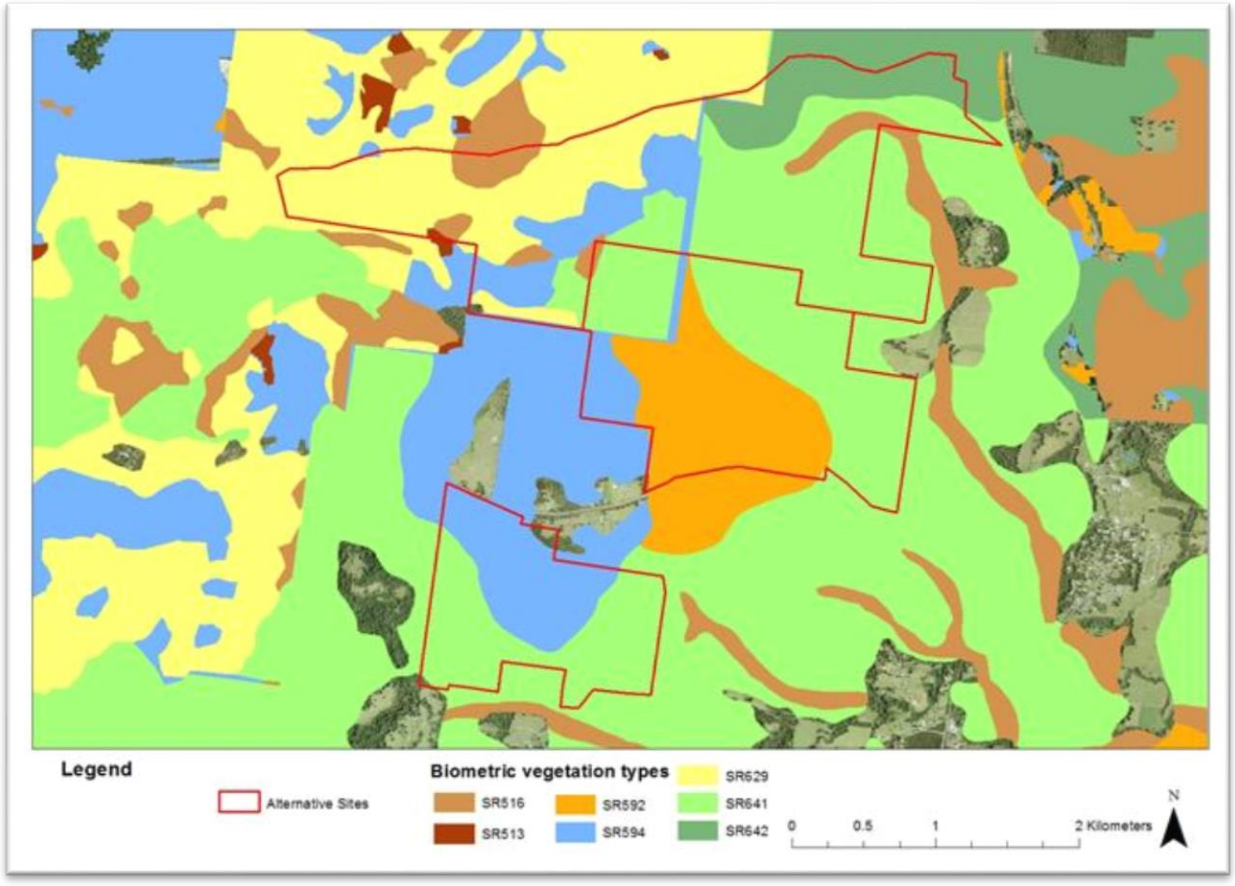


Figure 25 Biometric Vegetation Mapping for Blackbutt and Turpentine Roads

10.2.3 Alternative sites at Turpentine Road

There are three possible alternative sites identified at Turpentine Road within RU2 – Rural Landscape zoned land;

- Private and forestry land to the north-west identified as parts of the following; UPN – 97718, Lot 75 – 76, 188, 196 in DP755968, and Lot 107 DP755965 totalling approximately 270ha.
- Private and forestry land to the north-east identified as parts of the following; UPN – 94675, Lot 24, 30, 53, 103, 109 in DP755965, Lot 45 DP755968, Lot 1 – 4 DP1158140, and Lot 3 DP812890 totalling approximately 300ha.
- Crown and private land to the south identified as parts of the following; Lot 52 – 53, 190, 193, 194 – 195 in DP755968 totalling approximately 190ha.

An on-ground assessment of the privately owned portions was not permissible and an analysis of Shoalhaven City Council's GIS layers identified a number of creeks and gullies

(Figure 26) which would significantly restrict the area potentially available for a 40ha landfill site.

