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Flora and Fauna Assessment



Tripoli Way, Albion Park, NSW, 2527

Proposed road extension

Prepared for: Cardno

21 January 2022 – FINAL

PROJECT NUMBER	2016-042			
PROJECT NAME	Flora and Fauna Assessment			
PROJECT ADDRESS	Tripoli Way, Albion Park, NSW, 2527			
PREPARED FOR	Cardno			
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REVIEW	Technical	QA	Version	Date to client
	Will Introna		Draft 1.0	26 June 2020
	Ed Cooper		Draft 1.1	11 November 2021
	Ed Cooper		Draft 1.2	18 November 2021
	Ed Cooper		FINAL	21 January 2022

This report should be cited as: 'Ecoplanning (2022). Flora and Fauna Assessment– Tripoli Way, Albion Park, NSW, 2527. Prepared for Cardno.

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Glossary and abbreviations

Acronym	Description
BC Act	NSW <i>Biodiversity Conservation Act 2016</i>
DotE	Commonwealth Department of the Environment (now DotEE)
DotEE	Commonwealth Department of the Environment and Energy
DPIE	NSW Department of Planning, Industry and Environment
EEC	Endangered Ecological Community
ELA	Eco Logical Australia
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
FFA	Flora and Fauna Assessment
GHFF	Grey-headed Flying-fox
ha	Hectares
HBT	Hollow Bearing Tree
LGA	Local Government Area
mm/cm/m/km	millimetres/centimetres/metres/kilometres
MNES	Matters of National Environmental Significance
NPWS	National Parks and Wildlife Service
PCT	Plant Community Type
REF	Review of Environmental Factors
SDCP	Shellharbour Development Control Plan 2013
SLEP	Shellharbour Local Environment Plan 2013
TEC	Threatened Ecological Community, listed as vulnerable, endangered or critically endangered under either the BC Act and/or EPBC Act
WoNS	Weeds of National Significance
*	Denotes exotic species
†	Denotes both native and introduced species

1 Introduction

1.1 Purpose of report and legislative context

This flora and fauna assessment has been undertaken for the proposed construction of a road extension at Tripoli Way, Albion Park, NSW. The purpose of this report is to identify and assess the flora and fauna within the study area, and to assess the likely impacts of the proposed development. This report addresses the legislative context provided in **Table 1.1** and the proposal is to be assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This report will be used to inform the Review of Environmental Factors (REF) being prepared for the proposed works.

Table 1.1: Legislative framework addressed in this report.

Instrument	Considerations	Context
Commonwealth		
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	Matters of National Environmental Significance	An action will require approval from the Minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance.
State (New South Wales)		
<i>Biosecurity Act 2015</i>	Priority weeds	Describes the state and regional priorities for weeds in New South Wales.
<i>Biodiversity Conservation Act 2016</i> (BC Act)	Part 4, Divisions 2 and 5	Lists threatened species, populations, ecological communities and key threatening processes to be considered under Section 5A EP&A Act.
<i>Environmental Planning and Assessment Act 1979</i> (EP&A Act)	Part 5	Describes the planning context for infrastructure and environmental impact assessment.
<i>Fisheries Management Act 1994</i> (FM Act)	Schedules 4, 4A, 5 and 6 and Part 7	The Schedules list threatened species, populations, ecological communities and key threatening processes to be considered under Section 5A EP&A Act. Part 7 relates to any work that requires dredging or reclamation on water land.
<i>Water Management Act 2000</i> (WM Act)	Section 91	Controlled activity approval is required for activities in, on or under waterfront land.
Local		
Shellharbour Local Environmental Plan (SLEP) 2013	Clause 5.9 – Preservation of trees or vegetation	The objective of this clause is to preserve the amenity of the area, including biodiversity values, through the preservation of trees and other vegetation.
	Clause 6.5: Terrestrial biodiversity	The objective of this clause is to maintain terrestrial and aquatic biodiversity. It applies to land identified on the 'Natural Resources – Biodiversity Map'.



Instrument	Considerations	Context
Shellharbour Development Control Plan (DCP 2013)	Chapter 21: Preservation and Removal of Trees or Vegetation	<p>Some of the main objectives of Chapter 21 are:</p> <ul style="list-style-type: none"> a) To provide circumstances where trees or vegetation require a tree management permit if it is sought to ringbark, cut down, top, lop, remove, injure or wilfully destroy them. b) To provide advice on tree/vegetation removal and maintenance c) To preserve the amenity of the area, including biodiversity values, through the preservation of trees and vegetation

1.2 Site description

Following the *Threatened Species Test of Significance Guidelines* (OEH 2018) the subject land is defined as the area 'directly impacted upon by the proposal'. The study area is defined as the subject land and all areas that are indirectly impacted upon by the proposal.

The study area includes a number of partial lots traversing both public and private residential land as well as private agricultural allotments (**Figure 1.1**). It includes approximately 27.21 hectares (ha) of land, is situated in the Shellharbour Local Government Area (LGA) and is currently zoned under the Shellharbour Local Environmental Plan (SLEP) 2013 as RU1 – Primary Production, RU2 – Rural Landscape, R2 – Low Density Residential, RU6 – Transition, RE1 – Public Recreation and SP2 - Infrastructure.

The study area comprises largely cleared grassland with the closest continuous stretch of native vegetation occurring within ridges and gullies south of the township of Albion Park. The Macquarie Rivulet (5th order) runs eastwards just north of the study area, and the study area intersects a section of the Macquarie Rivulet Floodplain at the central-eastern end. The study area also intersects Hazelton Creek (3rd order) and two unnamed 1st order streams.

1.2.1 Local area

Unless otherwise stated, the local area is described as the area within 5 km of the study area (**Figure 1.2**). The local area includes land zoned as RU1 – Primary Production, RU2 – Rural Landscape and E3 – Environmental Management under the SLEP (2013). Native vegetation within the local area consists of predominantly cleared and/or disturbed lands, having historically been cleared for agriculture and grazing, and for residential development. Much of the remaining native vegetation within 5 km of the study area is associated with major drainage lines in the region, such as the Macquarie Rivulet and the steep ridges towards the foothills of the Illawarra Escarpment. Connectivity of native vegetation within the study area to the surrounding landscape has been interrupted by residential development and pastureland. The Macquarie Rivulet provides low-moderate connectivity to vegetation north of the study area.

1.3 Description of the proposed development

The proposal is for the extension of Tripoli Way to connect Tongarra Road at the western end of Albion Park to Terry Street at the eastern end. The subject land covers an area of 19.12 ha and includes the construction footprint and ancillary sites (**Figure 1.3**). The intent of the proposal is to reduce the impacts of predicted traffic growth on Albion Park. The proposal would involve the construction of new roadways and pedestrian walkways as well as upgrades to existing roadways. The proposed development will require the removal of a number of mature native trees and patches of native vegetation.

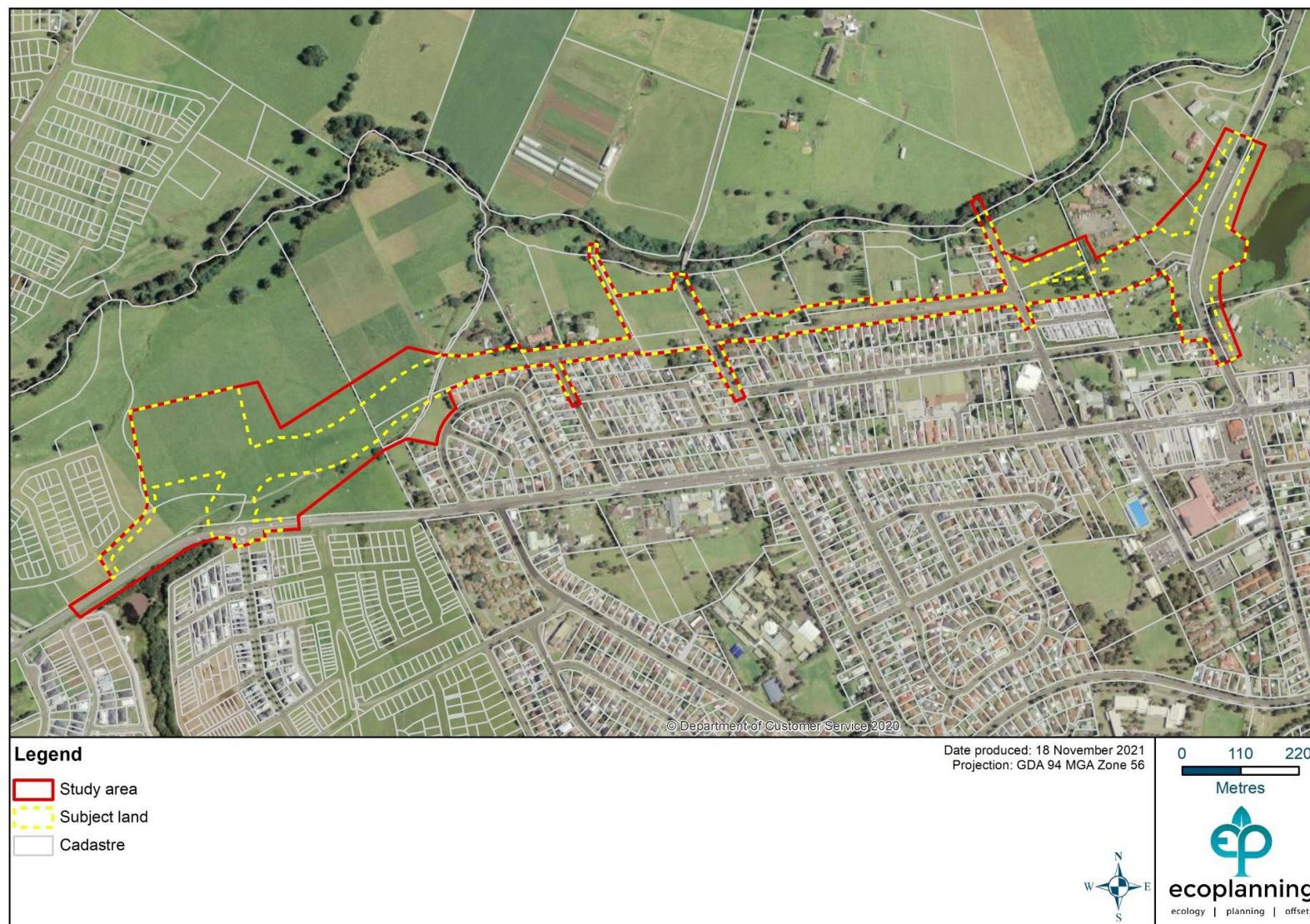


Figure 1.1: Study area.

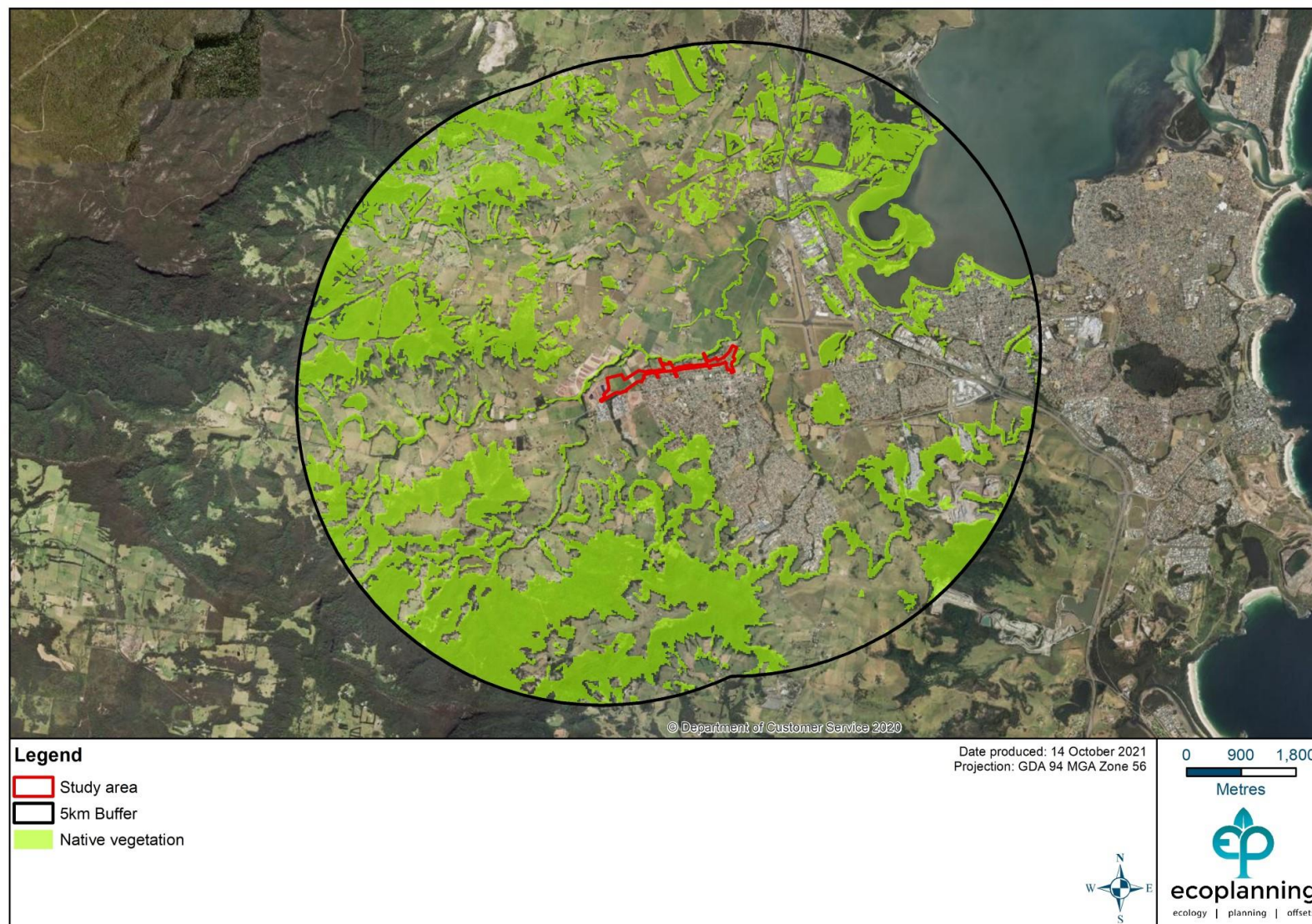


Figure 1.2: Mapped native vegetation in the local area (ELA 2015).

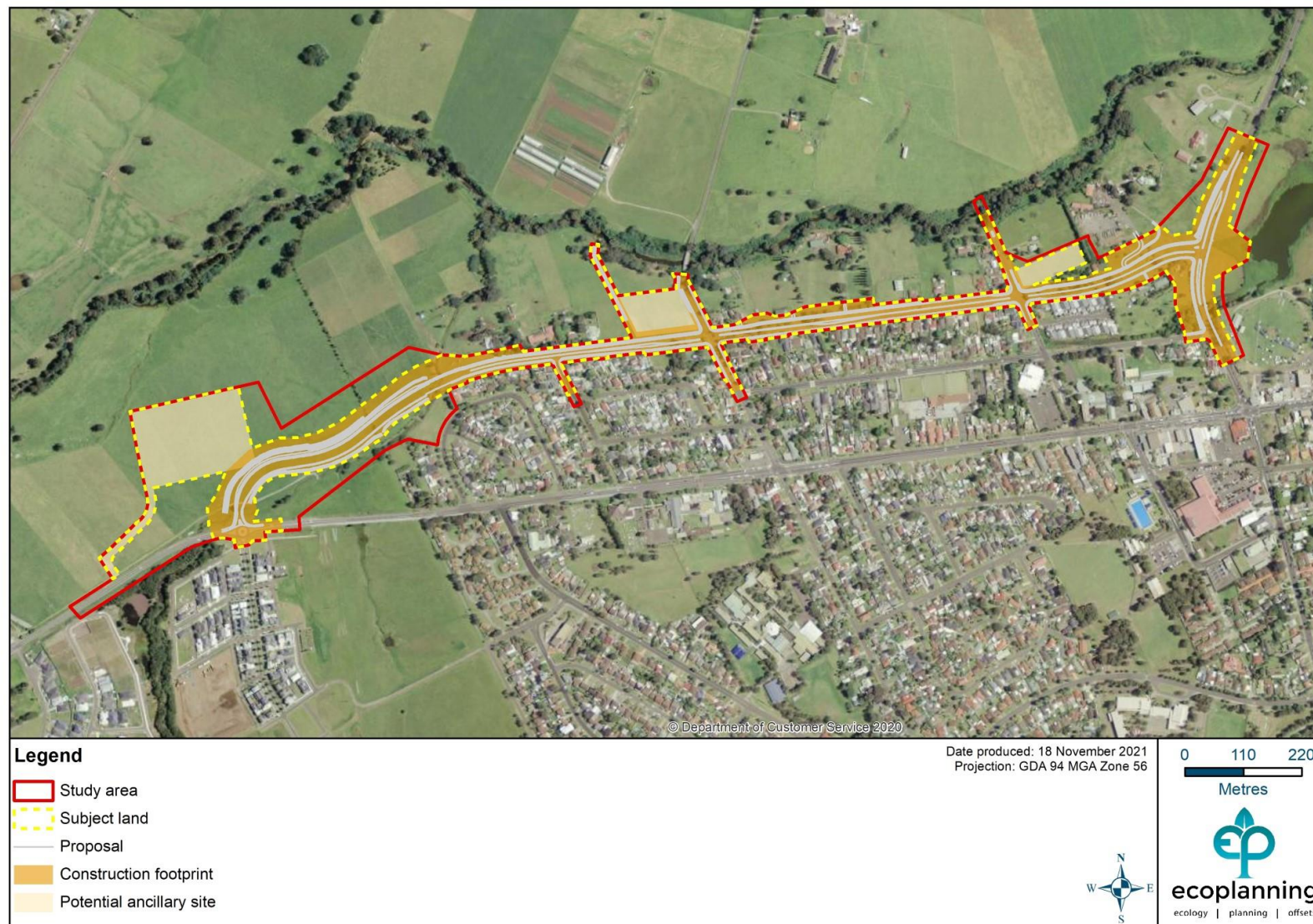


Figure 1.3: Proposed concept plan within the study area (supplied by Cardno 23/09/21).

2 Methods

2.1 Literature and database review

A site-specific literature and database review were undertaken prior to field survey and report preparation. This included desktop analysis of aerial photography and regional scale information from the following sources:

- BioNet Atlas (NSW Department of Planning, Industry and Environment (DPIE) 2020b)
- NSW Planning Viewer (DPIE 2020c)
- Protected Matters Search Tool (Commonwealth Department of the Environment and Energy (DoEE) 2020)
- SIX Maps (Land and Property Information (LPI) 2020)
- South East Local Land Services Biometric Vegetation Map (ELA 2015)
- Native Vegetation of the Illawarra Escarpment and Coastal Plain (NPWS 2002)

Polices and guidelines relating to the proposal:

- Threatened Species Test of Significance Guidelines (OEH 2018)

Threatened species, populations and migratory species recorded within 5 km of the study area in a search of the BioNet Atlas of NSW Wildlife (DPIE 2020b) were consolidated and their likelihood of occurrence was assessed by:

- review of location and date of recent (< 5 years) and historical (> 5-20 years) records
- review of available habitat within the study area and surrounding areas
- review of the scientific literature pertaining to each species and population
- applying expert knowledge of each species

The potential for threatened species, populations and/or migratory species to occur was then considered and the necessity for targeted field surveys was determined. Following field survey and review of available habitat within the study area, the potential for species to use the site and to be affected directly or indirectly by the proposal were considered as either:

- “Recent record” = Species has been recorded in the study area within the past 5 years
- “High” = Species has previously been recorded in the study area (>5 years ago) or in proximity to (for mobile species), and/or habitat is present that is likely to be used by a local population.
- “Moderate” = Suitable habitat for a species is present onsite but no evidence of a species detected and relatively high numbers of recent records (5-20 years) within 5 km of the study area or species highly mobile.
- “Low” = Suitable habitat species for a species is present onsite but limited or highly degraded, no evidence of a species detected and relatively low number of recent records within 5 km of the study area.

- “Not present” = suitable habitat for the species is not present onsite or adequate survey has determined species does not occur in the study area.

2.2 Field survey

A field survey was undertaken on 16 January 2020 by Lucas McKinnon (Principle Ecologist) and John Gollan (Ecologist). The field survey included a general flora and fauna habitat and vegetation community assessment. Weather conditions on the day were warm and overcast with light showers in the morning and moderate winds in the afternoon (**Table 2.1**).

Table 2.1: Daily Weather Observations taken from Shellharbour Airport Station 068241 (~1.5 km east of the study area).

Date	Temp (°C)		Rainfall (mm)	Max wind gust	
	Min	Max		Direction	Speed (km/h)
16/01/20	20.3	30.9	2.6	S	46

2.2.1 Vegetation communities and flora

Field survey involved traversing the study area, whilst recording all visible flora species and identifying potential habitat for threatened flora species. Areas of intact, resilient vegetation were surveyed more extensively than degraded areas of the site. Nomenclature follows the Flora of NSW (Harden 1990-2002) and updates provided in PlantNET (RBGDT 2020).

Field survey was undertaken to validate regional vegetation mapping of ELA (2015) and NPWS (2002) within the study area. Vegetation communities were checked against described Threatened Ecological Communities (TEC) listed under either the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the NSW *Biodiversity Conservation Act 2016* (BC Act).

2.2.2 Fauna and fauna habitat

Opportunistic fauna survey was undertaken for birds, amphibians, reptiles and mammals, which included opportunistic observations along with searches for signs of direct and indirect occupancy (i.e. scats, owl pellets, fur, bones, tracks, bark scratches, foliage chew marks and chewed cones of *Allocasuarina* spp. or *Pinus* spp. as well as some of the other cultivars known to be used by native fauna).

Fauna habitat searches were conducted for potential foraging, roosting, breeding or nesting habitat of nocturnal and diurnal species. This includes inspection for the presence of tree hollows, stags, bird nests, possum dreys, decorticated bark, rock shelters, rock outcrops/crevices, mature / old growth trees, food trees (*Banksia* spp., *Allocasuarina* spp., and winter-flowering eucalypts), culverts, dens, dams, riparian areas and refuge habitats of man-made structures.

Primary sources of literature accessed for species nomenclature were:

- Birds - Christidis and Boles (2008)
- Mammals - Van Dyck and Strahan (2008)



2.2.3 Survey limitations

The flora survey aimed to record as many species as possible. However, a definitive list of the flora within the study area cannot be gathered without systematic traverses and survey across a number of seasons. However, the techniques used in this investigation are considered adequate to gather the data necessary to validate the vegetation communities and vegetation condition in the study area and assess the likelihood of occurrence of any threatened flora species.

A full fauna survey following *Threatened Species Survey and Assessment Guidelines* (DPIE 2020d) was not undertaken as sufficient detail to determine the likelihood of occurrence of threatened and migratory species for the purpose of this report was achieved through a small amount of targeted survey and a habitat assessment during the field survey.

