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LOCAL ENVIRONMENT STUDY

At

PACIFIC HIGHWAY, BULADELAH, NSW (LOT 3 IN DP 1120817 AND LOT 100 IN DP 1139447)

PART 1 – VEGETATION COMPONENT

MAP 2011

EXECUTIVE SUMMARY

Brewery Australia Developments Pty. Ltd. commissioned *Clarke, Dowdle & Associates* to prepare an ecological survey as part of a Local Environmental Study (LES) on a large parcel of land at Bulahdelah. The objective of this ecological survey is to describe the flora characteristics of the subject site and to identify significant species, populations and ecological communities, and their habitats that occur. The report is presented in four separate components and this component deals with the vegetation.

The proposal is subject to New South Wales (NSW) and Commonwealth environmental statutes, notably the *Threatened Species Conservation Act* 1995 (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) respectively. Given the interaction between Commonwealth and State environment legislation, there is an obligation on all authorities to protect and conserve environmental attributes.

Flora surveys on the site were conducted over a four-year period by *Clarke Dowdle & Associates* and *Robert Payne-Ecological Surveys & Management.* The results from these surveys were collated and used in the production of this report component.

Flora surveys conducted so far by *Clarke Dowdle & Associates* and *Robert Payne-Ecological Surveys & Management* identified one threatened species, *Tetratheca juncea* the Black-eyed Susan to occur on Alum Mountain outside of the property. Previous records indicate this species was also present onsite on the Coastal Plain but the area has since been modified. In addition it was determined that the site also contained the habitat for other threatened orchid and plant species including *Coybas dowlingii, Cryptostylis hunteriana*, *Rhizanthella slateri, Asperula asthenes* and *Syzygium paniculatum.* However these species were not identified in the surveys conducted to date. Two ROTAP species, *Callistemon acuminatus and Eucalyptus fergusonii subsp fergusonii*, were found on the summit of Alum Mountain and the lower slopes respectively.

The vegetation mapping conducted by *Clarke Dowdle & Associates* and *Robert Payne-Ecological Surveys & Management* identified and mapped six map units using accurate DGPS and aerial photography survey techniques. The results, however, at this stage of the analysis are only temporary because they have been determined at a local scale. More preliminary regional scale data is now presented.

One endangered ecological community (EEC) was identified within two distinct areas on the site. These locations are back swamps associated with Frys Creek. This community qualifies as the Swamp Sclerophyll Forest EEC (*Melaleuca Forest with emergents in areas of impeded drainage*) listed on the Threatened Species Conservation Act, 1995. In addition, most vegetation on the property is significant at a regional scale and in particular the vegetation on the cliff faces and summit of Alum Mountain and that of the hanging swamp is unique. The upper slopes would appear to be more common than originally determined, in the northern part of the region, based upon the results of the latest regional surveys

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1.0 INTRODUCTION

Clarke, Dowdle & Associates have, together with *Robert Payne-Ecological Surveys & Management,* prepared an ecological survey as part of a Local Environmental Study (LES) on a large parcel of land at Bulahdelah, owned by *Brewery Australia Developments Pty. Ltd*. The ecological assessment has been undertaken to ensure the LES is consistent with the requirements of the *Environmental Planning and Assessment Act 1979*, the *Threatened Species Conservation Act 1995,* the *Environmental Protection and Biodiversity Conservation Act 1999* and guidelines developed by Great Lakes Council.

The documents for the LES study are prepared as four components. Part 1 is the flora, part 2 is the fauna, part 3 is planning and finally part 4 is the appendices. This component flora report forms part of the Local Environmental Study detailing the flora attributes of the area as a result of surveys undertaken between 2006 and 2010. Two stages for the study were used to compile the data. Stage 1, undertaken in 2006, involved the smaller area of the coastal plain which has now been cleared and modified under an approval for a resort facility and involved, at that time, only a flora and fauna survey. Stage 2 of the flora and fauna survey was expanded into an LES and includes all of the other land within the property boundaries (Figures 1, 2 & 3).

1.1 Aims and objectives

The aims and objectives of this survey and report are to address issues as set out in the document prepared by Great Lakes Council for local environmental studies. The main aims in relation to flora are:

- Identify, document and consider available ecological information pertaining to the site and its locality;
- Survey and describe the flora species and vegetation communities within the site;
- Determine and describe all features of biological significance within the site;
- Determine what threatened plant and orchid species are present or likely to be present
- Determine what endangered ecological communities and endangered populations are present or likely to be present.

2.0 LOCATION

The site is located approximately 1km north-east of Bulahdelah, NSW along the Pacific Highway (Figure 1). On the Bulahdelah 1:25 000 topographic map sheet (9333-3-S) the MGA grid co-ordinates are $_{4}$ 26 770E, $_{64}$ 14 770N. The site is also located in the Parish of Bulahdelah, the County of Gloucester in the Shire of Great Lakes. Cadastrally, the site is known as Lot 3 in DP 1120817 and Lot 100 in DP 113447 (Figures 1 & 2).

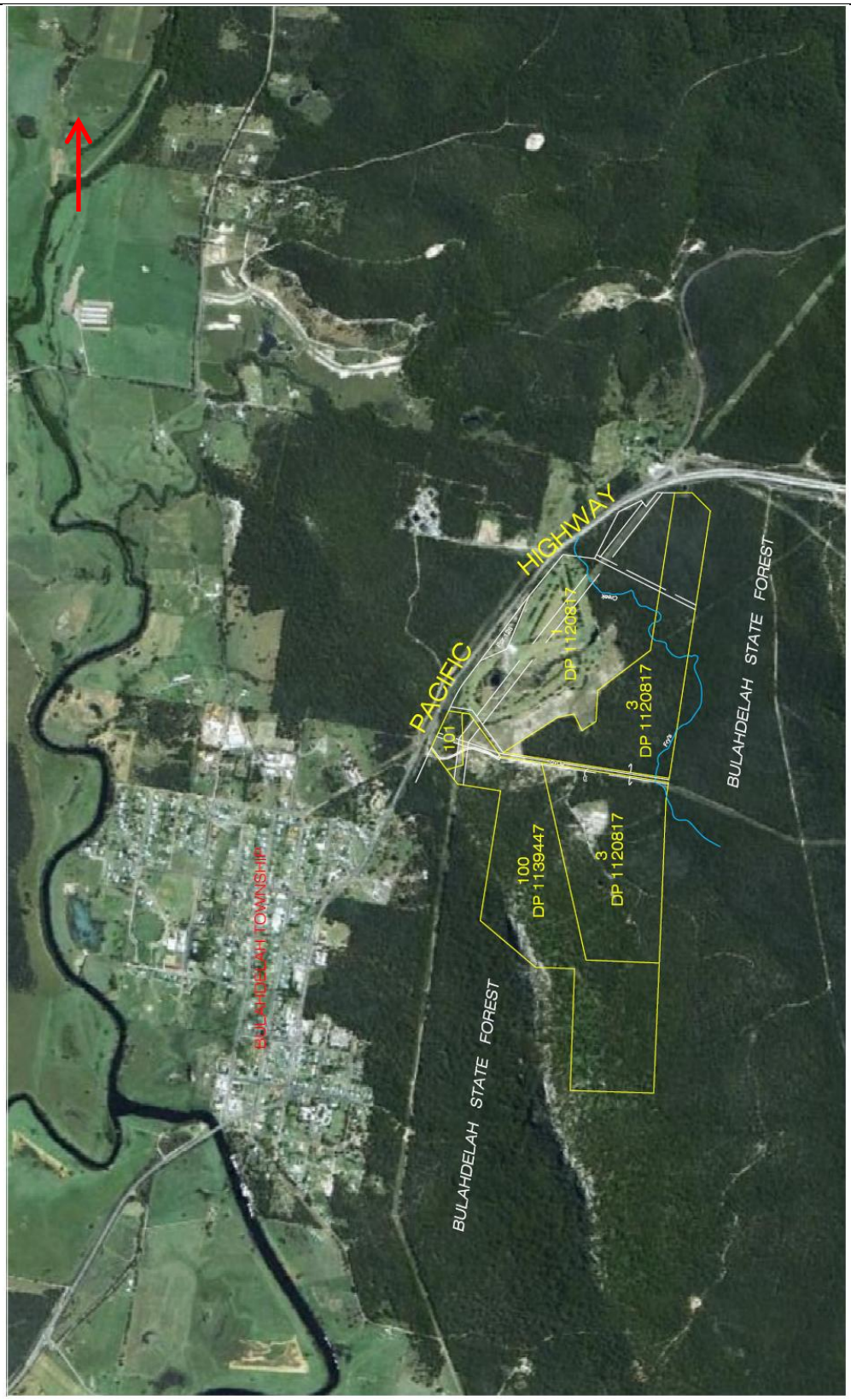


Figure 1 – Locality aerial photograph showing site in relation to Bulahdelah

Figure 2 – The subject site, showing cadastral boundaries, located east of the Pacific Highway

2.1 Characteristics of the site and the surrounds

The land subject to this study supports a mixture of forest types on the lower to mid slopes of Alum Mountain and the coastal plain. Logging has occurred over previous years and is responsible for the larger trees having been removed in these forests, based on the presence of existing stumps.

This vegetation on the slightly undulating coastal plain is dominated in the canopy by *Eucalyptus resinifera* Red Mahogany, *Eucalyptus piperita* Sydney Peppermint, *Corymbia gummifera,* Red Bloodwood, *Eucalyptus eugenioides* Thin-leaved Stringybark and *Angophora costata* Sydney Red Gum. Occasionally *Eucalyptus robusta* Swamp Mahogany occurs. Part of this vegetation was cleared and burnt in 2009 and now is re-generating.

Lower slopes of Alum Mountain within the property boundaries and over the coastal plain range from southern, south eastern and eastern aspects with ground measured slopes ranging between 1-3.5° (Photo 5). Some steeper slopes occur in conjunction with re-entrants in lower gully areas. Many intermittent drainage lines also occur and form ponds after rain. These gully re-entrants are not easily discernable on the contour plans, but can form significant ponds in the field. This drainage continues through the golf course to Frys Creek.

To the east and adjoining the subject land is Bulahdelah State Forest and to the south the subject site incorporates part of Alum Mountain. Frys Creek drains partly from the eastern side of Alum Mountain and on its course, tends to circumnavigate the subject site except at the northern end through the golf course. All drainage eventually enters the Myall River (Figure 2).

To the north of Frys Creek on the floodplain is a large area of moist forest which has impeded drainage characteristics. It is also has, on the ground surface, pock-marked undulations, which fill with water during rain and function as soaks. This area supports a tall Red Mahogany Forest with a dense Melaleuca sub canopy together with a dense grass and sedge and often shrub understorey (Photo 7). Within this area are a few very large trees with significant hollows.

Slopes directly below Alum Mountain are steep and dominated by tall Tallowood-Blackbutt-Grey Gum Forest generally with a dense ferny, shrub and undershrub layer. Discontinuous volcanic rock outcrops occur over these upper slopes but rock outcrops and rock debris are continuous over the mountain. On the northern end of Alum Mountain is a small area of low stunted Brush Box Forest with the remaining summit area supporting isolated, but wind sheared shrubs and undershrubs.

Sheer cliffs with vertical faces of the Alunite outcropping are a feature of the summit area of Alum Mountain. Most of the summit is inaccessible except with the aid of abseiling equipment. Caves, interstices and crevices are common on the sheer faces and the latter two habitats provide niches for more specialized plant species such as ferns, rock orchids, rainforest trees and undershrubs such as *Wilkiea huegeliana* (Photo 1) and *Tetratheca juncea* (Photo 7).

2.2 Fire history

From the NSW wildfire database (supplied by NSW DECCW mapping shows that, with respect to the vegetation, there has been an ever present wildfire history. Table 1 outlines

the fire history dates and location of the fires on the site and its surrounds from records provided.

Table 1 – Summary of Fire History for the site and its surrounds

Date of Fire	Areas Burnt on Site
13th-26th November 1968	Entire Site
1st July 1975	Northern portion partly Burnt
30th June 1976	Northern portion partly Burnt
1977-1978 (no actual date)	Eastern portion
11-12th September 1982	Southern portion
28-29 September 1984	Frys Creek
22-28 October 1986	Entire Site
1988-1989	Southern portion
1989-1990	Entire Site
1990-1991	South-east portion
20-23 August 1991	South-east portion
19th September 1994	North-east portion
1-4 November 1997	Coastal plain and upper slopes
28-29 October 1998	Alum Mountain and its immediate surrounds
1st January 2000	West of the property and opposite the golf course
5 and 17 September 2000	Northern Portion
4th December 2002	Eastern Portion
1st January 2006	Opposite the golf course

3.0 POTENTIAL THREATENED SPECIES AND ENDANGERED ECOLOGICAL COMMUNITIES

3.1 Wildlife atlas database records and protected matters search

Wildlife atlas records for flora were initially retrieved from the NSW and commonwealth databases in 2008 for a 10km range from the property and the results are presented in Table 2. The database was again updated in 2010, with further information gathered from the Hunter Central Rivers Catchment Management Authority (A. Paget pers. com.). Additional data was also obtained from the Royal Botanic Gardens Sydney as the study progressed on previous collections undertaken for Alum Mountain and its surrounds.

Those threatened species, highlighted in light brown, are applicable to the subject area and were used to undertake targeted surveys for threatened plant species that may be expected to occur over the subject property.

Table 2 – Threatened flora species that have been recorded within a 10km range of the property according to the NSW Wildlife Atlas Database and the Department of Arts, Heritage and Environment Protected Matters search. The table includes "Rare and threatened plant species" derived from the Plantnet website. Updated 2010.

Latin Name	Common Name	NSW TSC STATUS	EPBC Status
Tetratheca juncea	Black-eyed Susan	Vulnerable	Vulnerable
Angophora inopina	Charmhaven Apple	Vulnerable	Vulnerable
Callistemon linearifolius	Netted Bottle Brush	Vulnerable	Vulnerable
Syzygium paniculatum	Magenta Lilly Pilly	Endangered	Vulnerable
Corybas dowlingii	Red Helmut Orchid	Endangered	
Rhizanthella slateri	Eastern Underground Orchid	Vulnerable	Endangered
Melaleuca biconvexa		Vulnerable	Vulnerable
Allocasuarina defungens	Dwarf Heath Casuarina	Endangered	Endangered
Cryptostylis hunteriana	Leafless Tongue-orchid	Vulnerable	Vulnerable
Diuris pedunculata	Small Snake Orchid	Endangered	Endangered
Asperula asthenes	Trailing Woodruff	Vulnerable	Vulnerable
Lindernia alsinoides	Noah's False Chickweed	Endangered	
ROYAL BOTANIC GARDENS SYDNEY (plantnet)			
Callistemon acuminatus		ROTAP	
Eucalyptus fergusonii ssp. fergusonii	Ferguson's Ironbark	ROTAP	

Notes for Table 2:

- TSC- *Threatened Species and Conservation Act, 1995*
- EPBC- *Environment Protection and Biodiversity Conservation Act, 1999*
- ROTAP- Rare or Threatened Australian Plants
- Rows in orange are applicable to the subject property

One species is considered unlikely to be present due to its habitat characteristics. *Allocasuarina defungens* mainly occurs on and adjacent to sandplains and this habitat type is not present on the site or its surrounds

Of the relevant plant species listed above, the location and distance of each species from the site is given in Table 3 as required in the LES documentation. The plants listed are relevant for June 2010.

Table 3 – Recorded general locations and distance of the applicable threatened species listed on the TSC ACT, 1995.

SPECIES	DISTANCE FROM SUBJECT SITE	REMARKS
Tetratheca juncea	Mostly within 1 km	Alum Mountain
Angophora inopina	Between 3-4 km	Crawford River & Black Camp Creek
Callistemon linearifolius	Within 2km	Myall River
Syzygium paniculatum	Within 3 km	Crawford River
Corybas dowlingii	Within 2km	Alum Mountain
Cryptostylis hunteriana	Within 2km	Alum Mountain
Diuris pedunculata	Within 2km	Bulahdelah township – old record
Asperula asthenes	Within 2km	Bulahdelah township – old record
Lindernia alsiniodes	Within 3km	Crawford River

Rhizanthella slateri the Eastern Underground Orchid, along with *Melaleuca biconvexa*, were only recently found at Bulahdelah and both are listed as vulnerable under the TSC Act 1995 (Parsons Brinckerhoff, 2004). The orchid species is also listed as an "endangered population" within the Great Lakes local government area under the same act. The species is also listed as endangered under the EPBC Act, 1999. The information of the location and habitat of these two species have not been recorded on the NSW wildlife atlas database.

Lindernia alsiniodes may occur in moist habitats such as Melaleuca forest and has recently been re-recorded in the area, with previous records dating back to 1924. This species was only revived for this study through discussions with the Hunter-Central Rivers Catchment Management Authority. The recent records for this species are not available through the NSW Wildlife Atlas database.

Corybas dowlingii the Red Helmut Orchid only became listed as a threatened species recently in 2008.

3.2 Previous Local Studies

Previous flora studies of the local area are also relevant to what threatened species have been actually recorded in the immediate area and the location of these species can also help to evaluate the potential conservation significance of a subject site. This information is required under Great Lakes Council requirements. Thus, the Environmental Impact Statement for the Pacific Highway upgrade at Bulahdelah was used as it is the most relevant study relating to this proposal (Parsons Brinckerhoff, 2004).

The flora component of this study recorded a total of 374 flora species of which 26 species were weeds. Three species of national significance were recorded which were *Cryptostylis hunteriana* the Leafless Tongue Orchid, *Angophora inopina* the Black Apple and *Rhizanthella slateri* the Eastern Australian Underground Orchid. *Corybas sp. aff. acontiflorus* the Red Helmet Orchid (*C. dowlingii*), as it was known at that time, was also recorded. The rare Ferguson's Ironbark Eucalyptus *fergusonii subsp. fergusonii*, a ROTAP (rare or threatened Australian plant) species was also found (Table 3).

Previous to this study three species of national and state conservation significance had been recorded in the Bulahdelah area. These species were *Asperula asthenes* the Native Woodruff, *Syzygium paniculatum* the Magenta Lilly Pilly and *Tetratheca juncea* the Black-eyed Susan (Table 3).

Great Lakes Council advised there were no other relevant local surveys close to the subject site.

Table 4 – Plant species recorded by Parsons Brinckerhoff (2004) for the Roads & Traffic Authority survey.

Species Name	**Common Name**
Cryptostylis hunteriana	Leafless Tongue Orchid
Rhizanthella slateri	Eastern Australian Underground Orchid
Corybas sp. aff. acontiflorus (now C. dowlingii)	Red Helmet Orchid
Eucalyptus fergusonii subsp. fergusonii	Fergusons Ironbark

4.0 FLORA SURVEY METHODOLOGY

The map unit descriptions, vegetation mapping and the flora inventory was prepared using field survey techniques and supplemented with aerial photograph interpretation (especially flown for the project), statistical procedures, co-ordinate derivation using a hand held (GPS) and high powered differential global positioning system (DGPS) and a computer geographic information system (GIS). Survey methodology, at least for stage 2 of the project, was undertaken in accordance with the draft Department of Environment and Conservation guideline entitled *'Threatened Biodiversity Survey and Assessment: Guidelines for development and activities (2004)".*

4.1 Selection of quadrat sites

Initially in Stage 1 of the project (Payne, 2007) seven sites had been selected and surveyed for flora. These sites were mainly confined to the coastal plain but one site was located on the northern tip of the summit of Alum Mountain and another site was located on the slopes in Bulahdelah State Forest on Lot 122 DP 753154 (Figure 3). At that stage only a limited number of sites were required over a much smaller area.

For stage 2 of the project, which includes areas to be considered for compensatory offsets and the remainder of the subject site, the area was divided up into four separate blocks. These four blocks were determined for survey purposes but for ease of description were utilised for stratification units. These blocks were (Figure 3);

- Block 1 – the northern area beyond the transmission line but above the golf course known as Lot 3. This area is roughly includes the coastal plain with gently undulating slopes.
- Block 2 – the southern area beyond the transmission line which forms the remainder of Lot 3. This area incorporates the lower slopes of Alum Mountain.
- Blocks 3 & 4 – the northern areas of Lot 100. This area incorporates the upper slopes and summit of Alum Mountain.

From a reconnaissance survey and the use of the updated aerial photography extra flora quadrat sites were chosen. These sites were randomly selected for further botanical surveys (and other surveys that were related to the fauna component) based on the condition of the vegetation, the changes in floristics and structure of the vegetation, slope, aspect and landscape. Two of the additional sites were selected on the summit of Alum Mountain with one at the northern end in Lot 100 (Block 3) and another further to the south in State Forest (Figure 3). In all, the procedure involved a total of 24 quadrats but an additional quadrat was surveyed as part of the Hunter Council's 2007 regional mapping program and was included in the dataset (Appendix 1).

The additional site lies on the summit of Alum Mountain near the lookout and was included to determine the vegetation type for the summit of Alum Mountain, within and surrounding the property. Access to the summit of Alum Mountain to record vegetation is very limited and therefore only safe access points could be chosen.

A further three sites, within the upper slope forest, are located just outside property boundaries.

Survey site co-ordinates were derived as easting's and nothings for each quadrat using a GPS. The datum used was the Map grid of Australia (geodetic datum of Australia 1994/universal transverse Mercator projection for zone 56). Each site was plotted onto an aerial photograph image (Figure 3).

The stage 1 quadrat sites were surveyed in June 2007 whilst the stage 2 quadrat sites were surveyed in December 2008.

4.2 Botanical quadrat surveys

At the selected 25 sites (Appendix 1) botanical surveys were undertaken within a 20m x 20m ($400m^2$) or 40m x 10m quadrat, in the case of Frys Creek. Vegetation detail was recorded using the 2007 format sheet developed by *Hunter Councils* for the regional vegetation surveys. This format sheet utilised a cover score of 1-7.

Plant species, recorded within each quadrat, were mostly identified on site, but the more difficult specimens were collected and placed between sheets of newspaper in a plant press for later identification. Orchids, if found, were collected whole and inserted in test tubes filled with water for later identification.

Collected plant species were then identified in the office using a scientific binocular microscope and those that could not be identified definitively were taken to the *National Herbarium of NSW* and matched against specimens held in the *Public Herbarium*. Any unknown species were then given to Herbarium staff for identification. Rare or unusual plant species were also confirmed by Herbarium staff and taken for the Herbarium collection.

Table 5 – Stratification breakdown of survey sites

SITE	ASPECT (°)	HABITAT	GEOLOGY	NOTES
BLOCK 1				
BULST2EEC	278	Floodplain	Alluvium	Subject to inundation
BULST2SL1	275	Coastal plain (lower slopes)	Alum Mtn volcanics	
BULST2SL2	63	Coastal plain (lower slopes)	Alum Mtn volcanics	
BULST2SL6	81	Coastal plain (lower slopes)	Alum Mtn volcanics	
RPBULSL1	300	Coastal plain (lower slopes)	Alum Mtn volcanics	
BULF1	180	Coastal plain (lower slopes)	Alum Mtn volcanics	
BULF2	84	Coastal plain (lower slopes)	Alum Mtn volcanics	
BULF3	60	Coastal plain (lower slopes)	Alum Mtn volcanics	
BLOCK 2				
BULST2SL3	88	Midslope	Alum Mtn volcanics	
BULST2HS	40	Midslope (Hanging Swamp)	Alum Mtn volcanics	Gleyed soil with impeded drainage
BULST2SL4	20	Midslope	Alum Mtn volcanics	
BLOCK 3				
BULST2SL5	0	Midslope	Alum Mtn volcanics	
BULST2US6	338	Upper slope	Alum Mtn volcanics	
BULST2US5	75	Upper slope	Alum Mtn volcanics	
BULSTEUS4	62	Upper slope	Alum Mtn volcanics	
BLOCK 4				
BULST2US1	45	Upper slope	Alum Mtn volcanics	
ALUMSLO1	200	Upper slope	Alum Mtn volcanics	
BULST2US2	64	Upper slope	Alum Mtn volcanics	
BULST2US3	62	Upper slope	Alum Mtn volcanics	

ALUM MOUNTAIN SUMMIT				
BULSU1	39	Summit	Alum Mtn volcanics	Subject to desiccating winds; mostly rocky outcrop
BULSU2	295	Summit	Alum Mtn volcanics	Subject to desiccating winds; mostly rocky outcrop
ALUMMTN2	68	Summit	Alum Mtn volcanics	Subject to desiccating winds; mostly rocky outcrop
ALUMMTN1	240	Summit	Alum Mtn volcanics	Subject to desiccating winds; mostly rocky outcrop
FRYS CREEK				
FRYSCRK1	195	Drainage line	Alluvium	Subject to inundation
FRYSCRK2	270	Drainage line	Alluvium	Subject to inundation
Total quadrats = 25; Total area of property = 161.67ha				

4.3 Botanical surveys using targeted transects and searches

During the field quadrat surveys searches were made for those threatened plant species given in Tables 2 & 3. Additional targeted niche searches and random meander surveys (Cropper 1993) for each threatened species was also undertaken in specific habitats throughout the site. The effort employed is set out in Table 6 and displayed in Figure 3 with more refined detail showing dates and locations for the four year period given in Appendix 11.