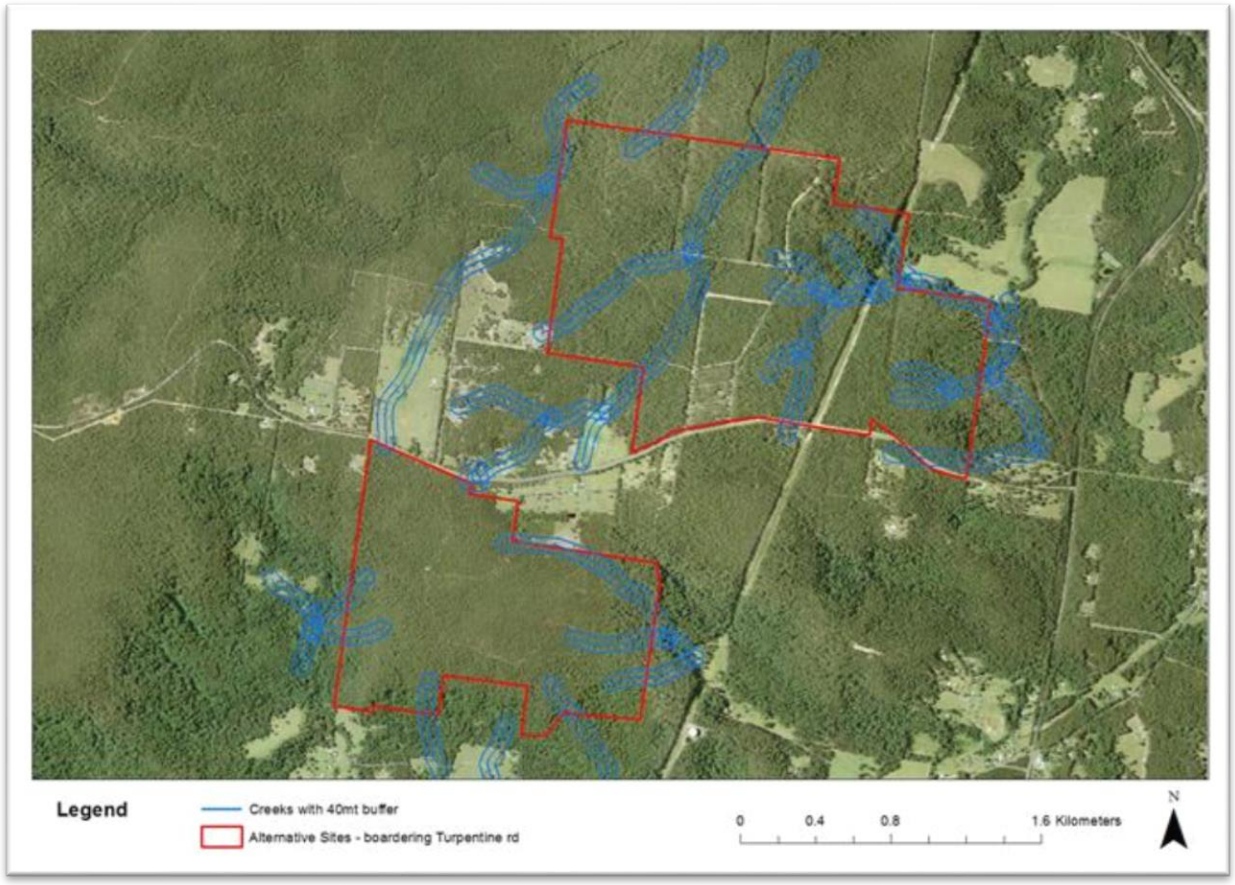


Figure 26 Turpentine Road potential alternate landfill sites and creeks with 40m buffer

Whilst the Turpentine Road site contains a potential area for a 40ha landfill site, developing the site would require the clearing of 40ha of the same vegetation type (SR594 Figure 25) as occurs on the proposed development site with potentially the same threatened species issues as the site at Flatrock Road Mundamia that requires 10ha of clearing.

10.3 Assessment of impacts

In terms of impacts to biodiversity, the subject site contains 14.52ha of native vegetation in moderate to good condition with an estimated hollow-bearing tree density of 27 trees per hectare (GHD 2014). An area of 9.87ha of this vegetation, representing known habitat for 2 Species Credit threatened fauna species (Squirrel Glider and Eastern Pygmy-possum), will be directly impacted (cleared) for the proposal. The proposal has been designed to maintain connectivity through the rest of the site to areas of known threatened species habitat to the south west, north and east.

The native vegetation to be cleared is in benchmark condition and is not of a type that is over-cleared, an Endangered Ecological Community, or contains or directly buffers or protects riparian areas. Clearing of this vegetation will require the retirement of 719 ecosystem credits for PCT594.

PC type code	Plant community type name	Management zone area (ha)	Loss in LandScape Value	Loss in site value score	EEC Offset Multiplier	Credits req for TS	TS with highest credit req	TS offset multiplier	Ecosystem credits required
SR594	Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion	9.87	21.00	90.10	1.0	719	Masked Owl	3.0	719

Figure 27 – Biobank Credit Calculator page "snip"

One threatened plant species was recorded on the site (*Triplarina nowraensis*) but is outside the development footprint and buffered by a minimum distance of 50m.

Whilst it has been confirmed via survey that a number of "ecosystem credit" threatened fauna species utilise the site and the subject site contains elements critical to the life cycle of viable local populations (potential breeding sites such as hollow-bearing trees), the biobank assessment methodology accepts the species as being able to withstand the loss. In the likely event threatened fauna are utilising tree hollows on the subject land, mitigation measures are proposed in relation to how and when hollow-bearing trees are to be removed.