3 Results

3.1 Literature and database review

3.1.1 Topography, drainage, soils and biodiversity layer

Macquarie Rivulet (5th order) (Strahler 1953) flows adjacent to the northern boundary of the study area. Hazelton Creek is a 3rd order watercourse that flows through the western portion of the study area. Two unnamed 1st order streams also flow through the western and eastern portions of the study area. The mapped locations of watercourses and the associated riparian corridors in accordance with the *Guidelines for controlled activities on waterfront land* (Natural Resource Access Regulator [NRAR] 2018)) are shown in **Figure 3.1**. Macquarie Rivulet and Hazelton Creek both had well vegetated riparian corridors and are both mapped as Key Fish Habitat (KFH) under the *Fisheries Management Act 1994* (FM Act). A VMP has been prepared for the drainage channels within the study area (See Ecoplaning 2020).

Regional scale soil landscape mapping (Hazelton & Tille 1990) maps the study area within the Albion Park (9028ap) and Fairy Meadow (9028fa) soil landscapes (**Figure 3.2**). Soils of the Albion Park soil landscape are associated with footslopes and drainage lines on Berry Formation. Soils of the Fairy Meadow soil landscape are associated with alluvial plains, floodplains, valley flats and terraces below the Illawarra Escarpment.

The study area includes land mapped on the NSW Department of Planning, Industry and Environment's (DPIE) 'Biodiversity Values Map' (BVM) (DPIE 2020a) (**Figure 3.3**). This includes land identified as 'Protected Riparian Land', which encompassing all Macquarie Rivulet (5th order stream) and parts of Hazelton Creek (3rd order stream). A small portion of the study area is also mapped as 'Terrestrial Biodiversity' on the Biodiversity Map under the SLEP (2013).

3.1.2 Threatened species, populations and migratory species

A search of relevant databases and literature identified a potential 45 threatened or migratory species with 5 km of the study area including twelve threatened flora species and 33 threatened or migratory fauna species (23 birds, eight microbats, one megabat, and one arboreal mammal) (**Figure 3.4**).

The likelihood of occurrence analysis undertaken prior to the field survey reduced the primary list to 14 threatened species that have a 'moderate' or 'high' likelihood to use the study area, and thus may be impacted by the proposed works. Field survey further reduced this list to nine species (see **Appendix A**), including:

- Threatened microbats
 - *Chalinolobus dwyeri* (Large-eared Pied Bat) (moderate)
 - *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) (moderate)
 - *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) (moderate)
 - *Miniopterus australis* (Little Bent-winged Bat) (moderate)
 - *Miniopterus orianae oceanensis* (Large Bent-winged Bat) (moderate)
 - *Myotis macropus* (Southern Myotis) (moderate)
 - *Saccolaimus flaviventris* (Yellow-bellied Sheath-tail-bat) (moderate)

- *Scoteanax rueppellii* (Greater Broad-nosed Bat) (moderate)
- Threatened megabats
 - *Pteropus poliocephalus* (Grey-headed Flying-fox (GHFF)) (recent record)

3.1.3 Vegetation and threatened ecological communities

Review of previous vegetation mapping within the study area (NPWS 2002) identified four vegetation communities (**Table 3.1** and **Figure 3.5**). These communities are:

- Floodplain Wetland (MU54),
- Lowland Woollybutt-Melaleuca Forest (MU24),
- Riparian River Oak Forest (MU37), and
- Weeds and Exotics (MU56c).

Riparian River Oak Forest is mapped adjacent to Macquarie Rivulet, the 5th order watercourse situated north of the study area. Floodplain Wetland is mapped adjacent to the unnamed 1st order watercourse along the eastern boundary of the study area. One small patch of Lowland Woollybutt-Melaleuca Forest is mapped within the south-eastern corner of the study area, and a small area within the centre of the study area is mapped as Weeds and Exotics. The remainder of the study area has not been mapped by NPWS (2002) as containing native vegetation.

Regional vegetation mapping by ELA (2015) mapped four vegetation communities in the study area (**Table 3.1** and **Figure 3.6**), including:

- Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion,
- Swamp Oak – Prickly Tea-tree – Swamp Paperbark swamp forest on coastal floodplains, Sydney Basin Bioregion and South East Corner Bioregion,
- Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion, and
- Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin and South East Corner.

The mapping of ELA (2015) and NPWS (2002) are generally consistent with each other. However, areas of Swamp Oak – Prickly Tea-tree – Swamp Paperbark swamp forest mapped by ELA (2015) have not been mapped by NPWS (2002). Furthermore, mapping by ELA (2015) has identified Swamp Oak swamp forest fringing estuaries where NPWS (2002) has mapped Riparian River Oak. These vegetation communities are not equivalent. An additional native vegetation community was identified, being Coastal Swamp Oak Forest (MU36).

Native vegetation communities mapped in the study area (NPWS 2002 and ELA 2015) comprise TECs listed under the BC Act and/or EPBC Act. The relationship between these native vegetation communities and TECs is summarised in **Table 3.1**.

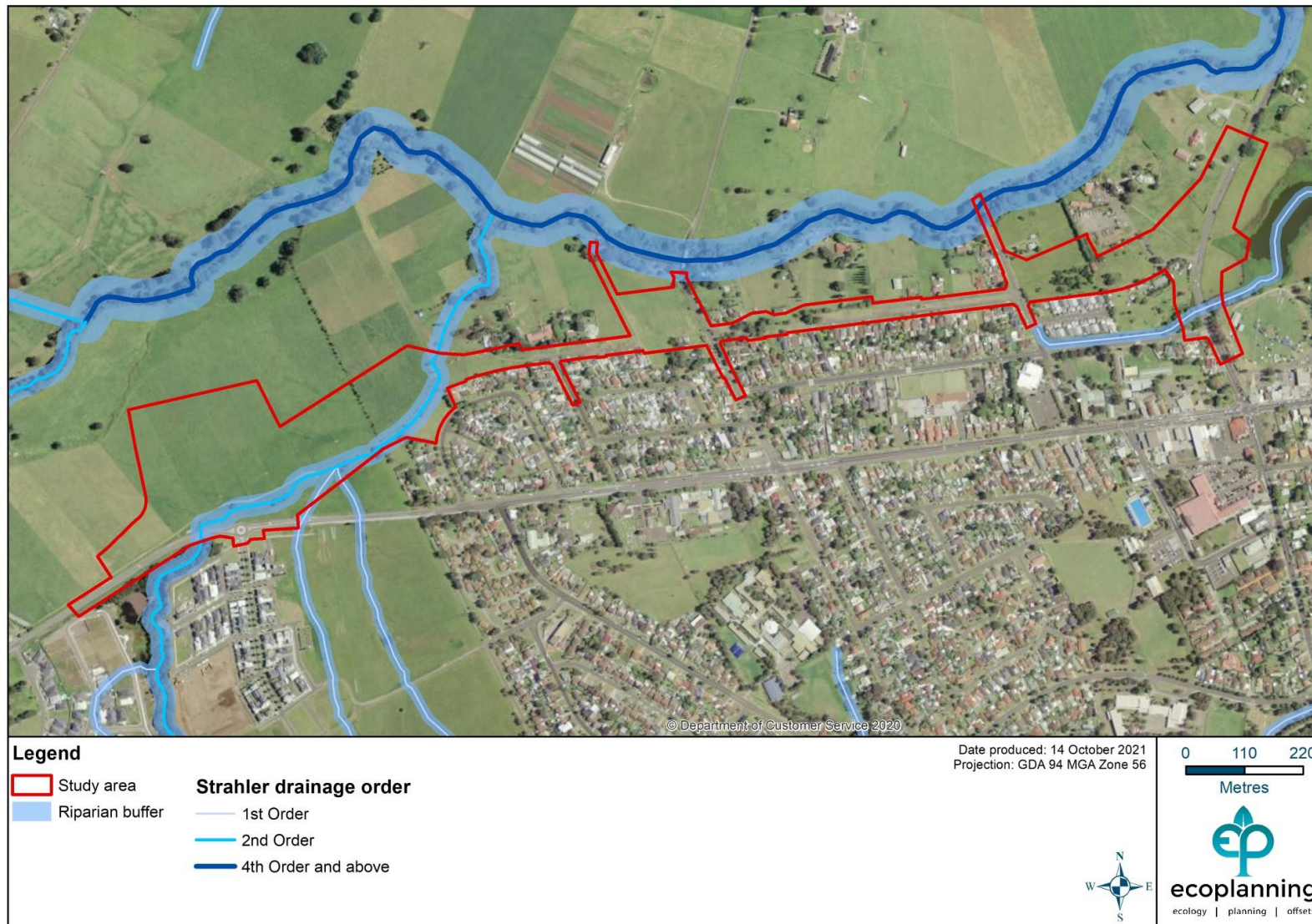


Figure 3.1: Mapped drainage lines and associated riparian buffers (NRAR 2018) within the study area.

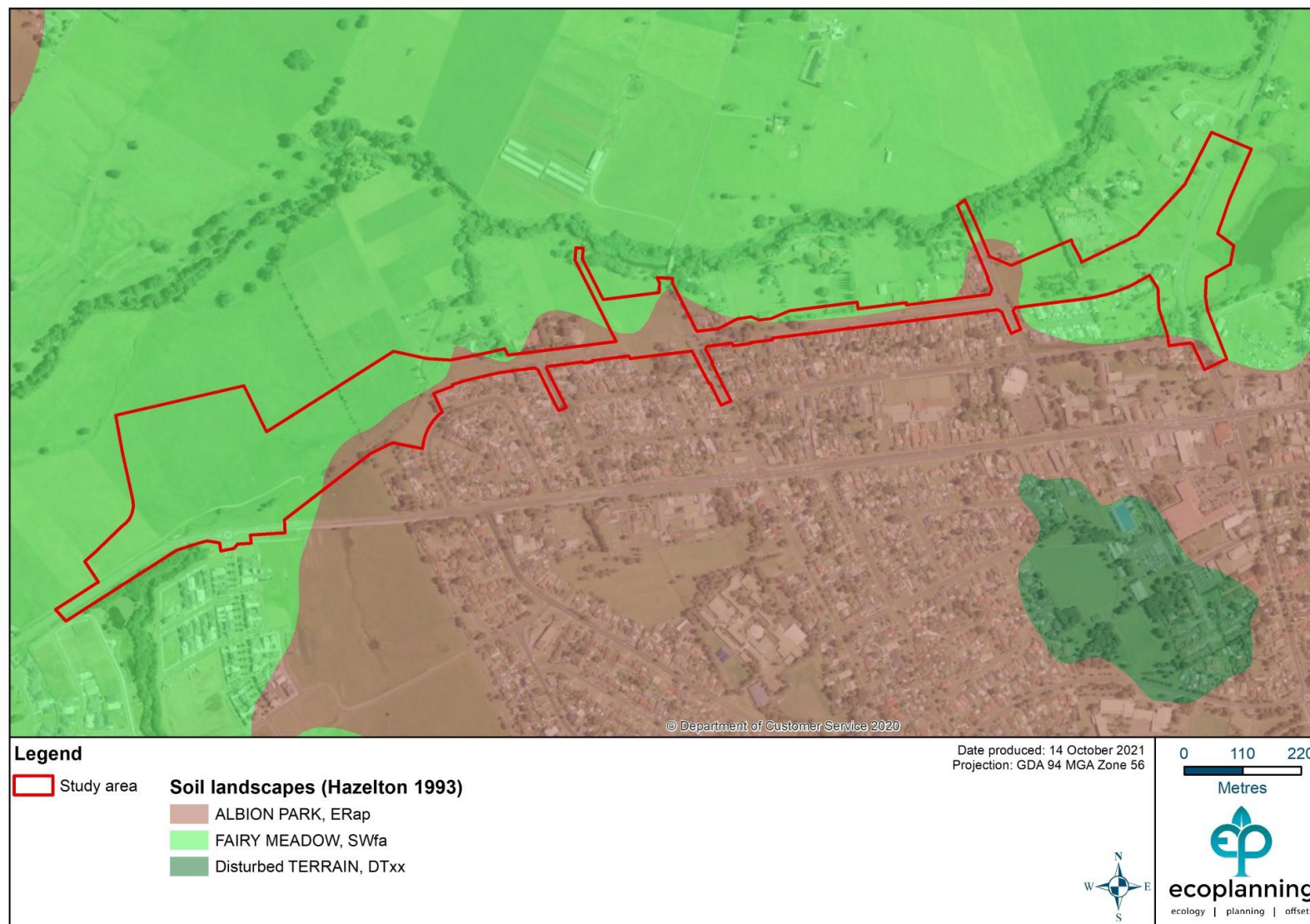


Figure 3.2: Soil landscapes in the study area (Hazelton & Tille 1990).

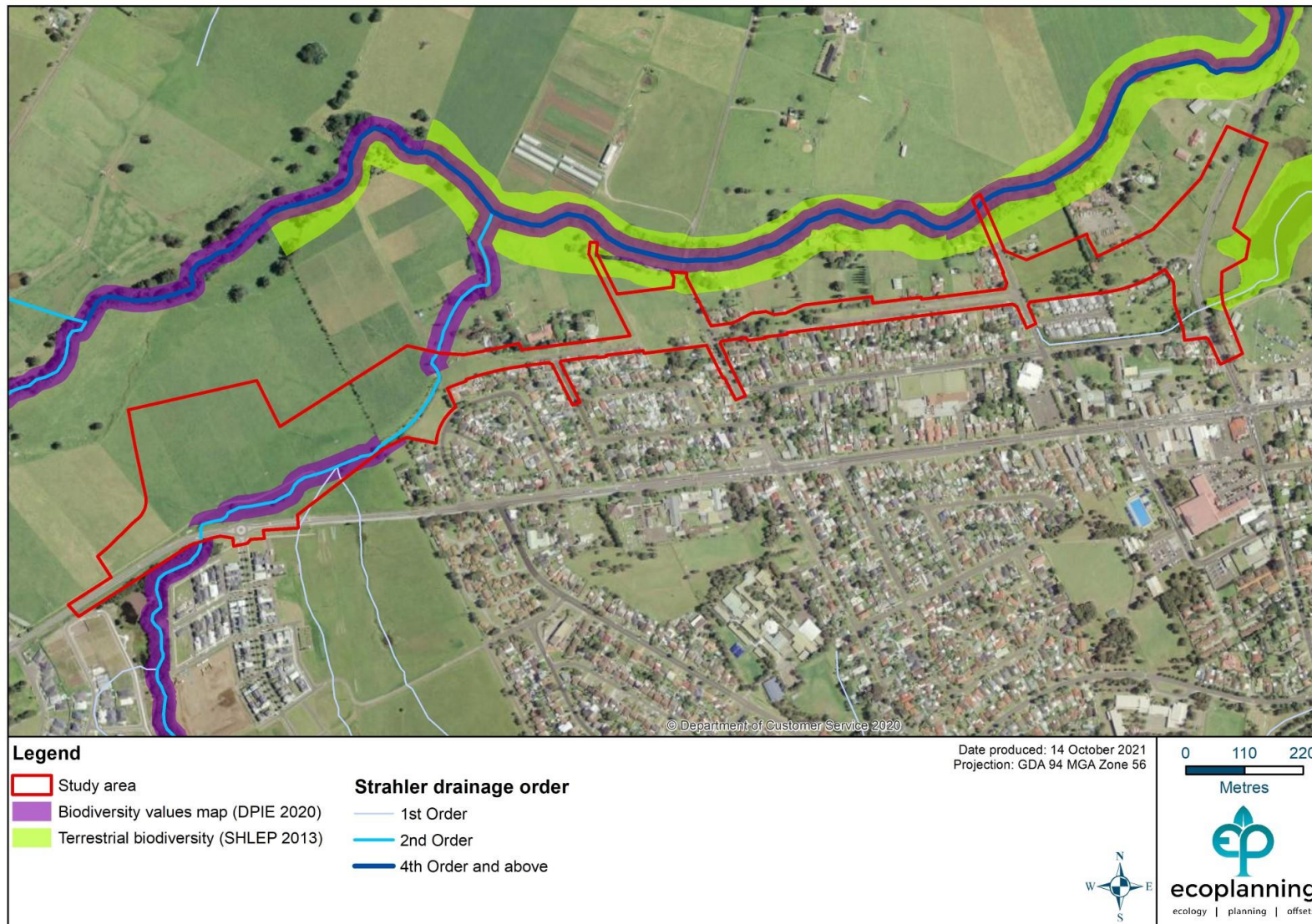


Figure 3.3: Land mapped on the BVM (DPIE 2020) and SLEP 2013 within the study area.

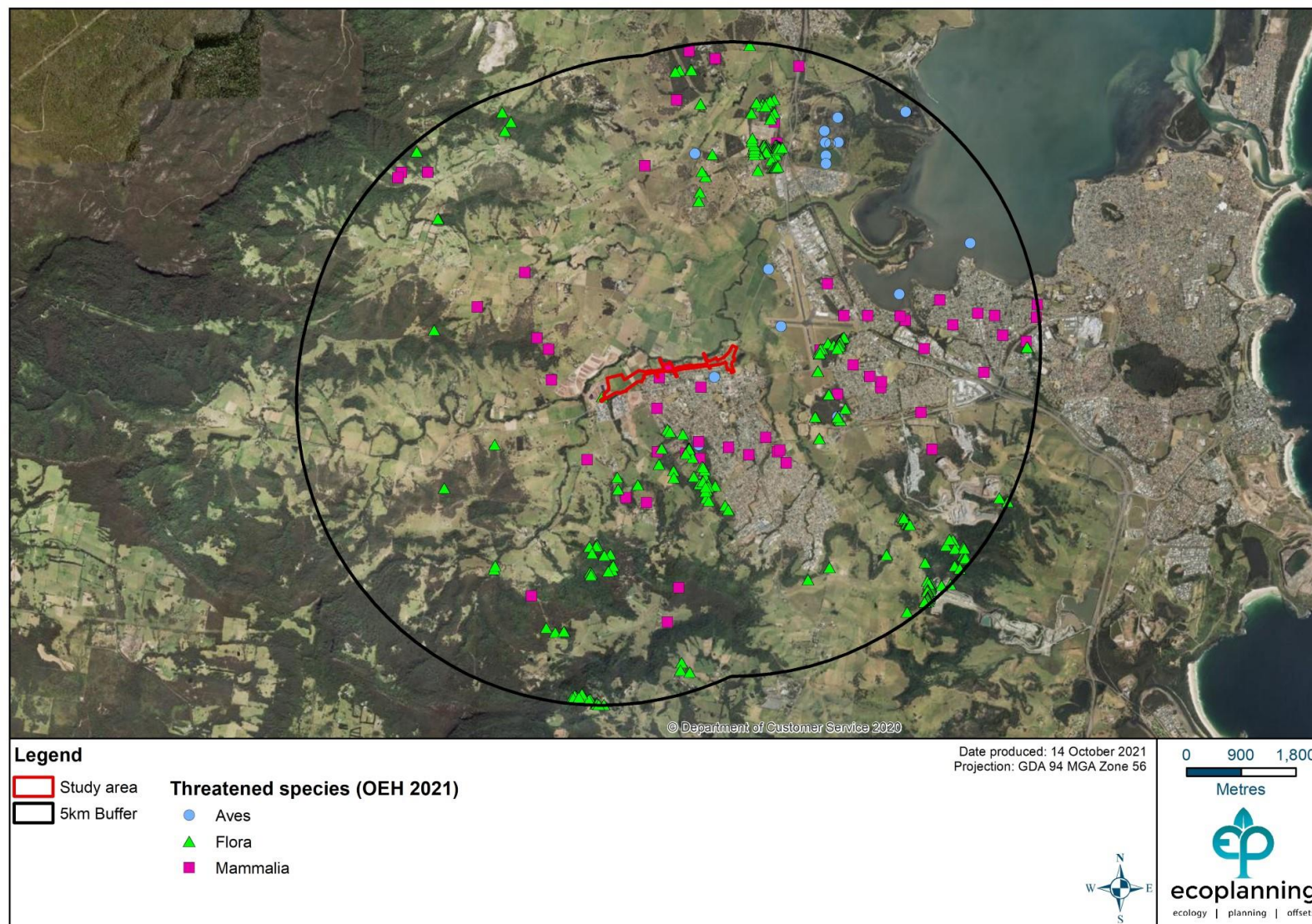


Figure 3.4: Threatened species records (DPIE 2021).

Table 3.1: Vegetation community nomenclature (NPWS 2002 and ELA 2015).

Vegetation communities (NPWS 2002)	Vegetation communities (ELA 2015)	BC Act TEC	EPBC Act TEC
Floodplain Wetland (MU54)	Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion	Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	N/A
Lowland Woollybutt-Melaleuca Forest (MU24)	Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin and South East Corner	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	Illawarra and South Coast Lowland Forest and Woodland
Riparian River Oak Forest (MU37)		N/A	N/A
Coastal Swamp Oak Forest (MU36)	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Coastal Swamp Oak (<i>Casuarina glauca</i>) Forest of New South Wales and South East Queensland
		River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	N/A

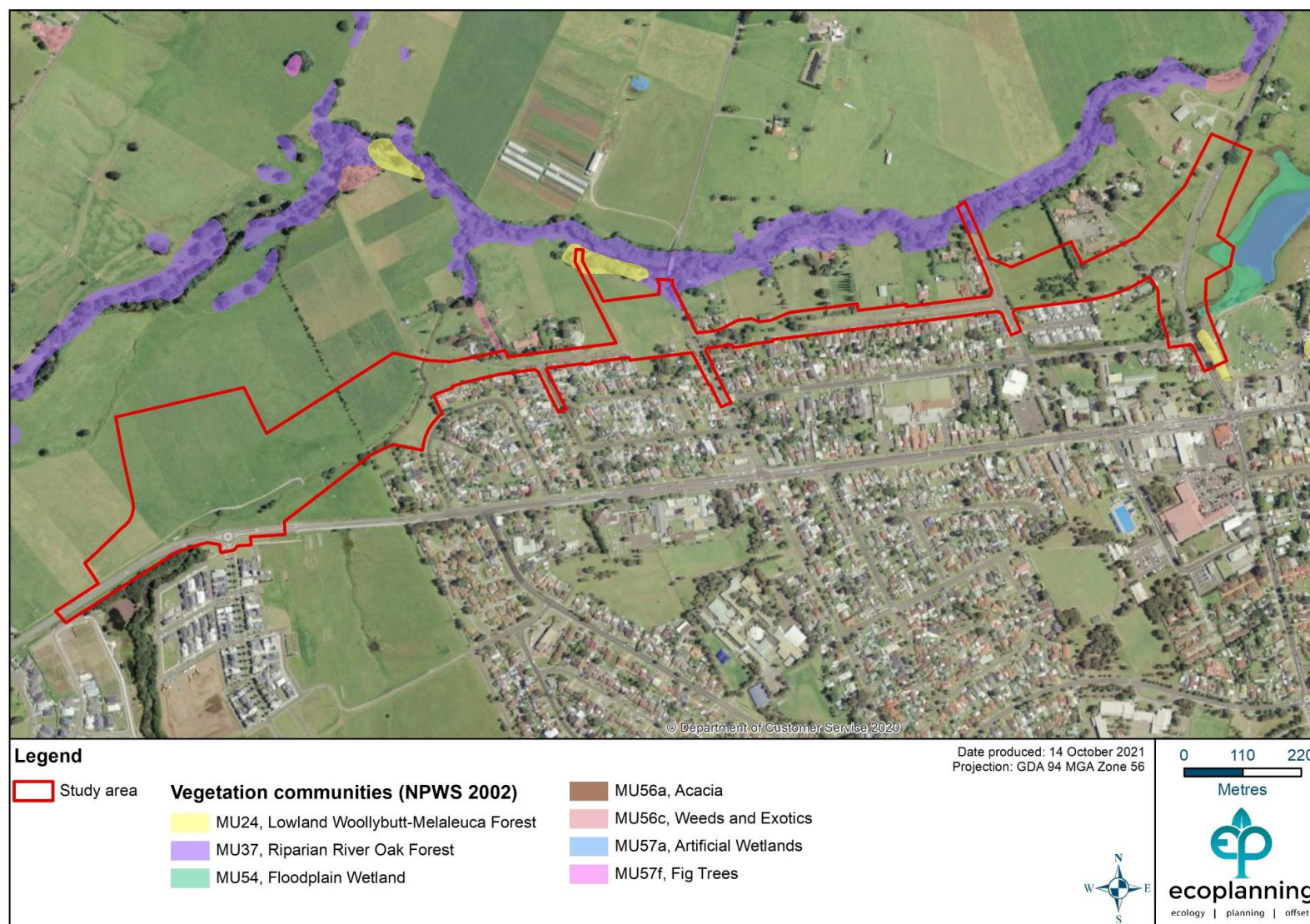


Figure 3.5: Vegetation mapping by NPWS (2002) within the study area.