Searches for the other "Rare or Threatened Plant Species" (ROTAP) (Briggs & Leigh, 1995) such as *Callistemon acuminatus* and *Eucalyptus fergusonii subsp. fergusonii* were also made based on the detail derived from Parsons Brinckerhoff (2004) and collections held at the National Herbarium of NSW. Specific searches were made for the former species on Alum Mountain and the latter on the slopes and coastal plain around the property.

A further specific search was made for *Syzygium paniculatum* along Frys Creek within the site and along the Myall River outside of the site boundaries. This search was conducted along Frys Creek to the Myall River and then along the Myall River as far as Warranulla. This search was based on information received from the National Herbarium of NSW that *S. paniculatum* had been previously seen, but not collected along the river at Bulahdelah. If the species could be located it would confirm the species occurrence at Bulahdelah (see wildlife atlas records-Tables 1 & 2).

In addition to the mapping quadrats and targeted surveys additional transects were undertaken along specialised niches to record additional plant species in 2010. In habitats considered unsuitable for plot based surveys, such as steep areas supporting rocky scree,

summits, cliff faces, cracks and crevices, transects were undertaken to document the additional plant species confined to these specialised habitats. Searches were also made for *Tetratheca juncea* on the northern face of Alum Mountain. Searches for rare orchids were undertaken along the dry gully inverts and floodplain of Frys Creek. Within these transects all plant species were recorded. These species were databased separately using the "YETI" program and included in the final plant species list (Appendix 3). Tables 6 & 7 set out the details of these surveys.

Targeted searches were made for *Corybas dowlingii* by investigating the north draining gullies below Alum Mountain within the tall forests and along Frys Creek during the flowering period. In addition a general random meander search over the whole property was undertaken for *Cryptostylis hunteriana,* also during the flowering period. This task mainly involved two people but sometimes only a single person was involved. Table 6 & 7 summarises the investigation undertaken.

During the course of this survey (August 2010) NSW DECCW advised that searches should also be made for *Galium australe* (Thompson, 2009: Appendix 20) and *Phaius australis* Swamp Orchid. Searches had not been conducted for these species up until August 2010.

It should be noted at this stage that the project was stopped for a period of 12 months in 2008-2009 due to the global financial crisis and further surveys during this period, except for one survey undertaken by Robert Payne in December 2009, could not be undertaken. As a result, some further surveys for *Corybas dowlingii* and *Diuris pedunculata,* beginning in June 2010, were undertaken to finalise the orchid section of the project.

Table 6 – Details of flora transects/targeted niche surveys

Date	Start co-ordinates	Habitat
12 August 2010	426694E, 6415051N	North draining exposed gully on northern slopes
12 August 2010	426944E, 6415001N	North draining sheltered and entrenched gully on northern slopes supporting some gully rainforest species
12 August 2010	426553E, 6414897N	Northern cliff face of Alum Mountain walking east
12 August 2010	427799E, 6414617N	Northern cliff face of Alum Mountain walking east
13 August 2010	427434E 6415761N	Frys Creek walking upstream to boundary
19 October 2010	427068E 6414534N	From mid way up gully then downslope and across slope
19 October 2010	427067E 6414519N	Downslope along gully to hanging swamp (Group 2/1 vegetation)
20 October 2010	427472E 6414613N	South-western edge of hanging swamp (Group 2/1 vegetation)
20 October 2010	426929E 6415186N	Northeast through Coastal Plain vegetation (Group 3 regrowth after fire)

20 October 2010	427214E, 6415251N	Northeast through Coastal Plain vegetation (Group 3 mature)
20 October 2010	427653E, 6415910N	West through Swamp Sclerophyll Forest vegetation 9Group 2/2)

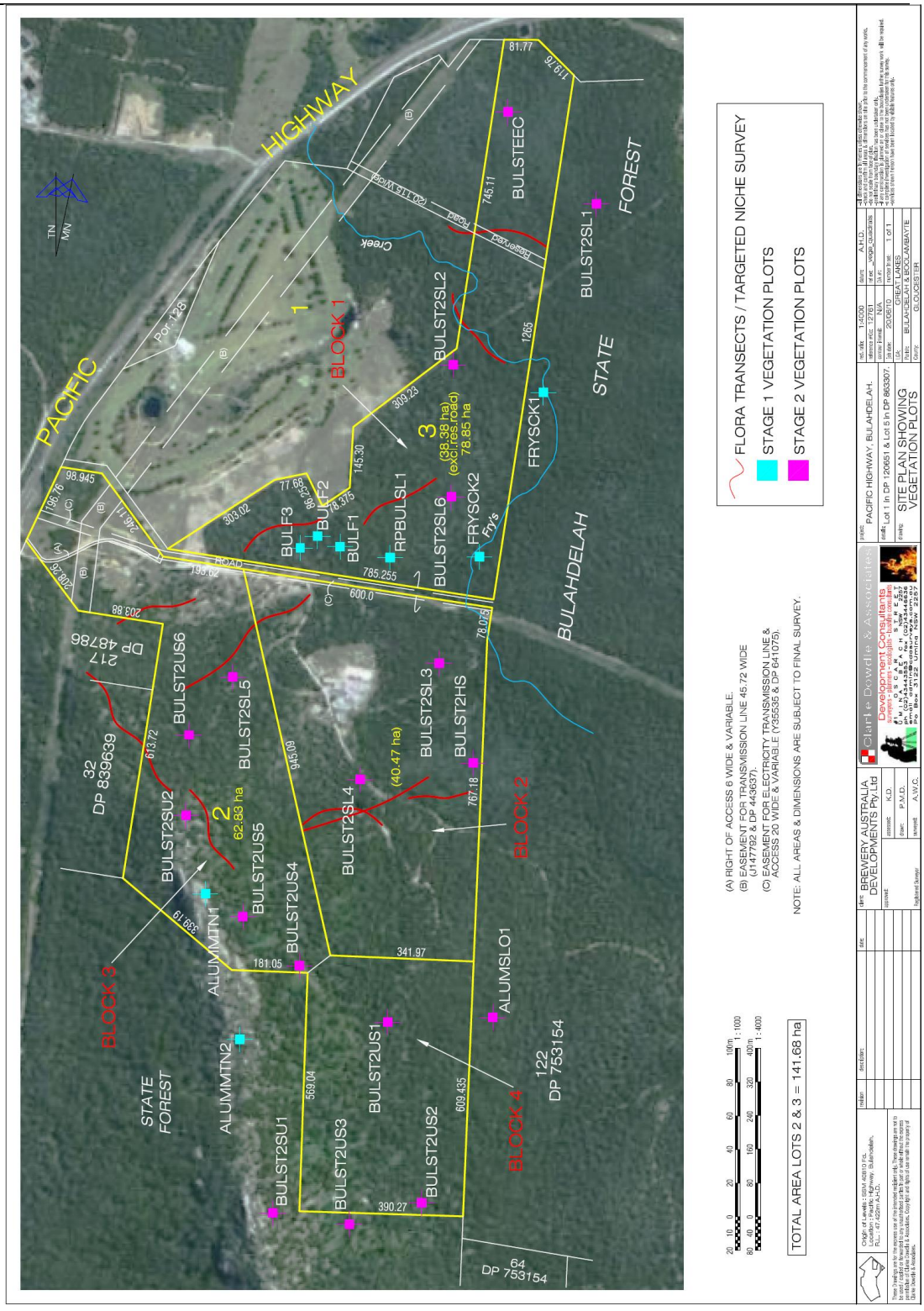
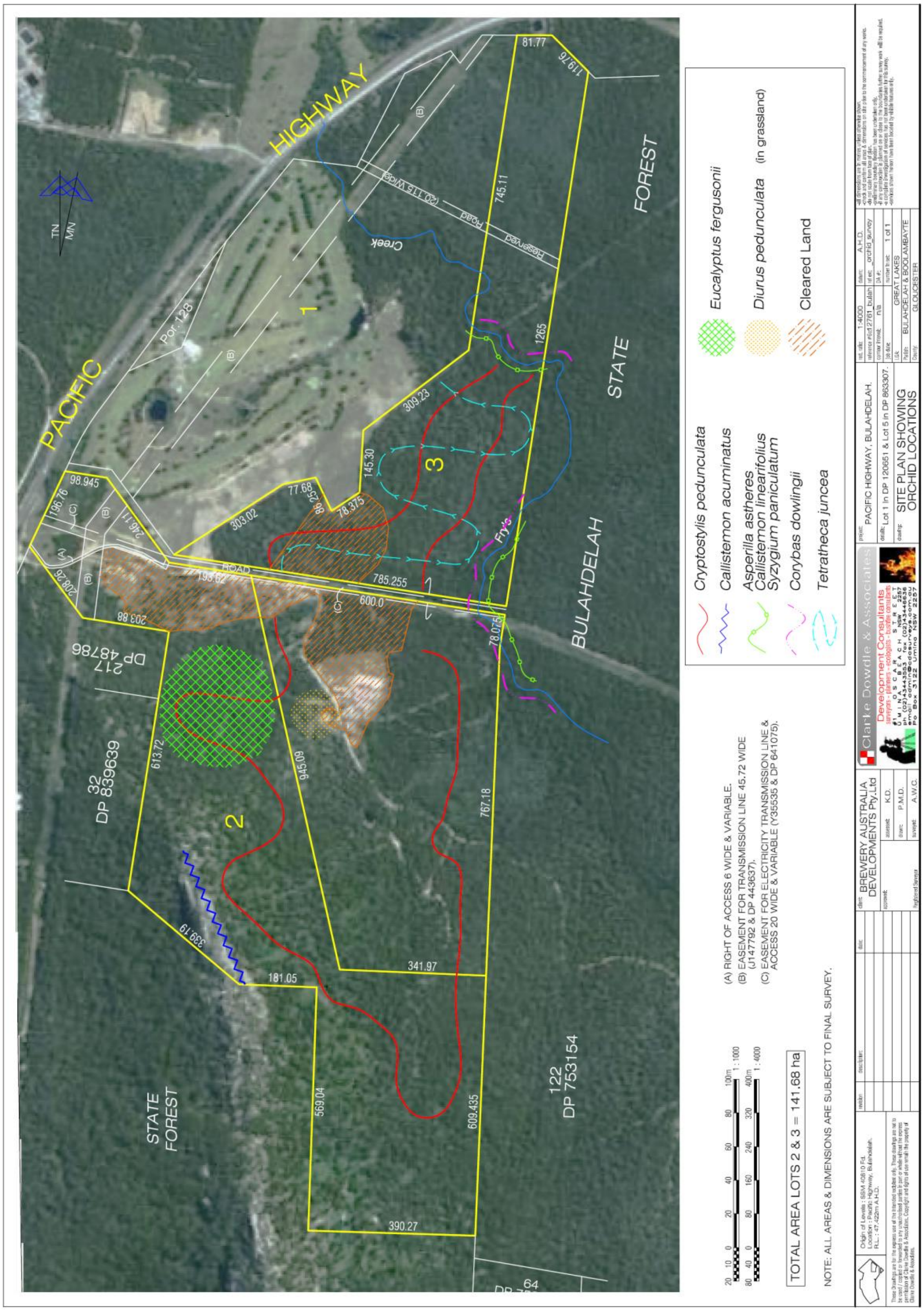


Figure 3- Map of the subject site and surrounds showing locations of flora quadrats and transect/targeted niche surveys.

Table 7 – Botanical survey, rare plant and orchid search summary mainly using random meander searches (See Figure 4 and Appendix 11 for relevant dates)

SPECIES	FLOWERING PERIOD/NECESSARY FEATURES	EFFORT/METHOD
Botanical Survey	N/A	96 manhours/ Targeted niche surveys
Rhizanthella slateri	October to November	At least 40 manhours/ Targeted niche surveys
Corybas dowlingi	June to August	44 manhours/ Targeted niche surveys
Cryptostylis hunteriana	August to February	At least 46 manhours/ Targeted niche surveys
Diuris pedunculata	August to December	At least 26 manhours/ Targeted niche surveys
Tetratheca juncea	Last week in July, August to October	36 manhours/ Targeted niche surveys
Syzygium paniculatum	December to February (leaves required as well as fruits)	At least 24 manhours/ Targeted niche surveys
Melaleuca biconvexa	September to October (leaves only required	At least 24 manhours/ Targeted niche surveys
Angophora inopina	December (leaves & fruit required)	At least 24 manhours/ Targeted niche surveys
Asperula asthenes	September to December	At least 24 manhours/ Targeted niche surveys
Callistemon linearifolius	September to March (leaves only required)	At least 24 manhours/ Targeted niche surveys
Callistemon acuminatus	September to December (flowers not required)	At least 2 manhours (restricted to summit) / Targeted niche surveys
Eucalyptus fergusonii subsp. fergusonii	June – July (not required)	At least 2 manhours/ Targeted niche surveys
Lindernia alsinoides	December	Nil; Not required as discussed at meeting at GLC 30/06/2010.


PACIFIC
HIGHWAY
STATE FOREST
BULAHDELAH
Eucalyptus fergusonii
Diurus pedunculata (in grassland)
Cleared Land
Cryptostylis pedunculata
Callistemon acuminatus
Asperilla astheres
Callistemon linearifolius
Syzygium paniculatum
Corybas dowlingii
Tetratheca juncea
(A) RIGHT OF ACCESS 6 WIDE & VARIABLE.
(B) EASEMENT FOR TRANSMISSION LINE 45.72 WIDE (J147792 & DP 443637).
(C) EASEMENT FOR ELECTRICITY TRANSMISSION LINE & ACCESS 20 WIDE & VARIABLE (Y35535 & DP 641075).
TOTAL AREA LOTS 2 & 3 = 141.68 ha
NOTE: ALL AREAS & DIMENSIONS ARE SUBJECT TO FINAL SURVEY.
BREWERY AUSTRALIA DEVELOPMENTS Pty Ltd
PACIFIC HIGHWAY, BULAHDELAH.
SITE PLAN SHOWING ORCHID LOCATIONS
Clarke Dowdle & Associates
122 DP 753154
32 DP 839639

4.4 Databasing

Databasing of the information recorded in each of the 25 quadrats and the transects was undertaken using the revised NSW Department of Conservation and Climate Change program YASD (Yet Another Survey Database), sometimes referred to as YETI, and this procedure was completed when most of the plant species were identified. Final additions were added following the completion of plant identification. The digital database information was then submitted to the NSW wildlife atlas database and is included as Appendix 10. Two separate plant species lists were generated. One list was generated from the quadrat based surveys and one list generated from transect based surveys (Appendix 3).

4.5 Vegetation analysis

Initially, a numerical analysis was performed on this local data set of 25 quadrats, using the DOS version of the PATN Program (Belbin, 1995). The Bray-Curtis measure of association was used to analyse the abundance scores and the initial agglomerative hierarchical classification of the data into groups was carried out using the FUSE module in PATN. A Flexible UPGMA strategy was applied to this classification with a beta left at the software default of -0.1. The outputs of the analyses were then interpreted and refined to produce a draft classification for determining map units.

Further analysis was also carried out of the data and matched against the regional output of Hunter Councils (Somerville, 2009). The dataset for this project was also included in the regional vegetation mapping review. Once a draft of the vegetation groups became available, through Hunter Councils, the diagnostic output, including the group percent frequencies and group average cover abundances was matched against the data for each of the quadrats to determine the relevant regional map units.

4.6 Field vegetation mapping

Field vegetation mapping of the derived map units, at a local scale, was undertaken using a "Trimble" high powered differential global positioning system (DGPS), which can provide accuracy to ± one meter in position. Traversing techniques were used to identify the map unit boundaries, which were based on the "positive" or most common species recorded within the survey quadrats. For the boundary of each vegetation community the traverse was entered into the DGPS as a string of points, which are later downloaded and differentially adjusted, to the nearest base station. After each days fieldwork, control points and/or cadastral corners were co-ordinated during the survey to tie the strings more accurately to the cadastral database (Figure 25).

A CAD operator then produced a map showing the polygons of the "strings", which represents the various vegetation communities and/or map units. These polygons were then identified and edited by the Ecologist. In some cases, such as the summit of Alum Mountain proper, access with the DGPS equipment was not possible and one vegetation community in this area was mapped directly onto the aerial map and digitized. The digital version of the mapping was then emailed to Great Lakes Council.

4.7 Soil Investigation

In light of the results of the PATN analysis further investigation was carried out on some soil types. For example, group 2 which, based on floristics, combined quadrats BULST2EEC and BULST2HS and formed a single group on the dendrogram (Table 8). The vegetation within these quadrats was obviously different floristically and structurally (Photos 1 & 2). At four

sites within group 2 sub-community 1, group 2 sub-community 2 and group 3, a soil auger was used to investigate and log the soil profile at three locations to a depth of 0.9m or until the rock strata was encountered. Soil type of each horizon layer, throughout each profile, was logged according to whether it was sand, loam and clay (McDonald et al, 1990). Depths and colour were recorded as well as soil moisture characteristics.

5.0 RESULTS

5.1 Vegetation groups

The numerical analysis performed through PATN produced five groups of vegetation, at a local scale. The results from the dendrogram are shown in Table 8 (Refer to Figure 3 for site locations). Table 8 also identifies the major environmental attributes for each vegetation group.

Table 8 – Vegetation groups showing quadrats and environmental attributes

GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5
ALUMMTN1	BULST2EEC	BULF1	ALUMMTN2	FRYSCK1
	BULST2HS	BULF2	BULST2SU1	FRYSCK2
		BULST2SL3	BULST2SU2	
		RPBULSL1	ALUMSLO1	
		BULST2SL4	BULST2US6	
		BULF3	BULST2US1	
		BULST2SL2	BULST2US2	
		BULSL2SL6	BULST2US3	
		BULST2SL1	BULST2US5	
		BULST2SL5	BULST2US4	
High summit and southern faces of Alum Mountain	Hanging swamps and areas with impeded drainage	Coastal plains and lower slopes	High summit and northern upper slopes of Alum Mountain	Riparian habitat along Frys Creek.

For the purposes of identifying vegetation groups, the five groups in Table 8 were accepted as they are easily recognized in the field. However, for a more refined description of the vegetation groups, Group 2 was further subdivided into two sub-groups based on soil type. One of the sub-groups qualifies as the "endangered ecological community" Swamp Sclerophyll Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions and the other is a "hanging swamp" wetland. These sub-groups are related to impeded drainage and/or boggy humus soil habitats. It should also be noted, however, that Group 2 is wetland with the former (BULST2EEC) having sandy loam and clay soils, which are subject to inundation and the latter (BULST2HS), having waterlogged clays. Table 9 details the results of each soil profile investigated.

Table 9 – Results of soil profiles using hand auger

Depth (m)	Group 2/1	Group 2/2	Group 3
0.1	Dark brown sand with minor clay. Very dry	Saturated peaty clay gley. Black in colour	Moist grey clay
0.2			
0.3		Saturated clay gley. Roots evident. Anoxic odour.	
0.4			Moist grey clay
0.5	Brown white sand with clay increasing with depth		
0.6			Moist orange grey clay. High plasticity.
0.7		Saturated clay gley with gravel. Anoxic odour.	
0.8	Very light grey to white sand with some clay. Very dry. Some roots evident.	Alunite bedrock	
0.9			

5.2 Vegetation map unit descriptions

The following descriptions are provided for the map units determined from the groups produced by the PATN program (Table 8). They are arranged logically along the cline from the coastal plain and lower slopes to the high summit of Alum Mountain. Locations and site images are presented in Appendices 1 and 2 respectively. Standard descriptions, used by the Royal Botanic Gardens and NSW Department of Environment and Conservation (2004), are provided for each map unit together with the Great Lakes Council local map unit equivalents as well as the regional map unit equivalents, if any, developed by Hunter Councils (Somerville, 2009). At this stage this data has not been incorporated into the regional mapping data, although it is in progress. The vegetation map units throughout the property are shown on Figure 25.

GROUP 1 STUNTED FOREST ON ALUM MOUNTAIN VOLCANICS
GREAT LAKES COUNCIL EQUIVALENT: Brushbox Stunted Forest Woodland

Structure Trees between five and six metres high with a canopy cover of 35 percent greater. This is the only dominant canopy layer. Generally a sparse lower tree, shrub and monocotyledon layer occurs as isolated plants. This layer does not exceed one metre high.

Main Species Present

Stunted Trees *Lophostemon confertus, Syncarpia glomulifera, Eucalyptus carnea* and *Allocasuarina littoralis.*

Very Low Trees and Shrubs
Syncarpia glomulifera, Leptospermum polyanthum and *Myrsine variabilis.*

Grass Tree *Xanthorrhoea latifolia ssp latifolia*

Monocotyledons and Grasses *Dianella caerulea var producta* and *Cleistochloa rigida*

Distribution Confined to the summit of Alum Mountain. The habitat is subject to strong winds and desiccating conditions.

Attributes Alum Mountain summit and southern aspects.

Regional Equivalent There is no equivalent regional vegetation community. Dataset requires new description.

GROUP 2 SUB-COMMUNITY 1; MELALEUCA FOREST WITH EMERGENTS IN AREAS OF IMPEDED DRAINAGE
GREAT LAKES COUNCIL EQUIVALENT: Red Mahogany/Paperbark Swamp Sclerophyll Forest

Structure Emergent trees between 18 to 20 metres high with a very sparse canopy cover. There is a persistent dense lower tree layer usually between 8-12 metres with a cover of 35 percent. A sparse shrub layer also occurs up to three metres high. The lower layer is a dense sedge, grass, undershrub and monocotyledon cover up to one metre high with a 100 percent cover.

Main Species Present
Emergent Trees *Eucalyptus resinifera ssp. hemilampra, rarely Eucalyptus robusta.*

Smaller Trees *Callistemon salignus, Melaleuca nodosa* and *Melaleuca sieberi.*

Shrubs *Callistemon salignus, Acacia longifolia* and *Leptospermum polygalifolium ssp cismontanum*

Sedges, Grasses and
Undershrubs *Anisopogon avenaceous, Entolasia marginata, Lepidosperma filiforme, Woollsia pungens* and *Pultenaea myrtoides*

Distribution Confined to the northern area on Lot 3.

Attributes Found in areas of impeded drainage. Considered as Swamp Sclerophyll Forest "endangered ecological community".

Regional Equivalent MU 198 *Melaleuca nodosa* woodland/shrubland on undulating areas of coastal lowlands.

GROUP 2 SUBCOMMUNITY 2; UPLAND OPEN SCRUB WITH EMERGENTS OF SWAMP MAHOGANY IN AREAS OF PERMANENT HIGH WATER TABLES GREAT LAKES COUNCIL EQUIVALENT: Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland

Structure Emergent trees occur between 12 to 15 metres high with a very sparse canopy cover. There is also a lower sparse tree layer up to eight metres high. A mid dense shrub layer is present up to five metres high together with a further lower shrub and sedge layer up three metres high. The lower layer is a dense reed, fern and undershrub layer up to one metre high.

Main Species Present

Emergent Trees *Eucalyptus robusta* and occasionally *Eucalyptus resinifera ssp. hemilampra.*

Smaller Trees *Eucalyptus robusta.*

Shrubs and sedges *Acacia longifolia, Callistemon pachyphyllus, Banksia robur, Gahnia sieberiana* and *Leptospermum polygalifolium ssp cismontanum*

Reeds and Ferns *Baumea rubiginosa, Gleichenia microphylla and Blechnum indicuum,*

Distribution Confined to two sites in the southern area on Lot 3.

Attributes Found in only two areas of bog drainage. Located at 30 metres above sea level. Very restricted in distribution and is to be regarded as "hanging swamp". Pockets of *Banksia robur* exist which is considered potential Eastern Pigmy Possum habitat.

Regional Equivalent There is no equivalent regional vegetation community but it is closely related to MU 188 *Leptospermum liversidgei*/Crimson Bottlebrush Wallum Wet Heath on the lower North coast.

GROUP 3 WOODLAND/FOREST ON ALUM MOUNTAIN VOLCANICS OVER LOWER COASTAL SLOPES AND PLAINS
GREAT LAKES COUNCIL EQUIVALENT: Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland

Structure Trees between 15 to 25 metres high with a canopy cover between 15-30 percent. Generally a sparse lower tree layer is apparent usually between 2-12 metres with a cover between 10-15 percent. The lower layer is a dense shrub cover between 0.5-2 metres high with a 90 percent cover, mainly of sedges and monocotyledons but sometimes grasses.