In terms of threatened species **two "species credit" species, the Squirrel Glider and the Eastern Pygmy-possum, are known to inhabit the site**.

Squirrel Glider are not common in the Shoalhaven City Council Local Government area based on the number of Wildlife Atlas records, and EPP is thought to be more common but not regularly detected due to a lack of targeted surveys effort. Loss of 9.87ha of known habitat for these species on the subject site requires the retirement of 217 and 197 credits for the Squirrel Glider and EPP respectively.

Scientific name	Common name	TS offset multiplier	Species credits required
Cercartetus nanus	Eastern Pygmy-possum	2.0	197
Petaurus norfolcensis	Squirrel Glider	2.2	217

Figure 28 – Biobank Credit Calculator page "snip"

10.4 Suggested mitigation measures / conditions of an approval

The Proposed Landfill extension of West Nowra Recycling & Waste Facility will have a direct impact via total clearing to approximately 10ha of known good quality habitat for a number of threatened species including hollow-dependant mammals. The clearing of the 10ha of known habitat will include scores of hollow-bearing trees and also reduce the size of a corridor through native fauna currently move and the area of habitat in the locality generally. To mitigate the direct loss of habitat and associated fauna including threatened species, the following mitigation measures should be part of any approval granted as "conditions of consent".

1. Prior to the commencement of any development footprint clearing works, 3 rope bridges with monitoring cameras will be installed over Flatrock Road a minimum of one month before clearing of the development footprint commences to allow arboreal fauna to be accustomed to the rope bridges and be used once clearing works commence. The exact locations for the rope bridges are to be determined by Shoalhaven City Council Environmental Assessment Officers in consultation with the relevant road engineers but approximate locations are found in Figure 29.
2. Prior to the commencement of any clearing works the extent of clearing must be accurately marked on the ground.
3. Clearing is only to be carried out during autumn and early winter following a trapping program to capture and relocate resident fauna. The trapping program is to involve terrestrial and arboreal trapping methods over a minimum of 2 separate occasions of 4 nights at an intensity to cover the clearing area under the supervision of a qualified and experienced ecologist. All methods and captures must be documented and recorded in a report to Shoalhaven City Council and fauna records submitted to the NSW Wildlife Atlas. All fauna captured are to be relocated to areas of suitable habitat at the direction of the supervising ecologist or retained and kept in the care of a licenced wildlife handler until such time they can be safely released.
4. All clearing works are to be planned in consultation with a supervising ecologist with experience in land clearing and animal capture and handling.
5. An experienced and qualified ecologist must supervise all clearing works on site. The ecologist may utilise the help of a NPWS licenced Wildlife Handler but be supervised on site by the ecologist.
6. To ensure any animals injured during the clearing are dealt with in a humane manner the supervising ecologist must have pre-organised a local vet to deal with injured native animals. Any animals injured during clearing works must be transported to the vet ASAP.

7. The clearing of the development extent must completed in the following stages under the supervision and direction of the supervising ecologist.
    a) Prior to clearing all hollow-bearing trees are to be clearly identified on site with a 5m buffer around the trunk using barrier fencing or marking tape.
    b) Stage one of clearing will be the under-scrubbing of the shrub layer and small trees less the 15cm in diameter at "breast height" under the supervision of the commissioned ecologist. The ecologist is to check logs on the ground for fauna and rescue / relocate fauna as far as practicable.
    c) Stage two of the clearing will be the felling of trees including hollow-bearing trees (HBT). Felling of HBTs is to be under the supervision of the ecologist and wildlife handler with hollow-bearing sections to be lowered to the ground using a "cherry picker" if it is known to contain fauna or potentially contains a fauna occupied hollow ("potentially" means the hollow can't be inspected by the ecologist or wildlife handler). Hollow sections may be dropped if known to be clear of fauna. Any trees with bird nests containing eggs must not be disturbed and can only be felled once the birds have fledged.
    d) Hollow-bearing sections must be placed, under the supervision of the ecologist in consultation with Shoalhaven City Council's Waste Services section, along disturbed areas on the subject land outside the development footprint.
8. Any disturbed bushland areas along Flatrock Road outside the development footprint (except for access to the monitoring wells) must be rehabilitated and returned to a weed free natural state using the services of a restoration ecologist or bush regenerator.
9. To improve fauna movements through the bushland remnant of the subject land, fencing in the south-west corner of the subject lot where it adjoins the neighbouring existing landfill site, and along that portion of the southern boundary of the landfill site outside the "landfill cells", will be removed to allow for the clear passage of native fauna. The fencing must be removed prior to the landfill extension area becoming operational.

Figure 29 Mitigation measures to enhance fauna movement through the site

To protect the significant environmental features on the site all clearing works are to be supervised by a suitably qualified environmental consultant in consultation with a suitability qualified and NSW National Parks & Wildlife Service licenced wildlife handler.

A suitably qualified and NSW National Parks & Wildlife Service licenced wildlife handler must be on site prior to, and during the removal of any trees or areas of potential habitat (vegetation and dams) on the property, to rescue fauna. Details of the wildlife handler must be provided to the consent authority a week prior to the commencement of clearing works.