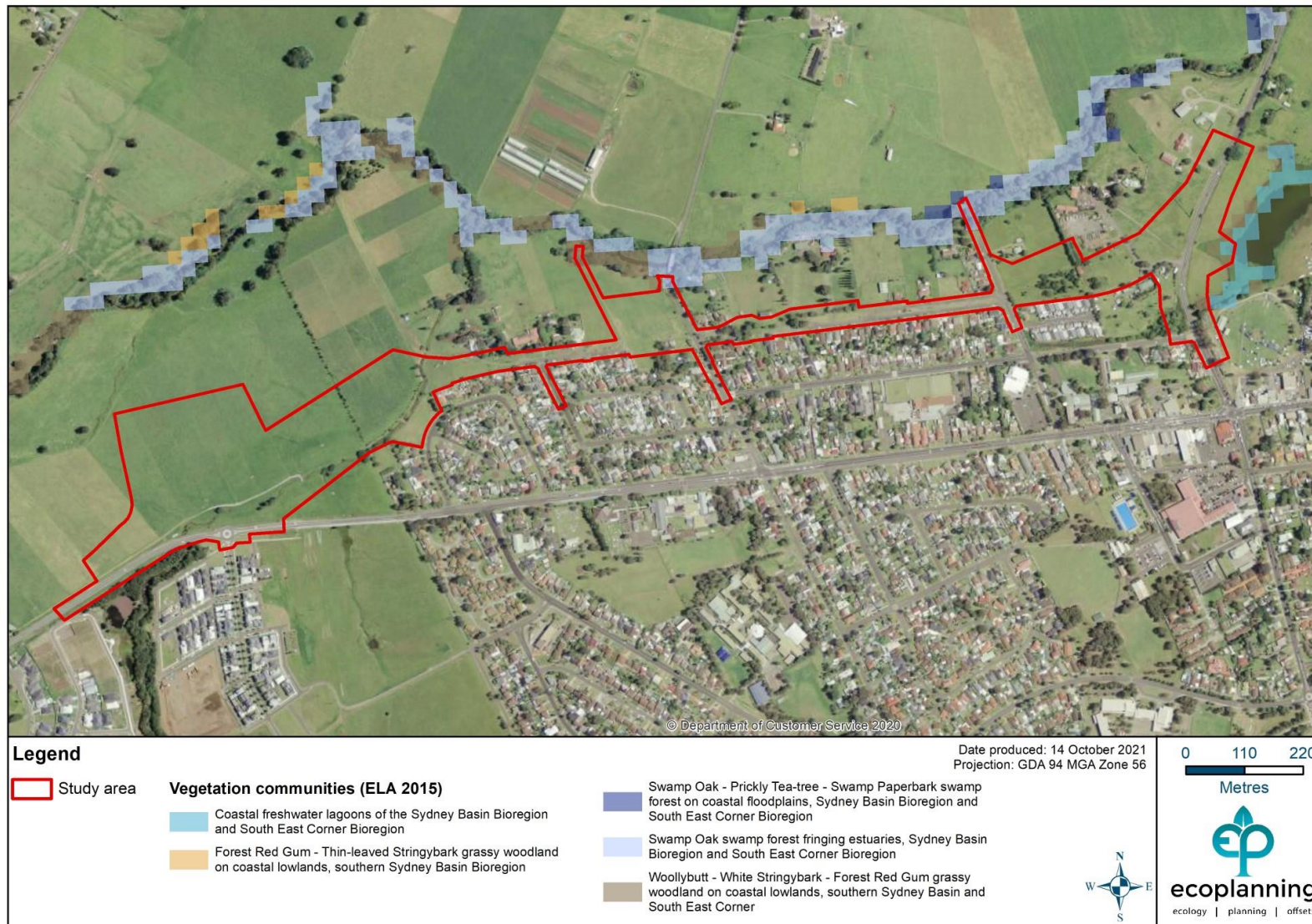


Figure 3.6: Vegetation communities within the study area (ELA 2015).

3.2 Field Survey

3.2.1 Native vegetation communities

The results of the field assessment were generally consistent with mapping by NPWS (2002), who had identified several native vegetation communities across the study area (**Figure 3.7**). Overall, the field assessment was not consistent with mapping by ELA (2015) (**Figure 3.6**).

Field survey confirmed the presence of Riparian River Oak Forest (MU37) as mapped by NPWS (2002) across 0.152 ha of the study area. This community does not form part of any TEC listed under the EPBC Act or BC act. Field validation confirmed the presence of Floodplain Wetland (MU54) as mapped by NPWS (2002) across 0.323 ha of the study area, which is equivalent to Coastal Freshwater Lagoons of the Sydney Basin Bioregion and South East Corner Bioregion as mapped by ELA (2015). This community forms part of the Endangered Ecological Community (EEC) Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner listed under the BC Act. An additional community was identified across 0.033 ha of the study area, Coastal Swamp Oak Forest (MU36). This community is a component of the EEC Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions listed under the EPBC Act and BC Act. Coastal Swamp Oak Forest identified within the study area does not align with the criteria to be considered a component of the EEC River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Coastal Swamp Oak Forest (MU36)

This vegetation zone is an isolated patch of *Casuarina glauca* (Swamp Oak) (**Figure 3.9**). At the time of assessment, the understorey of the vegetation zone was modified, comprising of a mixture of exotic and native species. These included native species such as *Persicaria decipiens* (Slender Knotweed), *Juncus usitatus*, *Typha orientalis* (Broadleaf Cumbungi) and *Pteridium esculentum* (Common Bracken), and pasture grasses and weeds such as *Cenchrus clandestinus** (Kikuyu), *Paspalum dilatatum** (Paspalum), *Plantago lanceolata** (Lamb's Tongues) and *Sida rhombifolia** (Paddy's Lucerne).

Riparian River Oak Forest (MU37)

The vegetation community Riparian River Oak (MU37) was identified within the riparian corridor of Macquarie Rivulet (**Figure 3.10**). This vegetation zone was in a highly disturbed condition and did not entirely conform to the community description given by NPWS (2002). This is probably due to either the high levels of disturbance, altered flow regimes and/or that it is a transitional type, with elements common to the vegetation community Coastal Swamp Oak Forest (MU36). While *Casuarina cunninghamiana* (River Oak) were common, so too were dense patches of exotic species such as *Erythrina x sykesii** (Coral Tree) and *Lantana camara** (Lantana). This community was also infested with the climbing weed, *Cardiospermum grandiflorum** (Balloon Vine).

Floodplain Wetland (MU54)

This vegetation zone was identified within the eastern portion of the study area (**Figure 3.11**). The drainage patterns of this community have been altered by urbanisation and for

infrastructure such as roads, and thus drainage lines are in poor condition. Although this vegetation zone was dominated by native species such as *Phragmites australis* (Common Reed) and *Typha orientalis* (Cumbungi), exotic weeds were also prolific, most notably the pasture grass, *Cenchrus clandestinus**

Aquatics and emergents

The standing, deeper pools of water within Hazelton Creek were dense with aquatic and emergent vegetation (**Figure 3.12**). The semi-aquatic weed, *Nasturtium officinale** (Watercress) and the emergent native reed, *Typha orientalis* (Broadleaf Cumbungi) were among the most dominant. Floating species, like *Lemna disperma* (Duck weed) and *Azolla* sp. covered the surface in places along Hazelton Creek. Where there is limited free-water and soils are saturated, *Cenchrus clandestinus** and *Cyperus eragrostis* (Umbrella Sedge) tended to dominate. The native semi-aquatics, *Ludwigia peploides* (Water Primrose) and *Alisma plantago-aquatica* (Water Plantain) were also commonly found.

Acacia Scrub (MU56a)

The vegetation zone Acacia Scrub (MU56a) was mapped as patches of heavily degraded vegetation across the study area (**Figure 3.13**). Native species present were those typical of disturbed and degraded habitats, such as *Acacia mearnsii* (Black Wattle) and *Pittosporum undulatum* (Native Daphne). Rare occurrences of *Eucalyptus tereticornis* (Forest Red Gum) were identified in this vegetation zone. The middle stratum was infested with large areas of *Lantana camara** and *Erythrina x sykesii**, and supported infestations of the climber *Ipomoea indica** (Morning Glory) in the canopy. Dominant ground cover weeds included *Cenchrus clandestinus**, *Colocasia esculenta** (Taro), *Tradescantia fluminensis** (Trad) and *Ricinus communis** (Castor Oil Plant). Overall, the habitat in this zone was degraded, with evidence of rubbish dumping and mounds resulting from earthworks.

Native plantings

This vegetation zone consisted of long, linear strips of vegetation beside Hazelton Creek, where a variety of native trees and shrubs had been planted (**Figure 3.14**). Species presence included *Corymbia maculata* (Spotted Gum), *Eucalyptus botryoides* (Bangalay), *Callistemon viminalis* (Weeping Bottlebrush), *Elaeocarpus reticulatus* (Blueberry Ash), *Banksia ericifolia* (Heath-leaved Banksia) and *Grevillea* hybrids.

Natives/non-native plantings

Areas of vegetation alongside existing residential streets and fence lines have been included in this vegetation zone (**Figure 3.15**). They are areas that are intensively managed by mowing, weeding and other routine maintenance. Species include a variety of trees, shrubs and turf grasses that are common ornamentals in urban landscapes. Species include *Lophostemon confertus*† (Queensland Brush box), *Eucalyptus microcorys* (Tallowwood), *Grevillea robusta*† (Silky Oak), *Corymbia citriodora** (Lemon-scented Gum), *Lagerstroemia indica** (Crepe Myrtle), *Cupressus x leylandii** (Leyland's Cypress) and *Jacaranda mimosifolia** (Jacaranda).

Cleared land 'exotic grassland/infrastructure'

Large areas of vegetation across the study area have no overstorey species and now consist of grasslands largely dominated by exotic grasses and herbaceous weeds (**Figure 3.16**). Dominant ground cover species included *Cenchrus clandestinus** and *Hypochaeris radicata** (Catsear). Where there is grazing by domestic cattle (western end of study area), species like *Sida rhombifolia**, *Senecio madagascariensis** (Fireweed), *Cichorium intybus** (Chicory) and *Medicago sativa** (Lucerne) were common.

3.2.2 Flora species

A total of 78 flora species were identified in the study area during the field survey, of which 36 were native and 42 were exotic or non-native (**Appendix D**). Nomenclature follows the Flora of NSW (Harden 1990-2002) and updates provided in PlantNET (RBGDT 2020).

Four priority weeds listed under the NSW *Biosecurity Act 2015* for Shellharbour LGA were recorded in the study area, all of which are Weeds of National Significance (WoNS) (**Table 3.2**).

Table 3.2: Priority weeds and Weeds of National Significance.

Common name	Scientific name	WoNS ¹	Duty
Madeira Vine	<i>Anredera cordifolia</i>	Y	Prohibition on dealings <i>Must not be imported into the State or sold</i>
Ground asparagus	<i>Asparagus aethiopicus</i>	Y	
Lantana	<i>Lantana camara</i>	Y	Mandatory Measure <i>Must not be imported into the State or sold</i> Regional Recommended Measure Exclusion zone: whole region excluding the core infestation area of Eurobodalla, Kiama, Shellharbour, Wollongong and the Shoalhaven local government area north of the Lantana Containment Line at 35°11'42" S <i>Whole region: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Core area: Land managers reduce impacts from the plant on priority assets.</i>
Fireweed	<i>Senecio madagascariensis</i>	Y	Mandatory Measure <i>Must not be imported into the State or sold</i> Regional Recommended Measure Exclusion zone: whole region except the core infestation area of Wollongong, Kiama, Shellharbour, Eurobodalla, Shoalhaven, Bega Valley and Wingecarribee councils <i>Whole region: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of</i>

Common name	Scientific name	WoNS ¹	Duty
			<i>the plant. Core area: Land managers reduce impacts from the plant on priority assets.</i>

¹ <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>

No threatened flora species listed under the *Biodiversity Conservation Act 2016* (BC Act) or *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) were recorded in the study area.

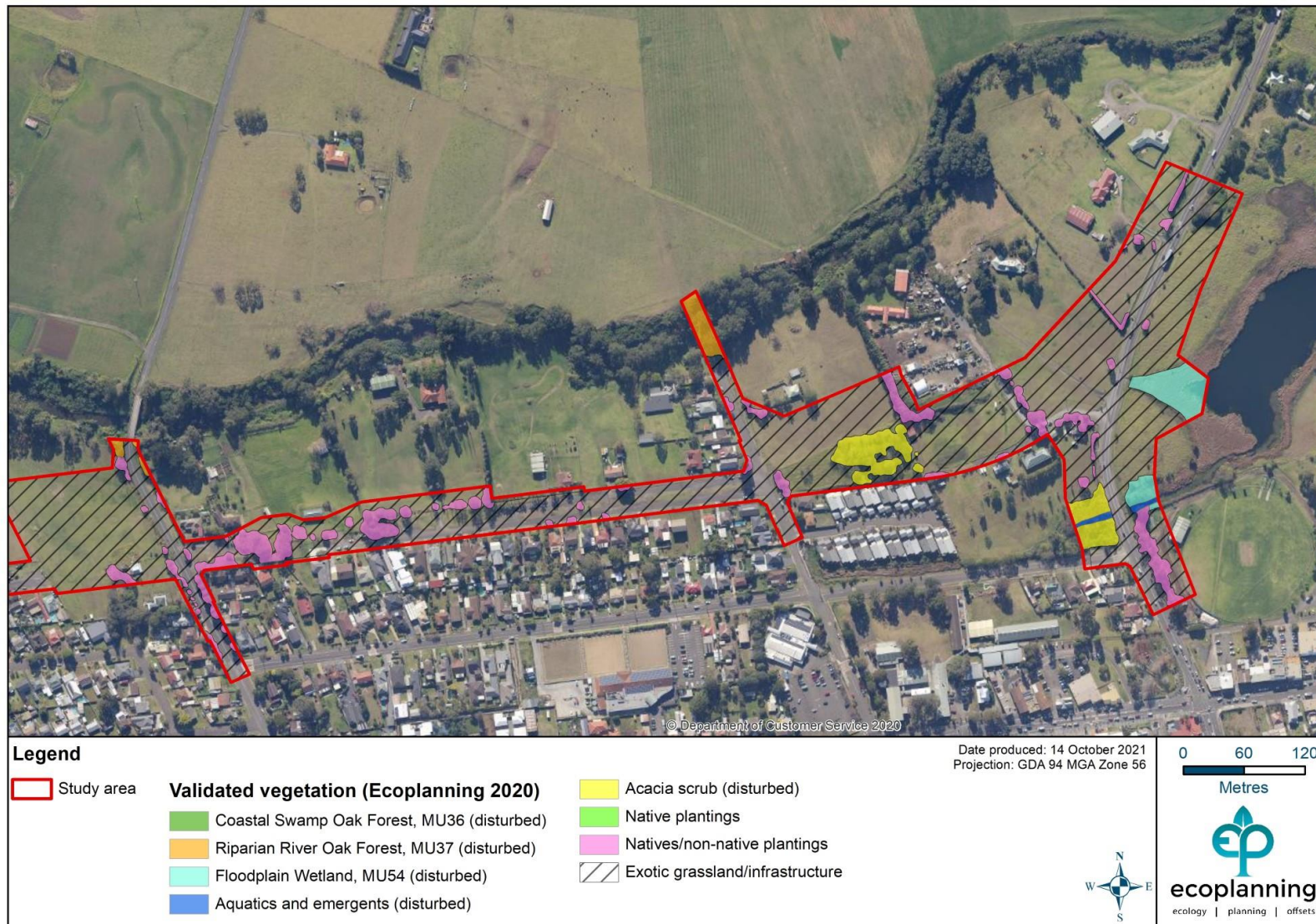


Figure 3.7: Field validated vegetation within the eastern portion of the study area (Ecoplanning 2020).

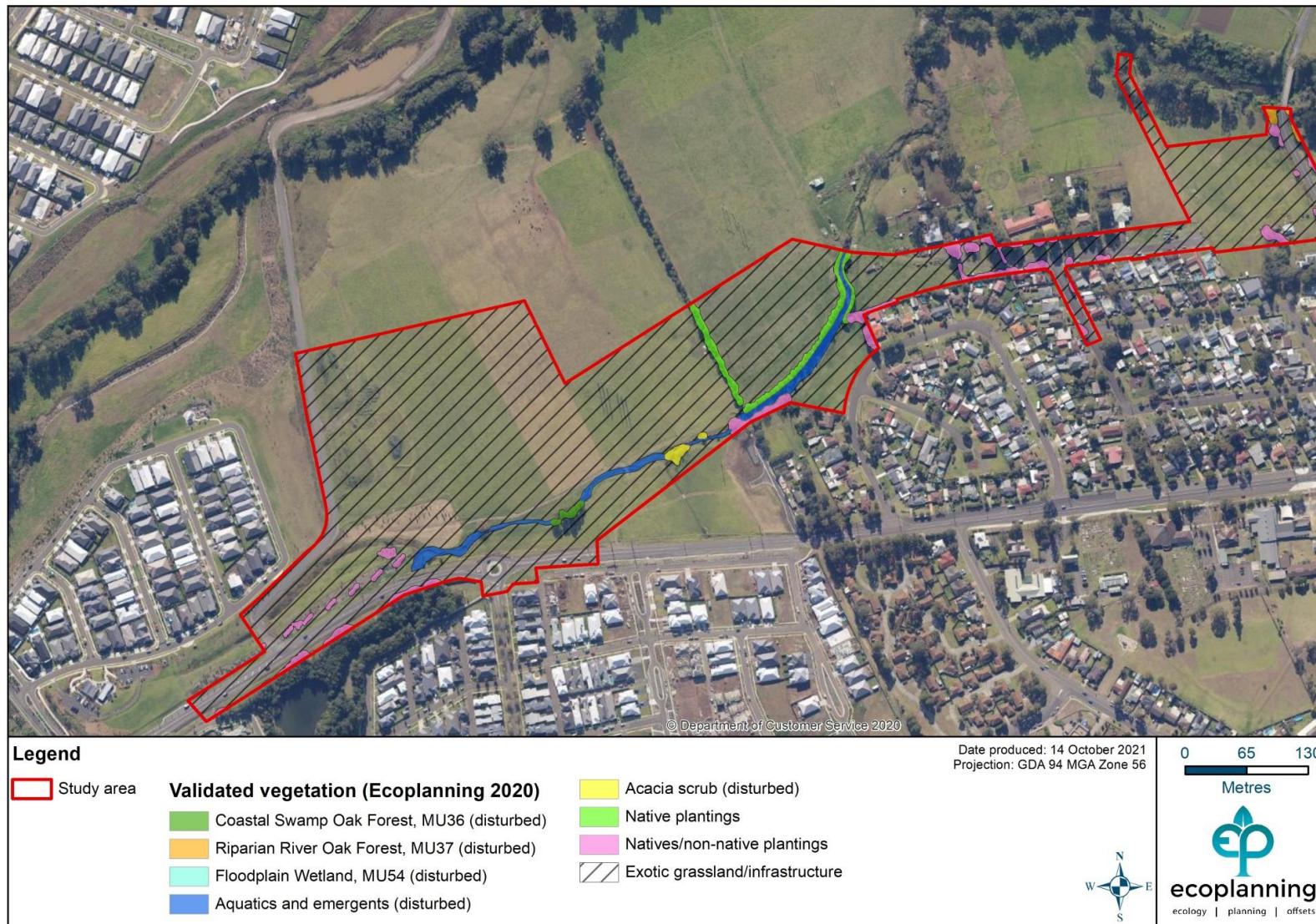


Figure 3.8: Field validated vegetation within the western portion of the study area (Ecoplanning 2020).



Figure 3.9: Coastal Swamp Oak Forest (MU36) within the study area.



Figure 3.10: Riparian River Oak Forest (MU37) within the study area.



Figure 3.11: Floodplain Wetland (MU54) identified within the study area.



Figure 3.12: Aquatics and emergents identified within mapped drainage lines within the study area.



Figure 3.13: Acacia Scrub (MU56a) identified across the study area.



Figure 3.14: Native plantings identified along mapped drainage lines within the study area.



Figure 3.15: Native/non-native plantings identified along residential streets within the study area.



Figure 3.16: Cleared land exotic grassland/infrastructure within the study area.

3.2.3 Fauna species

Field survey identified a total of 18 fauna species, of which five are introduced species. Of the 18 species, there were 15 birds and three mammals (**Appendix D**). No threatened fauna species were recorded in the study area during field survey.

3.2.4 Fauna habitat

Fauna habitat values identified within the study area that may provide refuge for a small to moderate range of native fauna included those associated with open grassland and woodland. The fauna habitat features identified within the study area are listed in **Table 3.3**.

Table 3.3: Key fauna habitat features present across the study area.