Main Species Present

Trees *Eucalyptus resinifera ssp helilampra, Eucalyptus piperita, Corymbia gummifera, Eucalyptus eugenioides, Angophora costata* and occasionally *Eucalyptus robusta.*

Smaller Trees *Corymbia gummifera, Angophora costata, Allocasuarina torulosa, Eucalyptus eugenioides, Allocasuarina littoralis, Persoonia levis, Persoonia linearis, Callistemon salignus, Persoonia levis, Persoonia linearis, Hakea dactyloides, Melaleuca nodosa* and *Melaleuca sieberi.*

Shrubs and Undershrubs

Dodonaea triquetra, Hibbertia empetrifolia ssp empetrifolia, Thysanotus tuberosus, Leptospermum polygalifolium ssp longifolium, Boronia pinnata, Daviesia ulicifolia, Pultenaea myrtoides, Pultenaea retusa, Pultenaea villosa, Acacia longifolia, Acacia mrytifolia, Acacia longifolia, Acacia ulicifolia, Banksia oblongifolia and *Banksia spinulosa.*

Sedges and monocotyledons *Ptilothrix duesta, Gahnia clarkei, Gahnia radula, Dianella caerulea, Lomandra confertifolia ssp. pallida*

Grasses *Entolasia stricta, Anisopogon avenaceous, Themeda australis*

Distribution Occurs on the lower coastal plains and lower slopes of Alum Mountain.

Attributes Found on the lower cline areas with yellow loam soils. The vegetation has been heavily logged in recent times.

Regional Equivalent Part of this mapunit at BULST2SL1 is closely related to MU 131 *Melaleuca sieberi/Lepyrodia scariosa* heathy woodland of coastal lowlands. The remainder of the area has no equivalent and requires a new description.

GROUP 4 WOODLAND/TALL FOREST ON UPPER SLOPES OF ALUM MOUNTAIN VOLCANICS
GREAT LAKES COUNCIL EQUIVALENT: Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest

Structure Trees between 12 to 20 metres high with a canopy cover between 10-30 percent. There is at times a sparse lower tree cover between 15-18 metres high. Generally a sparse lower tree layer or grass tree layer is apparent usually between 4-10 metres with a cover between 5-15 percent. There is at times a lower sparse shrub and scrambler cover up to three metres high. The lower layer is normally a dense fern cover up to one metre high with a 100 percent cover but on the summit of Alum Mountain there is only a sparse undershrub cover.

Main Species Present

Trees *Eucalyptus microcorys, Eucalyptus pilularis, Eucalyptus piperita, Eucalyptus propinqua, Angophora costata* and occasionally *Allocasuarina littoralis. Occasionally Eucalyptus fergusonii ssp fergusonii.* On the summit of Alum Mountain the community includes *Eucalyptus carnea and Lophostemon confertus.*

Smaller Trees *Eucalyptus microcorys, Allocasuarina littoralis, Allocasuarina torulosa, Angophora costata.* Occasionally *Eucalyptus fergusonii ssp fergusonii* and *Eucalyptus saligna*

Grass Tree *Xanthorrhoea malacophylla*

Sedges and shrubs
Lomandra longifolia, Oxylobium ilicifolium, Acacia falcata, Dodonaea triquetra, Leptospermum polyanthum

Scramblers *Aphanopetalum resinosum, Commelina cyanea* (Alum Mountain only)

Ferns *Calochlaena dubia, Pteridium esculentum*

Undershrubs
(Alum Mountain summit)
Helichrysum elatum, Correa relexa var reflexa, Plectranthus argentatus, Callistemon acuminatus, Einadia hastata and *Hibbertia obtusifolia.*

Distribution Occurs on the upper slopes of Alum Mountain.

Attributes Found on the upper rocky slopes and northern aspect of Alum Mountain

Regional Equivalent MU 038 Tallowwood/Smooth-barked Apple/Forest Oak shrub grass open forest.

GROUP 5 RIPARIAN TALL FOREST ON ALLUVIUM ALONG FRYS CREEK
GREAT LAKES COUNCIL EQUIVALENT: Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest

Structure Trees between 25 to 35 metres high with a canopy cover of 40 percent. Generally a dense lower tree layer is apparent, usually between 12-18 metres high, with a cover of 70 percent. The lower layer is a dense sedge and monocotyledon cover between 0.5-1.5 metres high with a 100 percent cover.

Main Species Present

Trees *Angophora costata, Syncarpia glomulifera, Eucalyptus piperita, Eucalyptus resinifera ssp. hemilampra, Syncarpia glomulifera* and *Eucalyptus microcorys.*

Smaller Trees *Callistemon salignus, Acmena smithii, Hakea dactyloides, Allocasuarina torulosa, Callicoma serratifolia* and *Melaleuca linariifolia.*

Sedges *Gahnia clarkei*

Monocotyledons

Lomandra longifolia and Lepidosperma longitudinale

Distribution Confined to the narrow drainage lines along Frys Creek.

Attributes Riparian habitat along major creek lines. Occasional trees of *E. robusta* are present.

Regional Equivalent There is no equivalent regional vegetation community.

Since some of the above map unit descriptions have now been allocated regional equivalents, new descriptions for the unallocated regional map units will be required for vegetation groups 1, 3, 2/2 and 5.

Table 10 provides a summary of the identified map units.

Table 10 – Map unit equivalents

Identified map units	Great Lakes Council equivalents	Regional equivalents
GROUP 1: STUNTED FOREST ON ALUM MOUNTAIN VOLCANICS	*Brushbox Stunted Forest/ Woodland*	No equivalent
GROUP 2 SUB-COMMUNITY 1: MELALEUCA FOREST WITH EMERGENTS IN AREAS OF IMPEDED DRAINAGE	*Red Mahogany/Paperbark Swamp Sclerophyll Forest*	MU 198 *Melaleuca nodosa* woodland/shrubland on undulating areas of coastal lowlands.
GROUP 2 SUBCOMMUNITY 2: UPLAND OPEN SCRUB WITH EMERGENTS OF SWAMP MAHOGANY IN AREAS OF PERMANENT HIGH WATER TABLES	*Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland*	No equivalent
GROUP 3: WOODLAND/FOREST ON ALUM MOUNTAIN VOLCANICS OVER LOWER COASTAL SLOPES AND PLAINS	*Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland*	Part qualifies as MU 131 *Melaleuca sieberi/Lepyrodia scariosa* heathy woodland of coastal lowlands.
GROUP 4: WOODLAND/TALL FOREST ON UPPER SLOPES OF ALUM MOUNTAIN VOLCANICS	*Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest*	MU 038 Tallowwood/Smooth-barked Apple/Forest Oak shrub grass open forest.
GROUP 5: RIPARIAN TALL FOREST ON ALLUVIUM ALONG FRYS CREEK	*Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest*	No equivalent

Along the faces of Alum Mountain there is a specialized niche habitat made up of crevices, cracks and intercises where some interesting species are present. Occasional *L. confertus* Brush Box trees are found, along with *Lomandra confertifolia ssp. pallida, Pyrrosia rupestris* Rock Felt Fern, *Davallia solida var. pyxidata* Hare's Foot Fern and *Plectranthus argentatus* colonies. There are also isolated unusual plants of *Dendrobium teretifolium* Rat's Tail Orchid, *Leptospermum polyanthum, Pleurosorus rutifolius* Basket Fern, *Daphnandra micrantha* Socketwood and *Callistemon acuminatus.* More common species such as *Einadia hastata*, *Helichrysum elatum, Wilkiea huegeliana* Veiny Wilkiea (Photo 1)*, Clematicissus opaca* Pepper Vine and *Adiantum hispidulum* Rough Maidenhair are found. Moist pockets of *Prostanthera incisa* occur at the base of the escarpment. This cliff face supports an unusual and unique type of flora, as a rock outcrop shrubland, in the Great Lakes LGA (Photo 1) but was not recognized as a separate vegetation community for this study.

Isolated larger trees of *L. confertus* along with *Ackama paniculosa* Soft Corkwood as well as *Alpinia caerulea* Native Ginger occur within upper reaches of one of the northern draining

gullies. Although considered to be a minor component of gully rainforest it is not large enough to warrant a separate map unit.

In summary five groups were derived to prepare descriptions of the vegetation on and below Alum Mountain. Group 1 (Table 10) represents the stunted Brush Box Forest found on the summit of Alum Mountain whilst group 2 is the Melaleuca forest with emergents in the area of impeded drainage located in the very north of the study area (block 3) and the area of upland "hanging swamp" (open scrub) with permanent high water tables in block 2. Group 3 is all the forest vegetation on the coastal plains and lower slopes and group 4 is the sparse woodland vegetation growing on the rocky scree slopes of Alum Mountain as well as the tall forests below. Group 5 is the riparian forest along Fry's Creek.

Photo 1- Rock cleft showing colonised by *Ficus rubiginosa* Port Jackson Fig and *Wilkiea huegeliana* Veiny Wilkiea.

To simplify the pattern of map units group 2 was subdivided further into two sub-communities based on the understorey vegetation and soil types. The Melaleuca forest with emergents has a grassy sedge and shrub low understorey with deep drier loamy sand soils and the area is subject to inundation in times of heavy rainfall. To elaborate, this vegetation community is also deemed to occur on an old backswamp of Fry's Creek and occurs below 12m AHD. Two locations were identified (see Figure 25). The upland open swamp, located just below the cliffs of Alum Mountain, which will be referred to as the "hanging swamp", has an understorey of taller and more diverse shrub, sedge, reed and fern species on waterlogged humic dark grey to black gleyed soils. On drying this soil is light clay.

Permanent high water tables are present because the alunite bedrock occurs at a shallow depth and is impervious. This community is at a higher level in the landscape occurring between 22 and 40m AHD. Two locations were also identified (Photos 3 & 4; Figure 25).

Photo 2. Dry sandy loam profile with A horizon on left and lighter coloured soil from the deeper horizon on right. Extracted from the Melaleuca forest with emergents (*Melaleuca Forest with emergents in areas of impeded drainage*). Soil profile length 0.8m.

Photo 3. Hanging Swamp (Upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables) after recent fire. The dense regrowth is *Gahnia sieberiana.*

Photo 4 – Hanging Swamp (Upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables) before fire. This habitat supports emergents of *Eucalyptus robusta* Swamp Mahogany with a dense sedgeland of *Gahnia sieberiana*. Shrubs are mainly *Callistemon pachyphyllus* with ferns of *Blechnum indicum.* At an elevation over 30 metres above sea level amongst tall forest of Tallowood and Blackbutt, the habitat is being considered as a unique form (Group 2/2 vegetation).

Photo 5. Soil profile from the Hanging Swamp. Gleyed waterlogged soils predominate. Note alunite gravel in the profile at right from bedrock. Soil profile length 0.8m.

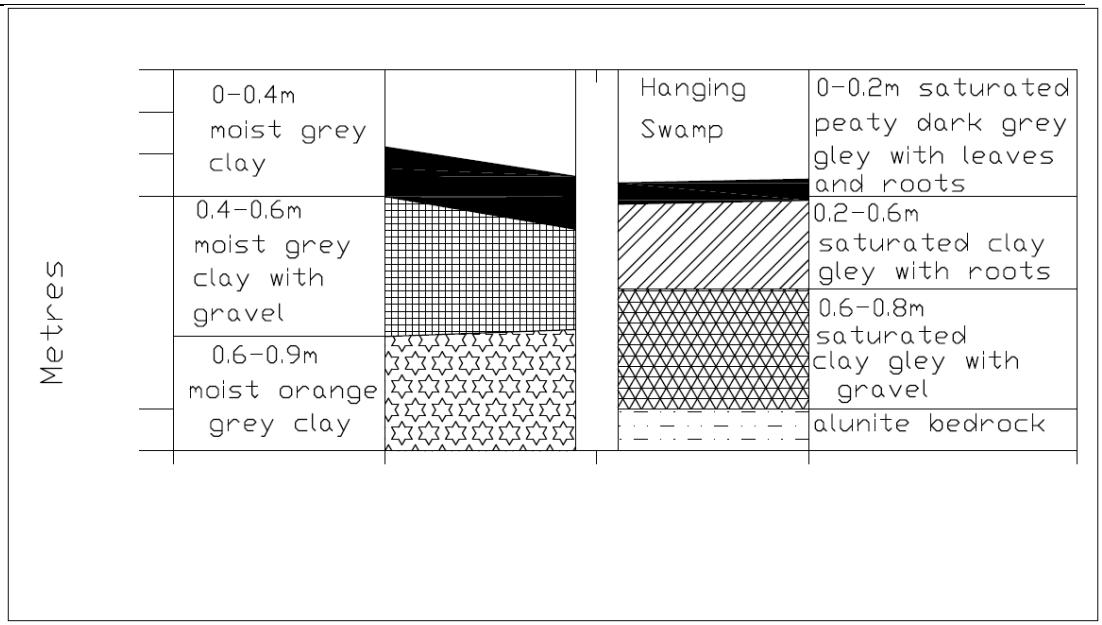


Figure 5– Graphical representation of the soil profile within the hanging swamp (right) and upslope from it within the forest (left).

5.3 Map unit significance

5.3.1 Melaleuca forest with emergents in areas of impeded drainage

Details of map unit significance are presented in Appendix 6. At least one of the map units (group 2 sub-community 1) qualifies as the endangered ecological community "Swamp Sclerophyll Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions". It is listed on the Threatened Species Conservation Act, 1995 and a photo from the vegetation at site, BULST2EEC, is shown as photo 5. Within this community *Eucalyptus resinifera ssp helilampra* Red Mahogany, is the main emergent with a very dominant treed *Melaleuca* understorey, whilst the ground layer comprises a dense reedland/sedgeland and sometimes shrubland. Swamp Mahogany *Eucalyptus robusta* is rare within this community.

Pock-marked undulations over the topographic surface are common. However, one of the features is that the vegetation is associated with a sandy loam or sandy clay alluvial soil which is periodically inundated and in the context of the landscape it is an alluvial flat associated with the coastal floodplain of Frys Creek. Only a small part of this vegetation at the outward edge occurs on lithic substrate. It is suggested that this outward edge be included within the EEC area (see Smith, 2006). Of the main species listed in the NSW Scientific Committee's determination *Eucalyptus resinifera subsp. hemilampra* Red Mahogany, *Melaleuca linariifolia* are the main canopy species present along with *Glochidion ferdinandi* Cheese Tree. Shrubs mainly include *Acacia longifolia* Sydney Golden Wattle, *Leptospermum polygalifolium subsp. polygalifolium* but there are isolated pockets of *Banksia oblongifolia* and *B. spinulosa*. *Ptilothrix duesta* occurs as a dense understorey throughout much of this vegetation (Photo 7). This map unit, being an EEC has significance at the state level.

5.3.2 Upland open scrub with emergents of swamp mahogany in areas of permanent high water tables

The "hanging swamp" habitat (Group 2 sub-community 2) at BULST2HS is a different type of wetland. Emergent trees, bordering on a woodland structure, are *Eucalyptus robusta* Swamp Mahogany whilst *Eucalyptus resinifera subsp. hemilampra* Red Mahogany is only occasionally present. There is no dominant reedland, but instead there is a sedgeland-shrubland-fernland dominated by *Gahnia sieberiana, Callistemon pachyphyllus* and *Blechnum indicum* (Photos 3 & 4). The uniqueness of this vegetation is that it occurs at 30 metres above sea level, just below Alum Mountain, giving it the qualities of an upland wetland or a "hanging swamp" in more general terms. Furthermore, this vegetation is also characterized by pock-marked undulations on the ground surface. This feature enables the wetland to trap water during heavy rain and during these times the undulations become breeding sites for amphibians. This ground characteristic is similar to that found in Wallum habitat on the mid north coast, on Hawkesbury Sandstone 'hanging swamps" in the Sydney Basin and throughout wetlands in the Wyong Shire.

Both of the above map units rate as being high for the significance category (Appendices 5 & 6 & Table 11). Part of the reason is that the "*Melaleuca forest with emergents in areas of impeded drainage"* (Photo 5) has the potential to support a number of threatened fauna species, which includes the Black Bittern *Ixobrychos flavicollis,* the Black-necked Stork *Ephippiorhynchus asiaticus*, the Grass Owl *Tyto capensis*, the Eastern Chestnut Mouse *Pseudomys gracilicaudatus,* the Koala *Phacolarctos cinereus* and the Squirrel Glider *Petaurus norfolcensis*. On the other hand the "*upland open scrub with emergents of Swamp Mahogany in areas of impeded drainage"* has the potential to support the Eastern Chestnut Mouse *Pseudomys gracilicaudatus,* the Koala *Phacolarctos cinereus,* the Squirrel Glider *Petaurus norfolcensis,* the Regent Honeyeater *Xanthomyza phrygia,* the Swift Parrot *Lathamus discolor* and the Grey-headed Flying Fox *Pteropus poliocephalus.* Even so, the latter map unit also has a high degree of uniqueness, which is also set out in the tables in Appendices 5 & 6.

Both vegetation communities have a high degree of naturalness and as far as can be seen, no weeds are present. Logging is also absent although it is ever present elsewhere over the subject site.

Photo 6- Quadrat BULST2EEC showing isolated emergent trees of *Eucalyptus resinifera ssp hemilampra* (foreground) with a dense subcanopy tree layer of *Melaleuca spp.* Occasionally *Callistemon salignus* is present. The ground layer is mainly *Entolasia marginata* and *Ptilothrix duesta.* This vegetation is considered to be Swamp Sclerophyll Forest.

5.3.3 Stunted forest on Alum Mountain volcanics

The stunted forest on the Alum Mountain summit (Group 1), which continues around the southern slopes, only scores a medium value for vegetation significance (Appendix 6 AMUMMTN1 SUMMIT). Nevertheless, this type of map unit is unique in the Great Lakes local government area being found further north as a different type in littoral sites and as tall forest although some more southern stands were recently found around Nabiac during the regional vegetation surveys for Hunter Councils (R. Payne pers. obs.). The reason for the decreased significance value is that the vegetation scores a lower value for complexity and threatened species and this is due to the windswept and desiccating conditions in a specialized harsh environment over a very small area.

5.3.4 Riparian forest on alluvium along Frys Creek

Group 5 the Riparian Forest on alluvium along Frys Creek is also of medium significance. This habitat is protected by means of the NSW Rivers and Foreshore Act, but it is narrow and therefore fragile and could be become subject to impacts from edge effects from any development. The vegetation exhibits a high degree of naturalness and no weeds were noted during the many surveys. Although no threatened orchid and other plant species were found, there is potential habitat for these species to be present.

Both Group 3 and Group 4 vegetation qualify as medium significance (Appendix 6) although they have been heavily logged in the recent past. In particular, much of Group 4 is disturbed below Alum Mountain, east and west of the upper track; with large invasions of *Lantana camara* Lantana and hazard reduction burning causing loss of natural understorey vegetation layers (see Appendix 2 BULST2US1 & BULST2US5). More weed invasion and damage to vegetation, caused by goats and abseiling, occurs on Alum Mountain.

Photo 7 – *Woodland/Forest on Alum Mountain Volcanics over lower coastal slopes and plains* showing pockets of *Banksia oblongifolia* amongst *Leptospermum polygalifolium ssp polygalifolium*. Such habitat conditions suggest the Eastern Pigmy Possum can be potentially present.

5.4 Map unit conservation status

Hager & Benson (1994) include in their assessment of the conservation status of vegetation communities in north eastern New South Wales some of the identified plant communities recognised on the property. *Stunted Forest on Alum Mountain Volcanics*, *Melaleuca Forest with emergents in areas of impeded drainage*, *Woodland/Forest on Alum Mountain Volcanics over lower coastal slopes and plains* and *Tallowood/Blackbutt/Sydney Peppermint Riparian Tall Forest* are included. It is noted that *Upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables* and *Riparian Tall Forest along Frys Creek* are too small to be recognised at a regional scale. Table 11 summarises the details.

Table 11 – Summary of conservation status of vegetation communities (Hager & Benson (1994)

	Stunted Forest on Alum Mountain Volcanics **(Forest Type 53; Floristic Group 710)**	***Melaleuca Forest with emergents in areas of impeded drainage*** **(Floristic Group 707)**	***Woodland/Forest on Alum Mountain Volcanics over lower coastal slopes and plains*** **(Forest Type 68; Floristic Group 707)**	***Riparian Tall Forest along Frys Creek*** **(Forest Types 36,37)**
STATE SCALE				
Samples in reserve in NSW (NPWS)	26	1	2	8
Samples in reserve in NSW (State Forests)	41	0	0	17
Conservation Code	Inadequately conserved over a major part of its range			
REGIONAL SCALE (SOUTH ZONE)				
Samples in reserve in south zone (NPWS)	7	0	1	0
Samples in reserve in south zone (State Forests)	9	0	0	9
Conservation Code	Inadequately conserved over all of its range	Poorly or not conserved	Inadequately conserved over all of its range	Poorly or not conserved
Conservation Reserves (as at 1994)	Ukerabagh NR; Uralba NR; Weelah NR; Yarravel NR & Arakoon NR.	Mt. Boss Yassabah SF; Dingo SF Rocky Hip section; Bulga SF Homewoods section; Ballengarra SF Kumbatine SF & Doyles River Seaview SF south Seaview section.		

Under the Hager & Benson (1994) classification all of the recognised mapunits on the property (groups 1, 2/1, 3 & 4) are either inadequately conserved or poorly conserved over all of its range at a regional scale.

The conservation classifications from the Forest Ecosystem data have been reproduced from data provided by Great Lakes Council in the review and are summarised in Table 11. All vegetation communities on the property can be recognised and all are regionally rare, regionally vulnerable or severely depleted.

Table 12 – Summary table of significance based on Forest Ecosystem Classification

Stunted Forest on Alum Mountain Volcanics	***Melaleuca Forest with emergents in areas of impeded drainage***	***Upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables***	***Woodland/Forest on Alum Mountain Volcanics over lower coastal slopes and plains***	***Tallowood/Blackbutt/Sydney Peppermint Riparian Tall Forest***	***Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest***
Regionally rare	Regionally rare	Regionally vulnerable	Regionally rare or severely depleted	Regionally rare	Severely depleted

Table 13 – Summary table of significance based on regional Forest Ecosystem Classification, State Significance and Habitat Significance Results

Habitat	State	Regional	Local (Appendix 6)
Riparian Tall Forest along Frys Creek		Severely depleted[1]	High
Melaleuca Forest with emergents in areas of impeded drainage	Swamp Sclerophyll Forest (EEC)	Regionally rare[1] Poorly or not conserved[2]	High
Upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables		Regionally vulnerable[1]	High
Woodland/Forest on Alum Mountain Volcanics over lower coastal slopes and plains		Regionally rare or severely depleted[1] Inadequately conserved over all of its range[2]	Medium
Woodland/Tall Forest on upper slopes of Alum Mountain Volcanics		Regionally rare[1] Poorly or not conserved[2]	Medium
Stunted Forest on Alum Mountain Volcanics		Regionally rare[1] Inadequately conserved over all of its range[2]	Medium

Notes for Table 13:
1= Forest Ecosystem Classification
2= Hager & Benson 1994

Table 14- Results of regional mapunit allocation on the subject site

Survey site no. (Figure 3)	Location on cline	Group	Remarks
ALUMMTN1	summit	1	Unique vegetation. New regional map unit required.
ALUMMTN2	summit	1	
BULST2US1	upper slopes	4	Allocated to MUO38 Tallowwood/Smooth-barked Apple/Forest Oak shrub/grass open forest.
BULST2US2	upper slopes	4	
BULST2US3	upper slopes	4	
BULST2US4	upper slopes	4	
BULST2US5	upper slopes	4	
BULST2US6	upper slopes	4	
BULST2SU1	upper slopes	4	
BULST2SU2	upper slopes	4	Unique vegetation. New regional map unit required.
BULST2SL3	lower slopes	3	Unique vegetation. New regional map unit required.
BULST2SL4	lower slopes	3	
BULST2SL5	lower slopes	3	
3			
BULST2HS	hanging swamp	2/2	Unique vegetation. New regional map unit required.
BULST2SL2	coastal plain	3	Unique vegetation. New regional map unit required.
BULST2SL6	coastal plain	3	
BULF1	coastal plain	3	
BULF2	coastal plain	3	
BULF3	coastal plain	3	
RPBULSL1	coastal plain	3	
FRYSCREEK1	drainage line	5	Unique vegetation. New regional map unit required.
FRYSCREEK2	drainage line	5	
BULST2EEC	lowland	2/1	Allocated to MU198 *Melaleuca nodosa* paperbark woodland/shrubland on undulating areas coastal lowlands.

An examination of the distribution of the known regional map units shows that MU 198 *Melaleuca nodosa* paperbark woodland/shrubland on undulating areas coastal lowlands occurs around Wamberal Lagoon, extensively around Wyong (23 recorded sites), along Tumbi Umbi Creek at Bateau Bay (two sites), then north at Munmorah (three sites), around Lake Macquarie (five sites), Newcastle, Booral, Pindimar, Karuah (three sites), along the Wallingat River and Khappinghat Creek, Yarratt State Forest and Corrigan. It appears to be better represented in the south of the region.

Map Unit O38 Tallowwood/Smooth-barked Apple/Forest Oak shrub/grass open forest has been recorded at 42 sites throughout the region with the southernmost area being Mandalong in the Wyong local government area. It is also found in Lake Macquarie on Mount Sugarloaf, north of Newcastle at Medowie and Dingo Peak and further north in the Nerong State Forest and Bulga State Forest. Within the local area it is found in Bulahdelah State Forest, at Boolambayte, Yarratt State Forest, Kiwarrik State Forest, Lansdowne State

Forest and Coopernook State Forest. Further north around Taree, Johns River State Forest and Wang Wauk State Forest supports this type of vegetation. Booti Booti State Recreation Area is a reserve holding this type of forest. Given the extensive distribution of this forest type, it cannot be regarded as regionally rare (Table 9).