Prior to the commencement of any clearing works the extent of clearing as shown on the approved plans must be accurately marked on the ground with temporary barrier fencing or similar visible material.

Trees to be cleared must be felled into the development area carefully so as not to damage trees to be retained in or beyond the development footprint.

Hollow-bearing trees must be felled carefully in sections utilising a “cherry picker” or crane if necessary to allow the rescue of native fauna. Hollow-bearing sections must be carefully lowered to the ground so as not to injure native fauna.

All clearing works and the associated machinery and waste must be contained within the development footprint within subject land (Lot 1 DP1104402 Flatrock Road Mundamia) or cleared land on the existing Flatrock Road Mundamia landfill site.

The parking of machinery and vehicles or the storing of building or landscaping materials, soil, spoil, or rubbish, outside the development footprint of the subject land (Lot 1 DP1104402 Flatrock Road Mundamia) or outside cleared land on the existing Flatrock Road Mundamia landfill site is prohibited.

Sediment erosion controls must be in place immediately following clearing and on the same day as clearing works commence.

To protect native gliding and flying mammals in the locality the use of barbed-wire for fences is prohibited.

The planting of plant species listed on the Weeds Australia NSW weeds list (www.weeds.org.au) is prohibited for the life of the development.

No exotic perennial grasses listed on the Final Determination of the NSW Scientific Committee for the key threatening process *Invasion of native plant communities by exotic perennial grasses,* shall be sown on the subject land for the life of the development. Native grasses must be sown in these areas, as this is the interface between disturbed areas and the remaining native vegetation.

Any landscaping of the site is be with local native plant species only.

11 Biodiversity credits required and "Offset strategy"

Below is the credit requirements generated by the Biobank Calculator and potential offset options.

Shoalhaven City Council is currently investigating the potential to biobank a site at Huskisson approximately 22km south east of the development site. It is currently the site for the Huskisson Recycling and Waste Facility with 55.28ha of the 72.36ha site available for biobanking. The 55.28ha has a credit value of 699 ecosystem credits.

Being a major project Shoalhaven City Council wishes to negotiate an alternate and "improved" offset option being land identified in Biobank Assessment (ID # 0099/2015/2215B). The proposed offset land is owned by Shoalhaven City Council and is identified as Lot 17 DP 857006 (235 Huskisson Rd, Huskisson) and totals 72.36ha. The land is approximately 22km south east of the development site and currently is the site for the Huskisson Recycling and Waste Facility but 55.2ha is available for a Biobank site.

The 55.28ha comprises of;

- 1.97ha of SR594 Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest with a credit value of 23 credits,
- 17.68ha of SR648 Swamp Mahogany swamp sclerophyll forest on coastal lowlands with a credit value of 184 credits, and
- 35.68ha of SR516 Blackbutt – Turpentine – Bangalay moist open forest on sheltered slopes and gullies with a credit value of 492 credits.

SR594 is listed as an "offset option" in the Full Credit Report for the Resource Recovery Park (RRP) development site.

Whilst not listed as "offset options", both SR516 and SR648 are 50% cleared within the Southern Rivers Catchment Area compared to 20% cleared for SR594. With SR648 also classified as an Endangered Ecological Community (Swamp Sclerophyll Forest on coastal floodplains) both the non-optioned vegetation community types are considered more valuable in terms of an offset.

Surveys of the proposed biobank site have also detected 7 threatened species; Yellow-bellied Glider, Glossy Black-cockatoo, Little Lorikeet, Square-tailed Kite, Eastern Bristlebird (EBB), Green & Golden Bell Frog (GGBF) and Eastern Pygmy-possum (EPP). Of the four species, EBB, GGBF and EPP are listed as species credit species within the Southern Rivers

Catchment Area with Biobank calculations equating to 100 credits for EBB, 81 credits for GGBF, and 333 credits for EPP (preliminary calculations yet to be approved by OEH).

Management actions proposed to “improve” the biobank site include;

- Fox baiting (the species has been detected on the offset site during fauna surveys),
- Weed control (weed species are growing around the perimeter of the existing landfill site), and
- Close and rehabilitate unauthorised tracks and install vehicle exclusion fencing.

12 References

Birdlife Australia website http://birdlife.org.au/projects/woodland-birds-for-biodiversity/regent-honeyeater-wl accessed 17 August 2015.

Commonwealth of Australia (2010), Survey guidelines for Australia's threatened birds. Accessed from the Australian Government's website www.environment.gov.au .

DECC (2008), Approved Recovery Plan for the Koala (*Phascolarctos cinereus*). NSW Department of Environment and Climate Change.

DECCW (2010), South Coast Regional Conservation Plan, Department of Environment, Climate Change and Water, Sydney

EPA (2015), NSW Energy from Waste Policy Statement. NSW State Government and Environmental Protection Agency, Sydney.

Keith, D. (2004). Ocean shores to desert dunes: the native vegetation of New South Wales and the ACT. NSW Department of Environment & Conservation, Hurstville NSW.

Locale Consulting (2014). Shoalhaven City Council Desktop Landfill Site Identification Study. Report for Shoalhaven City Council.