Habitat features	Fauna species
Open grassland	Birds, microchiropteran bats, reptiles and frogs
Planted vegetation	Diurnal and nocturnal birds, arboreal mammals and microchiropteran bats (Figure 3.17)
Watercourses	Fish, Birds, microchiropteran bats, reptiles and frogs (Figure 3.18)
Coarse woody debris	Arboreal mammals, microchiropteran bats, reptiles and frogs

Based on the habitat values within the study area, a suite of fauna species are likely to use the study area for foraging purposes, while coarse woody debris may provide potential refuge, nesting or breeding habitat for birds and mammals. It is possible that the more disturbed areas of native vegetation provided potential foraging habitat for disturbance tolerant and highly mobile species that rely on large areas for food resources, such as microbats and the Grey-headed Flying-fox (GHFF) (*Pteropus poliocephalus*).

No hollow bearing trees (HBTs) were identified within or near the proposed development. Therefore, the study area does not provide suitable roosting or nesting habitat for hollow-dependent bird species, including the Glossy Black-Cockatoo (*Calyptorhynchus lathami*), and larger forest owls, such as the Sooty Owl (*Tyto tenebricosa*). Similarly, no large stick nests were observed within the study area and, therefore, the study area does not represent breeding habitat for threatened birds of prey, such as the White-bellied Sea Eagle (*Haliaeetus leucogaster*), Little Eagle (*Hieraaetus morphnoides*) and Square-tailed Kite (*Lophoictinia isura*).

Based on the small amount and poor connectivity of native woodland identified within the study area, the Little Lorikeet (*Glossopsitta pusilla*) was considered as having a 'low' likelihood of utilising the study area. For the same reasons, the Koala (*Phascolarctos cinereus*) was considered as having a 'low' likelihood of occurrence within the study area and to be unlikely to use the study area on anything more than an intermittent or transient basis. Therefore, the small area of foraging habitat within the study area was unlikely to be important to the long-term survival of these species.

Based on the likelihood of occurrence (**Appendix A**) and incorporating the field-based habitat assessments, eight threatened fauna species have been identified as having a 'moderate'

potential to use the study area. Additionally, one threatened megabat species was recently recorded within the study area. The following threatened fauna species may be affected by the proposed works:

- *Chalinolobus dwyeri* (Large-eared Pied Bat) (moderate)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) (moderate)
- *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) (moderate)
- *Miniopterus australis* (Little Bent-winged Bat) (moderate)
- *Miniopterus orianae oceanensis* (Large Bent-winged Bat) (moderate)
- *Myotis macropus* (Southern Myotis) (moderate)
- *Saccolaimus flaviventris* (Yellow-bellied Sheath-tail-bat) (moderate)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat) (moderate)
- *Pteropus poliocephalus* (Grey-headed Flying-fox (GHFF)) (recent record)



Figure 3.17: Planted vegetation providing foraging, perching and roosting habitat.



Figure 3.18: Watercourse found within the study area.

4 Impact assessment

This section outlines the anticipated direct and indirect impacts of the proposed development and any proposed future development on the ecological values of the study area. Avoidance and mitigation measures are also proposed.

4.1 Direct impacts

Direct impacts associated with the proposed development include the clearing of vegetation and loss of fauna habitat within the subject land.

4.1.1 Vegetation clearing

Impacts to vegetation are anticipated through the direct clearing of up to a total of 0.72 ha of native vegetation, which includes 0.10 ha of Riparian River Oak Forest, 0.28 ha of Floodplain Wetland and 0.34 ha of Acacia Scrub (**Figure 4.1** and **Figure 4.2**). The remaining 18.40 ha of impacts from the current proposal will be to other vegetation, and includes land mapped as aquatics and emergent, native plantings, natives/non-native plantings and exotic grassland/infrastructure (**Table 4.1**).

Area calculations for direct impacts are based on all land within the subject land and the canopy cover of any individual trees proposed for removal to accommodate the proposed road extension.

Table 4.1: Direct impacts of the proposed works.

Vegetation community	Vegetation zone (condition class)	BC Act	EPBC Act	Area (ha)
Riparian River Oak Forest	Disturbed	Y	Y	0.10
Floodplain Wetland	Disturbed	Y	N	0.28
Acacia Scrub	Disturbed	N	N	0.34
Total native vegetation				0.72
Other	Aquatics and emergents	-	-	0.13
	Native plantings	-	-	0.15
	Natives/non-native plantings	-	-	1.17
	Exotic grassland/ infrastructure	-	-	16.96
Total other vegetation				18.40
Total vegetation				19.12

Note: subject to rounding errors.

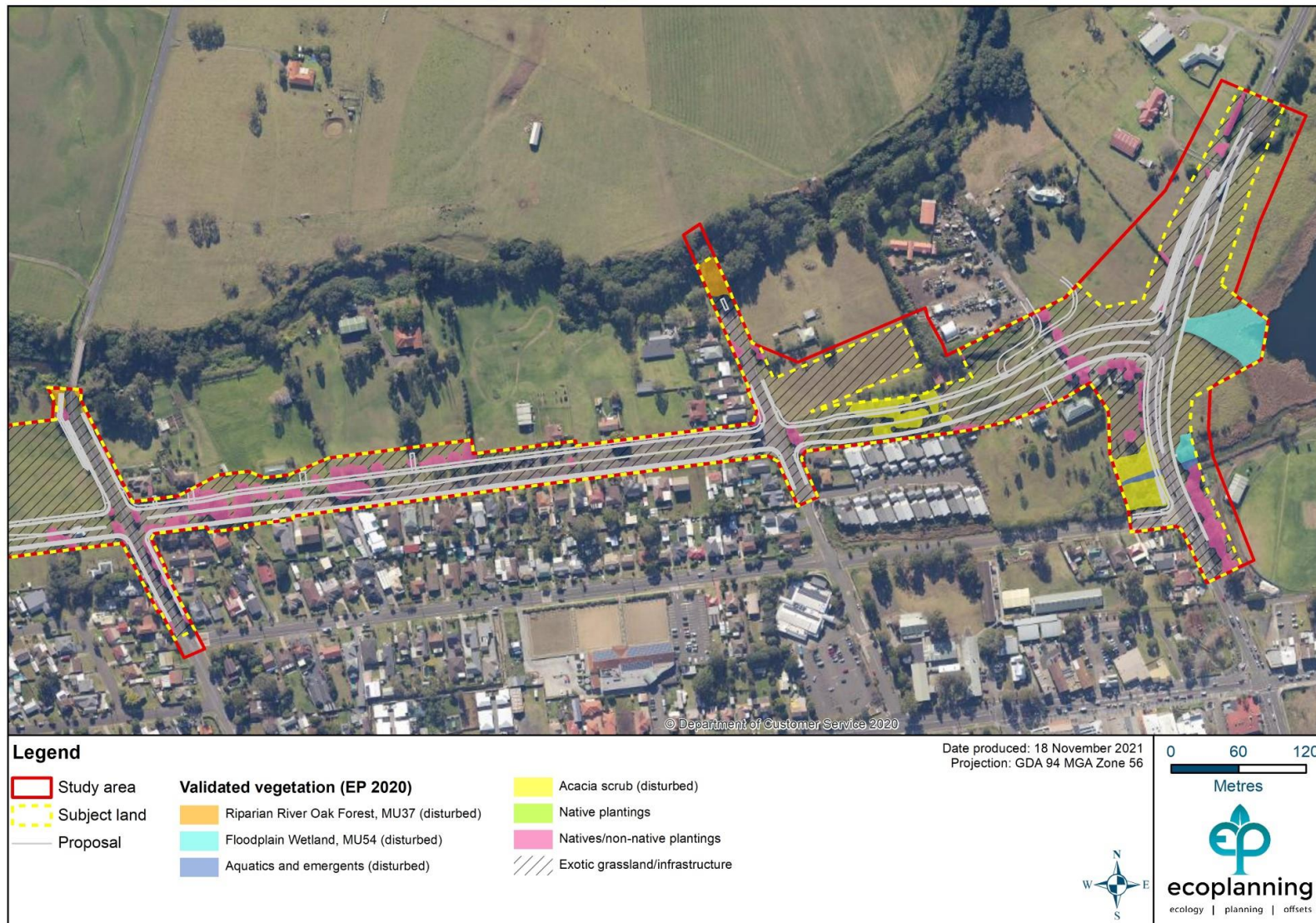


Figure 4.1: Proposed concept plan over mapped vegetation – within the eastern portion of the subject land.

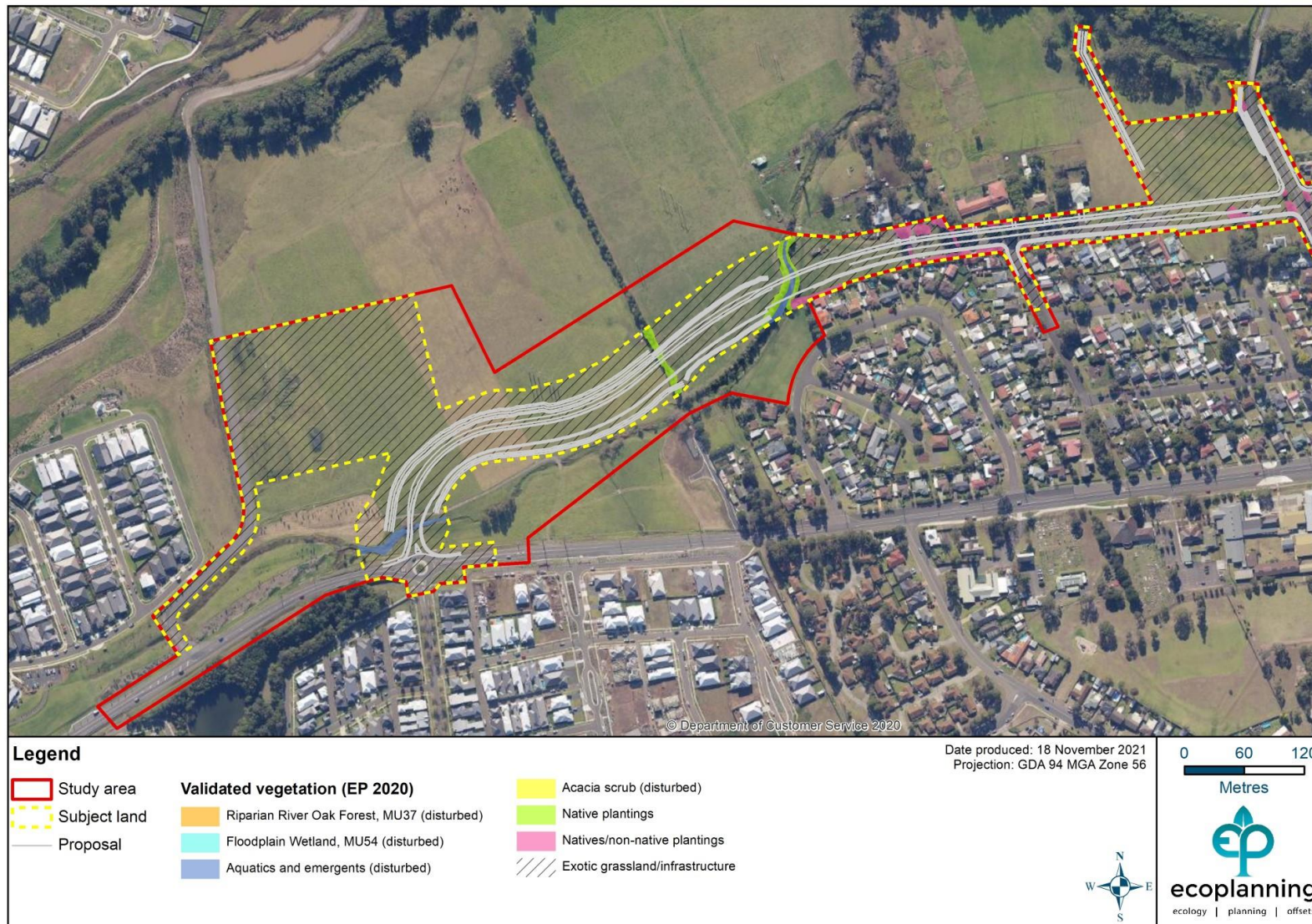


Figure 4.2: Proposed concept plan over mapped vegetation – within the western portion of the subject land.

4.1.2 Loss of fauna habitat

The current proposal will require the removal of a comparatively small amount of native vegetation (approximately 0.72 ha or ~2.6%) within the subject land. This constitutes marginal foraging habitat, consisting of Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub. Other vegetation within the subject land that may provide foraging habitat consists of 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings. The area mapped as exotic grassland/infrastructure that is required for removal is unlikely to provide any habitat to local fauna. The proposed development will remove potential fauna habitat such as mature trees, dense midstorey vegetation and planted vegetation. Given the amount of native vegetation proposed for removal, and the remaining habitat attributes along the Macquarie Rivulet along the northern portion of the study area, the proposed development is unlikely to have more than a negligible impact on local fauna. No hollow-bearing trees (HBTs) or stag trees were identified within the study area.

4.2 Indirect Impacts

It is difficult to quantify indirect impacts of the proposed development, but these may include impacts such as erosion and water quality impacts that may be associated with the construction phase of the project. These impacts will be managed through the development of a Construction Environmental Management Plan (CEMP).

Other potential indirect impacts include an increase in trampling of flora, rubbish dumping, the introduction of any pests, weeds or pathogens to the adjacent areas of native vegetation and habitat. However, given the already highly modified nature and present land use of the study area, indirect impacts from the proposal are minor and have a very low likelihood to occur, provided the suggested management measures are implemented.

4.3 Avoidance and mitigation

4.3.1 Vegetation clearing

The following avoidance and mitigation measures are recommended to avoid and minimise potential impacts to threatened species and native vegetation on the site:

- areas of native vegetation outside of the construction footprint will be “No Go-Zones” for people and machinery and will be clearly delineated,
- any exotic biomass cleared within the construction footprint will be removed from the study area and disposed of at an approved facility,
- develop a Construction Environmental Management Plan to address pollution and contamination issues, such as silt control, and oil/fuel/chemical storage/spill management, which could arise during construction,
- erosion and sediment control measures will be established before work begins and maintained in effective working order throughout the duration of the works, and until the study area has been stabilised to prevent off-site transport of eroded sediments,
- should fencing be required, it will need to allow safe passage of native wildlife,
- landscaping works are to be outside areas of bushland and do not include environmental weeds,

- removal of environmental weeds from the site and their ongoing control.

4.3.2 Pre-clearance protocols

No HBTs or stag trees are identified for removal within the construction footprint or subject land. As such, it is not necessary for an ecologist to be present onsite during the removal of the native vegetation proposed for removal. However, several non-threatened fauna species such as birds, arboreal mammals and amphibians are likely to be present in the subject land. Appropriate pre-clearance protocols will be put in place at the time of construction to avoid and mitigate any potential harm or injury to these individuals. These protocols are discussed below and should be included as a component of the Construction Environmental Management Plan.

4.3.3 Construction Environmental Management Plan (CEMP)

To avoid potential indirect offsite impact during construction, an appropriate Erosion and Sedimentation Control Plan (ESCP) should be in place following best practice protocols such as Landcom (2004). These control measures should be established before work begins, maintained throughout the works and kept in place until the impact area has been stabilised. Any areas of bare soil created as part of the proposed works should be stabilised as soon as practicable to avoid off-site transport of eroded sediments into nearby Hazelton Creek and Macquarie Rivulet.

It is recommended that the ESCP is included in a site-specific Construction Environmental Management Plan (CEMP) (that include tree clearing), prior to any construction works taking place. The site-specific plan also needs to consider the KFH within Macquarie Rivulet and Hazelton Creek (**Section 4.3.4**).

4.3.4 Riparian revegetation and Key Fish Habitat

The proposal will be assessed as a Part 5 activity. Much of the impact area is within 'waterfront land' under the WM Act (i.e. 40 m of the top of bank of the drainage line) and would typically require controlled activity approval. However, as a public authority, Shellharbour Council does not need to obtain a controlled activity approval for any controlled activated that it carries out in, on, or under waterfront land (NRAR 2018). A Vegetation Management Plan (VMP) is typically required as part of a controlled activity approval, however Shellharbour Council are exempt from the requirements of this Act. A VMP has still been prepared as requested by Cardno (Ecoplanning 2020).

Macquarie Rivulet and Hazelton Creek are considered KFH under the *FM Act*. Consequently, it is recommended that the establishment of construction and maintenance access tracks across the creek follow the fish passage guidelines for waterway crossings (Fairfull and Witheridge 2003). Additionally, an appropriate erosion and sediment control plan should be in place during works. The sedimentation plan should aim to minimise erosion during and post works which may enter Macquarie Rivulet and Hazelton Creek (**Section 4.3.3**).

4.4 Legislative context

4.4.1 Commonwealth listings

Two threatened species listed under the EPBC Act were assessed as having a 'moderate' likelihood or 'recent record' within the study area, *Chalinolobus dwyeri* (Large-eared Pied Bat), and *Pteropus poliocephalus* (Grey-headed Flying-fox), respectively (**Appendix A**). Assessment of the potential impact upon these species was assessed against the relevant components of the Significant Impact Guidelines (Commonwealth Department of the Environment (DotE) 2013; **Appendix B**). A significant impact upon these species is unlikely and a referral is not required for the Large-eared Bat Pied Bat or Grey-headed Flying-fox.

4.4.2 State listings

Biodiversity Conservation Act 2016

The following EEC and threatened species listed under the BC Act may be impacted by the proposal:

- Freshwater Wetlands on Coastal Floodplains EEC
- *Chalinolobus dwyeri* (Large-eared Pied Bat) (moderate)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) (moderate)
- *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) (moderate)
- *Miniopterus australis* (Little Bent-winged Bat) (moderate)
- *Miniopterus orianae oceanensis* (Large Bent-winged Bat) (moderate)
- *Myotis macropus* (Southern Myotis) (moderate)
- *Saccolaimus flaviventris* (Yellow-bellied Sheath-tail-bat) (moderate)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat) (moderate)
- *Pteropus poliocephalus* (Grey-headed Flying-fox (GHFF)) (recent record)

Impact assessment in accordance with Part 7.3 of the BC Act (i.e. the 'Test of Significance') and the associated guidelines (OEH 2017) have been undertaken. These assessments found that there is unlikely to be any significant impacts to the above-listed threatened species. Similarly, the impacts proposed to Swamp Oak Floodplain Forest and Freshwater Wetlands on Coastal Floodplains are unlikely to be significant.

4.4.3 Shellharbour LEP considerations

The study area is mapped as 'Terrestrial Biodiversity' on the Biodiversity Map under the SLEP (2013) and, therefore, the consent authority must consider the following matters under Clause 6.5.

Clause 6.5

Before determining a development application for development on land to which this clause applies, the consent authority must consider:

- a) *whether the development is likely to have:*
 - any adverse impact on the condition, ecological value and significance of the fauna and flora on the land, and

The proposal would remove 0.10 ha of native vegetation mapped as Riparian River Oak Forest, 0.28 ha of Floodplain Wetland and 0.34 ha of Acacia Scrub to accommodate the proposed road extension. Other vegetation within the subject land that may provide foraging habitat for local fauna species consists of 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings. The remaining 16.96 ha of impacts of the current proposal will be to land mapped exotic grassland/infrastructure. The proposal will require a relatively small area of native vegetation and, thus, a small area of potential foraging habitat would be impacted by the proposal. It is unlikely that the proposal would have an adverse impact on the condition, ecological value and significance of the fauna and flora in the subject land, given the low quality and fragmented nature of the vegetation identified within the study area.

- any adverse impact on the importance of the vegetation on the land to the habitat and survival of native fauna, and

A total of 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub, and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings is proposed for removal. All vegetation identified within the study area is highly disturbed and is of limited value to local fauna. The proposal would result in the removal of mature canopy trees, which do not contain any hollows. While the proposal will have an adverse impact resulting from the removal of native vegetation, this impact is not likely to be important for the habitat and survival of native fauna as this vegetation is highly disturbed and is, therefore, is only likely to provide resources for native fauna species that can utilise disturbed habitats.

- any potential to fragment, disturb or diminish the biodiversity structure, function and composition of the land, and

The vegetation identified within the study area is already in a highly disturbed condition and does not entirely conform to the community description of each respective native vegetation community. The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub, and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings is proposed for removal. The removal of vegetation within the subject land will increase fragmentation. However, given the subject land already exists in a highly degraded condition with isolation between vegetation patches already present, the proposal is unlikely to diminish the biodiversity structure, function and composition of the land.

- any adverse impact on the habitat elements providing connectivity on the land, and

The proposal would only require the removal of 0.72 ha of native vegetation within the subject land, and 1.44 ha of other vegetation. While the proposal will have an adverse impact resulting from the removal of native vegetation, this impact is not likely to be important for the habitat elements providing connectivity on the land as this vegetation is highly disturbed and exists in an already fragmented landscape.

- b) *any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.*

The proposal has largely avoided impacts to vegetation along the Macquarie Rivulet in the northern portion of the study area. Where impacts are proposed they are limited to highly disturbed vegetation that offer limited value to local fauna or threatened species. No HBTs or stags were identified within the study area.

5 Conclusion and recommendations

This report considered the potential impacts to threatened species, populations and ecological communities with respect to the proposed road extension at Tripoli Way, Albion Park. The proposed works involve the construction of new roadways, pedestrian walkways and upgrades to existing roadways. The proposed development will require the removal of a number of mature native trees and patches of native vegetation. The proposal would remove approximately 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub, 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings, and 16.96 ha mapped as exotic grassland/infrastructure to accommodate the proposed works. Riparian River Oak Forest constitute the EEC Swamp Oak Floodplain Forest under the BC Act, and Floodplain Wetland constitutes the EEC Freshwater Wetlands on Coastal Floodplains listed under the BC Act.

No threatened flora species listed under the EPBC Act or BC Act were identified in the study area during field assessment nor are considered likely to occur. No threatened fauna species listed under the EPBC Act or BC Act were recorded in the study area during field assessment. Nine threatened and migratory fauna species were assessed as having a 'recent record' or 'moderate' likelihood of occurring in the study area. Impacts to these threatened and migratory species will not be significant in accordance with Section 7.3 of the BC Act and the EPBC Act Significance Assessments (**Appendix B**). No HBTs or stag trees were identified in the study area.

In summary, the proposed development will not significantly impact threatened species, populations or ecological communities. A total of 16.96 ha (i.e. 88.7%) of the 19.12 ha subject land constitutes exotic grassland/infrastructure which has limited value to threatened species, populations or ecological communities. As such, the proposal has largely avoided impacts to native vegetation in the subject land. Where impacts are proposed they are limited to highly disturbed vegetation. Appropriate mitigation measures will be implemented (see **Section 4.3**) to further reduce the impacts of the proposed works. No HBTs or stag trees are proposed for removal and the habitat available to fauna will largely remain unchanged, with the exception for the removal of canopy trees.