5.5 Orchid surveys

The results of the orchid surveys are presented in Table 15. Six species of orchids have been found but none of these species are listed as threatened. The Eastern Underground Orchid was not found during the survey.

Table 15 – Results of the orchid survey.

Date	Orchid species	Where found	Status
August 2007	*Acianthus fornicatus*	*Woodland/Tall Forest on upper slopes of Alum Mountain Volcanics*; common.	Common (Harden)
4 August 2007; 12 August 2010	*Petalochilus catenata (Caladenia catenata)*	North facing slopes (*Woodland/Tall Forest on upper slopes of Alum Mountain Volcanics*) & coastal plain *(Woodland/Forest on Alum Mountain Volcanics over lower coastal slopes and plains).* Ground orchid.	Common (Harden)
3 December 2008	*Dockrillia teretifolia (Dendrobium teretifolium)*	North facing slopes (*Woodland/Tall Forest on upper slopes of Alum Mountain Volcanics*) at the base of Alum Mountain. Epiphytic on *Allocasuarina littoralis.*	Common(Harden)
12 August 2010	*Thelychition sp. (Dendrobium speciosum)*	Faces of Alum Mountain (*Woodland/Tall Forest on upper slopes of Alum Mountain Volcanics*). Lithophytic orchid.	Common(Harden)
12 August 2010	*Cestichus reflexa (Liparis reflexa)*	Faces of Alum Mountain (*Woodland/Tall Forest on upper slopes of Alum Mountain Volcanics)*. Lithophytic orchid.	Common(Harden)
20 October 2010	*Calochilus robertsonii*	*Woodland/Forest on Alum Mountain Volcanics over lower coastal slopes and plains.* Ground orchid	Common(Harden)

5.6 Floral species diversity

After more positive identification in the Public Herbarium at the National Herbarium of NSW, over 230 plant species were recorded during the Stage 1 and the initial Stage 2 surveys. Further targeted niche surveys resulted in an additional 69 native plant species being found giving a total of 300 plant species overall (Appendix 3). Few weed species were recorded in the quadrat and transect surveys. No threatened plant species were recorded on the property except for *Tetratheca juncea*, which was re-located on Alum Mountain but outside of the property boundaries. The only ground orchid species recorded during the surveys were the common species *Petalochilus catenata* White Fingers and *Acianthus fornicatus* the

Large Mosquito Orchid and both were found on the mid slopes in Group 4 vegetation. These orchids were found in small pockets at the beginning of August. The two lithophytic orchids found were *Cestichus reflexa* and *Thelychition sp. (Dendrobium speciosum)* Rock Orchid on the cliff faces of Alum Mountain but they are rare on the property. One tree orchid *Dockrillia teretifolia (Dendrobium teretifolium)* was also found on an *Allocasuarina* in Group 4 vegetation and is rare on the property.

More unusual plant species, however, are found on the cliff faces and summit of Alum Mountain. A form of *Callistemon acuminatus* with very pointed leaves was located and this species occurs with *Leptospermum polyanthum*, which is an extension of its previously known range in the collections at the National Herbarium. *Prostanthera incisa, Plectranthus argentatus, Pleurosorus rutifolius* Blanket Fern and a very hairy form of *Hibbertia obtusifolia* also occur. These plant species are locally uncommon and confined to specific habitats giving the mountain a unique type of flora. The three specimens of *Callistemon acuminatus, Pleurosorus rutifolius* and *Leptospermum polyanthum,* collected from the summit and cliff faces of Alum Mountain, were retained by the Herbarium as collection material (Appendix 7).

Eucalyptus fergusonii subsp. fergusonii was located on the lower northern slopes near the existing dwelling. Both *C. acuminatus* and *Eucalyptus fergusonii subsp. fergusonii* are listed Rare or Threatened Australian Plant (ROTAP) species. *Syzygium paniculatum* the Magenta Lilly Pilly, an endangered species, was not found during this survey on site or along the Myall River. However, it should be noted that some specimens of *Syzygium floribundum* growing along the Myall River and possibly Frys Creek, have psyllid infested short obovate leaves with the apex drawn out to a long fine point, which are typical features for *S. australe* or *S. paniculatum* (normally *S. floribundum* has long lanceolate wavy leaves). The few specimens located also flower at a similar time to the latter two species but the oil dots are more distinct. These trees, which were originally thought to be *S. paniculatum,* have been identified as *S. floribundum* (P. Wilson pers. com.). Collections from these trees have also been retained by the National Herbarium.

A list of plant species, as recorded from the quadrats and listed on Section 13 of the NSW National Parks & Wildlife Act, 1974 is given in Appendix 12.

The digital data from proforma field vegetation data sheets is given in Appendix 10.

5.7 Determination of potential threatened species and populations

The list of threatened plant species listed on the TSC Act, 1995 that have been found in the general area of Bulahdelah is presented in Table 16. The following details are provided on potential habitat of the species and in some cases previous studies have been referred to for habitat details.

Tetratheca juncea Black-eyed Susan was recorded on the stage 1 lands but searches during 2007, 2008 and 2010 failed to relocate the species on site. This species is also known to occur on the rock face of Alum Mountain (collection at the National Herbarium of NSW; Payne, 2001) and it was relocated again during this survey. The species was not found during the stage 2 site surveys on the remainder of the property but it is now also known to occur on some of the volcanic hilltops north of Karuah, found during the recent regional botanical surveys (R. Payne, pers. obs.). Based on the analysis of sites by Payne (2001) the species is most likely to be found in the MU 30 vegetation community (*Angophora costata- Eucalyptus capitellata- Corymbia gummifera*) or MU 31 vegetation community (*Eucalyptus haemastoma- Eucalyptus capitellata-Corymbia gummifera*) and at times in MU 15 Spotted

Gum- Ironbark Forest of the previous REMS study (NSW NPWS 2000). Driscoll (2003) found similar results with more updated vegetation analysis. Given the canopy dominant species, landscape units and the population present on Alum Mountain this species is likely to occur in Group 3 vegetation and Group 4 vegetation (Figure 5), especially on the cliff faces of Alum Mountain.

Photo 8. *Tetratheca juncea* found on Alum Mountain and occurring on rock faces.

Angophora inopina, the Black Apple was not found during the survey but potentially could occur within the Group 2 sub-community 1 and Group 3 vegetation areas. The Black Apple can be found in habitats ranging from very dry in the North Wyong area to impeded drainage areas in the Boolaroo area found during the regional vegetation surveys (R. Payne pers. obs., Payne & Duncan, 1999, Bell, 2005). Payne & Duncan (1999) state that this species occurs on the ridgetops of the coastal plain (Munmorah Conglomerate and undifferentiated geology) at Wyong in Sydney Red Gum-Brown Stringybark- Red Bloodwood – Scribbly Gum-Sydney Peppermint- Bastard Mahogany Forests whilst Bell, (2005) records the species occurring in Wyong as occurring in *Eucalyptus resinifera-Angophora costata* sedge woodland. The former is similar to Group 3 vegetation and the latter is a similar habitat to the Group 2 sub-community 1 vegetation (Figure 12).

Cryptostylis hunteriana the Leafless Tongue Orchid is known from the Alum Mountain State Forest (Bell, 2001). The species was not found during the surveys but based on the habitat descriptions reviewed by Bell (2001) the species does not appear to have a preferential habitat. Habitats reported are swamp heaths on sandy soils, scrubby swamp fringes, steep bare hillsides and coastal plains, favouring moist soils. It therefore could potentially occur over any part of the subject site (Figure 8).

Corybas dowlingii the Red Lantern Orchid is described in Jones (2004, 2006) who states the species is localised, growing in gullies on tall forested slopes on well drained gravelly soil. It has been found previously at Bulahdelah and its known range of occurrence is between

Bulahdelah and Freemans Waterholes between elevations of 10-200m. Although the species could not be found potential habitat exists on the slopes in group 3, 4 & 5 vegetation (Figure 9).

Rhizanthella slateri the Eastern Underground Orchid, despite considerable searching for the species, was unable to be found. Since the species was previously found in a dry drainage line dominated by *Gahnia clarkei* and on a western slope dominated with *Allocasuarina littoralis,* similar habitat on the subject site occurs with Group 4 vegetation which has several dry gullies dominated by *Gahnia clarkei* (Figure 7).

Diuris pedunculata the Small Snake Orchid was not found but this species is unlikely to occur on the property because its current known habitat (montane grassland and moist to wet grassy slopes) is not present (Jones, 2006). Surveys of the moist Kangaroo Grass grassland near the yabbie ponds would appear to be the only potential habitat (Figure 10).

Asperula asthenes the Trailing Woodruff: Bulahdelah is the type locality for *Asperula asthenes* and its range extends to Port Macquarie where it has been found on riverbanks, intermittedly flooded low lying sites, rainforest and *Melaleuca quinquenervia* forest (Thompson, 2009). It was not found during these surveys. Potential habitat exists along Frys Creek (Group 5 vegetation) and in group 2 sub community 1 north of Frys Creek and perhaps around the fringes of group 2 sub community 2 vegetation (Figure 11).

Lindernia alsiniodes Noahs False Chickweed occurs in Melaleuca wetland communities and is likely to be found in group 2 sub community 1, north of Frys Creek. This area is considered to be the Swamp Sclerophyll Forest EEC (Figure 16).

Syzygium paniculatum Magenta Lilly Pilly: The most likely habitat for *S. paniculatum* is along the Myall River or Frys Creek. The species has a preference for alluvial soils, particularly coastal sands (Payne, 1997). Nevertheless it was not found on site during these surveys despite extensive traverses along Frys Creek. The species is not easily differentiated from *S. australe* but its features are translucent rather than transparent oil dots caused by a palisade covering within the leaf tissue, a paniculate inflorescence and fruit containing polymorphic seeds (Photo 9). Potential habitat is shown in Figure 14.

Photo 9- *Syzygium paniculatum* showing the magenta coloured fruit.

Melaleuca biconvexa is a paperbark that was found nearby during the RTA surveys (PPK Environmental and Infrastructure, 2000) but the species stronghold is in the Gosford and Wyong LGA's with outlier populations found as far north as Taree and Port Macquarie and as far south as Jervis Bay. This species grows in low lying wetlands and sometimes Swamp Rainforest and the most likely potential habitat is Group 2/1 vegetation north of Frys Creek (Figure 13).

Callistemon linearifolius Netted Bottlebrush: There is an early record for this species at Bulahdelah but the locality is unknown. Populations on the Hawkesbury Sandstone geology on the Central Coast are found along drainage lines and sometimes clefts on escarpments associated with drainage. In the Lake Macquarie LGA the species is associated with drainage lines (Photo 9).The most likely habitat on the subject site is Group 5 vegetation along Frys Creek and the northern gullies in Group 3 & 4 vegetation (Figure 15).

Photo 9 – *Callistemon linearifolius* growing at Glendale Lake Macquarie.

Melaleuca groveana Groves Paperbark (vulnerable TSC Act, 1995) occurs elsewhere in the Great Lakes LGA but was not found during the surveys. This species occurs on the volcanic peaks throughout the Port Stephens LGA and south of Nerong. The species has a habitat preference for heath and shrubland on exposed sites at high altitude. It is likely to occur on Alum Mountain (Figure 19).

Grevillea guthrieana Guthries Grevillea (endangered TSC Act, EPBC Act 1997) is also found south of Nerong. The species was not found during the surveys, but could occur on Alum Mountain or along Frys Creek (Figure 20).

Callistemon acuminatus (a ROTAP species) is a small shrub with pointed undulate leaves, which has been previously recorded in the Bulahdelah area (collection at the National Herbarium of NSW). It was found during this survey on the summit of Alum Mountain (Photo 10) in Group 4 Woodland vegetation. It could occur elsewhere on the mountain (Figure 17).

Photo 10 – *Callistemon acuminatus,* a ROTAP species, occurs as a low growing stunted shrub on Alum Mountain.

Eucalyptus fergusonii subsp. fergusonii (a ROTAP species) was found on lower north facing slopes, near the existing dwelling, in Group 3 vegetation. The species could also occur in other areas of Group 3 vegetation (Figure 18).

Eucalyptus parramattensis subsp. decadens Parramatta Red Gum is a small eucalypt that grows amongst a variety of other eucalypt species often on poorly drained sites and can be confined to edges of wetlands or re-entrants. However the main factor that appears to govern it presence is a consistent water table. It is possible that the species could occur in swamp sclerophyll forest area north of Frys Creek (Figure 21).

Eucalyptus glaucina Slatey Red Gum. This species is found on the North Coast and Hunter River catchment and appears to be confined on deep moderately fertile soils and grassy woodlands. Habitat is not present on the property but may occur in the swamp sclerophyll forest area north of Frys Creek if anywhere at all (Figure 22).

Diuris praecox Rough Double Tail. The habitat of this species is very variable and on the central coast is found in dry sclerophyll forest on Munmorah Conglomerates and on perched sand dunes overlying Munmorah Conglomerates. The understorey ranges from mid dense to dense. The species may occur on the coastal plains based upon current knowledge of the habitat (Figure 24).

Table 16 – Threatened Plant Species that have been recorded in the general area.

SPECIES	CATEGORY	RELEVANT
Black-eyed Susan *Tetratheca juncea*	Vulnerable TSC, EPBC Acts.	Yes previously recorded on site and on Alum Mountain
Allocasuarina defungens	Endangered TSC	In the local area near the coast
Eastern Underground Orchid *Rhizanthella slateri*	Vulnerable TSC, Endangered EPBC Endangered population TSC	South of the study area on western aspects.
Leafless Tongue-orchid *Cryptostylis hunteriana*	Vulnerable TSC, EPBC Acts.	Yes previously recorded in Bulahdelah State Forest
Red Lantern Orchid *Corybas dowlingii*	Endangered TSC Act.	Yes previously recorded at Bulahdelah on the western slopes
Small Snake Orchid *Diuris pedunculata*	Endangered TSC, EPBC	Previously recorded at Bulahdelah but probably not relevant. Occurs in high montane grasslands.
Trailing Woodruff *Asperula asthenes*	Vulnerable TSC, EPBC Acts.	Yes previously recorded to the south of study area
Black Apple *Angophora inopina*	Vulnerable TSC, EPBC Acts.	Yes previously recorded at Bulahdelah
Magenta Lilly Pilly *Syzygium paniculatum*	Endangered TSC Act.	Yes previously recorded to the east near the coast.
Biconvex Melaleuca *Melaleuca biconvexa*	Vulnerable TSC, EPBC Acts	Yes previously recorded at Bulahdelah
Netted Bottlebrush *Callistemon linearifolius*	Vulnerable TSC	Yes previously recorded along the Myall River – early record
Noah's False Chickweed *Lindernia alsiniodes*	Endangered TSC	Recently recorded at Coopernook in wetlands (Information CMA)
Callistemon acuminatus	ROTAP	Previous early record from Bulahdelah. Found on the summit of Alum Mountain during this survey
Eucalyptus fergusonii subsp. fergusonii	ROTAP	Found during the RTA survey. Present on the property on lower north facing slopes
Melaleuca groveana	Vulnerable TSC	Previously recorded near Nerong on high hilltops. Also known from volcanic hilltops in Port Stephens shire.
Grevillea guthrieana	Endangered TSC, EPBC	Previously recorded near Nerong on high hilltops. Occurs on high cliffs and creek lines.

Notes for Table 16

- Orange highlight indicates species has been previous recorded on site

5.8 Determination of potential endangered ecological communities

This section covers endangered ecological communities and endangered populations and two areas of interest apply to this proposal which is the "Swamp Sclerophyll Forest on

coastal floodplains" endangered ecological community and the "Eastern Underground Orchid for the Great Lakes LGA" endangered population. The former has been adequately covered in the section Map unit significance but for the purposes of this section some additional comments are included.

Keith & Scott (2005) have compiled various plant descriptions relating to Swamp Sclerophyll Forest vegetation. In their compilation the authors describe various vegetation assemblages for Swamp Sclerophyll Forest but the main characteristics are an open too dense tree layer of eucalypts and paperbarks with a layer of small trees, shrubs and climbers. In particular, the ground layer vegetation is composed of abundant sedges, forbs, ferns and grasses including *Gahnia clarkei*. Whilst the plant descriptions derived from quadrat BULST2EEC do not fit exactly to those author's plant descriptions, the vegetation is similar in other parts of the EEC and the structural characteristics are similar. Thus the vegetation at BULST2EEC would be considered to have the characteristics of Swamp Sclerophyll Forest in this regard.

For such vegetation community to qualify as "Swamp Sclerophyll Forest on coastal floodplains" three criteria are important (see Smith 2006). These criteria are position in the landscape, soils and association with a floodplain, as determined in a Land & Environment Court decision (Motorplex vs. Port Stephens Council, 2007). From Keith & Scott (2005) it maybe concluded that position in the landscape, particularly occurrence on alluvial soils and floodplains, is the critical determinant of coastal floodplain EEC's rather than tree species dominance. Smith (op. cit.) further states that vegetation communities should not be considered EEC's based on dominant tree species, unless they also occur on coastal floodplain landforms or are associated with coastal floodplain landform in the manner specified in Scientific Committee determinations.

For there to be an association with a floodplain the vegetation community would need to be on a floodplain or on alluvial soils in periodically inundated drainage lines that are connected with a floodplain below the elevation limits specified in EEC determinants. The vegetation does occur on a current floodplain of Fry's Creek and is subject to periodic inundation and therefore should be regarded as Swamp Sclerophyll Forest. It should be noted though that the soil type does not show permanent water logging characteristics but is subject to frequent inundation.

On the other hand the group 2 vegetation at quadrat BULST2HS is more aligned to community 38 on sandplains (Keith & Scott, 2005) or Community No. 10 *Gahnia sieberiana-Gleichenia* sedgeland of Griffith et al., (2003) and to MU 171 *Leptospermum liversidgei*/Crimson Bottlebrush Wallum Wet Heath of the Lower North Coast (Somerville, 2009). However, this community description of Griffith et al. (2003) is for wallum on coastal sandplains. Given the habitat being dealt with on the subject site is not coastal sandplain but occurs at a higher elevation amongst tall forest on volcanic rock, the various classifications of these authors do not correlate very easily. This vegetation appears to be a unique form of "hanging swamp".

Table 17 provides a list of relevant EEC's in the bioregion that may be applicable to the subject property. All EEC's were considered, as well as traversing the entire property to search for any additional EEC's, but only Swamp Sclerophyll Forest on coastal floodplains was found and is relevant, given the site characteristics.

Table 17 – List of Endangered Ecological Communities for the NSW North Coast Bioregion

TSC listed Endangered Ecological Community	**EPBC Status**	**Potentially present on site**
Hunter Floodplain Red Gum Woodland	Not Listed	Not present
Central Hunter Grey Box/Ironbark Woodland	Not Listed	Not present
Central Hunter Ironbark/Spotted Gum Forest	Not Listed	Not present
Coastal Cypress Pine Forest	Not Listed	Not present
Grey Box/Grey Gum Wet Sclerophyll Forest	Not Listed	Not present
Lower Hunter Dry Rainforest	Vulnerable	Not present
White Gum Moist Forest	Not Listed	Not present
Coastal Saltmarsh	Not Listed	Not present
Freshwater Wetlands on Coastal Floodplains	Not Listed	Not present
Littoral Rainforest	Critically Endangered	Not present
Montane Peatlands and Swamps	Endangered	Not present
Sub-tropical Coastal Floodplain Forest	Not Listed	Not present
Swamp Sclerophyll Forest	Not Listed	**Present**
Themeda Grassland on Sea Cliffs and Coastal Headlands		Not present
Hunter Lowland Red Gum Forest	Not Listed	Not present
Lowland Rainforest on Floodplains	Not Listed	Not present

Table 18 also lists the threatened flora species for the Great Lakes local government area and from this data, derived from the NSW Wildlife Atlas Database and data collection at the National Herbarium of NSW, additional plant species that may potentially occur on the site were considered.

Table 18 – Threatened plant species that have been recorded in the Great Lakes local government area

Species	**Status**	**Potentially present**
Cynanchum elegans	E EPBC, TSC	No restricted to edges of dry rainforest
Senecio spathulatus	E TSC	No restricted to frontal sand dunes
Allocasuarina defungens	E EPBC, TSC	No restricted to coastal hills & headlands
Allocasuarina simulans	V EPBC, TSC	No heathland on coastal sands
Tetratheca juncea	**V EPBC, TSC**	**Yes previously recorded on site by HWR Ecological**
Chaemaesyce psammogeton	E TSC	No occurs on sand dunes & exposed headlands
Senna acclinus	E TSC	No restricted to rainforest
Maundia triglochiniodes	V TSC	No restricted to wetlands
Prostanthera densa	V EPBC, TSC	Yes possibly on rocky slopes of Alum Mountain
Angophora inopina	V EPBC, TSC	Yes possibly – has a variable habitat
Callistemon linearifolius	V TSC	May occur along Frys Creek

Eucalyptus parramattensis subsp. decadens	V EPBC, TSC	Yes possibly in EEC area
Eucalyptus glaucina	V EPBC, TSC	Yes possibly as an isolated tree
Melaleuca biconvexa	V EPBC TSC	Yes possibly in EEC area
Melaleuca groveana	V TSC	Yes possibly on Alum Mountain as isolated individuals
Syzygium paniculatum	E TSC	May occur along Frys Creek
Corybas dowlingii	E EPBC V TSC	May occur in dry gullies and along Frys Creek
Cryptostylis hunteriana	V EPBC, TSC	May occur on property anywhere
Diuris pedunculata	E EPBC TSC	No restricted to grassy slopes & flats
Diuris praecox	V EPBC, TSC	Yes potential habitat
Genoplesium littorale	CE TSC	No restricted to coastal heath
Grevillea guthrieana	E EPBC TSC	Possibly on Alum Mountain
Asperula asthenes	V EPBC, TSC	May occur along Frys Creek
Lindernia alsiniodes	E TSC	Possibly in the EEC area
Rhizanthella slateri	V TSCE EPBC Endangered population at Bulahdelah	Possibly could occur on slopes, dry gullies and coastal plains
Euphasia ciliolata	V TSC	No montane habitats only
Tasmannia glaucifolia	V TSC	No prefers cool temperate rainforest
Tasmannia purpurascens	V TSC	No montane habitats only

Of the known threatened plant species listed for the Great Lakes local government area 14 species could possibly occur on the subject property based on known habitat characteristics but it is unlikely given the extent of survey that has now been undertaken. A number of these species have potential habitat characteristics that are found along Frys Creek. Three orchid species (one of which is an endangered population) could occur on the coastal slopes and plains including the drier northern gullies. Two plant species (*Grevillea guthrieana* and *Melaleuca groveana*) could occur on Alum Mountain. If any additional plants of the Eastern Underground Orchid were present this population would qualify as the "endangered population" on the TSC Act, 1995.

Those threatened plant species, listed on the EPBC Act, 1997, are also presented in Table 18. There are no endangered populations listed for this act and one endangered ecological community is applicable. This EEC is "Littoral Rainforest & Coastal Vine Thickets of Eastern Australia" but this vegetation is not present within the study area.

The population of *Tetratheca juncea* on the property could not be found and may have vanished as a result of clearing and modification of the coastal plain vegetation. The small northern most known population on Alum Mountain is not within the boundaries of the property.