Mills, K. (2000). Shoalhaven City Council Vegetation Mapping Project. A report to the Shoalhaven City Council by Kevin Mills & Associates

NPWS (2003). Recovery Plan for the Yellow-bellied Glider (*Petaurus australis*). NSW National Parks and Wildlife Service, Hurstville NSW.

NSW Office of Environment & Heritage, Bionet Website accessed on 2 August 2015.

OEH (2013) Compilation map: Biometric vegetation types and endangered ecological communities of the Shoalhaven, Euobodalla & Bega Valley local government areas. A living map Version 2.0. Technical Report, NSW Office of Environment & Heritage, Queanbeyan

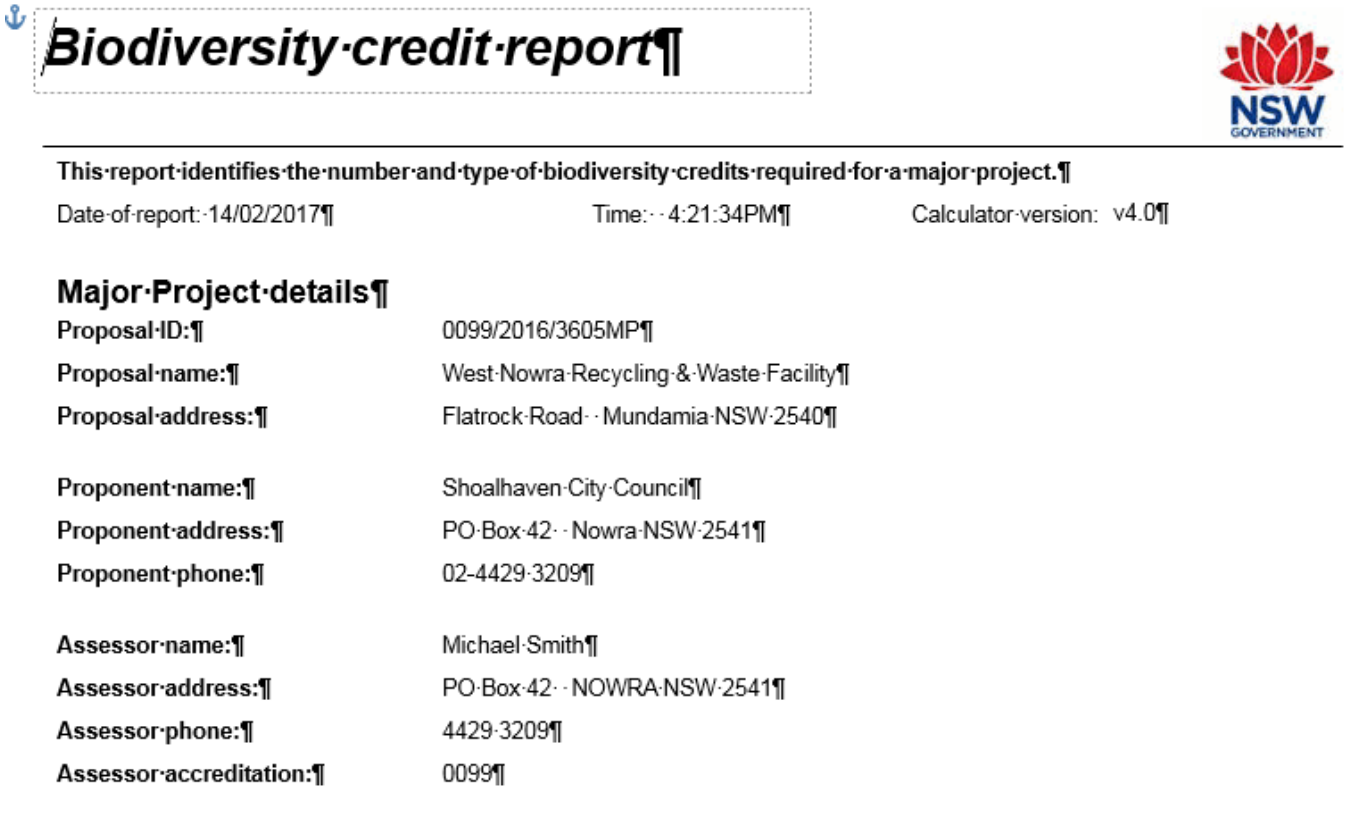
OEH (2014b) Biobanking Assessment Methodology 2014 (September 2014).NSW Office of Environment & Heritage, Sydney NSW

OEH (2014a) Framework for Biodiversity Assessment, NSW Biodiversity Offsets Policy for Major Projects. NSW Office of Environment & Heritage, Sydney NSW

Stephenson, A. W. (2011). *Orchid Species of the Shoalhaven NSW Australia.* Self Published. Nowra, NSW Australia.