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Appendix A Species likelihood of occurrence

The potential for each threatened species, population and/or migratory species to occur was then considered and the necessity for targeted field surveys was determined. Following field surveys and review of available habitat within the study area, the potential for species to use the site and be affected directly or indirectly by the proposal were considered as either:

- “Recent record” = species has been recorded in the study area within the past 5 years
- “High” = species has previously been recorded in the study area (<5 years ago) or in proximity (for mobile species), and/or habitat is present that is likely to be used by a local population
- “Moderate” = suitable habitat for a species is present onsite but no evidence of a species detected and relatively high number of recent records (5-20 years) within the region or species is highly mobile
- “Low” = suitable habitat for a species is present onsite but limited or highly degraded, no evidence of a species detected and relatively low number of recent records within the region
- “Not present” = suitable habitat for the species is not present onsite or adequate survey has determined species does not occur in the study area

Scientific Name Common Name	Legal status	Number of records	Most recent and proximity	Closest record and date	Likelihood of occurrence	
					Prior to field assessment	Post field assessment
KINGDOM: Animalia; CLASS: Aves						
<i>Ardenna pacifica</i> Wedge-tailed Shearwater	BC Act: P EPBC Act: J	1	4.3 km (05/10/2018)	4.3 km (05/10/2018)		
<i>Artamus cyanopterus cyanopterus</i> Dusky Woodswallow	BC Act: V,P	2	3.1 km (20/11/2009)	2.5 km (07/01/2004)		
<i>Botaurus poiciloptilus</i> Australasian Bittern	BC Act: E1,P EPBC Act: E	1	3.4 km (07/06/2016)	3.4 km (07/06/2016)	Low	Low
<i>Calidris acuminata</i> Sharp-tailed Sandpiper	BC Act: P EPBC Act: C,J,K	26	3.7 km (01/01/2018)	0.8 km (28/02/2007)		
<i>Calidris melanotos</i> Pectoral Sandpiper	BC Act: P EPBC Act: J,K	1	0.8 km (28/02/2007)	0.8 km (28/02/2007)	Low	Low
<i>Calidris ruficollis</i> Red-necked Stint	BC Act: P EPBC Act: C,J,K	2	3.1 km (27/12/2014)	3.1 km (27/12/2014)		
<i>Circus assimilis</i> Spotted Harrier	BC Act: V,P EPBC Act:	2	1.4 km (18/10/2013)	1.4 km (18/10/2013)	Low	Low
<i>Daphoenositta chrysoptera</i> Varied Sittella	BC Act = V,P	1	1.2 km (12/10/2009)	1.2 km (12/10/2009)		
<i>Epthianura albifrons</i> White-fronted Chat	BC Act = V,P	2	3.1 km (06/11/2011)	3.1 km (06/11/2011)		
<i>Gallinago hardwickii</i> Latham's Snipe	BC Act: P EPBC Act: J,K	15	3.7 km (21/09/2017)	3.1 km (06/01/2017)	Low	Low

Scientific Name Common Name	Legal status	Number of records	Most recent and proximity	Closest record and date	Likelihood of occurrence	
					Prior to field assessment	Post field assessment
<i>Haematopus longirostris</i> Pied Oystercatcher	BC Act: E1,P	2	2.8 km (12/10/2020)	2.8 km (12/10/2020)	Low	Low
<i>Haliaeetus leucogaster</i> White-bellied Sea-Eagle	BC Act: V,P	22	3.1 km (06/01/2017)	2.3 km (22/04/2012)	Low	Low
<i>Hieraaetus morphnoides</i> Little Eagle	BC Act: V,P	3	3.8 km (24/06/2016)	3.1 km (06/11/2011)	Low	Low
<i>Hirundapus caudacutus</i> White-throated Needle-tail	BC Act: P EPBC Act: V,C,J,K	3	3.8 km (28/02/2016)	2.8 km (20/12/2010)	Low	Low
<i>Hydroprogne caspia</i> Caspian Tern	BC Act: P EPBC Act: J	13	3 km (07/11/2017)	3 km (07/11/2017)	Low	Low
<i>Lathamus discolor</i> Swift Parrot	BC Act: E1,P,3 EPBC Act: CE	1	0.2 km (22/09/2008)	0.2 km (22/09/2008)	Moderate	Low
<i>Limosa lapponica</i> Bar-tailed Godwit	BC Act: P EPBC Act: C,J,K	5	2.8 km (12/10/2020)	2 km (22/10/2011)	Low	Low
<i>Lophoictinia isura</i> Square-tailed Kite	BC Act: V,P,3	2	3.8 km (24/06/2016)	3.8 km (24/06/2016)	Low	Low
<i>Ninox strenua</i> Powerful Owl	BC Act: V,P,3	2	2.6 km (02/02/2016)	2.6 km (02/02/2016)	Low	Low
<i>Numenius madagascariensis</i> Eastern Curlew	BC Act: P EPBC Act: CE,C,J,K	1	2.2 km (23/10/2002)	2.2 km (23/10/2002)	Low	Low
<i>Oxyura australis</i> Blue-billed Duck	BC Act: V,P	47	3.7 km (01/01/2018)	3.7 km (01/01/2018)	Low	Low

Scientific Name Common Name	Legal status	Number of records	Most recent and proximity	Closest record and date	Likelihood of occurrence	
					Prior to field assessment	Post field assessment
<i>Pandion cristatus</i> Eastern Osprey	BC Act: V,P,3	22	4 km (14/09/2017)	2 km (22/10/2011)	Low	Low
<i>Petroica boodang</i> Scarlet Robin	BC Act: V,P	2	3.8 km (15/08/2015)	1.9 km (01/05/2011)	Low	Low
<i>Petroica phoenicea</i> Flame Robin	BC Act: V,P	1	1.3 km (11/12/2012)	1.3 km (11/12/2012)	Low	Low
<i>Rostratula australis</i> Australian Painted Snipe	BC Act: E1,P EPBC Act: E	1	2 km (22/10/2011)	2 km (22/10/2011)	Low	Low
<i>Stictonetta naevosa</i> Freckled Duck	BC Act: V,P	47	3 km (07/11/2017)	2.8 km (26/05/2003)	Low	Low
<i>Thalasseus bergii</i> Crested Tern	BC Act: P EPBC Act: J	1	2.5 km (07/01/2004)	2.5 km (07/01/2004)	Low	Low
<i>Tringa nebularia</i> Common Greenshank	BC Act: P EPBC Act: C,J,K	1	2 km (22/10/2011)	2 km (22/10/2011)	Low	Low
<i>Tyto tenebricosa</i> Sooty Owl	BC Act: V,P,3	1	4.1 km (19/08/2015)	4.1 km (19/08/2015)	Low	Low
KINGDOM: Animalia; CLASS: Mammalia						
<i>Chalinolobus dwyeri</i> Large-eared Pied Bat	BC Act: V,P EPBC Act = V	6	3.2 km (08/08/2019)	0.9 km (11/10/2018)	Moderate	Moderate
<i>Falsistrellus tasmaniensis</i> Eastern False Pipistrelle	BC Act: V,P	7	3.2 km (08/08/2019)	1.1 km (03/03/2019)	Moderate	Moderate
<i>Micronomus norfolkensis</i> Eastern Coastal Free-tailed Bat	BC Act: V,P	8	3.7 km (09/04/2015)	1.4 km (20/02/2015)	Moderate	Moderate

Scientific Name Common Name	Legal status	Number of records	Most recent and proximity	Closest record and date	Likelihood of occurrence	
					Prior to field assessment	Post field assessment
<i>Miniopterus australis</i> Little Bent-winged Bat	BC Act: V,P	13	1.1 km (12/11/2019)	1.1 km (03/03/2019)	Moderate	Moderate
<i>Miniopterus orianae oceanensis</i> Large Bent-winged Bat	BC Act: V,P	12	1.1 km (12/11/2019)	1.1 km (12/11/2019)	Low	Moderate
<i>Myotis macropus</i> Southern Myotis	BC Act: V,P	4	3.2 km (08/08/2019)	0.9 km (11/10/2018)	Moderate	Moderate
<i>Petaurus norfolcensis</i> Squirrel Glider	BC Act: V,P	1	1.8 km (08/12/2018)	1.8 km (08/12/2018)	Moderate	Low
<i>Phascolarctos cinereus</i> Koala	BC Act: V,P EPBC Act: V	1	1.4 km (25/12/2014)	1.4 km (25/12/2014)	Moderate	Low
<i>Pteropus poliocephalus</i> Grey-headed Flying-fox	BC Act: V,P EPBC Act: V	52	4.3 km (23/03/2019)	0 km (23/11/2015)	Listed previously as recent record	Listed previously as recent record
<i>Saccolaimus flaviventris</i> Yellow-bellied Sheath-tail-bat	BC Act: V,P	4	1.1 km (03/03/2019)	1.1 km (03/03/2019)	Moderate	Moderate
<i>Scoteanax rueppellii</i> Greater Broad-nosed Bat	BC Act: V,P	6	1.1 km (03/03/2019)	1.1 km (03/03/2019)	Moderate	Moderate
KINGDOM: Plantae						
<i>Chorizema parviflorum</i> <i>Chorizema parviflorum</i> Benth. in the Wollongong and Shellharbour Local Government Areas	BC Act: E2	113	4.6 km (11/07/2020)	1.4 km (02/09/2014)	Moderate	Low
<i>Cynanchum elegans</i> White-flowered Wax Plant	BC Act: E1 EPBC Act: E	18	4.5 km (03/12/2020)	1.2 km (18/10/2005)	Low	Low

Scientific Name Common Name	Legal status	Number of records	Most recent and proximity	Closest record and date	Likelihood of occurrence	
					Prior to field assessment	Post field assessment
<i>Daphnandra johnsonii</i> Illawarra Socketwood	BC Act: E1 EPBC Act: E	35	4.9 km (16/02/2018)	2.5 km (30/11/2016)	Low	Low
<i>Gossia acmenoides</i> Gossia acmenoides population in the Sydney Basin Bioregion south of the Georges River	BC Act: E2	1	2.2 km (23/04/2016)	2.2 km (23/04/2016)	Low	Low
<i>Irenepharsus trypherus</i> Illawarra Irene	BC Act: E1 EPBC Act: E	14	2.5 km (17/01/2019)	1.3 km (09/11/2016)	Moderate	Low
<i>Lespedeza juncea</i> subsp. <i>sericea</i> Lespedeza juncea subsp. <i>sericea</i> in the Wollongong Local Government Area	BC Act: E2	1	5 km (06/03/2018)	5 km (06/03/2018)	Low	Low
<i>Pimelea curviflora</i> var. <i>curviflora</i>	BC Act: V EPBC Act: V	21	1.4 km (12/01/2021)	1.3 km (16/07/2019)	Moderate	Low
<i>Pimelea spicata</i> Spiked Rice-flower	BC Act: E1 EPBC Act: E	3	4.8 km (17/02/2016)	4.8 km (17/02/2016)	Low	Low
<i>Pterostylis gibbosa</i> Illawarra Greenhood	BC Act: E1,P,2 EPBC Act: E	146	4 km (04/09/2020)	1.4 km (01/11/2018)	Low	Low
<i>Rhodamnia rubescens</i> Scrub Turpentine	BC Act: E4A	4	2.7 km (05/04/2018)	2.3 km (23/04/2016)	Low	Low
<i>Solanum celatum</i>	BC Act: E1	19	0 km (21/09/2019)	0 km (21/09/2019)	High	Low
<i>Zieria granulata</i> Illawarra Zieria	BC Act: E1 EPBC Act: E	82	3.8 km (30/03/2021)	0.9 km (01/08/2002)	Moderate	Low

Unless other stated, text is taken from the OEH Threatened Species (<http://www.environment.nsw.gov.au/threatenedspecies/>); Legal Status codes from the Atlas of NSW Wildlife: V = Vulnerable, E1 = Endangered, E2 = Endangered Population, C = China and Australia Migratory Bird Agreement (CAMBA), J = Japan and Australia Migratory Bird Agreement (JAMBA); K = Republic of Korea and Australia Migratory Bird Agreement (ROKAMBA), BC Act = *NSW Biodiversity Conservation Act 2016*, EPBC Act = *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

Appendix B Assessments of Significance

Commonwealth listings under the EPBC Act

The EPBC Act Matters of National Environmental Significance (MNES) (EPBC Act Significant Impact Guidelines) (DoE 2013) provides 'Significant Impact Criteria' that are to be used to assist in determining whether a proposed action is likely to have a significant impact on a MNES and subsequently the need for referral. MNES identified within the study area have been addressed below.

Large-eared Pied Bat (*Chalinolobus dwyeri*) – vulnerable species

The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species

An 'important population' is defined by DoE (2013) as a population that is necessary for a species long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

The proposal is unlikely to lead to a long-term decrease in the size of an important population of the Large-eared Pied Bat, as the site does not constitute breeding habitat for the species. Four records have been made of the Large-eared Pied Bat in the local area (DPIE 2020), with the most recent record made on 3 March 2019 approximately 1 km from the study area, and the closest record within 900 m of the study area recorded on 11 October 2018. The species has the potential to utilise the habitat in the study area as foraging habitat, however, is unlikely to utilise the site for breeding or roosting, given the species tendencies to reside in caves and cliff crevices. Thus, the habitat in the study area does not provide roosting habitat and the impacts of the proposal are specific to the removal of foraging habitat. In consideration of the above, the proposal will not directly impact on Large-eared Pied Bat or lead to a long-term decrease in an important population.

- reduce the area of occupancy of an important population

An 'important population' is not present at the study area, nor is roosting or breeding habitat. Therefore, the proposal will not reduce the area for an important population of Large-eared Pied Bat.

- fragment an existing important population into two or more populations

An important population of Large-eared Pied Bat is not present within the study area. Furthermore, the proposal will not result in the fragmentation or isolation of other remnants, as it does not act as an intermediary patch between two (or more) areas of habitat. The vegetation in the study area occurs in an already fragmented landscape and retains low – moderate connectivity to larger expanses of bushland, such as those along the Macquarie Rivulet.

- adversely affect habitat critical to the survival of a species

The national recovery plan for the Large-eared Pied Bat specifies areas of habitat critical to the survival of the species (DERM 2011), including:

- Sandstone cliffs within proximity to fertile wooded valley habitat.
- Rainforest and moist eucalypt forest habitats on other geological substrates (viz. rhyolite, trachyte and basalt) at high elevation.

Sandstone cliffs occur west of the study area within Macquarie Pass and other escarpment areas. These provide potential roosting habitat for the Large-eared Pied Bat and constitute habitat critical to the survival of the species. However, the study area does not contain these habitat features, and is located sufficiently far enough away as to not indirectly impact on the critical habitat. The study area does not contain rainforest or moist eucalypt forest on the geology or elevations required to be classified as critical habitat (DERM 2011).

- disrupt the breeding cycle of an important population

The Large-eared Pied Bat is unlikely to roost in the study area, and thus will not be impacted by the proposed development. As no population occurs in the study area it also fails to meet the criteria of being an 'important population'.

- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed action is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. No occupied habitat would be directly or indirectly impacted and sufficient foraging habitat remains in the locality.

- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat

The proposed works are unlikely to result in invasive species that are harmful.

- introduce disease that may cause the species to decline, or

The proposed works are unlikely to introduce disease that may cause the species to decline.

- interfere substantially with the recovery of the species.

The proposed action is unlikely to interfere with the recovery of the Large-eared Pied Bat, given that the species does not utilise the study area for roosting. A relatively small area of potential

foraging habitat will be removed, which mostly consists of small areas of native and exotic vegetation, and cleared land.

Conclusion of EPBC Act Significant Impact Guidelines (DoE 2013) for Large-eared Pied Bat.

A referral is not recommended for Large-eared Pied Bat, as:

- no breeding or roosting habitat would be removed,
- a small area (0.72 ha native vegetation and 1.44 ha other vegetation) would be removed which constitutes foraging habitat,
- the site does not support an 'important population' of Large-eared Pied Bat, and
- the proposal will not impact on habitat critical to the survival of the species.

Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable species

Grey-headed Flying-fox (GHFF) occurs within 200 km of the eastern coastline of Australia, from Rockhampton in Queensland to Adelaide in South Australia. They prefer subtropical and temperate rainforest, tall sclerophyll forests and woodlands, as well as heaths and swamps. Roosting areas are often selected upon their proximity to a regular food source (within 20 km), often in gullies, close to water, or in vegetation with a dense canopy. This species roosts communally in large, established camps which can support several thousand individuals. The GHFF can travel up to 50 km from camp to forage (typically <20 km), where they feed on nectar and pollen from *Eucalyptus*, *Banksia* and *Melaleuca* spp., as well as the fruits of native and exotic species.

Threats to this species include:

- Loss of roosting and foraging site
- Heat stress
- Electrocution on powerlines and entanglement in netting.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species

The proposal is unlikely to lead to a long-term decrease in the size of an important population of the GHFF, as the site does not contain a camp of GHFF. The most recent record of the species was made on 26 April 2018 approximately 3.32 km from the study area and a record of the species was made within the study area on 23 November 2017 (DPIE 2020). It is likely that the GHFF may occasionally use the vegetation in the study area for foraging. However, the proposal will not lead to a decrease in the population of the GHFF, as the species is not being directly impacted by the proposal. Large areas of vegetated land available for foraging are found within the local area, including vegetation found along the Macquarie Rivulet and planted vegetation within residential areas.

- reduce the area of occupancy of an important population

The proposal is unlikely to reduce the area of occupancy for the GHFF, as no resident population occurs within the study area or immediate surrounds. The closest GHFF camp is located in Blackbutt Reserve (DotEE 2020b), approximately 6.5 km east of the study area.

Furthermore, the species could continue to fly over the study area, or forage in the canopy tree proposed within the Landscape Plan.

- fragment an existing important population into two or more populations

The proposal is unlikely to lead to the fragmentation of a GHFF population, as the effects of fragmentation on GHFF is more important in areas directly surrounding roosting habitat. Furthermore, the ability for GHFF to travel large distances makes them less susceptible to the impacts of fragmentation. The study area is sufficiently far enough away from the closest GHFF population in Blackbutt Reserve (DotEE 2020b) so as to not substantially impact on the species.

- adversely affect habitat critical to the survival of a species

According to the Draft National Recovery Plan for the GHFF, foraging habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival, or essential habitat (DECCW 2009), including:

- productive during winter and spring, when food bottlenecks have been identified
- known to support populations of > 30 000 individuals within an area of 50 km radius (the maximum foraging distance of an adult)

Corymbia maculata, which is a winter and spring flowering species, has been planted within the study area, and, therefore, could provide foraging habitat for the GHFF during this period. It is possible that the study area may be used during food availability bottlenecks. However, given the limited amount of foraging habitat present in the study area compared to vegetation in the local area (along Macquarie Rivulet and west towards the escarpment), the importance of the habitat proposed for removal is substantially reduced. The closest known population to support >10,000 individuals is located approximately 40 km north-west of the study area at Picton, with between 10,000-16,000 individuals of this species recorded from this camp in August 2019 (DotEE 2020b). The vegetation in the study area likely constitutes habitat critical to the survival of the species, although the removal of canopy trees will not result in an adverse impact.

- disrupt the breeding cycle of an important population

The proposed development is unlikely to disrupt the breeding cycle of an important population given the abundance of potential foraging habitat adjoining the site along Macquarie Rivulet and west towards the escarpment.

- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub, and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings to accommodate the proposed works. Given that only a relatively small area of native vegetation will be removed, the proposal is unlikely to remove habitat to an extent that will cause a decline in GHFF. Furthermore, the local area contains substantial foraging habitat for the species, including along Macquarie Rivulet and west towards the escarpment.

- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed works are unlikely to result in invasive species that are harmful.

- introduce disease that may cause the species to decline, or

The proposed works are unlikely to introduce disease that may cause the species to decline.

- interfere substantially with the recovery of the species.

The proposal is unlikely to substantially interfere with the recovery of the species as the amount of potential habitat requiring removal is small.

Conclusion of EPBC Act Significant Impact Guidelines (DotE 2013) for GHFF.

A referral is not recommended for the GHFF, as:

- no breeding or roosting habitat would be removed,
- a small area (0.72 ha native vegetation and 1.44 ha other vegetation) would be removed which constitutes foraging habitat,
- the proposal is unlikely to impact on the breeding cycle of nearby populations, and
- the proposal would not have an adverse effect on critical habitat.

State listings under the BC Act

The following factors listed under Part 7.3 of the BC Act must be taken into account when deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats. The below assessments have been prepared in accordance with the appropriate guidelines (OEH 2018).

Freshwater Wetlands on Coastal Floodplains – EEC

The Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions are associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes but may also occur in backbarrier landforms where floodplains adjoin coastal sandplains. Generally occur below 20 m elevation on level areas. They are dominated by herbaceous plants and have very few woody species. The structure and composition of the community varies both spatially and temporally depending on the water regime: Those that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 metre tall and dominated by amphibious plants including *Paspalum distichum* (Water Couch), *Leersia hexandra* (Swamp Rice-grass), *Pseudoraphis spinescens* (Mud Grass) and *Carex appressa* (Tussock Sedge). Common threats to this community include land clearing, changes in hydrological regimes from past and present drainage, and changes in surface water flows through drains, levees and flood gates.

- a. *in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*

Not applicable.

- b. *in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

For the purposes of this report the local occurrence of Freshwater Wetlands on Coastal Floodplains includes the vegetation in the study area and adjoining areas of the community around the study area where the transfer of genetic material is considered likely to occur (**Appendix C**). The local occurrence of Freshwater Wetlands on Coastal Floodplains covers an area of approximately 12.31 ha (NPWS 2002).

The proposal is unlikely to adversely and substantially modify the community such that it would put the local occurrence at risk of extinction. The proposal would result in 0.28 ha of direct impacts to Freshwater Wetlands on Coastal Floodplains, which represents 2.27% of the local occurrence. It is unlikely that the proposal would have an adverse effect on the extent of the community, given the relatively small amount of vegetation proposed for removal and that extensive areas of the EEC will remain adjacent to the study area.

- c. *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity,*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality*

The proposed impacts would disturb a small amount of vegetation in the study area. The proposal would remove 0.28 ha of Freshwater Wetlands on Coastal Floodplains to accommodate the proposal.

The proposed development is unlikely to result in the fragmentation or isolation of areas of habitat as the area of vegetation to be removed is small and does not make up an intermediary patch between two (or more) areas of habitat. Instead, it constitutes the removal of vegetation on the outer edges of the local occurrence.

The importance of the habitat to be removed in the study area is likely to be low, given the only a small area, of a much larger stand of the EEC, is to be impacted. The impacts associated

with the proposal would result in a small amount of vegetation removal relative to that within the surrounding area.

- d. *whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).*

The proposed activity is unlikely to have an adverse effect (either directly or indirectly) on any declared area of outstanding biodiversity value.