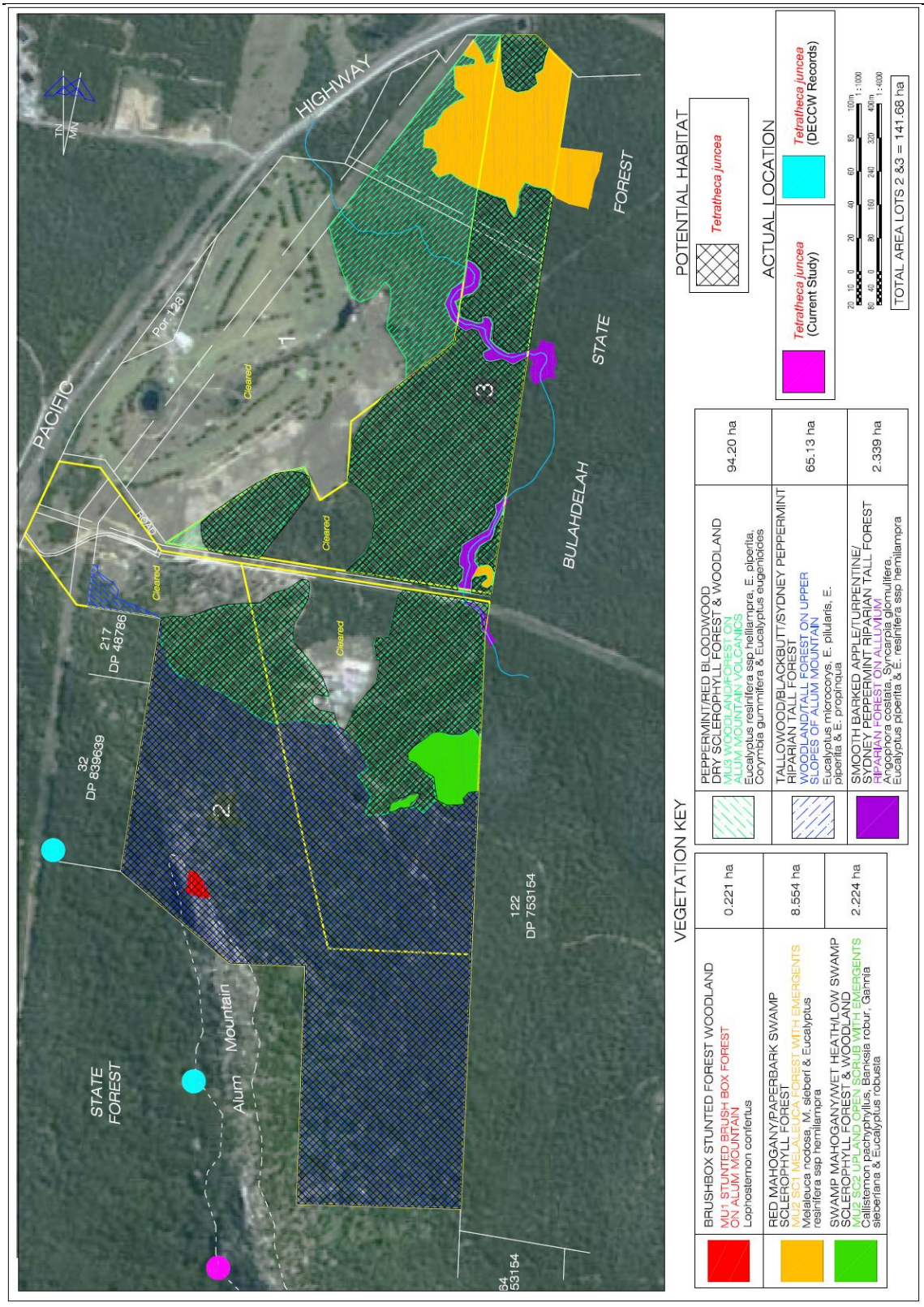


Figure 6 – Potential and actual habitat for *Tetratheca juncea* Black-eyed Susan**.**

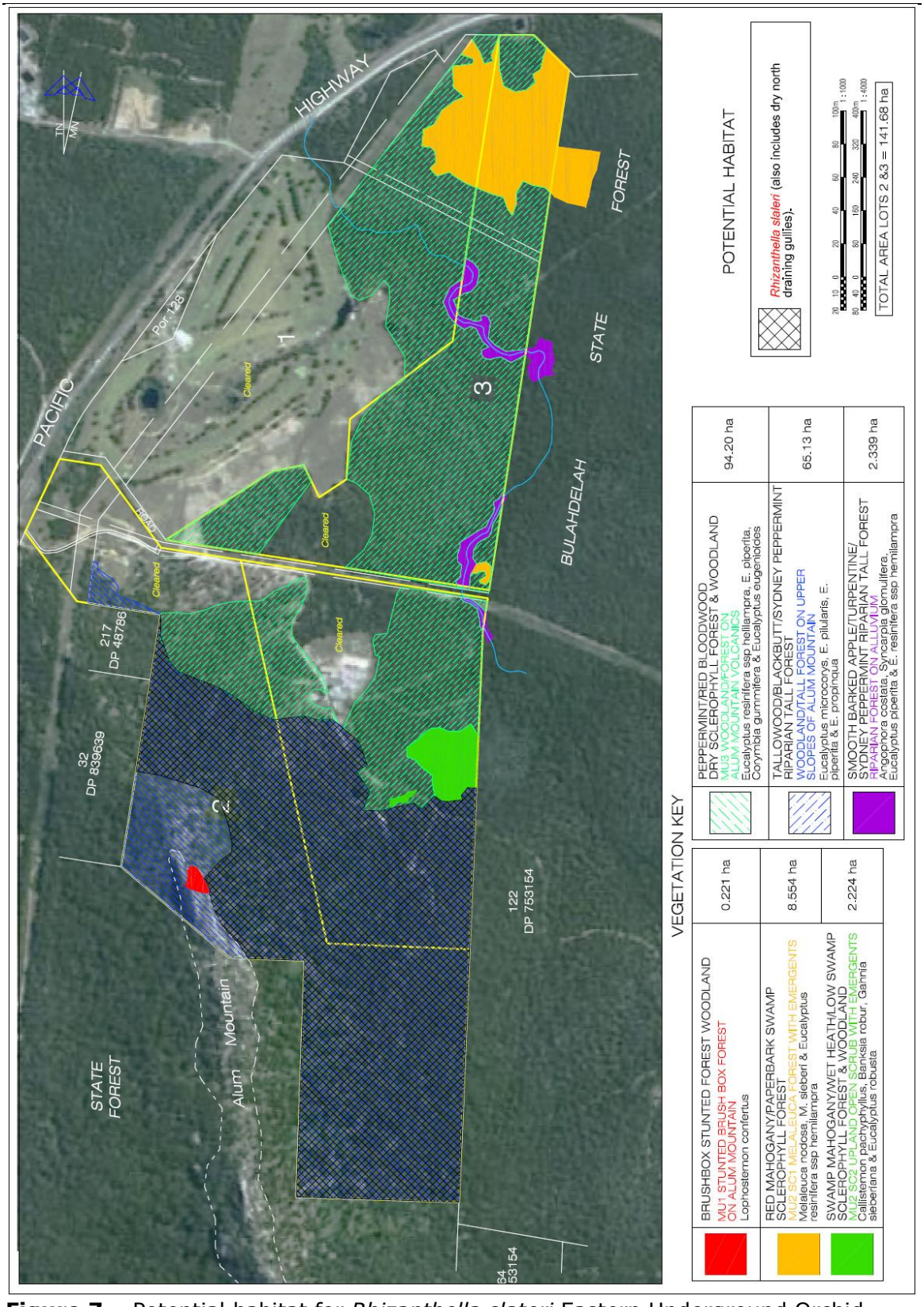


Figure 7 – Potential habitat for *Rhizanthella slateri* Eastern Underground Orchid

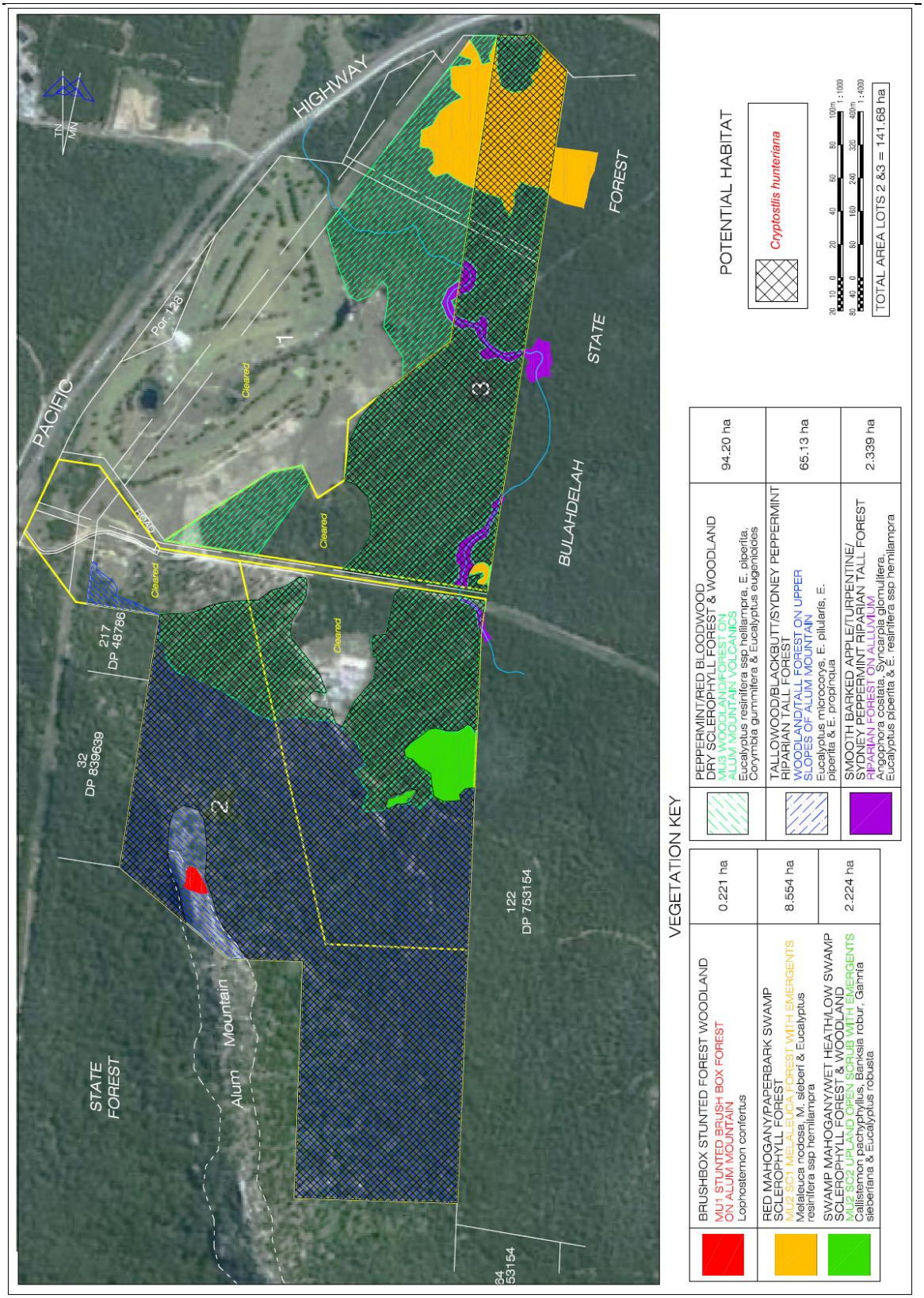


Figure 8 – Potential habitat for *Cryptostylis hunteriana* Leafless Tongue Orchid.

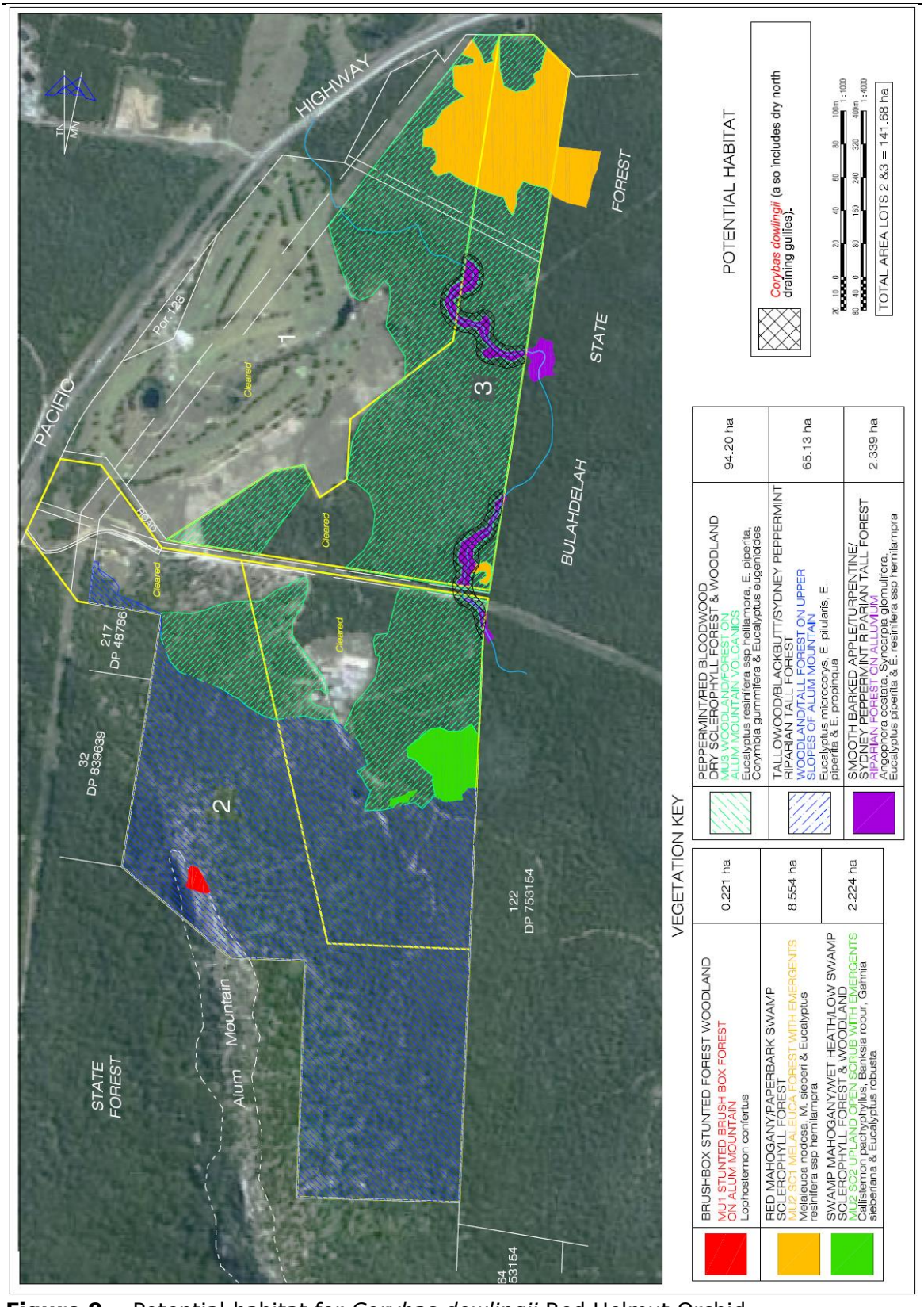


Figure 9 – Potential habitat for *Corybas dowlingii* Red Helmut Orchid.

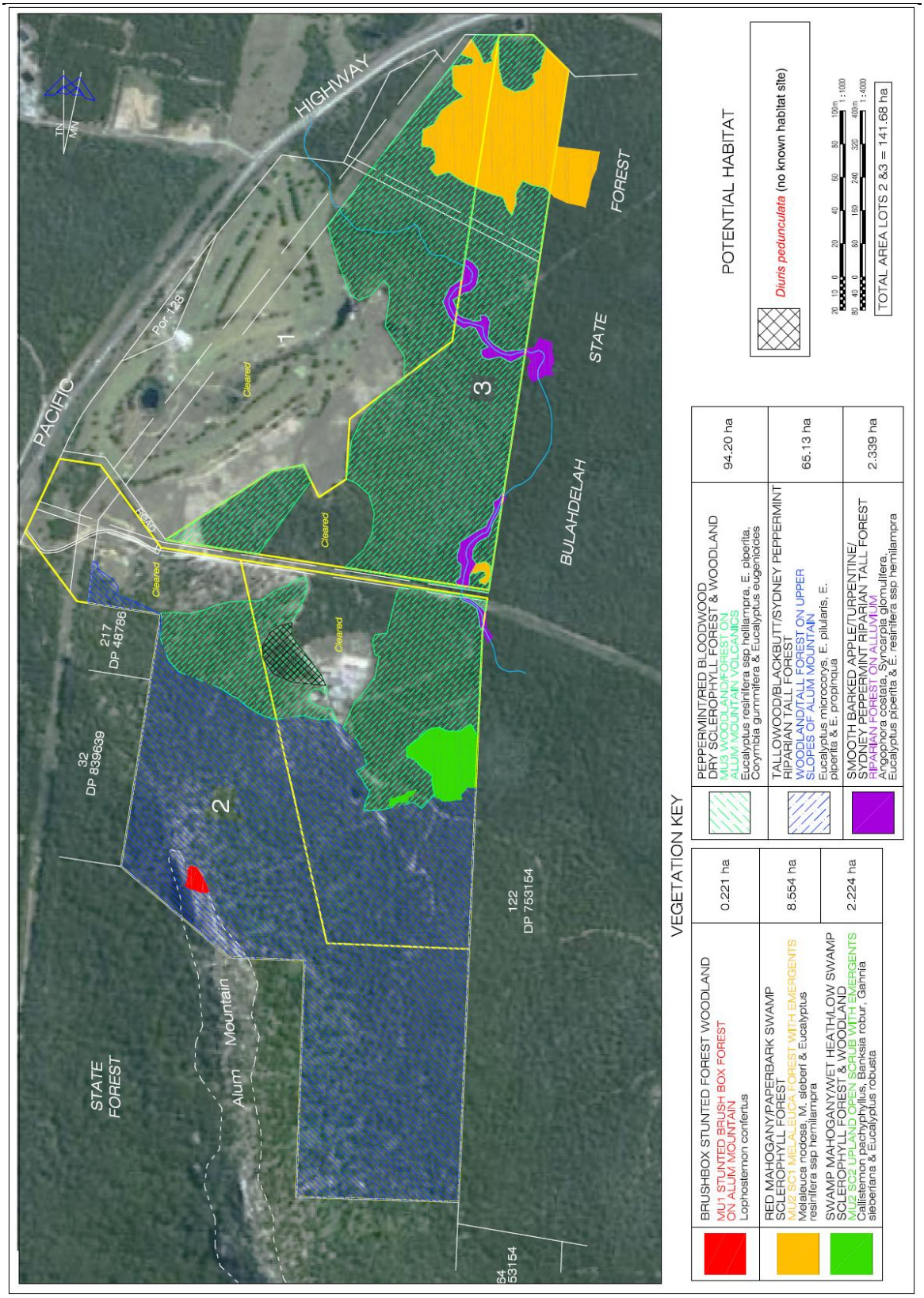


Figure 10 – Potential habitat for *Diuris pedunculata* Small-snake Orchid.

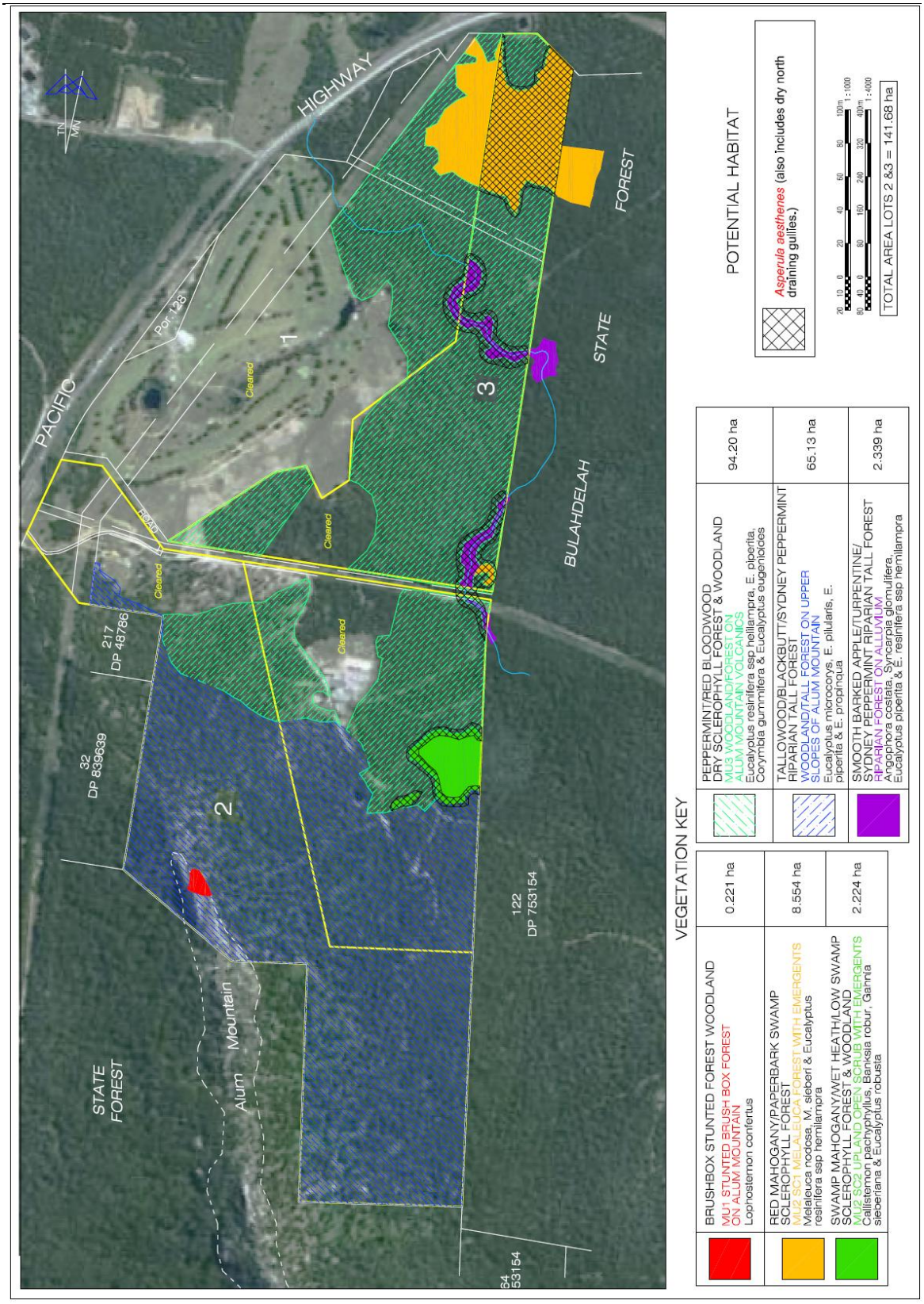


Figure 11 – Potential habitat for *Asperula asthenes* Trailing Woodruff.