Stephenson, Alan (2016). Personal communications with Alan Stephenson as a recognised local Shoalhaven orchid expert

Appendix 1 – Biodiversity Credit Report



Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 14/02/2017 Time: 4:21:34PM Calculator version: v4.0

Major Project details

Proposal ID:	0099/2016/3605MP
Proposal name:	West Nowra Recycling & Waste Facility
Proposal address:	Flatrock Road Mundamia NSW 2540
Proponent name:	Shoalhaven City Council
Proponent address:	PO Box 42 Nowra NSW 2541
Proponent phone:	02-4429 3209
Assessor name:	Michael Smith
Assessor address:	PO Box 42 NOWRA NSW 2541
Assessor phone:	4429 3209
Assessor accreditation:	0099

Figure 30 – Biobanking Final Credit Report, Page 1

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion	9.87	719.00
Total	9.87	719

Credit profiles

1. Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion, (SR594)

Number of ecosystem credits created	719
IBRA sub-region	Ettrema

Offset options - Plant Community types	Offset options - IBRA sub-regions
Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion, (SR594) Ironbark - Woollybutt - White Stringybark open forest on coastal hills, South East Corner Bioregion, (SR559) Messmate dry shrubby forest on sandstone, far southern South East Corner Bioregion, (SR577) Red Bloodwood - Silvertop Ash - White Stringybark heathy open forest on coastal foothills, southern South East Corner Bioregion, (SR596) Silvertop Ash - Blue-leaved Stringybark - Red Bloodwood dry shrubby open forest on ridges of the hinterland foothills, northern South East Corner Bioregion, (SR621) Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion, (SR624) Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion, (SR628) Silvertop Ash - White Stringybark shrubby open forest of the escarpment ranges, southern South East Corner Bioregion, (SR631) White Stringybark - Narrow-leaved Peppermint dry open forest on hinterland hills, far south of the South East Corner Bioregion, (SR668)	Ettrema and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Figure 31 – Biobanking Final Credit Report, Page 2

Summary·of·species·credits·required¶

Common·name¶	Scientific·name¶	Extent·of·impact·Ha·or·individuals¶	Number·of·species·credits·created¶
Eastern·Pygmy-possum¶	Cercartetus·nanus¶	·9.87	·197
Squirrel·Glider¶	Petaurus·norfolcensis¶	·9.87	·217

Figure 32 – Biobanking Final Credit Report, Page 3

Appendix 2 – Expert Orchid Assessment Reports

Expert Report 1 – *Calochillus pulchellus*

Caleana Consultancy
ABN 57 883 139 901 43 McKay Street
NOWRA NSW 2541
Ph. 04011 95321

The purpose of this report.

With my knowledge of Shoalhaven orchid species I have been engaged Shoalhaven City Council to assess the potential for the Target Species, Endangered Orchid Species, *Calochilus pulchellus* to occur on Lot 342 DP 257515, 114 Flatrock Road Mundamia and Lot 1 DP 1104402 Flatrock Road Mundamia.

Survey Method Used.
An on foot survey was conducted of both sites to determine the vegetation type and the potential for the endangered terrestrial orchid species *C. pulchellus* to occur at either location.

Date of Survey.
The survey was conducted on 13-9-2015 in fine weather and two hours were required for this assessment. Thirty minutes were used to assess Lot 342 and 1.5hrs to assess Lot 1.

Findings.
On Lot 342 which is 3.58ha there is an existing Animal Shelter Facility with fenced areas for larger animals and a small dam on one section. The habitat is open remnant dry sclerophyll forest with a minimal tree cover and sparse ground cover shrubs.
Orchids located on this site:
Cryptostylis subulata—Large Tongue Orchid
Cryptostylis erecta—Bonnet Orchid
Thelymitra ixioides—Dotted Sun Orchid
Thelymitra spp. in early bud—Sun Orchid
Caladenia fuscata—Dusky Fingers
Caladenia carnea—Pink Fingers

Lot 1 is 14.52ha and is intact dry sclerophyll forest with a consistent mature tree cover, a medium density low to medium height tree cover and ground cover with few open areas.
Orchids located on this site:
Cymbidium suave—Snake Flower
Cryptostylis erecta—Bonnet Orchid
Cryptostylis subulata—Large Tongue Orchid
Cryptostylis leptochila—Small Tongue Orchid
Acianthus fornicatus—Large Mosquito Orchid
Corybas aconitiflorus—Cradle Orchid

Conclusion:
Lot 342 is unsuitable to house *Calochilus pulchellus* as it is largely cleared with little natural vegetation remaining.
Lot 1 is also unsuitable for *Calochilus pulchellus* as it also is of the wrong vegetation type. I have visited all sites known to house this species and all are low to medium heath with no medium or large over storey, although the Vincentia site has two medium height *Eucalyptus haemastoma* trees at its northern extremity.
Alan W. Stephenson

Expert Report 2 – *Pterostylis ventricosa, Pterostylis vernalis*

Caleana Consultancy
ABN 57 883 139 901 43 McKay Street
NOWRA NSW 2541
Ph: 44217773
Mob. 04011 95321

The Purpose of this Report.
To establish the possibility of land along Flatrock Road West Nowra to provide a habitat for Critically Endangered terrestrial orchid species *Speculantha ventricosa* (Syn. *Pterostylis ventricosa*) and *Speculantha vernalis* (Syn. *Pterostylis vernalis)* This land of 14.52ha is to be used for the extension of the existing Shoalhaven City Council landfill facility and is identified as Lot 1 DP 1104402 Flatrock Road Mundamia

Survey Method Used.
An on foot survey was conducted across all accessible areas of the site.