- e. *whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

There is one key threatening processes of relevance to this ecological community:

- Clearing of native vegetation

The proposal would remove 0.28 ha of Freshwater Wetlands on Coastal Floodplains to accommodate the proposal. A majority of this community will remain within the local area, specifically within the floodplain adjacent to the study area and within the local area. Further, the potential for indirect impacts from the proposal such as weed invasion will be managed in accordance with the mitigation measures outlined in **Section 4**.

Conclusion of test of significance for Floodplain Wetland

The proposed development is unlikely to have a significant impact on Freshwater Wetlands on Coastal Floodplains, as:

- a small area (0.28 ha) of Freshwater Wetlands on Coastal Floodplains is proposed for removal,
- the proposal is unlikely to have an adverse effect on the extent of the local occurrence, such that it is likely to be placed at risk of extinction, and
- the importance of the area of the community to be removed is likely to be low given the amount of this community directly adjacent to the study area.

Tree-hollow roosting microchiropteran bat species

The following five microchiropteran bat species have previously been recorded within a 5 km radius of the study area:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*)
- Southern Myotis (*Myotis macropus*)
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*):

The Eastern False Pipistrelle is found along the south-east rangers and coastline of Australia, spanning from southern Queensland to Victoria and Tasmania. It can be found in moist areas with trees greater than 20 m. This species forages above or just below the tree canopy for flying insects such as moths and weevils. This species hibernates in winter, roosting in hollows, houses or under bark.

The Eastern Coastal Free-tailed Bat occurs along the coastal regions of eastern Australia. In NSW its range expands west out over the Great Diving Range. The habitat preference of the Eastern Coastal Free-tailed Bat is poorly known, however, it has been observed to occur in dry eucalypt forest, coastal woodland, riparian zones and wet sclerophyll forests. The Eastern Coastal Free-tailed Bat forages for moths above forest canopy and along forest edges, and also consumes ground based invertebrates (e.g. ants and beetles). Hollow bearing trees are their preferred roosting sites.

The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. It generally roosts in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. It forages over streams and pools catching insects and small fish by raking their feet across the water surface.

The Yellow-bellied Sheath-tail-bat is a microchiropteran bat species listed as vulnerable under the BC Act. This species is a wide-ranging species found across northern and eastern Australia. The species roosts singly or in groups of up to six, in tree hollows and buildings and in treeless areas they are known to utilise mammal burrows.

The Greater Broad-nosed Bat occurs from north-eastern Victoria to the Atherton Tableland. In NSW, it occurs along the entire east coast but does not occur at altitudes above 500 m. It uses a variety of habitat from woodlands through to moist and dry eucalypt forest and rainforest. It is most commonly found in tall wet forest. It usually roosts in tree hollows but has also been found in buildings.

- a. *in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*

It is possible that the vegetation in the study area provides potential foraging habitat for the five species of microbat. The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub, and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings to accommodate the proposed works. The local population of the species is likely to rely on large areas for foraging and would use the large intact areas of bushland in the local (i.e. west towards Macquarie Pass National Park and Budderoo National Park). Thus, the proposal would not substantially reduce the foraging resources for a viable local population of the microbat species.

No HBTs or stags were identified within the study area, thus the study area is unlikely to provide roosting and/or breeding habitat for the microbat species. As such, the proposal is unlikely to impact on breeding or roosting habitat. Based on the relatively small amount of native vegetation to be removed and the lack of breeding habitat for the species within the study area, the proposal would not have an adverse effect on the lifecycle of the five species of microbat to an extent that may place the local population at risk of extinction.

- b. *in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.*

Not applicable.

- c. *in relation to the habitat of a threatened species, population or ecological community:*
 - (i) *the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity,*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.*

The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings to accommodate the proposed works.

The proposed development would not result in the fragmentation or isolation of other areas of habitat for the species. The vegetation in the study area occurs in an already fragmented landscape and retains low – moderate connectivity to larger expanses of bushland, such as those along the Macquarie Rivulet.

It is possible that the five species of microbat could use the study area as foraging habitat. However, the importance of the habitat to be removed for the long-term survival of the species of microbat in the local area is low, given the availability of habitat in the surround area, the lack of HBTs within the study area, and relatively small amount (0.72 ha of native vegetation and 1.44 ha of other vegetation) of foraging habitat.

- d. *whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).*

The proposed activity would not have any adverse effect (either directly or indirectly) on any declared area of outstanding biodiversity value.

- e. *whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

There is one key threatening processes of relevance to this species:

- clearing of native vegetation.

The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub and 1.44 ha of land mapped as aquatics and

emergent, native plantings and natives/non-native plantings. This is a total of 2.16 ha of foraging habitat for the five species.

Conclusion of test of significance for Eastern False Pipistrelle, Eastern Coastal Free-tailed Bat, Southern Myotis, Yellow-bellied Sheath-tail-bat and Greater Broad-nosed Bat

The proposed development would not have a significant impact on the Eastern False Pipistrelle, Eastern Coastal Free-tailed Bat, Southern Myotis, Yellow-bellied Sheath-tail-bat and Greater Broad-nosed Bat, as:

- a small amount of potential foraging habitat is proposed for removal (2.16 ha),
- the vegetation proposed for removal is of low importance, given the large amount of native vegetation in the local area,
- the proposal would not affect the life cycle of the species such that a viable population will be placed at risk of extinction, and
- no HBTs are proposed for removal, which could represent roosting or breeding habitat for the species.

Cave roosting microchiropteran bat species

The following three microchiropteran bat species have previously been recorded within a 5 km radius of the study area:

- Large-eared pied Bat (*Chalinolobus dwyeri*)
- Little Bent-winged Bat (*Miniopterus australis*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*)

A description of the Large-eared Pied Bat is found in the Commonwealth listings above.

The Little Bent-winged Bat occurs along the east coast of Australia ranging from Cape York Qld south to Wollongong, NSW. They are generally found in well-timbered areas of moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. It can be distinguished from the Common Bentwing-Bat by its smaller size. They roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts and bridges with foraging occurring at night for small insects beneath the canopy of densely vegetated habitats.

Large Bent-winged Bat occupies a range of forested environments (including wet and dry sclerophyll forests), along the coastal portion of eastern Australia, and through the Northern Territory and Kimberley area (subject to subdivision of this species). This species forages from just above the tree canopy, to many times the canopy height in forested areas, and will use open areas where it is known to forage at lower levels. Moths appear to be the main dietary component. This highly mobile species is capable of large regional movements in relation to seasonal differences in reproductive behaviour and winter hibernation. Though, individuals often use numerous roosts (including, mines, culverts, stormwater channels, buildings, and occasionally tree-hollows), it congregates in large numbers at a small number of nursery caves to breed and hibernate.

- a. *in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*



It is possible that the study area represents potential foraging habitat for the species. The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings to accommodate the proposed works. The local population of the species is likely to rely on large areas for foraging and would use the large intact areas of bushland in the local (i.e. west towards Macquarie Pass National Park and Budderoo National Park). Thus, the proposal would not substantially reduce the foraging resources for a viable local population of the microbat species.

The study area does not constitute roosting or breeding habitat, as it does not contain caves or rock crevices in cliffs, which are required roosting habitat for the species. As such, the proposal is unlikely to have an adverse effect on the lifecycle of the Large-eared Pied Bat, Little Bent-winged Bat or Large Bent-winged Bat, such that a viable local population is at risk of extinction.

- b. in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:*
 - (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.*

Not applicable.

- c. in relation to the habitat of a threatened species, population or ecological community:*
 - (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity,*
 - (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*
 - (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.*

The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings to accommodate the proposed works. Vegetation within the study area is highly degraded and is, therefore, of limited value for foraging purposes to the three cave-dwelling microbat species. As the study area does not contain caves or rock crevices in cliffs which are required roosting habitat for the species, it does not constitute roosting or breeding habitat.

The proposed development would not result in the fragmentation or isolation of other areas of habitat for the species. The vegetation in the study area occurs in an already fragmented landscape and retains low – moderate connectivity to larger expanses of bushland, such as those along the Macquarie Rivulet.

It is possible that the Large-eared Pied Bat, Little Bent-winged Bat and Large Bent-winged Bat could use the study area as foraging habitat. However, the importance of the habitat to be

removed for the long-term survival of the two species is low, given the availability of habitat in the local area and the lack of potential roosting or breeding habitat within the study area.

- d. *whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).*

The proposed activity would not have any adverse effect (either directly or indirectly) on any declared area of outstanding biodiversity value.

- e. *whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

There is one key threatening processes of relevance to this species:

- clearing of native vegetation.

The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings. This is a total of 2.16 ha of foraging habitat for the three species.

Conclusion of test of significance for Large-eared Pied Bat, Little Bent-winged Bat and Large Bent-winged Bat

The proposed development would not have a significant impact on the Large-eared Pied Bat, Little Bent-winged Bat and Large Bent-winged Bat, as:

- a small amount of potential foraging habitat is proposed for removal (2.16 ha),
- the vegetation proposed for removal is of low importance, given the large amount of native vegetation in the local area,
- no caves, cliffs or rock crevices or vegetation in close proximity of these features will be impacted by the proposal, and
- the proposal would not affect the life cycle of the species such that a viable population will be placed at risk of extinction.

Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable species

A description of the GHFF is found in the Commonwealth listings above.

- a. *in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*

There are 52 records of the GHFF within 5 km of the study area (DPIE 2020). The most recent record of the species was made on 26 April 2018 approximately 3.32 km from the study area and a record of the species was made within the study area on 23 November 2017 (DPIE 2020). The study area and adjoining areas of bushland do not contain a roosting camp of GHFF. However, it is likely that the GHFF may occasionally use the vegetation in the study area for foraging.

The proposal would result in the removal of 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings to accommodate the proposed works. The local population of the species is likely to rely on large areas for foraging and would use the large intact areas of bushland in the local (i.e. west towards Macquarie Pass National Park and Budderoo National Park). Thus, the proposal would not substantially reduce the foraging resources for a viable local population of the microbat species.

- b. in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:*
 - (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.*

Not applicable.

- c. in relation to the habitat of a threatened species, population or ecological community:*
 - (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity,*
 - (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*
 - (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.*

The proposal would remove a total of 2.16 ha of foraging habitat to accommodate the proposed works. The GHFF is unlikely to rely on the vegetation identified within the study area, as it is highly degraded and is, therefore, of limited value for foraging purposes. The species could continue to use the vegetation adjacent to the study area for foraging.

The proposed development would not result in the fragmentation or isolation of other areas of habitat for the species. The vegetation in the study area occurs in an already fragmented landscape and retains low – moderate connectivity to larger expanses of bushland, such as those along the Macquarie Rivulet.

It is possible that the GHFF could continue to forage in the canopy trees proposed within the Landscape Plan or continue to fly over the study area and forage in other vegetation in the local area. Nevertheless, the potential foraging habitat proposed for removal in the study area is of low importance for the long-term survival of this species.

- d. whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).*

The proposed activity would not have any adverse effect (either directly or indirectly) on any declared area of outstanding biodiversity value.



- e. *whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

There is one key threatening processes of relevance to this species:

- clearing of native vegetation.

The proposal would remove 0.72 ha of native vegetation mapped as Riparian River Oak Forest, Floodplain Wetland and Acacia Scrub and 1.44 ha of land mapped as aquatics and emergent, native plantings and natives/non-native plantings. This is a total of 2.16 ha of foraging habitat for the GHFF.

Conclusion of test of significance for GHFF

The proposed development would not have a significant impact on the GHFF, as:

- no roosts were identified in the study area or adjoining areas during field assessment,
- a small amount of potential foraging habitat is proposed for removal (2.16 ha),
- the vegetation proposed for removal is of low importance, given the large amount of native vegetation in the local area and the ability of the species to forage over large areas, and
- the proposal would not affect the life cycle of the species such that a viable population will be placed at risk of extinction.

Appendix C Local occurrence of Coastal Swamp Oak Forest and Floodplain Wetland



Appendix D Flora and fauna species inventories

Flora

Family	Scientific Name	Common name	Native/Exotic
Alismataceae	<i>Alisma plantago-aquatica</i>	Water Plantain	Forb (FG)
Apiaceae	<i>Cyclospermum leptophyllum</i>	Slender Celery	Exotic
Apiaceae	<i>Foeniculum vulgare</i>	Fennel	Exotic
Araceae	<i>Colocasia esculenta</i>	Taro	Exotic
Araliaceae	<i>Hedera helix</i>	English Ivy	Exotic
Asparagaceae	<i>Asparagus aethiopicus</i>	Asparagus Fern	Exotic
Asparagaceae	<i>Asparagus virgatus</i>	Asparagus Fern	Exotic
Asteraceae	<i>Bidens pilosa</i>	Cobbler's Pegs	Exotic
Asteraceae	<i>Conyza</i> sp.	A Fleabane	Exotic
Asteraceae	<i>Hypochaeris radicata</i>	Catsear	Exotic
Asteraceae	<i>Onopordum acanthium</i> subsp. <i>acanthium</i>	Scotch Thistle	Exotic
Asteraceae	<i>Senecio madagascariensis</i>	Fireweed	Exotic
Asteraceae	<i>Sonchus oleraceus</i>	Common Sowthistle	Exotic
Asteraceae	<i>Cichorium intybus</i>	Chicory	Exotic
Azollaceae	<i>Azolla</i> sp.		Fern (EG)
Basellaceae	<i>Anredera cordifolia</i>	Madeira Vine	Exotic
Bignoniaceae	<i>Jacaranda mimosifolia</i>	Jacaranda	Exotic
Bignoniaceae	<i>Pandorea pandorana</i>	Wonga Vine	Other (OG)
Brassicaceae	<i>Nasturtium officinale</i>	Watercress	Exotic

Family	Scientific Name	Common name	Native/Exotic
Buxaceae	<i>Buxus microphylla</i>		Exotic
Casuarinaceae	<i>Casuarina cunninghamiana</i>	River oak	Tree (TG)
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak	Tree (TG)
Commelinaceae	<i>Commelina cyanea</i>	Native Wandering Jew	Forb (FG)
Commelinaceae	<i>Tradescantia fluminensis</i>	Trad	Exotic
Convolvulaceae	<i>Ipomoea indica</i>	Morning Glory	Exotic
Cupressaceae	<i>Cupressus x leylandii</i>	Leyland's Cyperus	Exotic
Cyperaceae	<i>Cyperus eragrostis</i>	Umbrella Sedge	Exotic
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Common Bracken	Fern (EG)
Elaeocarpaceae	<i>Elaeocarpus reticulatus</i>	Blueberry Ash	Shrub (SG)
Euphorbiaceae	<i>Ricinus communis</i>	Castor Oil Plant	Exotic
Fabaceae (Faboideae)	<i>Erythrina x sykesii</i>	Coral tree	Exotic
Fabaceae (Faboideae)	<i>Medicago sativa</i>	Lucerne	Exotic
Fabaceae (Faboideae)	<i>Trifolium repens</i>	White Clover	Exotic
Fabaceae (Mimosoideae)	<i>Acacia binervia</i>	Coast Myall	Tree (TG)
Fabaceae (Mimosoideae)	<i>Acacia mearnsii</i>	Black Wattle	Shrub (SG)
Juncaceae	<i>Juncus usitatus</i>		Grass & grasslike (GG)
Hamamelidaceae	<i>Liquidambar styraciflua</i>	Sweetgum	Exotic
Lemnaceae	<i>Lemna disperma</i>	Duck Weed	Forb (FG)

Family	Scientific Name	Common name	Native/Exotic
Lemnaceae	<i>Lemna</i> sp.		Forb (FG)
Lythraceae	<i>Lagerstroemia indica</i>	Crape Myrtle	Exotic
Malvaceae	<i>Sida rhombifolia</i>	Paddy's Lucerne	Exotic
Meliaceae	<i>Melia azedarach</i>	White Cedar	Tree (TG)
Myrtaceae	<i>Backhousia myrtifolia</i>	Grey Myrtle	Shrub (SG)
Myrtaceae	<i>Callistemon viminalis</i>	Weeping Bottlebrush	Tree (TG)
Myrtaceae	<i>Corymbia citriodora</i>	Lemon-scented Gum	Exotic
Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum	Tree (TG)
Myrtaceae	<i>Eucalyptus botryoides</i>	Bangalay	Tree (TG)
Myrtaceae	<i>Eucalyptus microcorys</i>	Tallowwood	Tree (TG)
Myrtaceae	<i>Eucalyptus pilularis</i>	Blackbutt	Tree (TG)
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum	Tree (TG)
Myrtaceae	<i>Lophostemon confertus</i>	Brush Box	Tree (TG)
Myrtaceae	<i>Melaleuca armillaris</i> subsp. <i>armillaris</i>	Bracelet Honey-myrtle	Shrub (SG)
Myrtaceae	<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark	Shrub (SG)
Myrtaceae	<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree	Shrub (SG)
Myrtaceae	<i>Syzygium australe</i>	Brush Cherry	Shrub (SG)
Oleaceae	<i>Ligustrum lucidum</i>	Large-leaved Privet	Exotic
Oleaceae	<i>Ligustrum sinense</i>	Small-leaved Privet	Exotic
Onagraceae	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Water Primrose	Forb (FG)
Pittosporaceae	<i>Pittosporum undulatum</i>	Sweet Pittosporum	Shrub (SG)

Family	Scientific Name	Common name	Native/Exotic
Plantaginaceae	<i>Plantago lanceolata</i>	Lamb's Tongues	Exotic
Poaceae	<i>Bromus catharticus</i>	Prarie Grass	Exotic
Poaceae	<i>Cenchrus clandestinus</i>	Kikuyu Grass	Exotic
Poaceae	<i>Paspalum dilatatum</i>	Paspalum	Exotic
Poaceae	<i>Paspalum urvillei</i>	Vasey Grass	Exotic
Poaceae	<i>Phragmites australis</i>	Common Reed	Grass and grasslike (GG)
Poaceae	<i>Polypogon monspeliensis</i>	Annual Beardgrass	Exotic
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed	Forb (FG)
Polygonaceae	<i>Persicaria</i> sp.	Knotweed	Forb (FG)
Polygonaceae	<i>Persicaria strigosa</i>		Forb (FG)
Polygonaceae	<i>Rumex crispus</i>	Curled Dock	Exotic
Proteaceae	<i>Banksia ericifolia</i>	Heath-leaved Banksia	Shrub (SG)
Proteaceae	<i>Grevillea robusta</i>	Silky Oak	Tree (TG)
Proteaceae	<i>Grevillea</i> sp.	Honey Gem	Shrub (SG)
Sapindaceae	<i>Cardiospermum grandiflorum</i>	Balloon Vine	Exotic
Solanaceae	<i>Solanum nigrum</i>	Black-berry Nightshade	Exotic
Typhaceae	<i>Typha orientalis</i>	Broad-leaved Cumbungi	Grass & grasslike (GG)
Verbenaceae	<i>Lantana camara</i>	Lantana	Exotic
Verbenaceae	<i>Verbena bonariensis</i>	Purpletop	Exotic

* denotes exotic species. Denotes native species, but not native to botanical subregion

Fauna

Class	Family	Scientific name	Common name	Native/ Exotic	Observation Type
Aves	Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird	Native	W
Aves	Artamidae	<i>Gymnorhina tibicen</i>	Australian Magpie	Native	Ow
Aves	Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	Native	W
Aves	Cacatuidae	<i>Eolophus roseicapilla</i>	Galah	Native	Ow
Aves	Casuariidae	<i>Dromaius novaehollandiae</i>	Emu	Native	O
Aves	Charadriidae	<i>Vanellus miles</i>	Masked Lapwing	Native	O
Aves	Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon	Native	O
Aves	Corvidae	<i>Corvus coronoides</i>	Australian Raven	Native	Ow
Aves	Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	Native	Ow
Aves	Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner	Native	Ow
Aves	Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark	Native	Ow
Aves	Phasianidae	<i>Gallus</i>	Red Junglefowl	Exotic	W
Aves	Psittacidae	<i>Trichoglossus moluccanus</i>	Rainbow Lorikeet	Native	Ow
Aves	Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail	Native	Ow
Aves	Sturnidae	<i>Acridotheres tristis</i>	Common Myna	Exotic	Wo
Mammalia	Bovidae	<i>Bos taurus</i>	Cattle	Exotic	W
Mammalia	Bovidae	<i>Ovis aries</i>	Sheep	Exotic	W
Mammalia	Canidae	<i>Canis lupus</i>	Dog	Exotic	W

O = observed; W = heard



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Vegetation Management Plan



Tripoli Way, Albion Park, NSW, 2527

Prepared for: Cardno

21 January 2022 Version: FINAL

PROJECT NUMBER	2020 - 042		
PROJECT NAME	Vegetation Management Plan		
PROJECT ADDRESS	Tripoli Way, Albion Park, NSW, 2527		
PREPARED FOR	Cardno		
AUTHOR/S	Stephanie Cerato and Nathan Storch		
REVIEW	Technical	QA	Version
	Ed Cooper		Draft 1.0
VERSION	Version		Date to client
	FINAL		21 January 2022

This report should be cited as: 'Ecoplanning (2022). Vegetation Management Plan – Tripoli Way, Albion Park, NSW, 2527. Prepared for Cardno.'

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Glossary and abbreviations

Acronym	Description
BC Act	NSW <i>Biodiversity Conservation Act 2016</i>
DCP	Development Control Plan
DPIE	NSW Department of Planning, Industry and Environment
ELA	Eco Logical Australia
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ha	Hectares
LGA	Local Government Area
MZ	Management Zone
NPWS	National Parks and Wildlife Service
NRAR	Natural Resources Access Regulator
masl	Metres above sea level
PCT	Plant Community Type
REF	Review of Environmental Factors
SLEP	Shellharbour Local Environment Plan 2013
TEC	Threatened Ecological Community
ToB	Top of Bank
VMP	Vegetation Management Plan
VRZ	Vegetated Riparian Zone
WoNS	Weeds of National Significance
*	Denotes exotic species
†	Denotes both native and introduced species



1 Introduction

1.1 Description of project and purpose of Vegetation Management Plan

This Vegetation Management Plan (VMP) has been prepared to guide the management of retained and restored vegetation as part of a road extension at Tripoli Way, Albion Park, NSW (the 'study area'; **Figure 1.1**). The proposed development will connect Tongarra Road at the western end of Albion Park to Terry Street at the eastern end, reducing impacts of predicted traffic growth on Albion Park. To mitigate the impacts of the proposal, riparian corridors within the study area (the 'VMP subject site'; **Figure 1.1**) will be rehabilitated and managed. A VMP is required to ensure that potential impacts to the vegetation in the VMP subject site, such as fencing, grazing, access, weed treatments, regeneration and rehabilitation, are addressed to ensure the vegetation is protected.

The proposed road extension is subject to controls as part of the Shellharbour Development Control Plan (SDCP) 2013. Under this plan, the study area is zoned as mostly R2 – Low Density Residential and SP2 – Infrastructure. Some areas of the study area that coincide with watercourses are zoned mostly RU1 – Primary Production and RU2 – Rural Landscape.