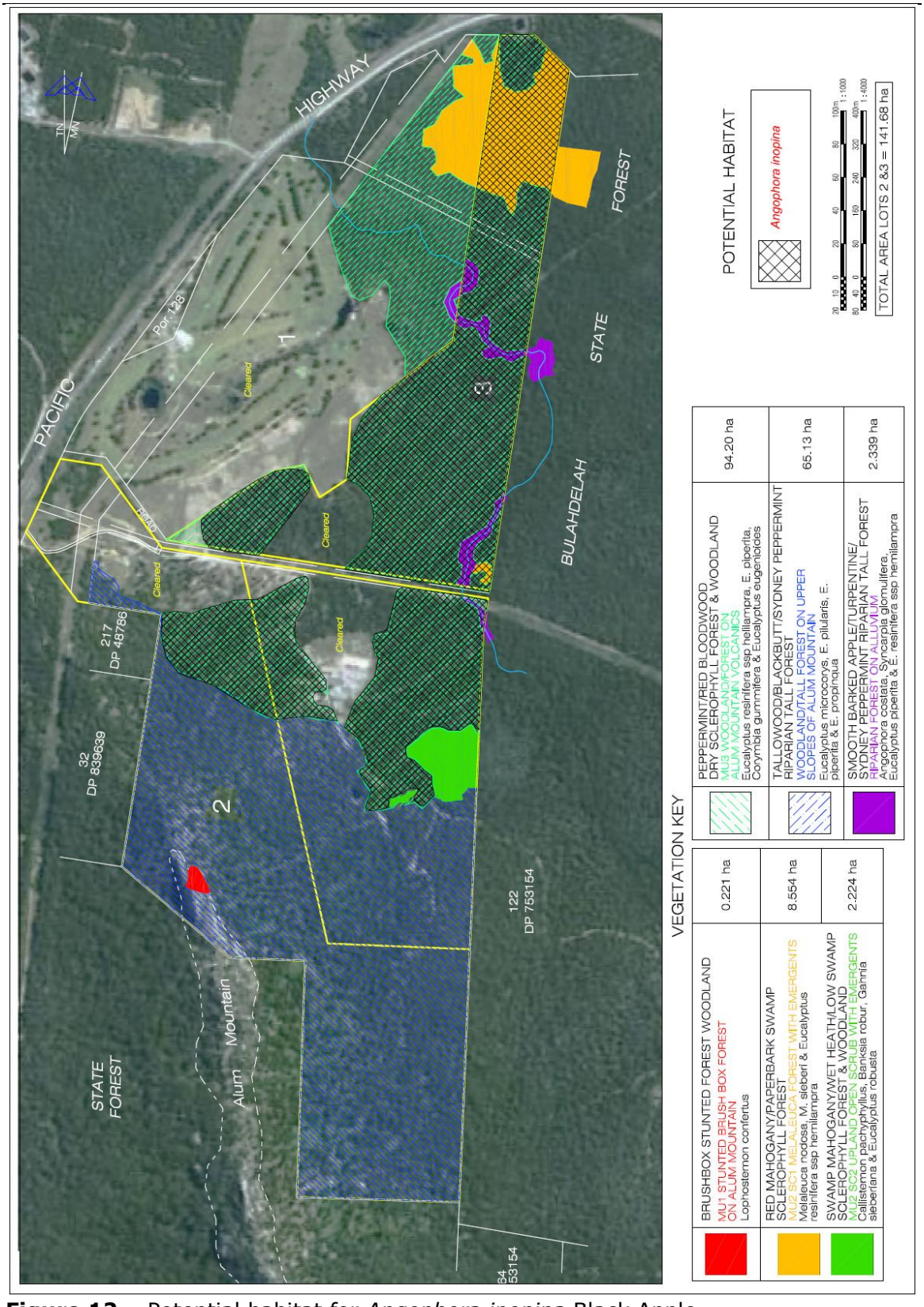


Figure 12 – Potential habitat for *Angophora inopina* Black Apple

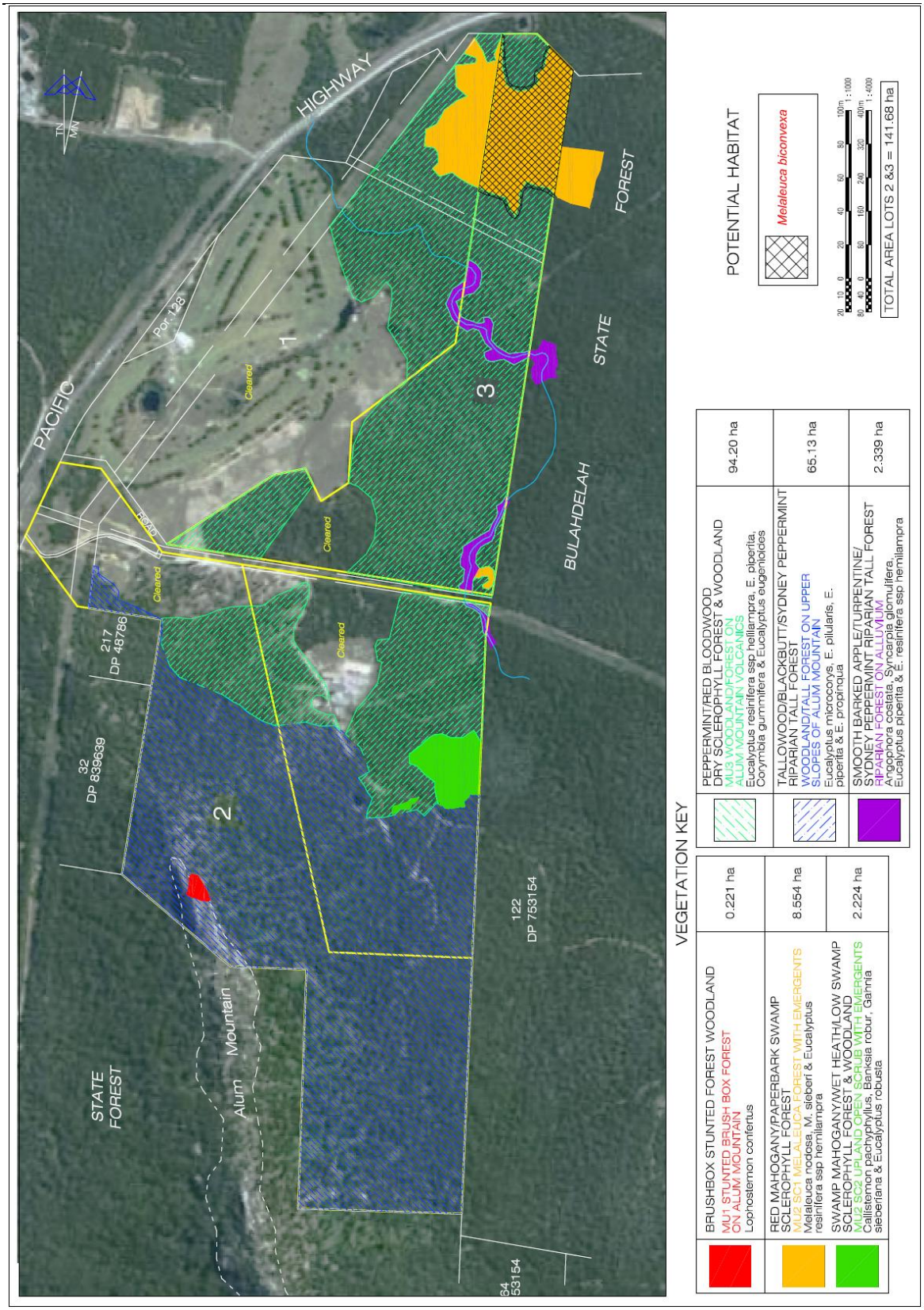


Figure 13 – Potential habitat of *Melaleuca biconvexa.*

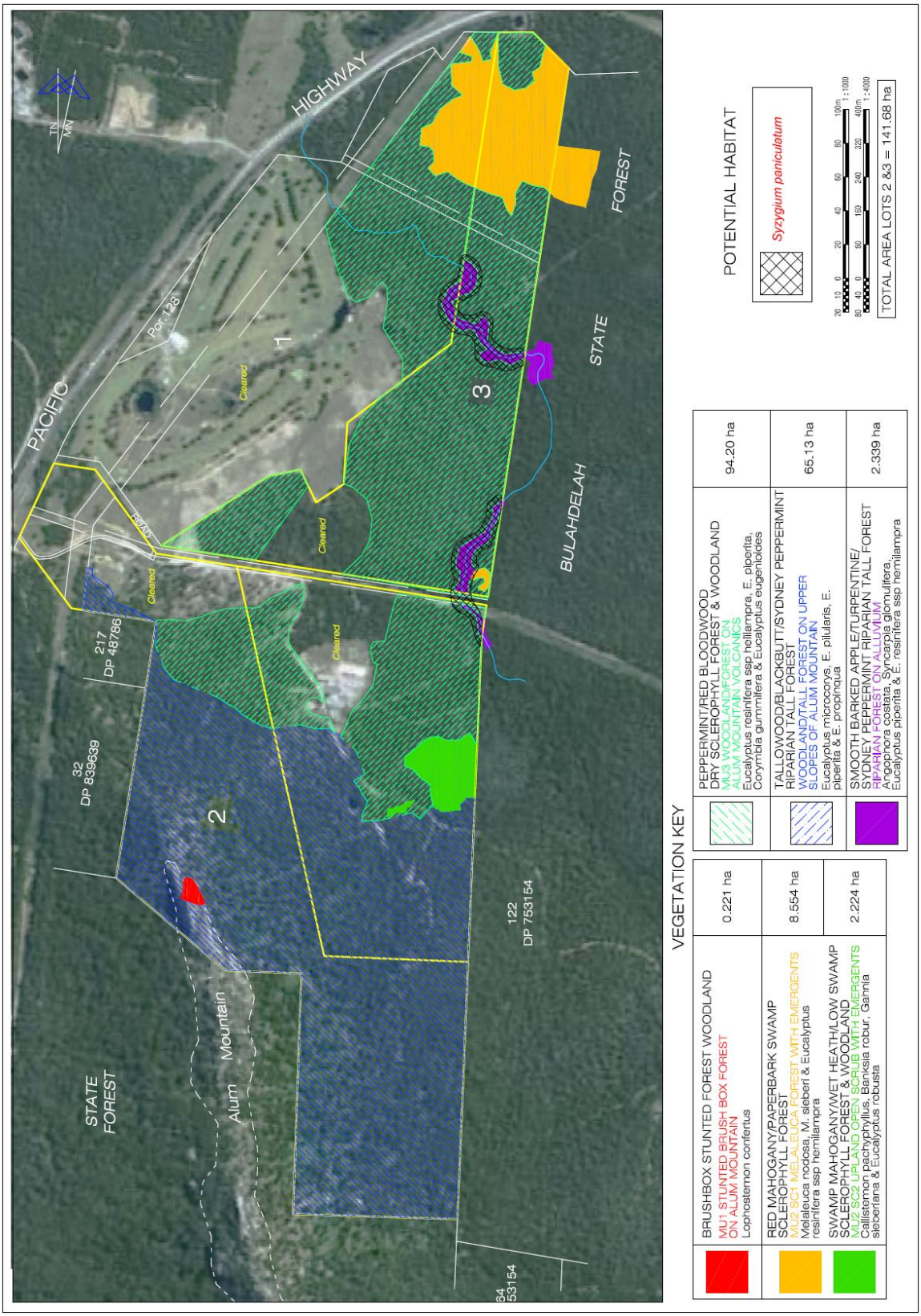


Figure 14 – Potential habitat for *Syzygium paniculatum* Magenta Lilly Pilly

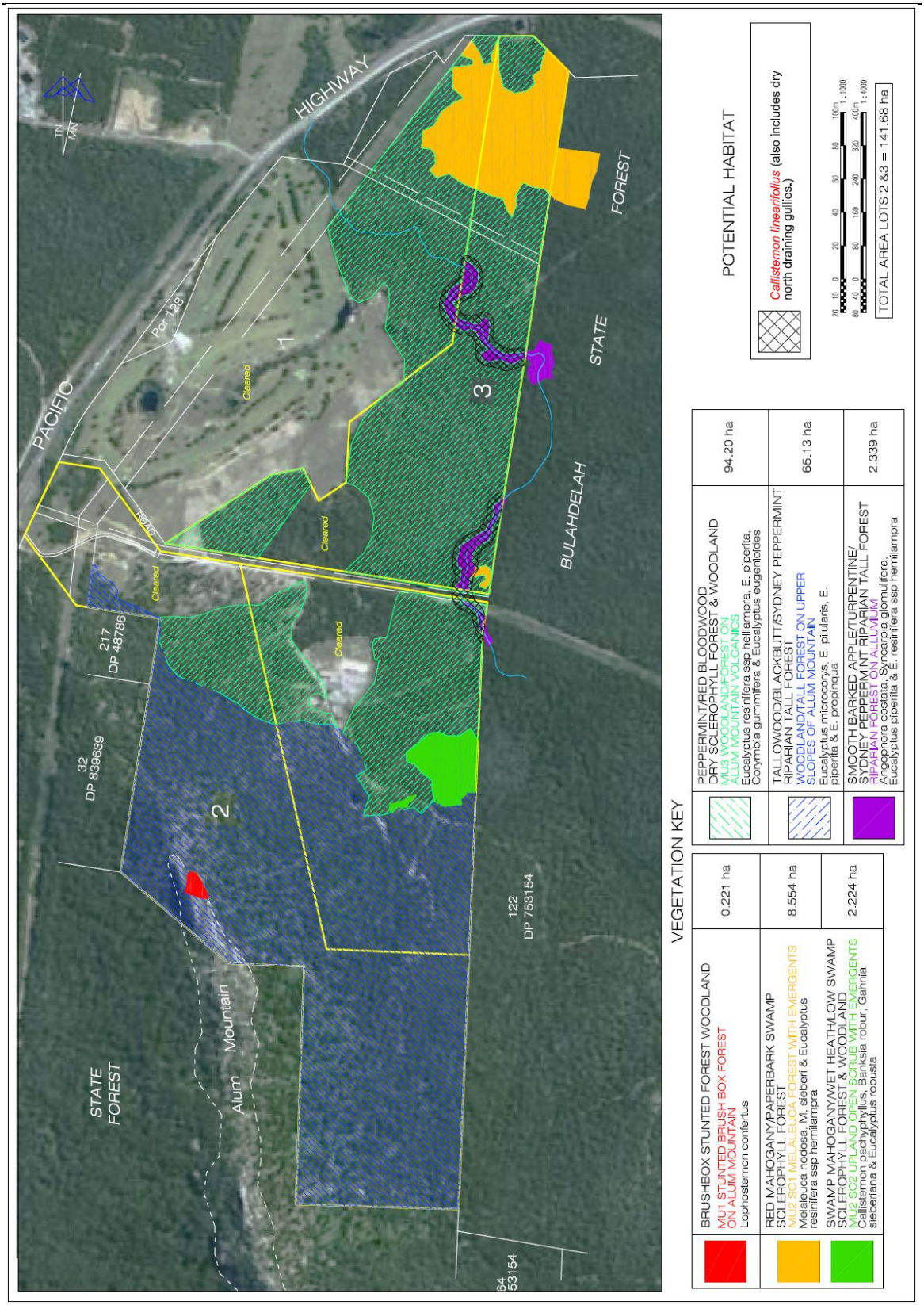


Figure 15 – Potential habitat for *Callistemon linearifolius* Netted Bottlebrush**.**

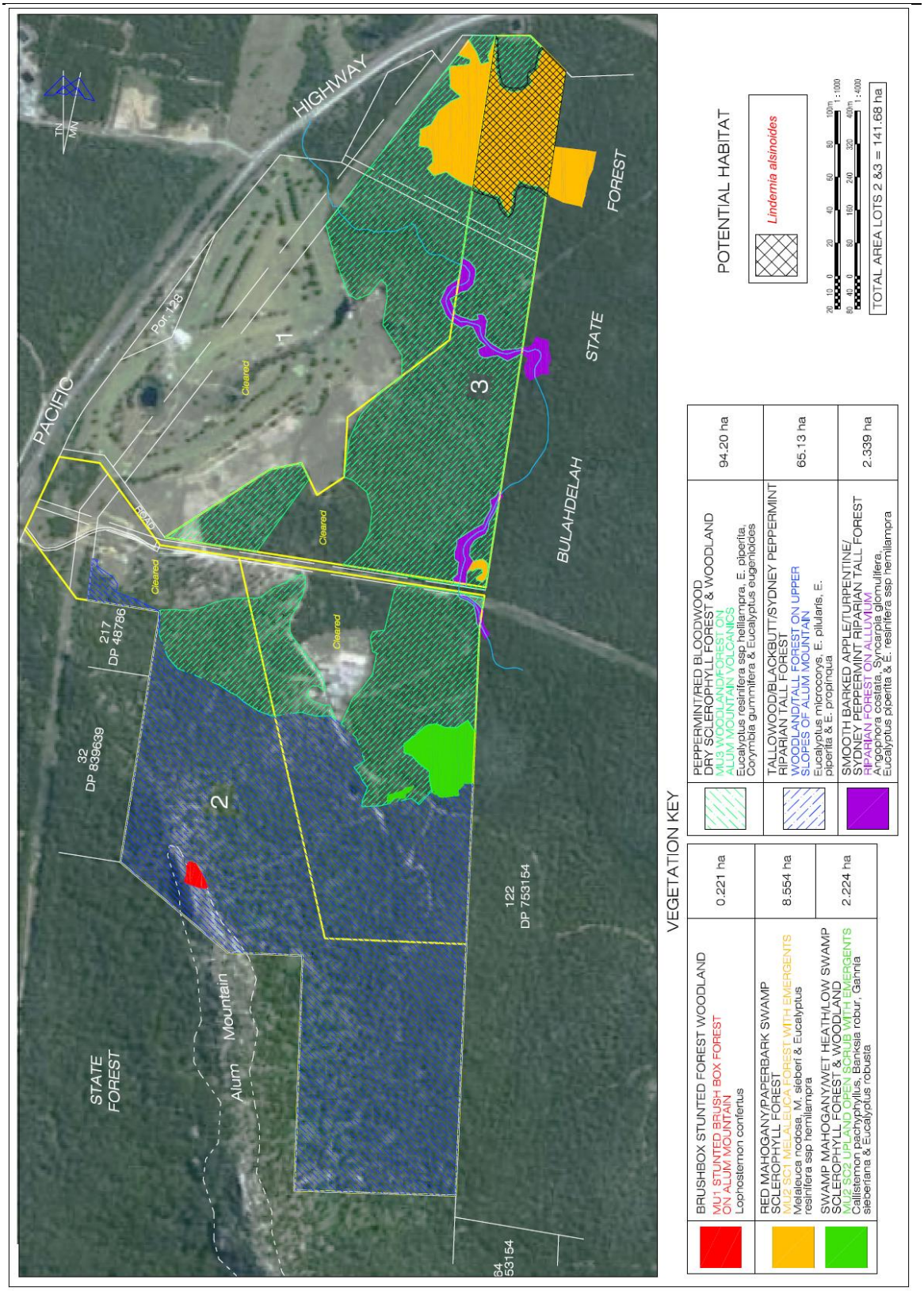


Figure 16 – Potential habitat for *Lindernia alsinoides* Noah's Chickweed

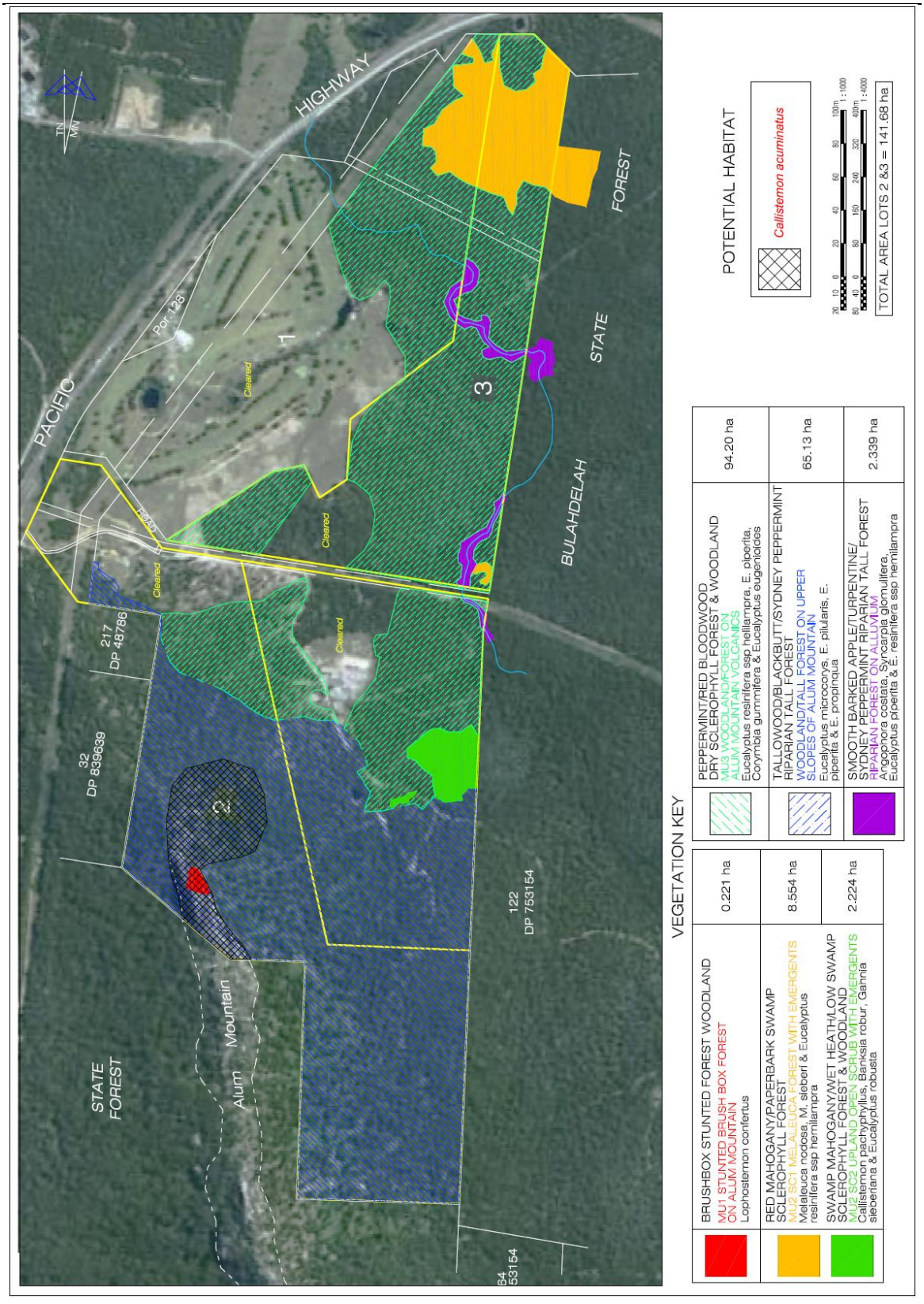


Figure 17 – Potential and actual habitat for *Callistemon acuminatus*

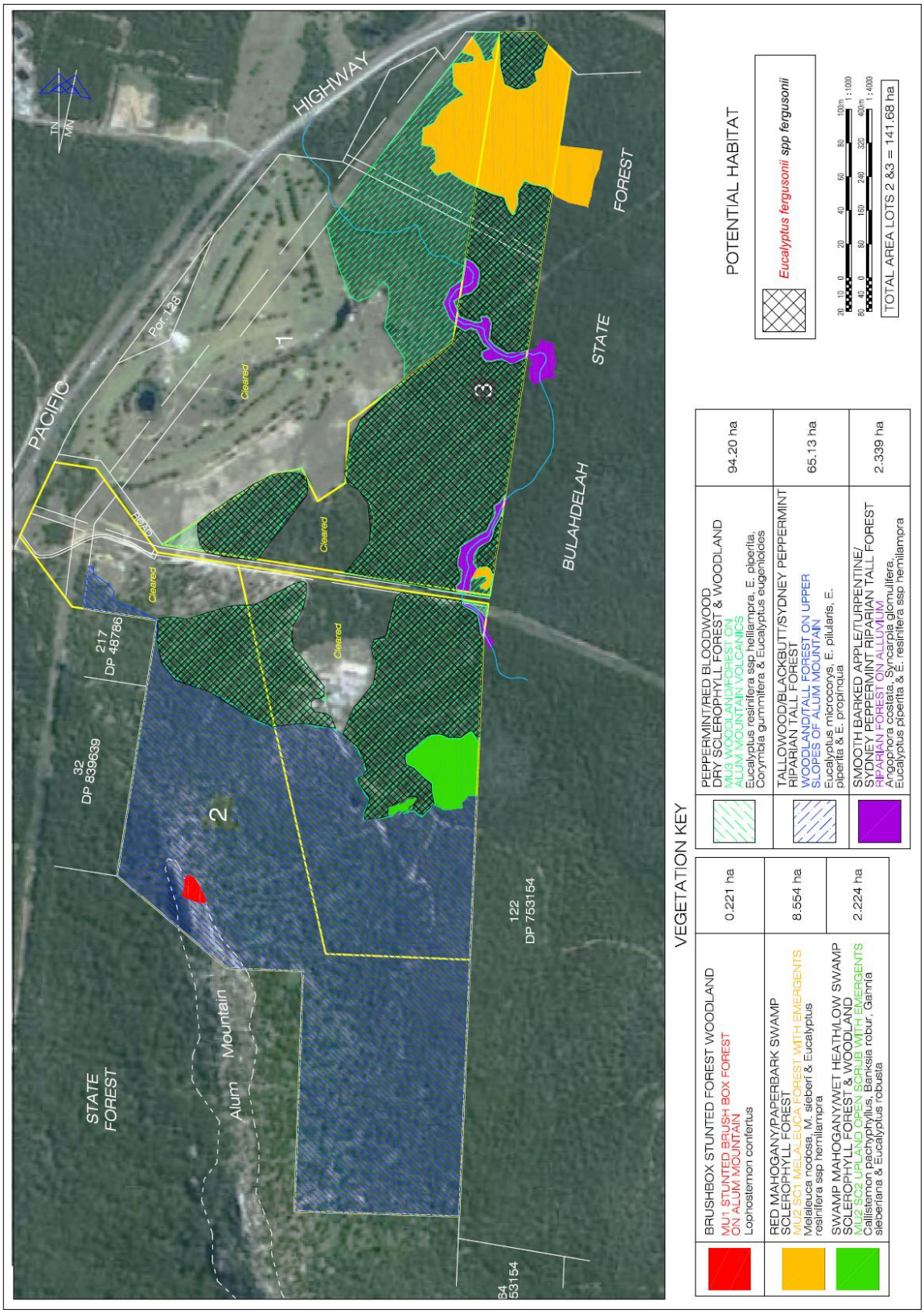

HIGHWAY
PACIFIC
BULAHDELAH
STATE FOREST
STATE FOREST
Alum Mountain
Por 128
Cleared
Cleared
Cleared
Cleared
Cleared
1
2
3
217 DP 48786
32 DP 839639
122 DP 753154
64 53154
TN
MN
POTENTIAL HABITAT
Eucalyptus fergusonii spp fergusonii
TOTAL AREA LOTS 2 &3 = 141.68 ha
VEGETATION KEY
BRUSHBOX STUNTED FOREST WOODLAND
MU1 STUNTED BRUSH BOX FOREST ON ALUM MOUNTAIN
Lophostemon confertus
0.221 ha
RED MAHOGANY/PAPERBARK SWAMP SCLEROPHYLL FOREST
MU2 SC1 MELALEUCA FOREST WITH EMERGENTS
Melaleuca nodosa, M. sieberi & Eucalyptus resinifera ssp hemilampra
8.554 ha
SWAMP MAHOGANY/WET HEATH/LOW SWAMP SCLEROPHYLL FOREST & WOODLAND
MU2 SC2 UPLAND OPEN SCRUB WITH EMERGENTS
Callistemon pachyphyllus, Banksia robur, Gannia sieberiana & Eucalyptus robusta
2.224 ha
PEPPERMINT/RED BLOODWOOD DRY SCLEROPHYLL FOREST & WOODLAND
MU3 WOODLAND/FOREST ON ALUM MOUNTAIN VOLCANICS
Eucalyptus resinifera ssp hemilampra, E. piperita, Corymbia gummifera & Eucalyptus eugenioides
94.20 ha
TALLWOOD/BLACKBUTT/SYDNEY PEPPERMINT RIPARIAN TALL FOREST
WOODLAND/TALL FOREST ON UPPER SLOPES OF ALUM MOUNTAIN
Eucalyptus microcorys, E. pilularis, E. piperita & E. propinqua
65.13 ha
SMOOTH BARKED APPLE/TURPENTINE/ SYDNEY PEPPERMINT RIPARIAN TALL FOREST
RIPARIAN FOREST ON ALLUVIUM
Angophora costata, Syncarpia glomulifera, Eucalyptus piperita & E. resinifera ssp hemilampra
2.339 ha