Date of Survey.
The survey was conducted in fine weather on 31-3-2016 after first establishing the presence of the species at the nearest known site where numerous plants were recorded in flower and bud.

Findings.
Numerous orchid species were located and identified, mainly via leaves and are listed below. Leaves of several *Thelymitra* species (Sun Orchid) were also noted but identification is not possible until plants are in flower. However, no threatened species in this genus are known to occur in the region.
Cryptostylis erecta—Bonnet Orchid
Cryptostylis subulata—Large Tongue Orchid
Cryptostylis leptochila—Spotted Tongue Orchid
Acianthus fornicatus—Large Mosquito Orchid
Corybas aconitiflorus—Cradle Orchid
Cymbidium suave (plant) - Snake Orchid

Conclusion.
Lot 1 is 14.52ha of intact dry sclerophyll forest with a consistent mature tree cover, a medium density low to medium height tree cover and ground cover with few open areas. This habitat type is unsuitable for *S. ventricosa* and all sites where this orchid occurs are known to me. The overall tree canopy cover while not dense is too dense for these species, which only occurs in open to semi-open forest with open to bare sections. Leaf litter across most of the site is too dense as are the low to medium shrubs and ground covering plants.

The habitat is also unsuitable for *Speculantha vernalis* due to the absence of it's known habitat preference for sandstone rock shelf, occasionally covered with shallow soil. It also has a preference for two shrubs, *Leptospermum sejunctum* and *Kunzea ambigua*. Neither the sandstone nor shrubs are present on the site and therefore I feel confident in stating, neither orchid will occur on this site.

Alan W. Stephenson

Appendix 3 – SEARS

Attachment A – Standard Environmental Assessment Requirements

Biodiversity
1. Biodiversity impacts related to the proposed development are to be assessed and documented in accordance with the Framework for Biodiversity Assessment, unless otherwise agreed by OEH, by a person accredited in accordance with s142B(1)(c) of the *Threatened Species Conservation Act 1995*.
Aboriginal cultural heritage
2. The EIS must identify and describe the tangible and intangible Aboriginal cultural heritage values that exist across the whole area that will be affected by the development and document these in the EIS. This may include the need for surface survey and test excavation. The identification of cultural heritage values should be guided by the *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (DECCW, 2011) and consultation with OEH regional officers.
3. Where Aboriginal cultural heritage values are identified, consultation with Aboriginal people must be undertaken and documented in accordance with the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW). The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be documented in the EIS.
4. Impacts on Aboriginal cultural heritage values are to be assessed and documented in the EIS. The EIS must demonstrate attempts to avoid impact upon cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, the EIS must outline measures proposed to mitigate impacts. Any objects recorded as part of the assessment must be documented and notified to OEH.
Historic heritage
5. The EIS must provide a heritage assessment including but not limited to an assessment of impacts to *State and local heritage* including conservation areas, natural heritage areas, places of Aboriginal heritage value, buildings, works, relics, gardens, landscapes, views, trees should be assessed. Where impacts to State or locally significant heritage items are identified, the assessment shall: a. outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures) generally consistent with the NSW Heritage Manual (1996), b. be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria), c. include a statement of heritage impact for all heritage items (including significance assessment), d. consider impacts including, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, landscape and vistas, and architectural noise treatment (as relevant), and e. where potential archaeological impacts have been identified develop an appropriate archaeological assessment methodology, including research design, to guide physical archaeological test excavations (terrestrial and maritime as relevant) and include the results of these test excavations.
Water and soils
6. The EIS must map the following features relevant to water and soils including:

	a. Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map). b. Rivers, streams, wetlands, estuaries (as described in Appendix 2 of the Framework for Biodiversity Assessment). c. Groundwater. d. Groundwater dependent ecosystems. e. Proposed intake and discharge locations.
7.	The EIS must describe background conditions for any water resource likely to be affected by the development, including: a. Existing surface and groundwater. b. Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations. c. Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters. d. Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government.
8.	The EIS must assess the impacts of the development on water quality, including: a. The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction. b. Identification of proposed monitoring of water quality.
9.	The EIS must assess the impact of the development on hydrology, including: a. Water balance including quantity, quality and source. b. Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas. c. Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems. d. Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (eg river benches). e. Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water. f. Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options. g. Identification of proposed monitoring of hydrological attributes.

Flooding and coastal erosion
10. The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: a. Flood prone land b. Flood planning area, the area below the flood planning level. c. Hydraulic categorisation (floodways and flood storage areas).
11. The [EIS/EA] must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.
12. The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: a. Current flood behaviour for a range of design events as identified in 8) above. The 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.
13. Modelling in the EIS must consider and document: a. The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood. b. Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories. c. Relevant provisions of the NSW Floodplain Development Manual 2005.
14. The EIS must assess the impacts on the proposed development on flood behaviour, including: a. Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. b. Consistency with Council floodplain risk management plans. c. Compatibility with the flood hazard of the land. d. Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. e. Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site. f. Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. g. Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council. h. Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council. i. Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent

Attachment B – Project Specific Requirements

A. Impacts on the following species will require further consideration and provision of the information specified in s9.2 of the Framework for Biodiversity Assessment:

- *Acacia bynoeana*
- *Gallium australe*
- *Melaleuca deanei*
- *Triplarina nowraensis*
- *Hibbertia stricta subsp. Furcatula*
- *Calochilus pulchellus*
- *Pterostylis ventricosa*
- *Pterostylis vernalis*
- *Genoplesium baueri*
- *Cryptostylis hunteriana*

B. Surveys for all species must include targeted searches in all habitat (including marginal habitat) on the subject site.