The objective of this VMP is to provide feasible management options for the restoration of Vegetated Riparian Zones (VRZs) following impacts to mapped streams within the study area. The VMP subject site is specific to impacts to the VRZ of Macquarie Rivulet (5th order), Hazelton Creek (3rd order) and the floodplain within the eastern portion of the study area. The VMP subject site consists of six polygons as shown in **Figure 1.1**.

This VMP outlines management methods for protecting and enhancing the native vegetation within the VRZ of mapped streams, and to prescribe habitat management principles when clearing native vegetation. Revegetation of the cleared areas of the site and primary woody-weed removal will be implemented to achieve the VMPs primary objectives, which include:

- restoration and management of riparian zones to buffer Macquarie Rivulet, Hazelton Creek and the area of floodplain vegetation from the impacts of the surrounding land use (e.g. nutrient enriched runoff). This will contribute to the health of the watercourses and floodplain in the subject site and the overall catchment,
- revegetation of the subject site with a combination of native midstorey, overstorey and grasses/groundcovers, in consideration of the sites flooding capacity,
- improving the integrity (including structure and composition) of native vegetation within the VMP subject site through weed management and assisted natural regeneration,
- improving the quality of the habitat for threatened fauna species that inhabit or pass through retained native vegetation, and
- improvement of the soil stability of the riparian zones through the revegetation of appropriate species.

This report includes a proposal for staging of works to sufficiently guide the weed treatment, revegetation and general restoration of the subject site by a qualified bush regeneration company. This VMP is intended to be implemented over a 5-year period.



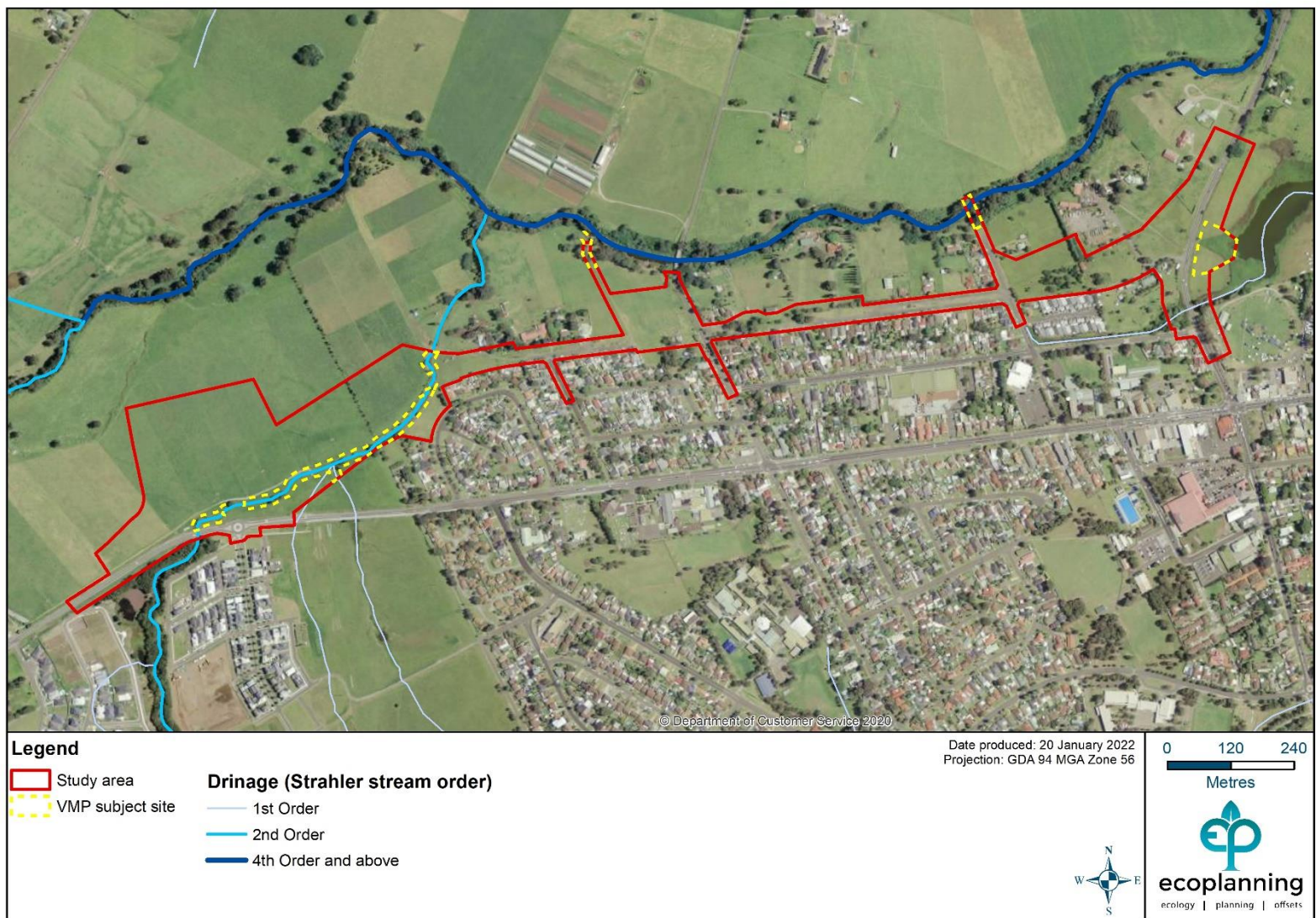


Figure 1.1: Study area and VMP subject site, including mapped drainage lines.

1.2 Site description

The suburb of Albion Park is situated in the Macquarie Valley on the western fringes of Shellharbour (**Figure 1.2**). The study area is situated in the Shellharbour Local Government Area (LGA) and includes a number of partial lots traversing both public and private residential land, and private agricultural allotments. The study area is zoned under Shellharbour Local Environment Plan (SLEP) 2013 as RU1 – Primary Production, RU2 – Rural Landscape, R2 – Low Density Residential, RU6 – Transition, RE1 – Public Recreation and SP2 – Infrastructure.

On a broader scale, the study area is situated along the northern most extent of Albion Park, covering a large area between across Albion Park and into the suburb of Calderwood. The topography is relatively flat and drops-off to the north towards a winding narrow watercourse that carries the Macquarie Rivulet (5th order stream) across the length of the study area. Large areas of native vegetation occur along the Georges River (**Figure 1.3**).

Situated at approximately 10 metres above sea level (masl), the study area comprises 27.1 hectares (ha) of largely cleared grassland and areas of planted vegetation along existing roads and residential housing. Stands of disturbed native vegetation occur within ridges and gullies of mapped watercourses identified within the study area.

The VMP subject site is approximately 1.82 ha and is restricted to vegetation within mapped watercourses and floodplains in the study area. Most of the subject site is heavily degraded, showing evidence of past disturbance and weed invasion. Woody weed species, including *Erythrina x sykesii** (Coral Tree) and *Lantana camara** (Lantana), dominated the upper and middle stratum of Macquarie Rivulet and Hazelton Creek. The groundlayer was mostly dominated by herbaceous weeds and exotic grasses, including *Cenchrus clandestinus** (Kikuyu), *Paspalum dilatatum** (Paspalum), *Plantago lanceolata** (Lamb's Tongues) and *Sida rhombifolia** (Paddy's Lucerne).

Restoration of the VMP subject site will require substantial intervention, including woody-weed removal, spray preparation, revegetation and ongoing secondary and maintenance works to ensure the successful establishment of planted native vegetation. Management actions required for the restoration of the VMP subject site are discussed further in **Section 3** and in **Appendix C**.

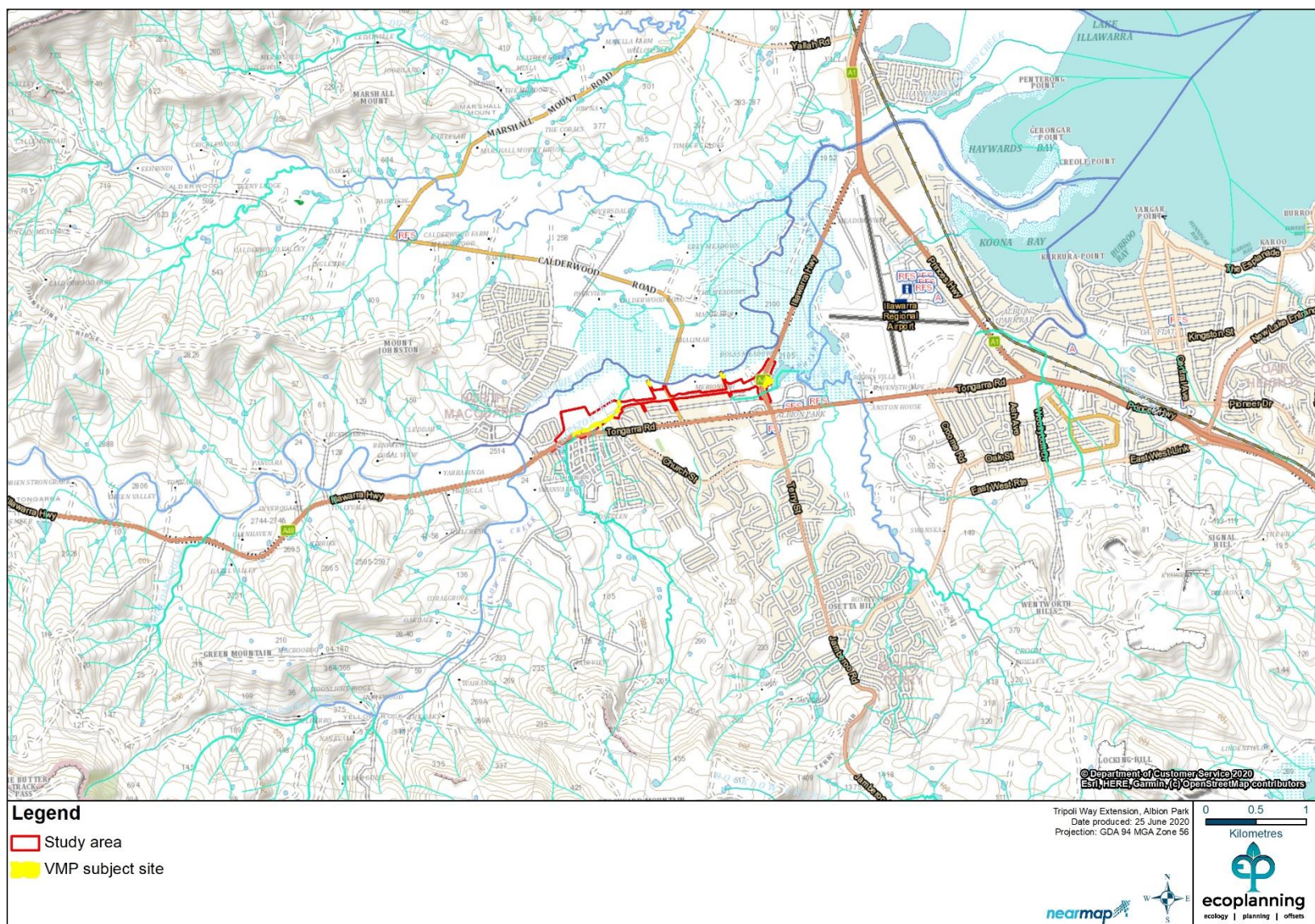


Figure 1.2: Locality of the study area, depicting surround suburbs and landscape features.

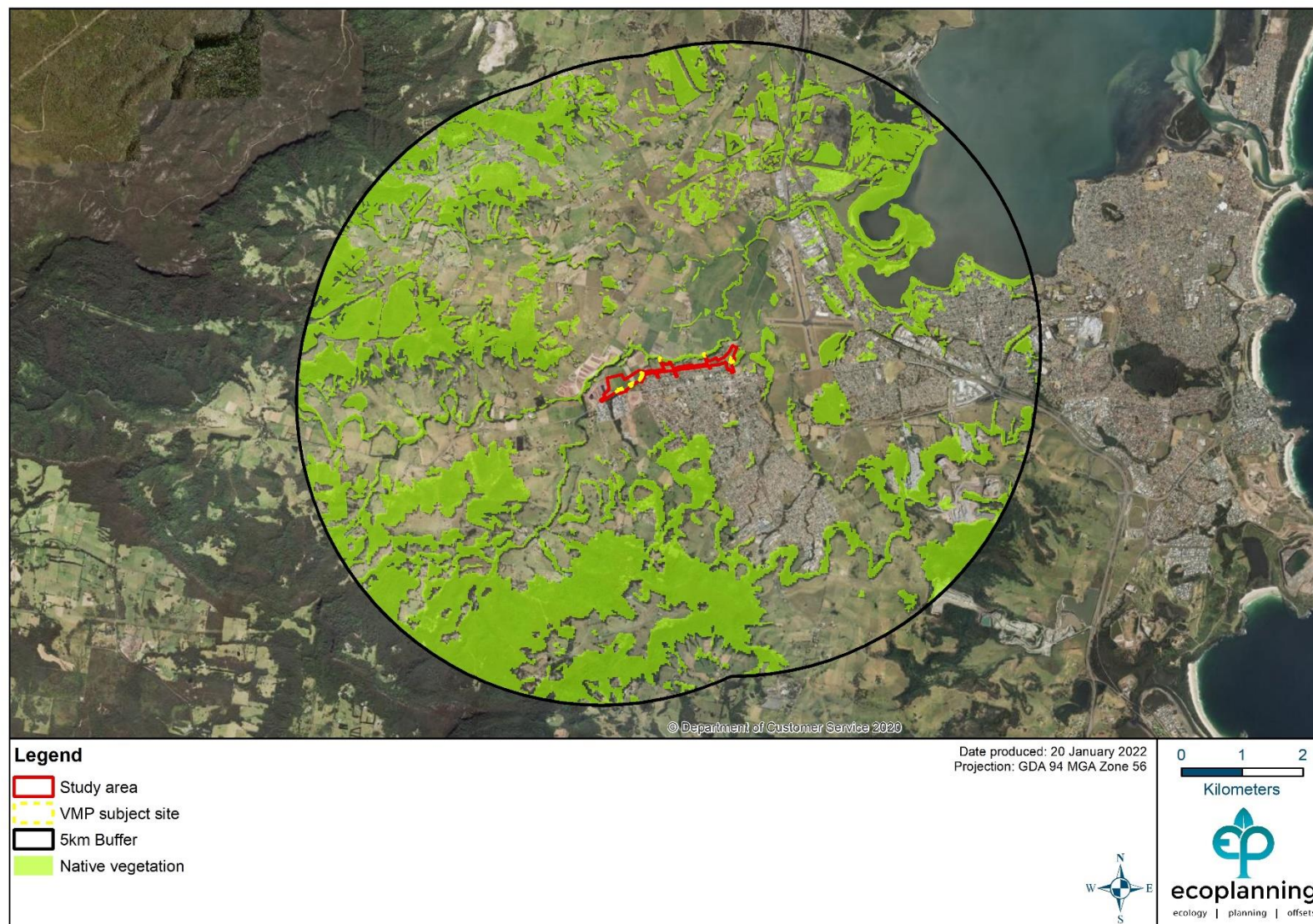


Figure 1.3: Native vegetation cover within the local area (ELA 2015).

2 Site Assessment

2.1 Methods

A field survey was undertaken on 16 January 2020 by Lucas McKinnon (Principle Ecologist) and John Gollan (Ecologist). The field survey included a general flora and fauna habitat and vegetation community assessment. Weather conditions on the day were warm and overcast with light showers in the morning and moderate winds in the afternoon (**Table 2.1**).

Table 2.1: Daily Weather Observations taken from Shellharbour Airport Station 068241 (~1.5 km east of the study area).

Date	Temp (°C)		Rainfall (mm)	Max wind gust	
	Min	Max		Direction	Speed (km/h)
16/01/20	20.3	30.9	2.6	S	46

The field assessment aimed to determine the overall resilience of the subject site, and thus its capacity to respond to regeneration works. It also aimed to identify impacts of erosion to watercourses following vegetation clearing in riparian zones.

Appropriate management methods were considered, with the aim of identifying areas of the subject site requiring revegetation, as opposed to assisted natural regeneration. The subject site was surveyed to determine the problematic exotic species present and aimed to identify all priority weeds and Weeds of National Significance (WoNS). During the survey, appropriate weed treatment techniques were considered for the dominant exotic species within the subject site. All vegetation patches were assessed to determine their location, extent, structure and floristics.

2.2 Results

2.2.1 Plant communities

Review of previous vegetation mapping within the study area (NPWS 2002) identified four vegetation communities (**Figure 2.1**), namely:

- Floodplain Wetland (MU54)
- Lowland Woollybutt-Melaleuca Forest (MU24)
- Riparian River Oak Forest (MU37)
- Weeds and Exotics (MU56c)

Regional vegetation mapping by ELA (2015) mapped four vegetation communities across the study area (**Figure 2.2**), including:

- Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion,
- Swamp oak – prickly tea-tree – swamp paperbark swamp forest on coastal floodplains, Sydney Basin Bioregion and South East Corner Bioregion,
- Swamp oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion, and

-
- Woollybutt – white stringybark – forest red gum grassy woodland on coastal lowlands, southern Sydney Basin and South East Corner.

The results of the field assessment were generally consistent with mapping by NPWS (2002) and ELA (2015), who had identified several native vegetation communities across the study area (**Figure 2.3** and **Figure 2.4**). However, areas of Swamp Oak – Prickly Tea-tree – Swamp Paperbark swamp forest and Swamp Oak swamp forest fringing estuaries as mapped by ELA (2015) were not identified in the study area. Field assessment was most consistent with mapping by NPWS (2002). However, an additional native vegetation community was identified, being Coastal Swamp Oak Forest (MU36).

Native vegetation communities mapped in the study area comprise TECs listed under the BC Act and/or EPBC Act. The relationship between these native vegetation communities and TECs is summarised in **Table 2.2**.

Coastal Swamp Oak Forest (MU36)

This vegetation zone is an isolated patch of *Casuarina glauca* (Swamp Oak) (**Figure 2.5**). At the time of assessment, the understorey of the vegetation zone was modified, comprising a mixture of exotic and native species. These included native species such as *Persicaria decipiens* (Slender Knotweed), *Juncus usitatus*, *Typha orientalis* (Broadleaf Cumbungi) and *Pteridium esculentum* (Common Bracken), and pasture grasses and weeds such as *Cenchrus clandestinus** (Kikuyu), *Paspalum dilatatum** (Paspalum), *Plantago lanceolata** (Lamb's Tongues) and *Sida rhombifolia** (Paddy's Lucerne).

Riparian River Oak Forest (MU37)

The vegetation community Riparian River Oak (MU37) was identified within the riparian corridor of Macquarie Rivulet (**Figure 2.6**). This vegetation zone was in a highly disturbed condition and did not entirely conform to the community description given by NPWS (2002). This is probably due to either the high levels of disturbance, altered flow regimes and/or that it is a transitional type, with elements common to the vegetation community Coastal Swamp Oak Forest (MU36). While *Casuarina cunninghamiana* (River Oak) was common, so too were dense patches of exotic species such as *Erythrina x sykesii** (Coral Tree) and *Lantana camara** (Lantana). This community was also infested with the climbing weed, *Cardiospermum grandiflorum** (Balloon Vine).

Floodplain Wetland (MU54)

This vegetation zone was identified within the eastern portion of the study area (**Figure 2.7**). The drainage patterns of this community have been altered by urbanisation and for infrastructure such as roads, and thus drainage lines are in poor condition. Although this vegetation zone was dominated by native species such as *Phragmites australis* (Common Reed) and *Typha orientalis* (Cumbungi), exotic weeds were also prolific, most notably the pasture grass, *Cenchrus clandestinus** (Kikuyu).

Aquatics and emergents

The standing, deeper pools of water within Hazelton Creek were dense with aquatic and emergent vegetation (**Figure 2.8**). The semi-aquatic weed, *Nasturtium officinale** (Watercress) and the emergent native reed, *Typha orientalis* (Broadleaf Cumbungi) were

among the most dominant. Floating species, like *Lemna disperma* (Duck weed) and *Azolla* sp. covered the surface in places along Hazelton Creek. Where there is limited free-water and soils are saturated, *Cenchrus clandestinus** (Kikuyu) and *Cyperus eragrostis* (Umbrella Sedge) tended to dominate. The native semi-aquatics, *Ludwigia peploides* (Water Primrose) and *Alisma plantago-aquatica* (Water Plantain) were also commonly found.

Acacia Scrub (MU56a)

The vegetation zone Acacia Scrub (MU56a) was mapped as patches of heavily degraded vegetation across the study area. Native species present were those typical of disturbed and degraded habitats, such as *Acacia mearnsii* (Black Wattle) and *Pittosporum undulatum* (Native Daphne). Rare occurrences of *Eucalyptus tereticornis* (Forest Red Gum) were identified in this vegetation zone. The middle stratum was infested with large areas of *Lantana camara** (Lantana) and *Erythrina x sykesii** (Coral Tree), and supported infestations of the climber *Ipomoea indica** (Morning Glory) in the canopy. Dominant ground cover weeds included *Cenchrus clandestinus**, *Colocasia esculenta** (Taro), *Tradescantia fluminensis** (Trad) and *Ricinus communis** (Castor Oil Plant). Overall, the habitat in this zone was degraded, with evidence of rubbish dumping and mounds resulting from earthworks.

Native plantings

This vegetation zone consisted of long, linear strips of vegetation beside Hazelton Creek, where a variety of native trees and shrubs had been planted (**Figure 2.9**). Species presence included *Corymbia maculata* (Spotted Gum), *Eucalyptus botryoides* (Bangalay), *Callistemon viminalis* (Weeping Bottlebrush), *Elaeocarpus reticulatus* (Blueberry Ash), *Banksia ericifolia* (Heath-leaved Banksia) and *Grevillea* hybrids.

Natives/non-native plantings

Areas of vegetation alongside existing residential streets and fence lines have been included in this vegetation zone. They are areas that are intensively managed by mowing, weeding and other routine maintenance. Species include a variety of trees, shrubs and turf grasses that are common ornamentals in urban landscapes. Species include *Lophostemon confertus*[†] (Queensland Brush box), *Eucalyptus microcorys* (Tallowwood), *Grevillea robusta*[†] (Silky Oak), *Corymbia citriodora** (Lemon-scented Gum), *Lagerstroemia indica** (Crepe Myrtle), *Cupressus x leylandii** (Leyland's Cyperus) and *Jacaranda mimosifolia** (Jacaranda).

Cleared land 'exotic grassland/infrastructure'

Large areas of vegetation across the study area have no overstorey species and now consist of grasslands largely dominated by exotic grasses and herbaceous weeds (**Figure 2.10**Figure 2.10). Dominant ground cover species included *Cenchrus clandestinus** (Kikuyu) and *Hypochaeris radicata** (Catsear). Where there is grazing by domestic cattle (western end of study area), species like *Sida rhombifolia** (Paddy's Lucerne), *Senecio madagascariensis** (Fireweed), *Cichorium intybus** (Chicory) and *Medicago sativa** (Lucerne) were common.