Figure 18 – Potential habitat for *Eucalyptus* fergusonii *subsp. fergusonii* Ferguson's Ironbark

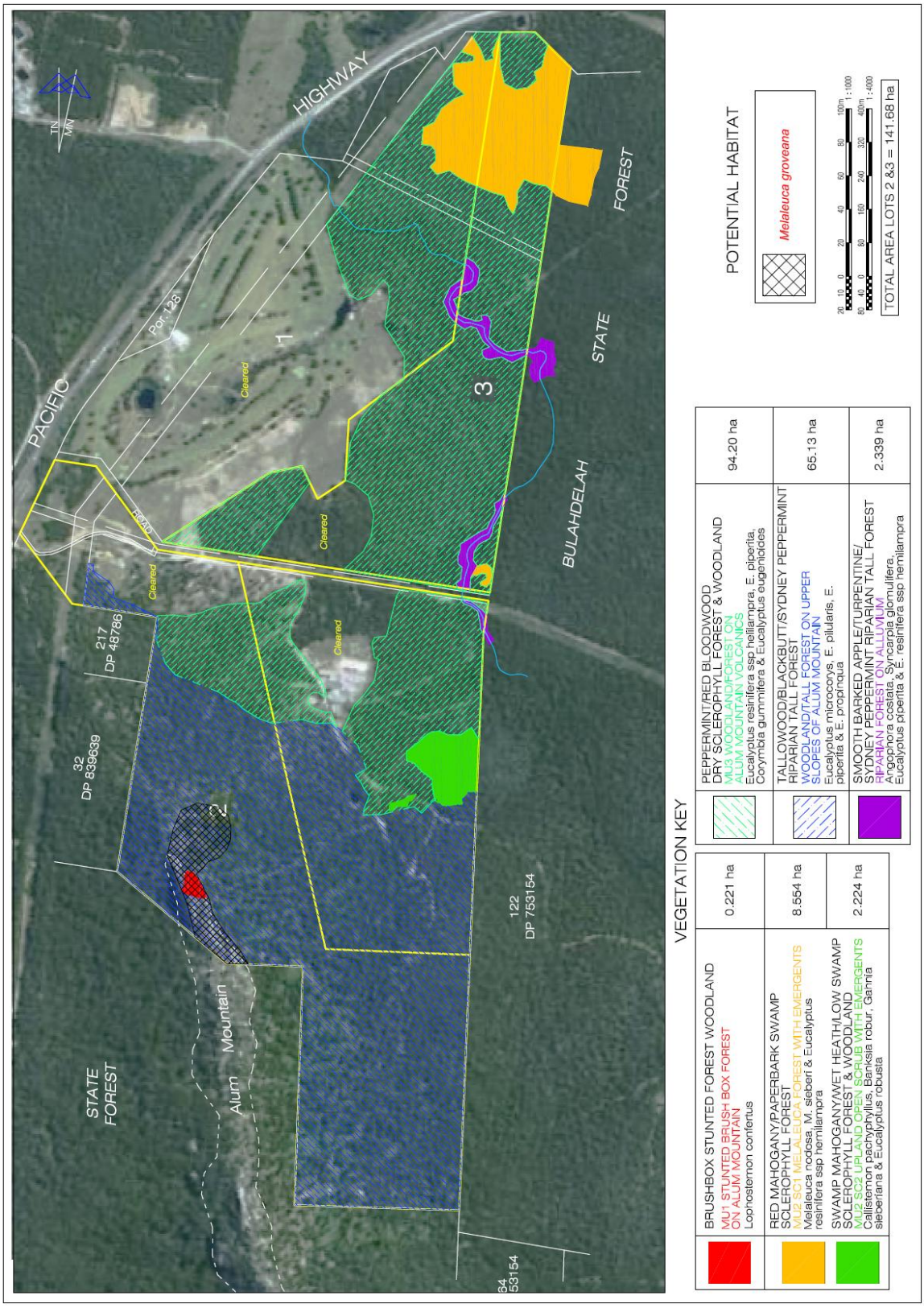


Figure 19 – Potential habitat for *Melaleuca groveana*

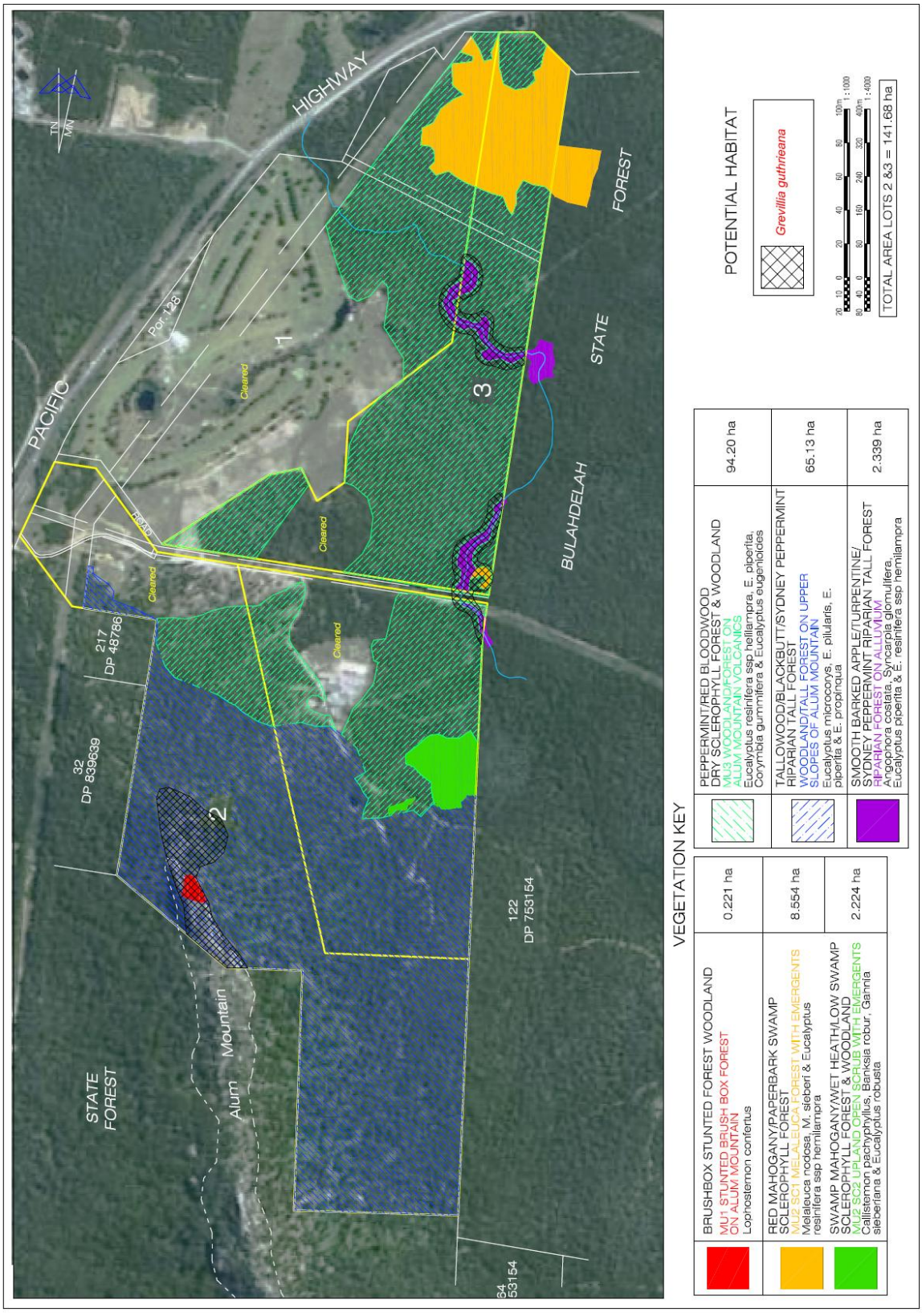


Figure 20 – Potential habitat for *Grevillea guthrieana* Guthries Grevillea**.**

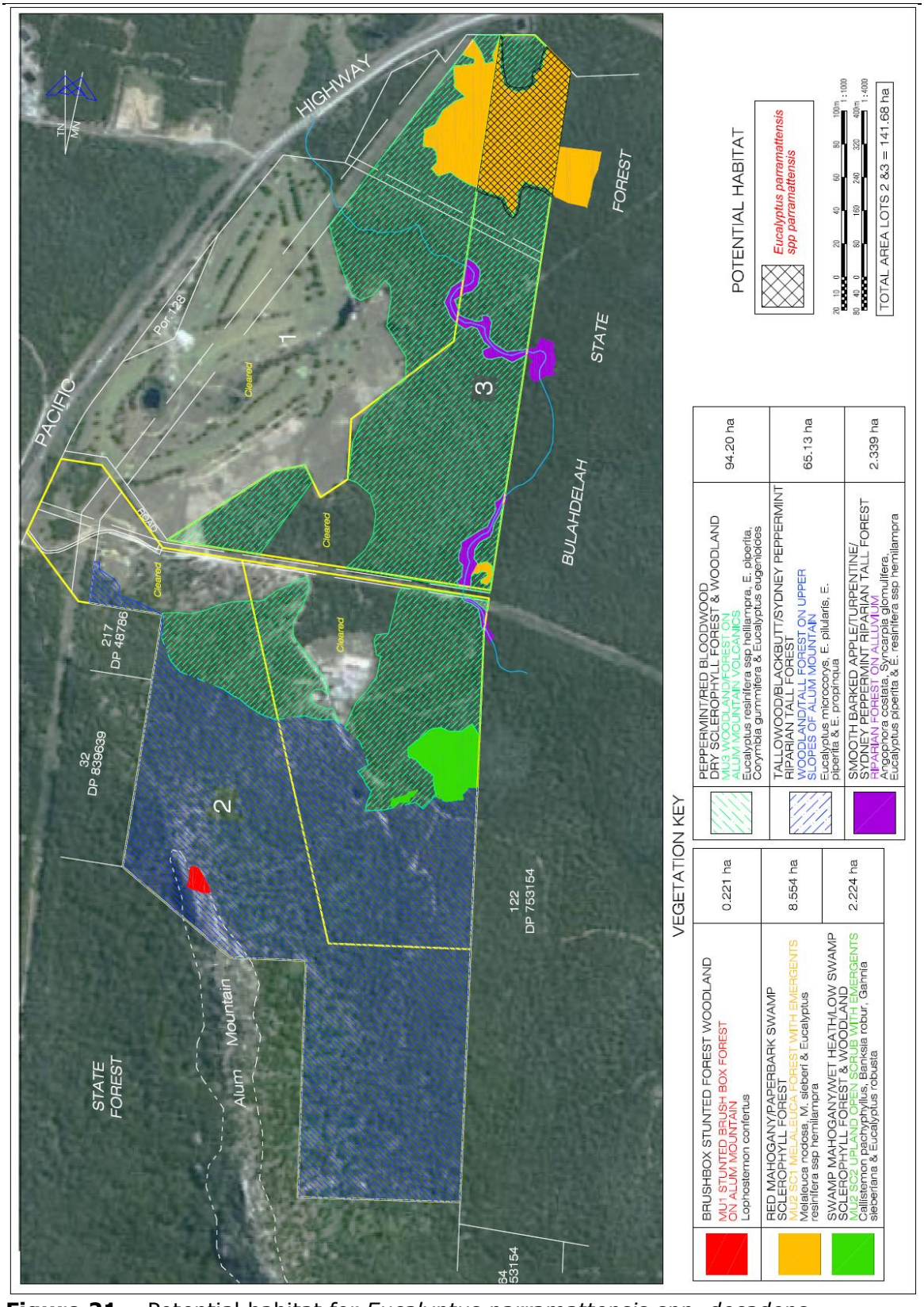


Figure 21 – Potential habitat for *Eucalyptus parramattensis spp. decadens*

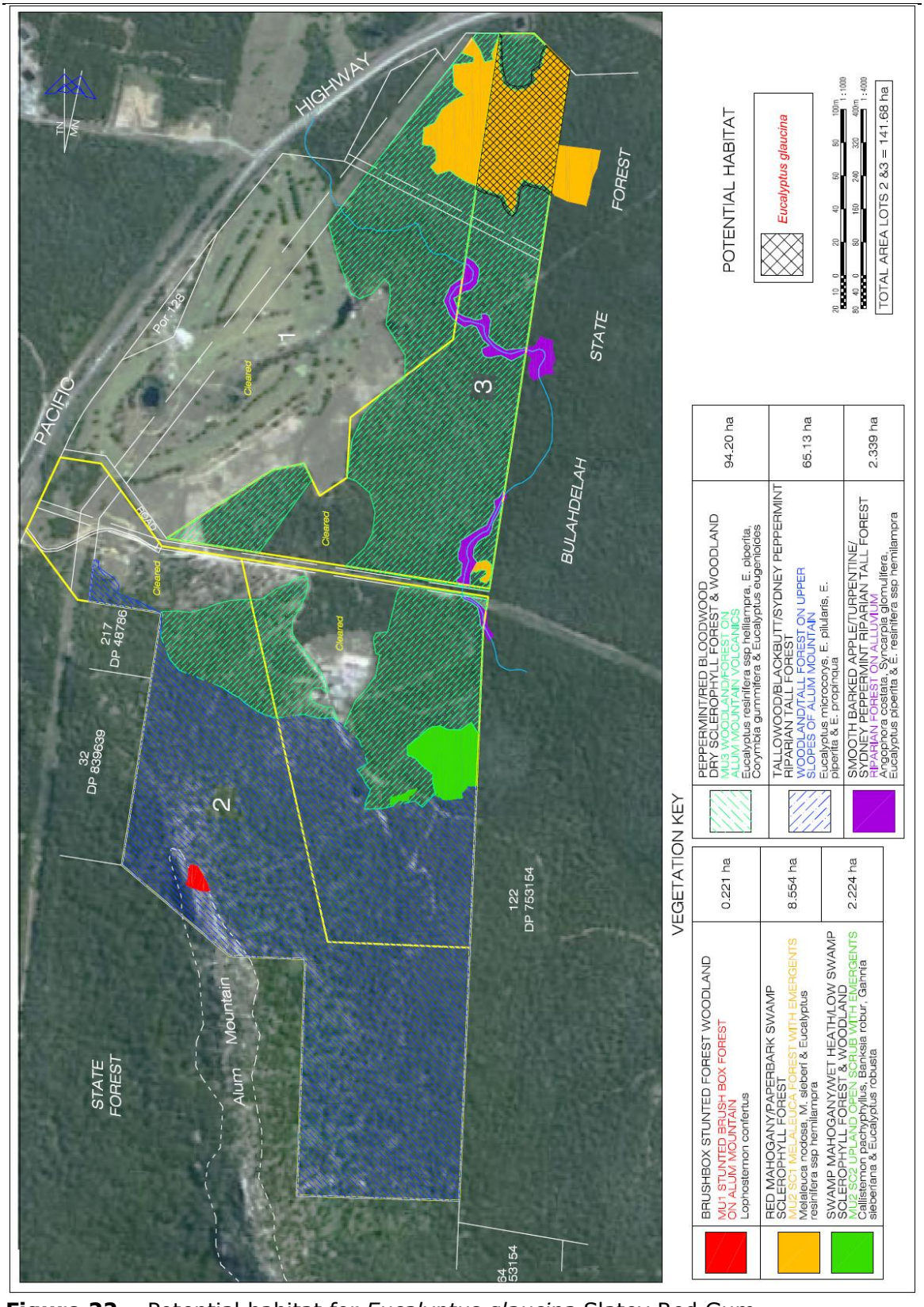


Figure 22 – Potential habitat for *Eucalyptus glaucina* Slatey Red Gum

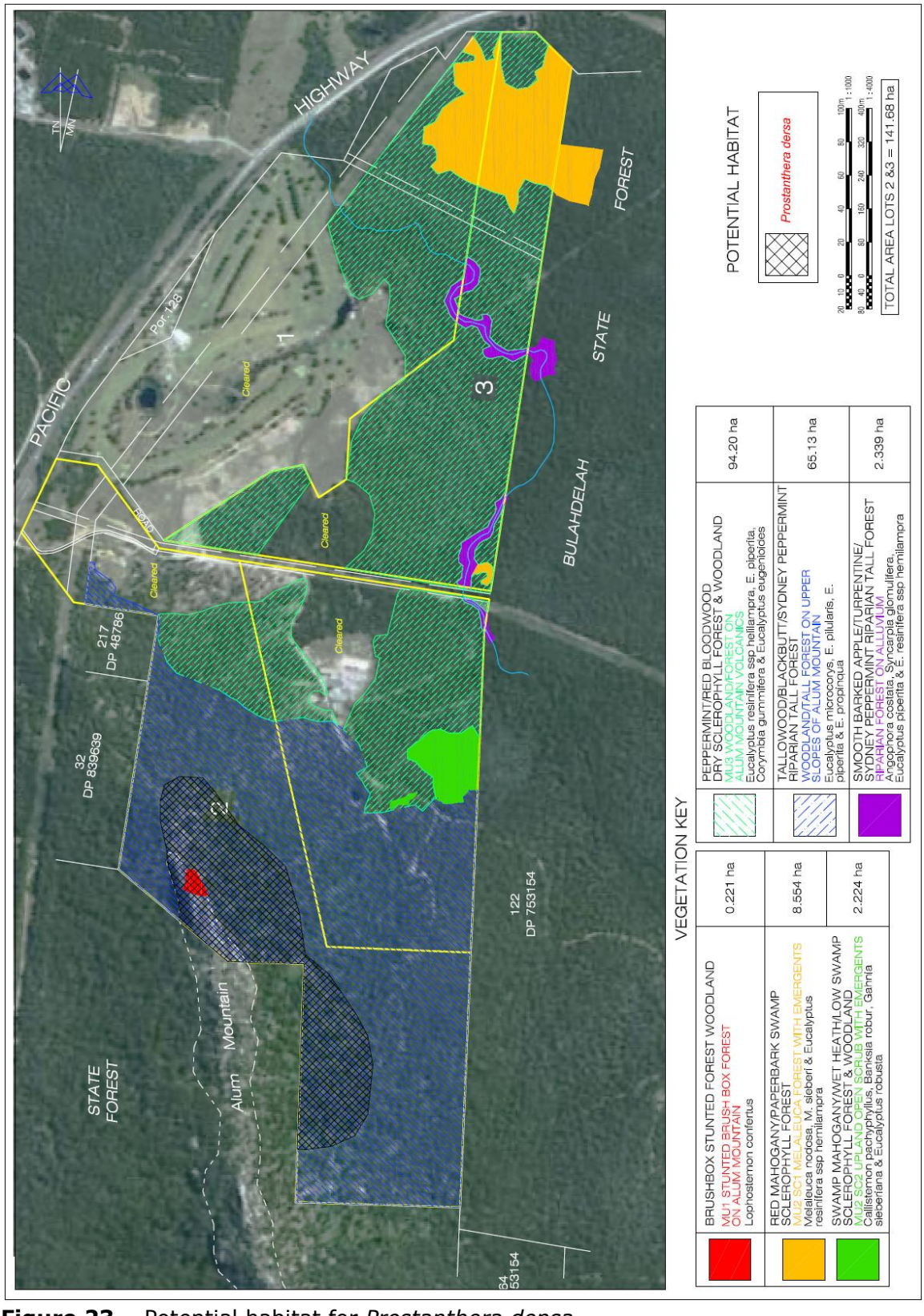


Figure 23 – Potential habitat for *Prostanthera densa*

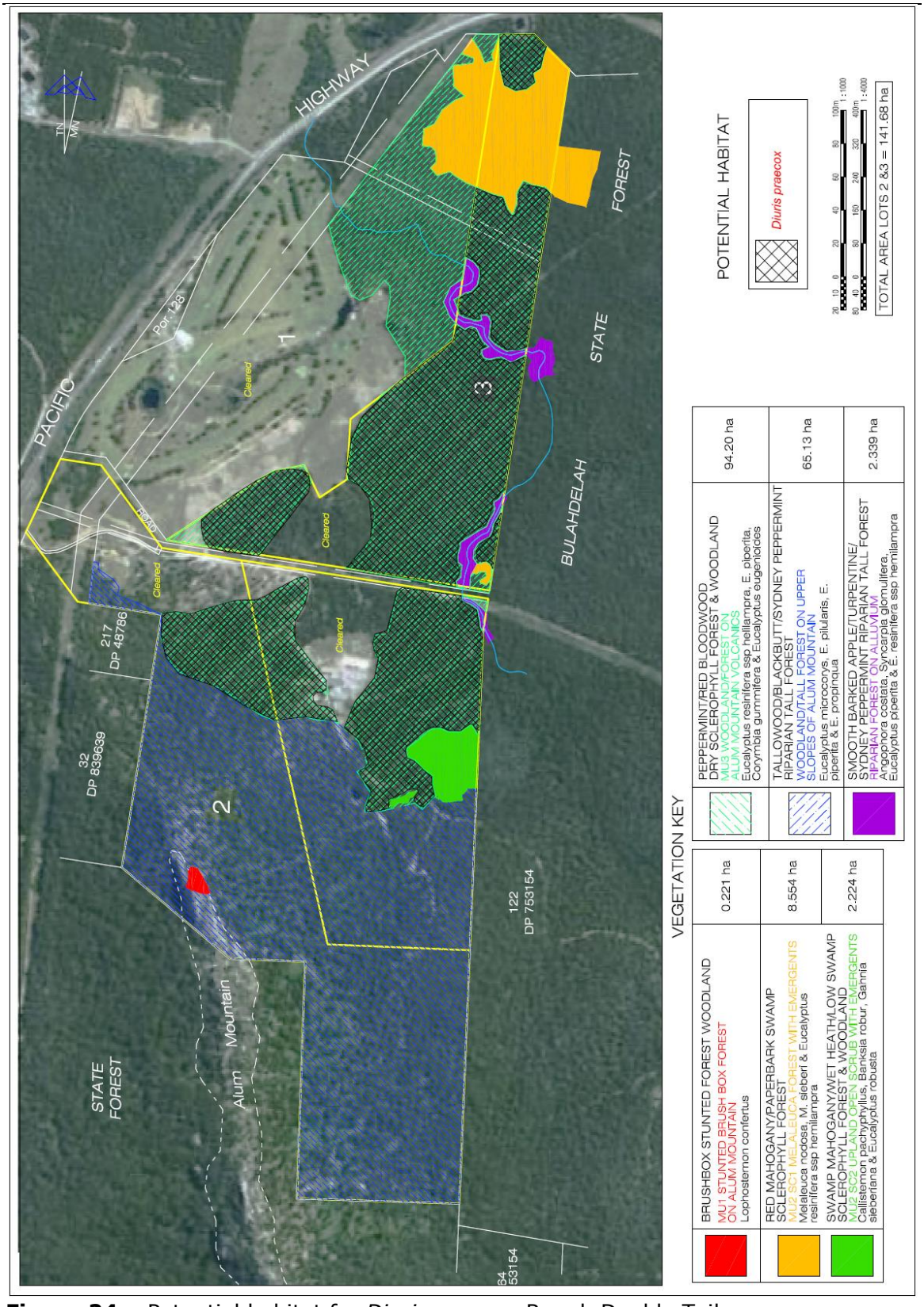


Figure 24 – Potential habitat for *Diuris praecox* Rough Double Tail

5.9 Identification of map unit boundaries

As previously stated map unit boundaries were defined on the ground using a high powered differential GPS. However the map unit identification procedure involved one difficulty. Whilst the boundaries of the Melaleuca forest with emergents, the upland open scrub (group 2 vegetation units) and riparian forest, was clearly distinct from one another, the boundary between forest on coastal lower slopes/coastal plains (group 3) and tall forest on upper slopes (group 4) was not. On the return site visit in January 2010 this vegetation had been hazard reduced and therefore the boundary between the two vegetation groups became indistinct in that a wide treed ecotone, without understorey, was present. All of the understorey vegetation was in a state of re-growth and there was difficulty distinguishing understorey vegetation species. Therefore, this boundary is shown on Figure 25 as a dotted line to indicate this uncertainty. Otherwise the remainder of the boundaries are satisfactory.

Alternatively, group 2 and group 5 vegetation units were easy to distinguish and no problems were encountered during the DGPS survey procedure. It should be noted that the boundary line chosen will have an accuracy of ± one metre in position at each traverse point but vegetation boundary determination can be interpreted differently by various Ecologists (see Payne & Harty, 1998; Winning, King & Bailey, 2000; Bignold, 2006). In this particular case, the vegetation boundary line was defined as a mean line through the ecotonal area (i.e. the overlap area between two adjoining vegetation types) whilst some Ecologists will determine the boundary at the extreme limit of the ecotone.