C. Surveys for orchids must undertake consecutive/parallel 5m wide transects covering all potential habitat (including marginal habitat) on the subject site. Surveys must involve walking along each transect searching for the species, and must be undertaken during the species' flowering season. Flowering season must be confirmed by survey of flowering at known reference sites.

Appendix 4 – March 2017 Hollow-bearing Trees inventory

TREE #	SPECIES	HEIGHT	# HOLLOWS <10CM	10 - 20CM	> 20CM
1	*Eucalyptus sclerophylla*	10.7	1	6	0
2	*Eucalyptus sclerophylla*	7.5	0	1	0
3	*Eucalyptus sclerophylla*	13.3	4	0	0
4	*Eucalyptus sclerophylla*	14.5	0	1	0
5	dead	18.1	0	1	0
6	*Eucalyptus sclerophylla*	11.1	0	1	0
7	*Eucalyptus sclerophylla*	19.5	0	3	0
8	*Eucalyptus sclerophylla*	16.9	0	1	1
9	*Eucalyptus sclerophylla*	20.3	0	2	1
10	*Eucalyptus sclerophylla*	14.7	4	0	0
11	*Eucalyptus sclerophylla*	11.9	0	3	0
12	*Eucalyptus* sp.	11.1	0	1	0
13	*Eucalyptus sclerophylla*	19.7	0	3	0
14	*Eucalyptus sclerophylla*	15.3	2	3	0
15	*Eucalyptus sclerophylla*	15.1	0	1	0

16	*Eucalyptus sclerophylla*	18.7	0	3	0
17	*Eucalyptus sclerophylla*	11.7	0	1	1
18	*Eucalyptus sclerophylla*	14.1	0	3	0
19	*Eucalyptus* sp.	18.3	1	0	0
20	*Eucalyptus sclerophylla*	15.3	6	0	0
21	*Eucalyptus sclerophylla*	16.3	2	0	0
22	*Corymbia gummifera*	11.5	0	0	1
23	*Eucalyptus sclerophylla*	10.5	2	0	0
24	*Eucalyptus sclerophylla*	10.3	1	0	0
25	*Corymbia gummifera*	18.9	1	0	0
26	*Eucalyptus sclerophylla*	14.9	1	3	0
27	*Corymbia gummifera*	10.5	0	3	0
28	*Eucalyptus sclerophylla*	12.5	0	3	0
29	*Eucalyptus sclerophylla*	14.3	0	2	0
30	*Corymbia gummifera*	14.5	0	2	0
31	dead	9.5	0	0	1
32	dead	8.9	0	0	1
33	*Eucalyptus sclerophylla*	12.3	1	1	0
34	dead	12.1	0	0	1

35	*Eucalyptus sp.*	13.4	1	0	0
36	dead	9.2	0	0	1
37	*Eucalyptus sclerophylla*	14.1	0	0	3
38	*Eucalyptus punctata*	12.2	0	2	1
39	*Eucalyptus sclerophylla*	16.5	2	0	0
40	dead	15.3	0	0	2
41	*Eucalyptus punctata*	16.9	0	1	0
42	*Corymbia gummifera*	16.9	0	3	0
43	*Eucalyptus punctata*	14.7	0	0	1
44	*Eucalyptus sclerophylla*	16.7	0	1	0
45	*Eucalyptus sclerophylla*	17.3	0	0	2
46	dead	8.7		0	1
47	*Eucalyptus sclerophylla*	15.3	0	1	1
48	*Eucalyptus sclerophylla*	15.3	2	0	0
49	*Eucalyptus sclerophylla*	11.5	0	1	0
50	*Eucalyptus sclerophylla*	13.3	0	1	0
51	*Eucalyptus punctata*	14.9	0	1	0
52	*Eucalyptus punctata*	15.3	0	1	1
53	*Eucalyptus sclerophylla*	18.3	0	1	0

54	*Eucalyptus sclerophylla*	13	0	4	1
55	*Corymbia gummifera*	16.5	0	0	1
56	*Eucalyptus sclerophylla*	16.7	0	0	1
57	*Eucalyptus sclerophylla*	17.9	0	0	1
58	*Corymbia gummifera*	21.9	0	0	2
59	*Corymbia gummifera*	16	0	1	0
60	*Eucalyptus sclerophylla*	16	0	2	1
61	*Eucalyptus sclerophylla*	17	0	2	0
62	*Eucalyptus sclerophylla*	20.7	0	0	2
63	*Corymbia gummifera*	20.7	0	0	2
64	*Eucalyptus sclerophylla*	21	0	1	0
65	*Corymbia gummifera*	14	0	0	1
66	*Eucalyptus sclerophylla*	10	0	1	0
67	*Eucalyptus sclerophylla*	15.1	1	0	1
68	*Eucalyptus* sp.	12.1	0	0	1