The Fry's Creek riparian forest boundary was based upon the presence of rainforest species and the *Gahnia clarkei* and *Lepidosperma longitudinale* understorey. This would appear adequate for the purposes of the local environmental study because both understorey species would have a positive diagnostic value. In some cases small tributaries are present, dominated by these *Gahnia clarkei* sedgelands. These areas were ignored for the purposes of this study because many of these tiny tributaries are present which would have made the survey too time consuming.

With respect to making the digital map the derived or true co-ordinates, received by the DGPS, were plotted onto the base map. To determine the accuracy of the survey, cadastral marks were also surveyed after each days survey work and these points are also plotted onto the map. A small triangle of error always occurs between the derived co-ordinates and the cadastral marks and therefore the set of mapped polygons are adjusted to fit the cadastral marks. This results in the true co-ordinates being slightly modified.

The boundaries of the map units have not been marked in the field. This is because too many points were required to define the boundary.

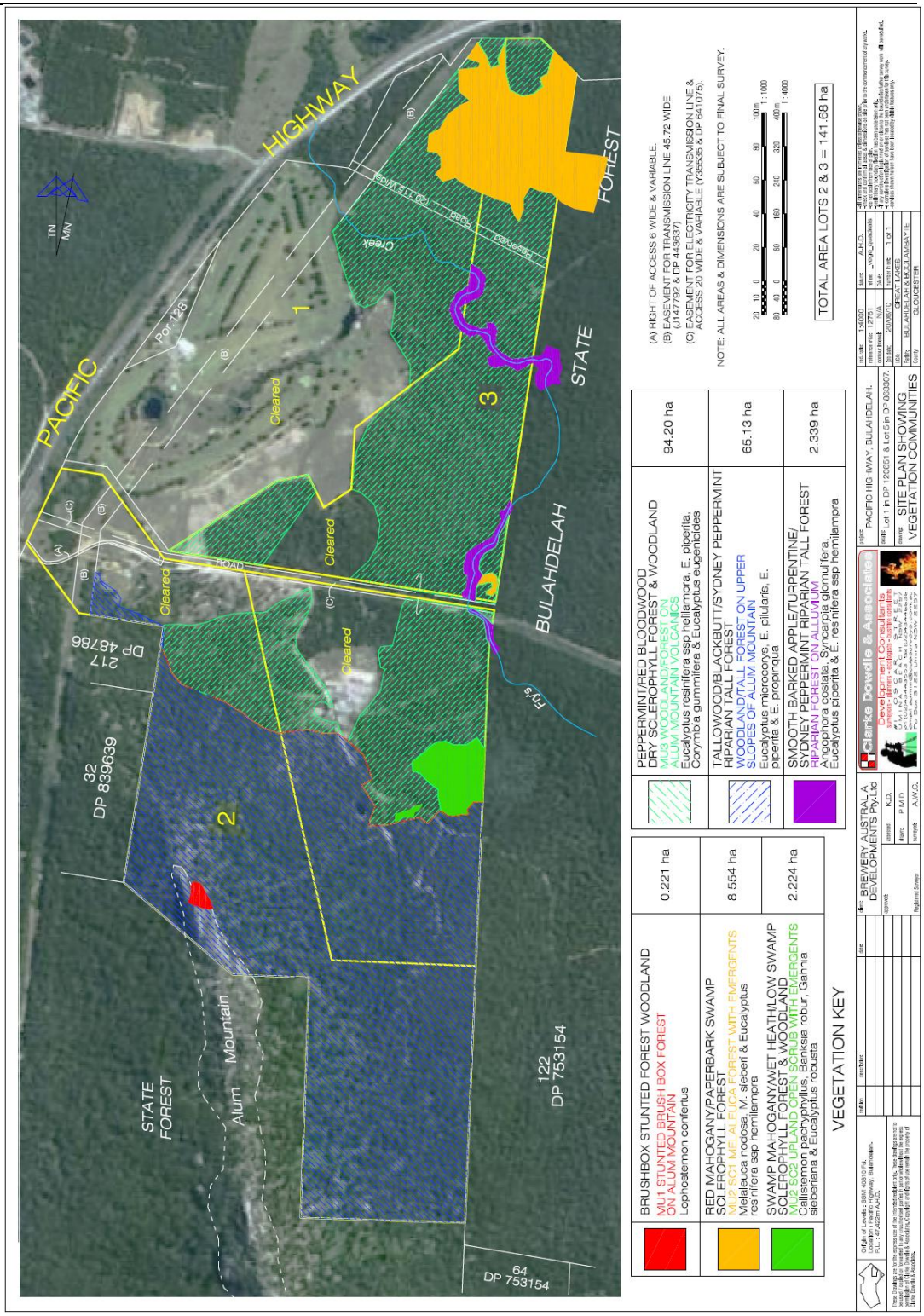


Figure 25 – Vegetation mapping of the subject site (NB. The boundary between Woodland/Forest on Alum Mountain Volcanics over lower coastal slopes and plains &

Woodland/Tall Forest on upper slopes of Alum Mountain Volcanics is shown partly a red dotted line).

5.10 Proposed future land usage

The proponent has provided a preliminary design layout for the envisaged land usage upon the subject site. The following Figure 26 outlines the proposed design layout underlain with the existing map units.

From the proposed development layout on the site and the accurately defined map unit boundaries, table 19 outlines the potential area of landtake to each map unit within the site.

Table 19 – Potential landtake of the proposed development

Vegetation	Area of map unit within the site (hectares)	Area of potential landtake (hectares)	Percentage landtake of map unit(%)
GROUP 1	0.22	0	0
GROUP 2 SUB-COMMUNITY 1	5.31	0	0
GROUP 2 SUBCOMMUNITY 2	2.22	1.27	57.1
GROUP 3	81.22	20.31	25
GROUP 4	65.13	3.922	6
GROUP 5	2.2	0	0

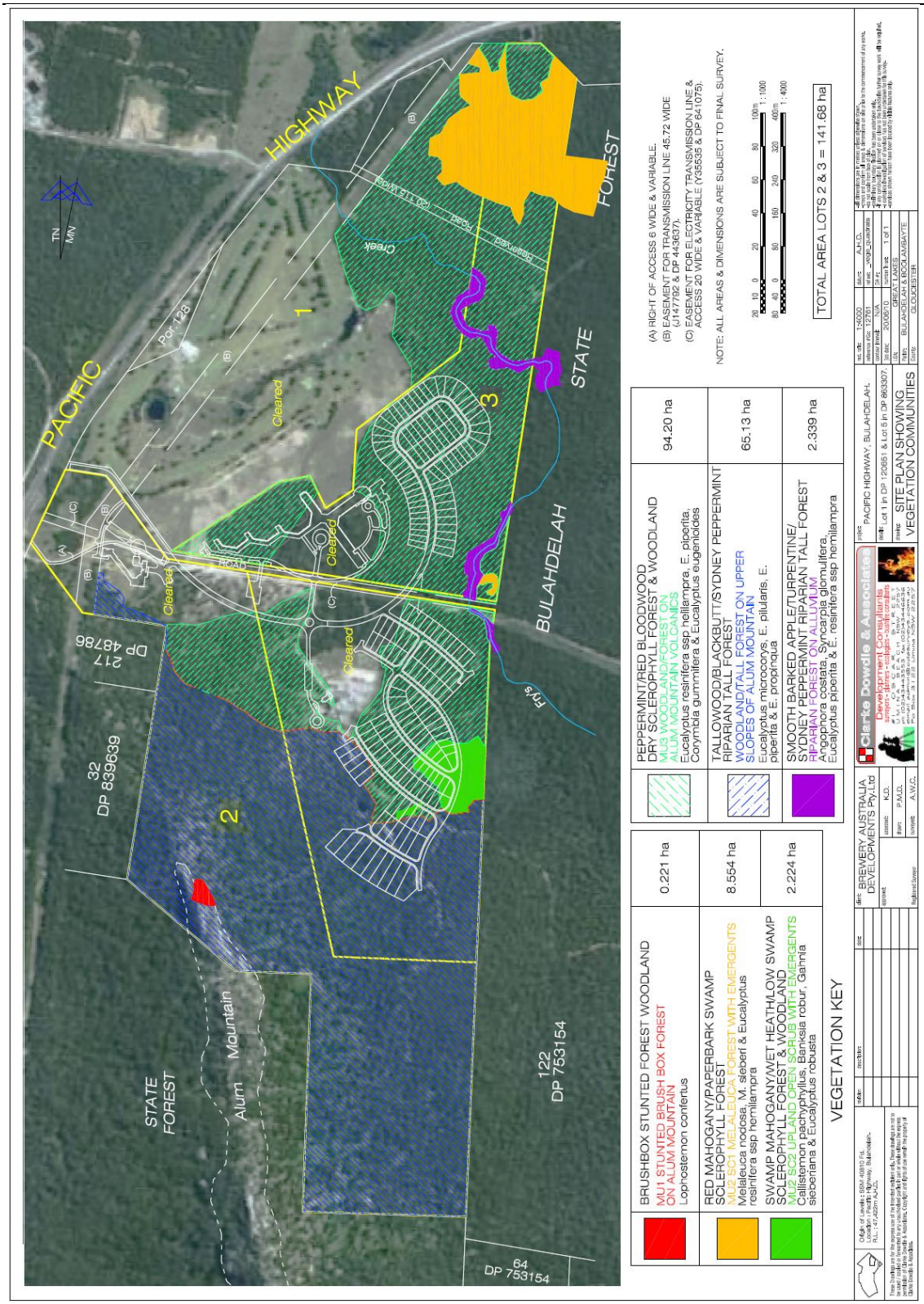


Figure 26 – Overlay map showing the proposed development in relation to the vegetation communities.

5.11 Classification of vegetation under the Native Vegetation Act

Under the Native Vegetation Act 2003 the following definitions are provided to categorise native act:

- Native vegetation means indigenous vegetation and includes trees, understorey plants, groundcover plants and plants occurring in a wetland. For vegetation to be indigenous it must have been present prior to European settlement.

- Remnant native vegetation means any native vegetation other than regrowth.

- Regrowth vegetation means native vegetation that has regrown since 1 January 1983.

Figure 27 shows the vegetation classifications on the subject site and for most of the site vegetation can be classified as remnant native vegetation. Some regrowth vegetation does occur but is restricted to the area immediately north and south of the existing dwelling.

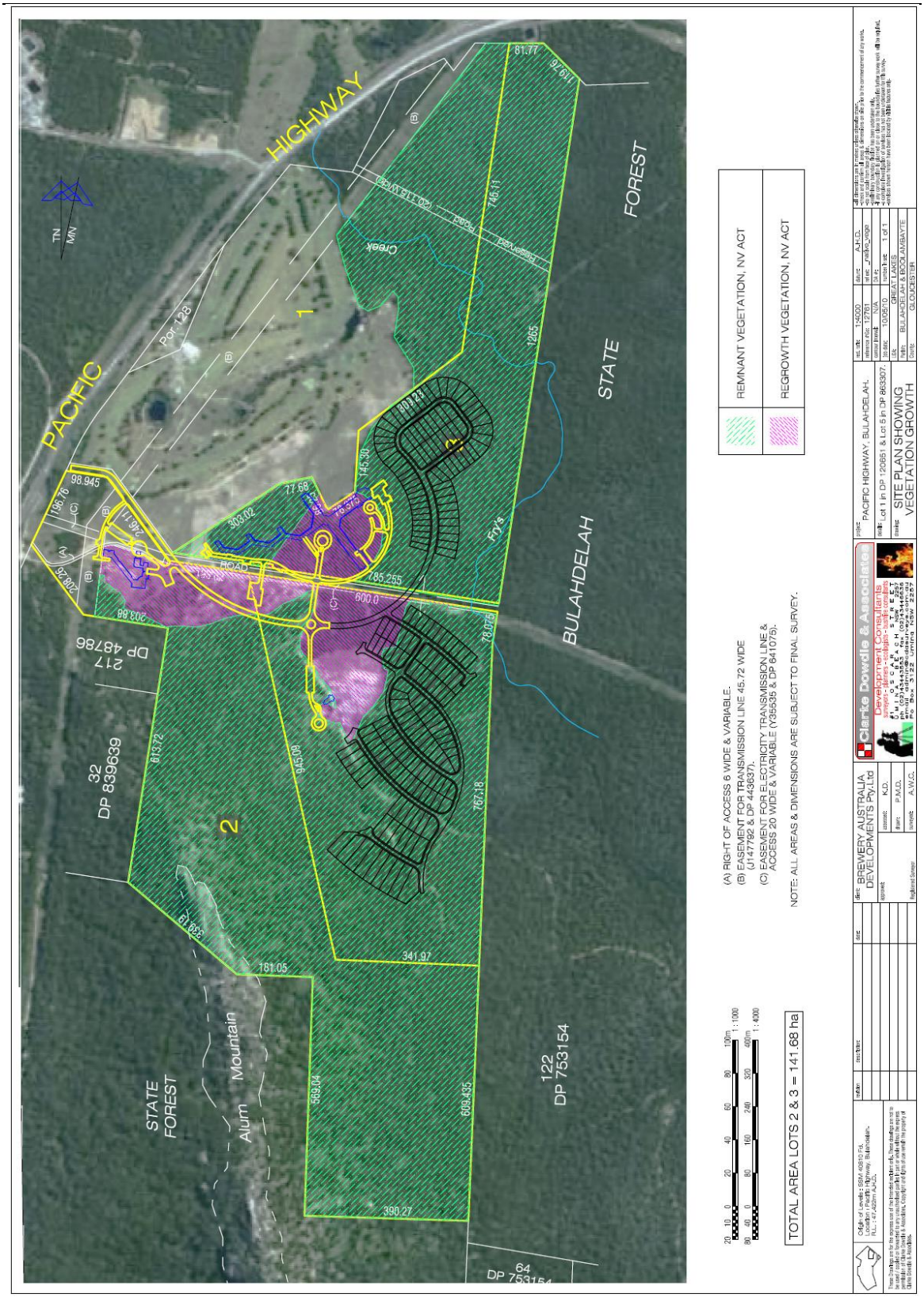


Figure 27 – Classification of vegetation on the subject site under the Native Vegetation Act, 2003 along with the proposed development layout.

6.0 DISCUSSION

The local environmental vegetation study of Alum Mountain and surrounds utilized an adequate number of survey plots to determine map units and/or vegetation communities. Additional transects were undertaken along the cliff faces of Alum Mountain, the dry northern gullies and Frys Creek to comply with NSW DECCW requirements for adequate survey. A further minor number of transect surveys would still be required through Group 3 and Group 4 vegetation to comply with NSW DECC requirements. Additional targeted surveys were undertaken to establish the presence of threatened species and orchids.

However, the site is large and to-date the only rare plant species recorded was *Tetratheca juncea* Black-eyed Susan on the coastal plain by Geoff Winning (HWR Ecological) and on the Alum Mountain rock face by Peter Hind (Royal Botanic Gardens) and Robert Payne. Although no further plants of *T. juncea* were found, it is likely to be present but the area would not be regarded as an "important area" for the species in terms of large population numbers. The species is, however, at its known northern limit of distribution at Alum Mountain which makes the population important. Currently on public exhibition by the Commonwealth Department of Arts, Heritage & Environment is the revision of *T. juncea* and any further information on this population status must wait for the findings of that investigation.

Nevertheless, even though searches for other rare plant species were not found, *Asperula asthenes* and *Syzygium paniculatum* could occur along Fry's Creek and *Corybas dowlingii* could also be present in the same habitat, as well as in the drier gullies and slopes. *Lindernia alsinoides* could also be present in the Melaleuca wetlands north of Frys Creek and *Cryptistylis hunteriana* could be present anywhere throughout the property.

At this stage, surveys for the rare orchid species have been completed but surveys for *Lindernia alsiniodes* were not undertaken because its preferred habitat is Melaleuca wetland, which is present north of Frys Creek but is anticipated to be protected under this proposal. Between August and February is the correct timing for targeting *Cryptostylis hunteriana* and it is noted from the NSW Department of Climate Change website that *C. dowlingii, Cryptostylis hunteriana* and *Rhizanthella slateri* were all located on the same western slope of Alum Mountain but this project does not involve slopes that are west facing. However, the site does support dry northern facing gullies with *Gahnia clarkei* sedgelands which are present at the known location for the Eastern Underground Orchid. Given all these circumstances the property was randomly searched from June to February for rare orchids and plants, without any success. Nevertheless, further searches are still required for the Eastern Underground Orchid and perhaps the Small-snake Orchid.

Given that the PATN analysis merged together, at a local scale, the hanging swamp (group 2 sub-community1) and the Swamp Sclerophyll Forest EEC (group 2 sub-community 2) they are, in reality, two distinctly different map units. Both sites merged into the one group because of similar dominant canopy tree and sub-canopy tree species. However, understorey vegetation, soil type and position in the landscape (the latter being an important determinant for an EEC) are distinctly different with the former being permanently waterlogged and the latter being subject to inundation in times of heavy rain. As the Swamp Sclerophyll Forest is within a backswamp of Fry's Creek these areas are to be regarded as the Swamp Sclerophyll Forest on coastal floodplains EEC under the Threatened Species Conservation Act, 1995. The hanging swamp escapes this classification because of its non association with a floodplain drainage line. It occurs at this higher elevation because of seepage from Alum Mountain over an impervious rock stratum.

Others could argue that group 2 sub-community 1 is not Swamp Sclerophyll Forest because the substrate is not waterlogged permanently. *Melaleuca spp.* also quite often occur as a dominant sub-canopy tree elsewhere in the region e.g. in the Wyong Spotted Gum - Red Mahogany-White Stringybark Forests on flats as well as slopes. Within these forests at Wyong there is a sandy clay layer of high plasticity at about 0.6m depth, which retains runoff within the shallow surface layer and which causes runoff to flow along and sit just below the surface on top of the clay layer. This soil type is conducive to the establishment of an understorey of *Melaleuca spp*. but this is not the case at Bulahdelah for the Swamp Sclerophyll Forest soils are largely sands with only minor clay content. Thus runoff within the Bulahdelah Swamp Sclerophyll Forest has the capability of draining more quickly through the soil profile and is not retained at or near the surface, except for the short post rainfall period.

Nevertheless, it can be shown by the contour shapes that overflow drainage from Frys Creek would enter the SSF area indicating that the vegetation is a backswamp from the main stream.

The boundaries of this EEC maybe somewhat exaggerated at this stage (Figure 25). Subsequent investigation shows some areas are dominated in the understorey *by Entolasia marginata?, Gahnia radula, Banksia spinulosa, B. oblongifolia* and *Leptospermum polygalifolium subsp. polygalifolium.* A larger number of canopy trees are also present. Whilst these species are components listed in the NSW Scientific Committee's determination further quadrats are required to more precisely define the EEC area for any further regional analysis. The boundary line of the EEC has included, at this stage, the *Melaleuca spp*. sedge and grass species listed in the determination where the community occurs on the 'associated" lithic substrate soils, which is how the EEC was determined at Raymond Terrace (Motorplex vs. Port Stephens Council, 2007).

The vegetation mapping for this project is based upon specially flown recent aerial photography to cover the site which was not otherwise available. Through a process of aerial triangulation, accurate measurement of field survey ground control and three dimensional transformations, the survey team produced an accurate base map for vegetation mapping purposes. The vegetation mapping is also based on precision, with the use of high-powered DGPS and as a result the polygons of the smaller map units reflect this. They would differ, perhaps significantly, from the broader modelling approach to be adopted by Hunter Councils for the regional mapping, but nevertheless this mapping is more than suitable for incorporation into the regional mapping program (M. Somerville pers. com., June 2010).

The map units derived for this project are at a finer scale than what has been determined in the regional mapping process. The lower north coast has a number of vegetation communities that have been poorly sampled previously. For example, during this process the vegetation of the Alum Mountain volcanics has now been sampled and the regional map units have been able to be determined and if equivalents exist.(see section 7.4).

Conservation attributes for vegetation are all high for all of the vegetation identified using the earlier criteria developed by the various authorities (Table 10). Further updated analysis of the regional vegetation map units shows that at least the conservation status of the upper slope vegetation can be moderated based on an update of its distribution. All of the other map units are still rated at a fairly high status.

Somerville (2009) does not record the coastal plain vegetation in the most recent regional update. Group 3 vegetation, being dominated by Red Mahogany, according to the conservation documents (e.g. Hager & Benson, 1994), is recognized as being regionally rare or severely depleted and Somerville (2009) does not include such a map unit in the most recent regional analysis, which includes the Great Lakes LGA. Tables 11 & 12 summarises the earlier vegetation significance criteria and Table 14 provides the update based on regional criteria.

7.0 SURVEY LIMITATIONS AND ADEQUACY

There are some limitations to this survey and this was caused by the disjunct nature of the project. Initially a mammal and tree hollow survey was completed by HWR Ecological but no detailed report was prepared. Due to unforeseen circumstances only limited field notes and maps survive covering the results of this fieldwork, which at that time, was prepared for a flora and fauna survey of only part the property. The flora survey, in particular, was still outstanding. Following discussions with *Great Lakes Shire Council* and having regard to the original proposal prepared by HWR Ecological (2006) several flora and fauna issues remained to be completed over the subject site and the adjoining land.

Surveys that followed to compile the flora and fauna data are disjunct. Initially, surveys were begun by HWR Ecological in 2005 and due to unforeseen circumstances were not able to be continued. Clarke, Dowdle & Associates took over responsibility of the surveys in 2006 and the project was temporarily stopped by the client in April 2007. The project re-commenced some months later but ceased for a further 12 month period between 2009 and 2010. Further re-commencement began in early 2010 but the project was terminated in August 2010 during the orchid searches.

This report is version 5 of the documentation for the LES which is a final draft. This version of the LES includes references to the Hager & Benson (1994) conservation status document. In relation to the Forest Ecosystem document, the necessary information required and highlighted in the review, was adopted from those comments made by Great Lakes Council.

The project could be improved if extra transect surveys were undertaken through the EEC area to determine a more complete species composition. However due to any future land use not utilising this area, further transects are not deemed necessary.

The following lists what was achieved and what is still outstanding;

QUADRATS:

- **Alluvium** – 2.339 ha; Two quadrats surveyed and two required.
- **Floodplain** – 8.554 ha; One quadrat surveyed but two required. However this part of the property was only included in the project during the very late stages.
- **Summit** – approximately 5 ha; Four quadrats surveyed but only two required.
- **Upper slope/midslope** - 51.57 ha; Eleven quadrats surveyed but only three required.
- **Coastal plain** – 94.20 ha; Seven quadrats surveyed but only three required.

TRANSECTS:

- **Alluvium** – 2.339 ha; One transect undertaken along full length of creek. Two 100m transects required. Probably adequate
- **Floodplain** – 8.554 ha; No transects surveyed but two required. However this part of the property was only included in the project during the very late stages.
- **Summit** – approximately 5 ha; Two transects surveyed and two required. Adequate.
- **Upper slope/midslope** - 51.57 ha; Two transects surveyed but three required. Inadequate.
- **Coastal plain** – 94.20 ha; Two transects surveyed at this stage and three required. Inadequate.

8.0 CONCLUSIONS

The flora study of Lot 3 in DP 1120817 and Lot 100 in DP 113447 was carried out over a period of four years by HWR Ecological, Robert Payne (Ecological Surveys & Management) and Kristan Dowdle (Clarke, Dowdle & Associates). Although the study has not been finalised the following has been found in relation to flora;

- Two areas, one which is larger and located north of Frys Creek and the other smaller area at the southern end of Frys Creek are examples of the endangered ecological community "Swamp Sclerophyll Forest on coastal floodplains".
- Two areas below Alum Mountain at a higher elevation are an example of "hanging swamp" vegetation which appears to be unique in the Lower North Coast Region and should be retained and/or included in the planning design and/or wildlife corridor for any future development
- *Tetratheca juncea,* a threatened species, was recorded by HWR Ecological in the initial stages of the project on the Coastal Plain and a small population is still present on Alum Mountain outside of the site boundaries. No other threatened plant species were recorded.
- *Callistemon acuminatus* and *Eucalyptus fergusonii subsp fergusonii*, listed ROTAP species, were collected from the summit of Alum Mountain and from the lower slopes near the dwelling respectively.
- Two other species, *Leptospermum polyanthum* and *Pleurosorus rutifolius* were found confined to Alum Mountain and are regarded as being uncommon at a local scale.
- Most of the identified vegetation map units, as set out in the conservation documents, are considered to be significant at a regional scale, although that map unit (Tallowwood forests) occurring on the upper slopes appears to be well represented in the region.
- The property subject, to this study, also supports potential habitat for other rare or threatened plants and orchids, known to occur in the Great Lakes LGA.
- Relatively precise mapping showing the vegetation map units was compiled using specially flown aerial photography and the combination of field traversing and a high powered differential GPS and has been provided to Great Lakes Council in digital format.
- Further investigation is required on the impact on the vegetation from goats and abseiling activities on the cliff faces and summit of Alum Mountain.

There may be still some outstanding issues relating to the flora. Further orchid surveys for *Rhizanthella slateri* Eastern Underground Orchid and *Diuris pedunculata* the Small-snake Orchid may be required. NSW DECCW, if they are involved in the process may require further targeted surveys for *Galium australe* and *Phaius australis*.

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