2.2.2 Site resilience

Resilience is a measure of a sites capacity to respond to restoration works and is often an indication of the extent and severity of past disturbance. Field assessment determined that

the VMP subject site has a low capacity for natural regeneration to occur. The riparian zones on the site are heavily degraded from past and current land use, including vegetation clearing and intensive grazing. These areas will require substantial active restoration to be successful, including primary woody weed removal, revegetation and ongoing secondary and maintenance works. It is anticipated that natural recruitment and regeneration of the canopy will occur following primary and secondary weed removal and in the absence of disturbance.

Areas mapped as 'exotic grassland/infrastructure' did not contain native groundlayer species and have minimal capacity to respond to assisted natural regeneration. As such, more intensive revegetation and rehabilitation works will be required using a suitable selection of native plant species to reconstruct and restore. Areas of the subject site containing woody weeds will be managed similarly to the cleared areas of the site, following primary and secondary woody-weed removal.

Table 2.2: Vegetation community nomenclature (NPWS 2002 and ELA 2015).

Vegetation communities (NPWS 2002)	Vegetation communities (ELA 2015)	BC Act TEC	EPBC Act TEC
Floodplain Wetland (MU54)	Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion	Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	N/A
Lowland Woollybutt-Melaleuca Forest (MU24)	Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin and South East Corner	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	Illawarra and South Coast Lowland Forest and Woodland
Riparian River Oak Forest (MU37)		N/A	N/A
Coastal Swamp Oak Forest (MU36)	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Coastal Swamp Oak (<i>Casuarina glauca</i>) Forest of New South Wales and South East Queensland
		River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	N/A

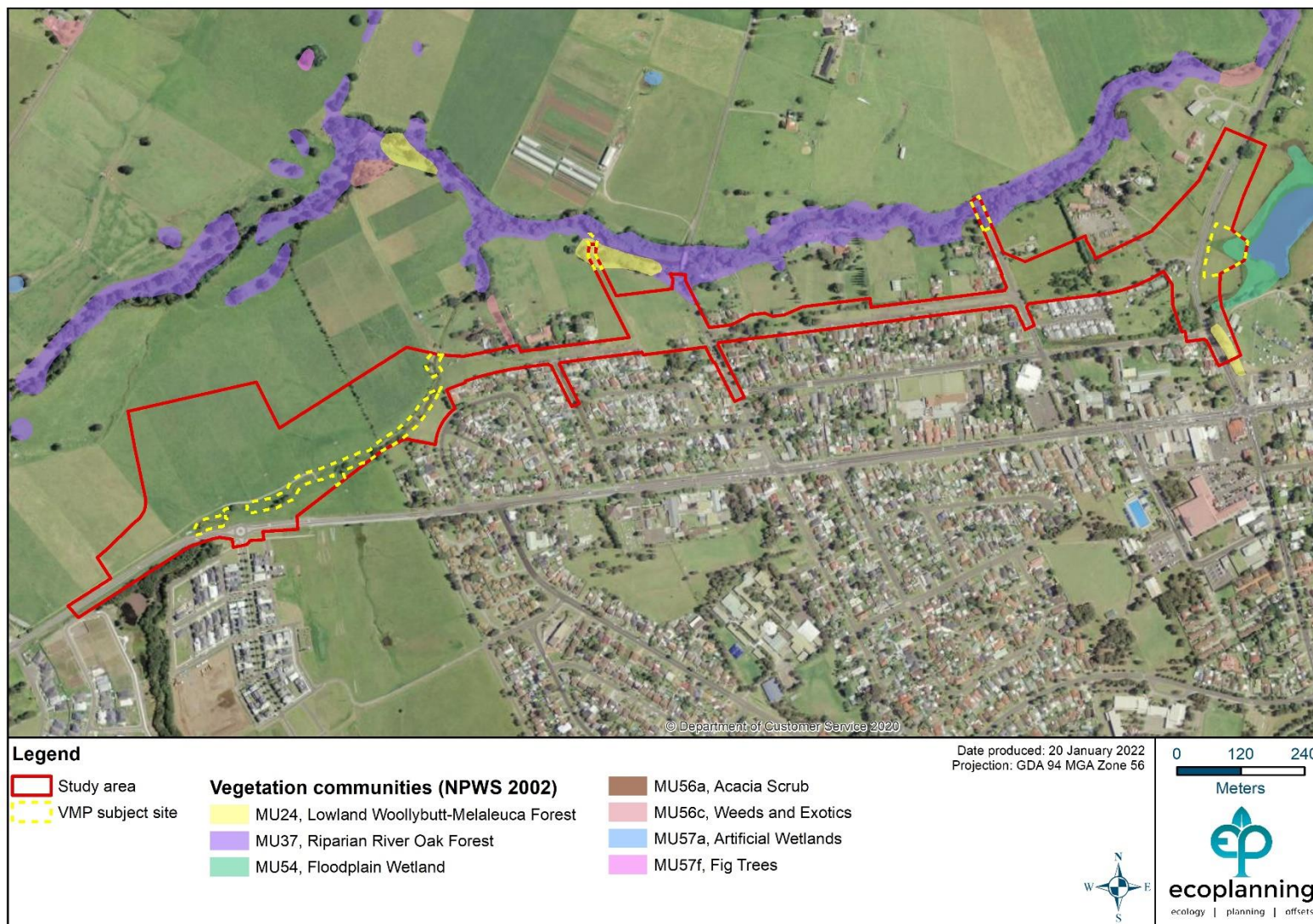


Figure 2.1: Regional vegetation mapping of the study area (NPWS 2002).

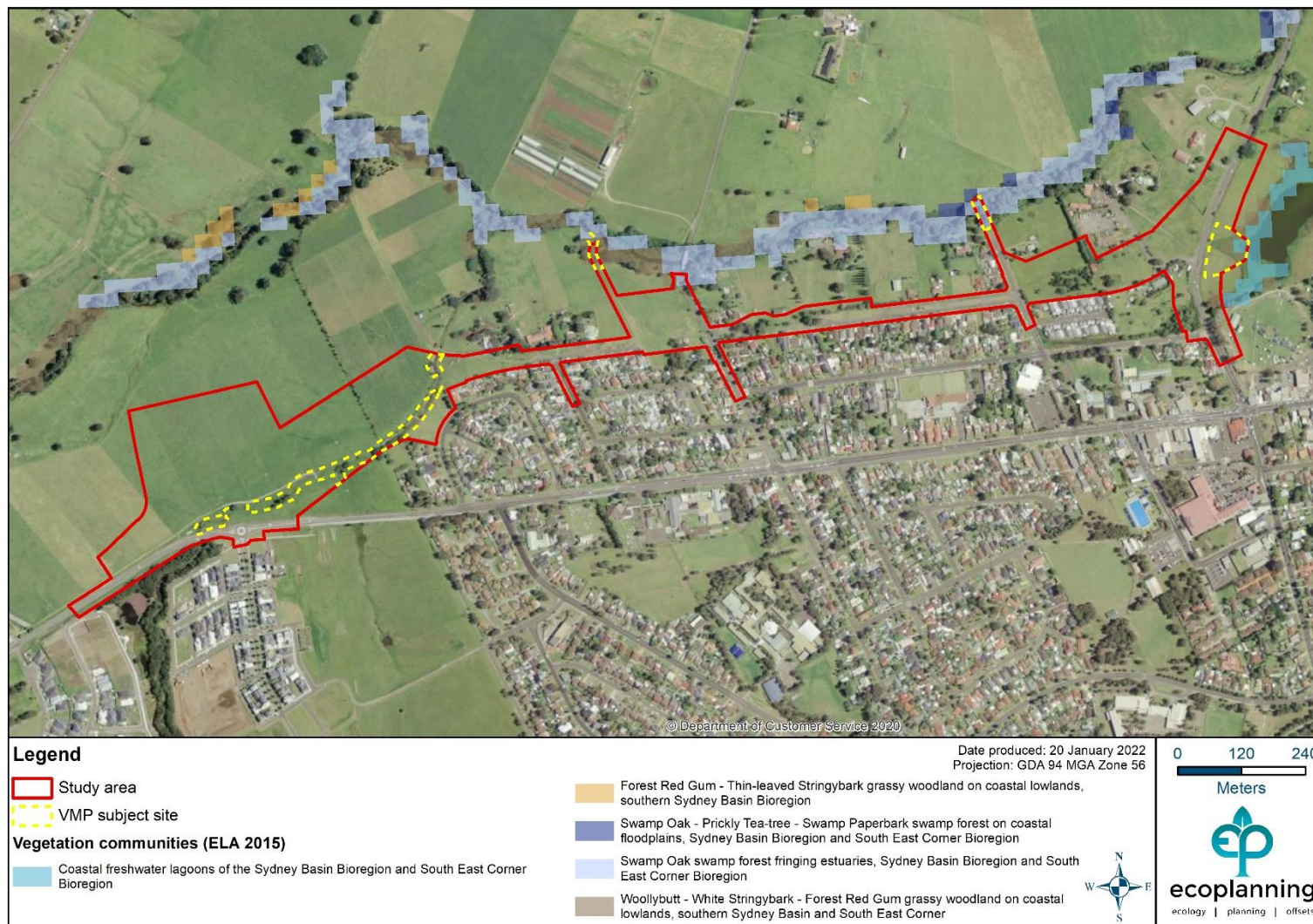


Figure 2.2: Regional vegetation mapping of the study area (ELA 2015).

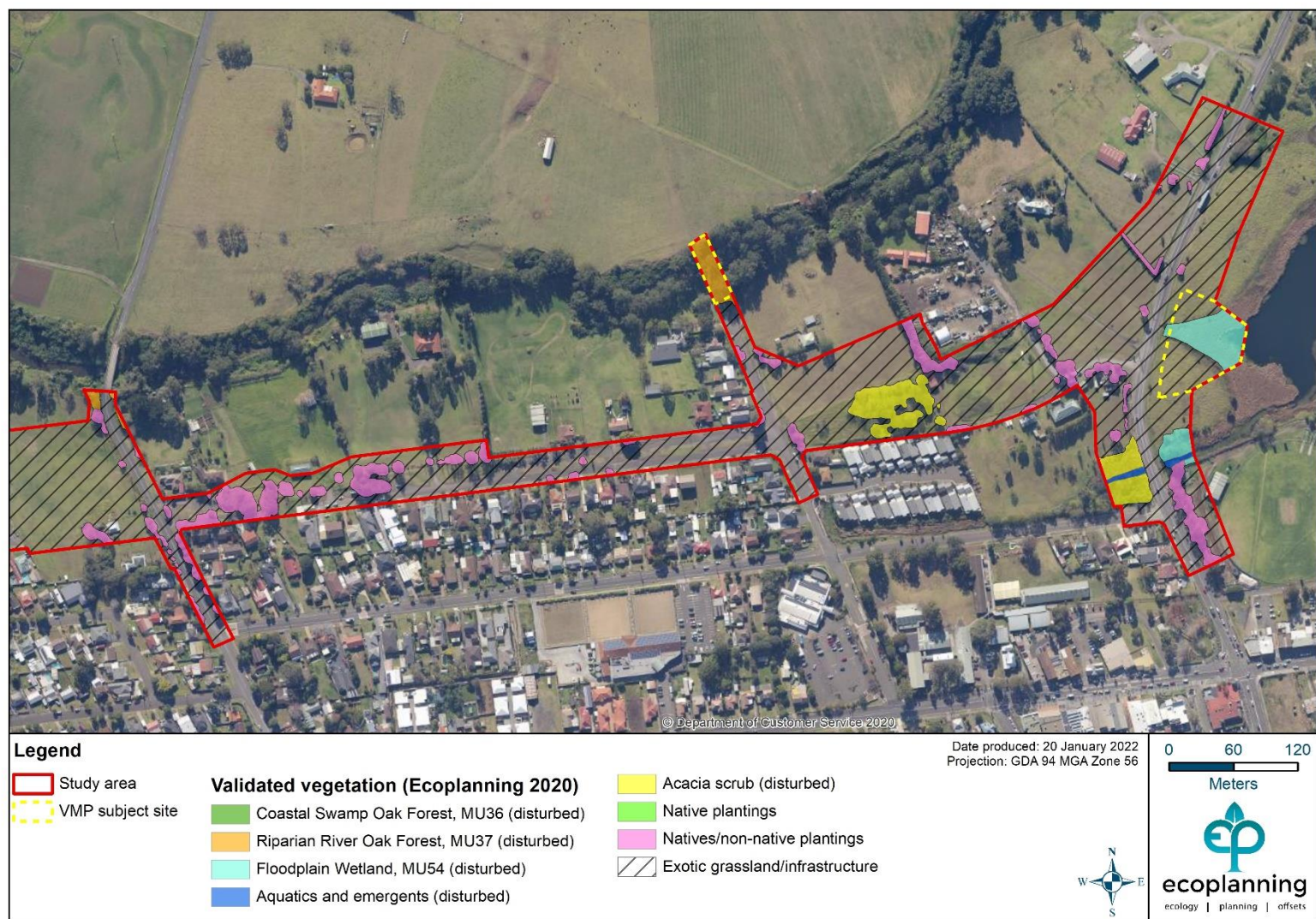


Figure 2.3: Validated vegetation mapping within the eastern portion of the study area (Ecoplanning 2022).

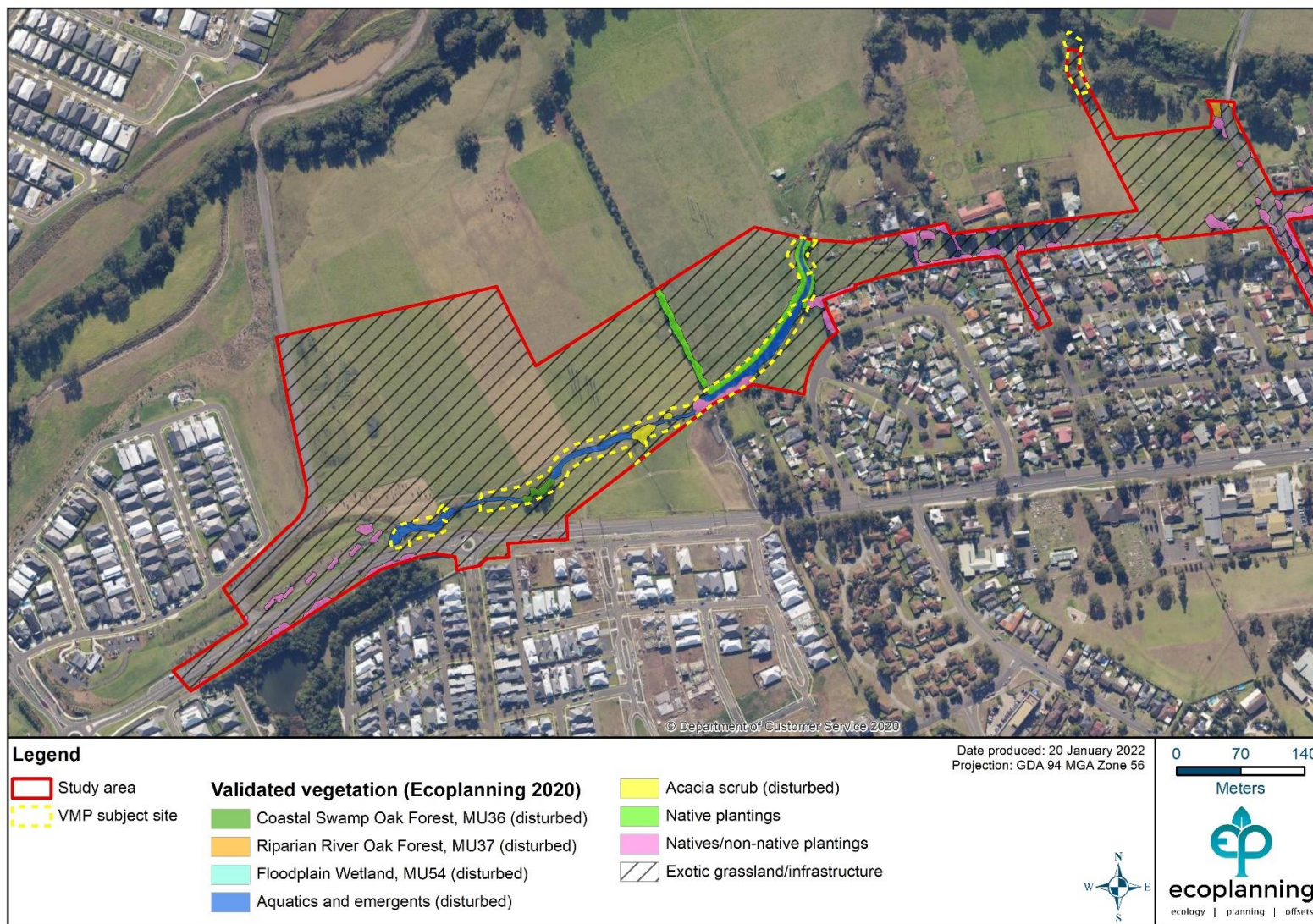


Figure 2.4: Validated vegetation mapping within the western portion of the study area (Ecoplanning 2022).



Figure 2.5: Coastal Swamp Oak Forest (MU36) within the VMP subject site.



Figure 2.6: Riparian River Oak Forest (MU37) within the VMP subject site.



Figure 2.7: Floodplain Wetland (MU54) identified within the VMP subject site.



Figure 2.8: Aquatics and emergents identified within mapped drainage lines within the VMP subject site.



Figure 2.9: Native plantings identified along mapped drainage lines within the VMP subject site.



Figure 2.10: Cleared land exotic grassland/infrastructure within the study area.

Flora species

A total of 78 flora species were identified in the study area during the field survey, of which 36 were native and 42 were exotic or non-native species (**Appendix A**). Nomenclature follows the Flora of NSW (Harden 1990-2002) and updates provided in PlantNET (RBGDT 2020).

Four priority weeds listed under the NSW *Biosecurity Act 2015* for Shellharbour LGA were recorded in the study area, all of which are Weeds of National Significance (WoNS) (**Table 2.3**).

Table 2.3: Priority weeds and Weeds of National Significance (WONS).

Common name	Scientific name	WoNS ¹	Duty
Madeira Vine	<i>Anredera cordifolia</i>	Y	Prohibition on dealings <i>Must not be imported into the State or sold</i>
Ground asparagus	<i>Asparagus aethiopicus</i>	Y	
Lantana	<i>Lantana camara</i>	Y	Mandatory Measure <i>Must not be imported into the State or sold</i> Regional Recommended Measure Exclusion zone: whole region excluding the core infestation area of Eurobodalla, Kiama, Shellharbour, Wollongong and the Shoalhaven local government area north of the Lantana Containment Line at 35°11'42 S <i>Whole region: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Core area: Land managers reduce impacts from the plant on priority assets.</i>
Fireweed	<i>Senecio madagascariensis</i>	Y	Mandatory Measure <i>Must not be imported into the State or sold</i> Regional Recommended Measure Exclusion zone: whole region except the core infestation area of Wollongong, Kiama, Shellharbour, Eurobodalla, Shoalhaven, Bega Valley and Wingecarribee councils <i>Whole region: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Core area: Land managers reduce impacts from the plant on priority assets.</i>

¹ <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>

No threatened flora species listed under the *Biodiversity Conservation Act 2016* (BC Act) or *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) were recorded in the study area or subject site.

3 Vegetation management

Vegetation management works outlined below will be implemented for the subject site. Weed management should begin prior to development within the study area, where practicable. In areas where complete clearing of vegetation will be performed, weed management should immediately follow. A suitably qualified and experienced bush regeneration contractor as per **Section 4.3** must be engaged to carry out all vegetation management works.

3.1 Preliminary works

3.1.1 Seed collection

Species identified for revegetation are outlined in **Appendix B**. Given the condition of vegetation within (and near) the subject site, if collection of is not achievable, all plants should be sourced from a local nursery or bush regeneration company that supply high quality indigenous stock (not horticultural varieties).

Record keeping of seed collection and planting locations is to be as per the Flora Bank guidelines (Mortlock 1999, and the bush regeneration contractor is responsible for recording this information. The supplier of the locally sourced tubestock will be required to guarantee local collection of seed and also possess a Section 132C licence under the NSW *National Parks and Wildlife Act 1974* will be required to undertake seed collection works.

3.1.2 Fencing

Stock proof fencing should be installed around the perimeter of the VMP subject site to discourage unauthorised access by people, as well as prevent access by cattle. The fencing will consist of strained wire fences and include barbed wire if stock is adjacent to the fence. Fencing should be installed prior to the initiation of the contract, particularly prior to revegetation works being undertaken.

3.1.3 Signage

Signage in accordance with Shellharbour City Council standardised signs for conservation areas will be installed at select locations along the perimeter of the subject site. The exact information and location of these signs will be determined during implementation of the works in accordance with the VMP. At a minimum, the signage should be positioned at all main access points or visual areas along the perimeter of the site and should state that the area is being managed for conservation purposes.

3.1.4 Adaptive management

As the VMP extends over a 5-year period, flexibility is required to allow the successful bush regeneration contractor to adapt to changing site conditions and to suit desired management techniques, provided that the performance criteria can still be met.

3.2 Weed management techniques

Weed management will be carried out using primary and secondary treatments followed by ongoing maintenance. Weed treatments will include mechanical removal techniques,

herbicide application (direct and spray applications) and natural shading techniques. Disturbance of the soil during the weed management process should be minimised at all times (see Buchanan 2000, Bradley 2002). Weed control objectives and treatment techniques are outlined below in and Key Performance Indicators included in (**Appendix C**).

3.2.1 Primary treatment

Primary weed treatment is the initial treatment of a moderate to severe weed infestation and anticipates that follow up management will be required as native vegetation establishes. Methods to be applied can include hand weeding, herbicide application and mechanical removal. Mechanical removal techniques relevant to the weed being removed (Buchanan 2000; Bradley 2002) should be used for all woody weeds. Herbicide application, such as backpack spraying, should be avoided where off target loss of native species is likely to occur, but used in direct application for woody species where cut-and-paint and drill-and-inject methods are used.

3.2.2 Secondary treatment

Secondary weed treatment involves follow-up treatments to maintain a competitive advantage for native vegetation regeneration and plantings. Any new weed infestations should also be treated.

3.2.3 Maintenance weed management

Maintenance weed management is the long-term management of a site to prevent weeds from becoming re-established after primary and secondary weed management, after regeneration has started to compete and/or after revegetated areas have been established. Zones in good condition will already be at maintenance levels, and management should focus on fine hand-weeding, further woody weed regrowth treatments or preparation and spot-spraying. Zones in poor condition will require substantial effort in primary and secondary treatment before maintenance can begin. A structured maintenance regime will reduce the time taken for the site to reach a reasonable level of stability.

3.2.4 Weed Disposal

All seeding herbaceous material and tubers should be bagged, removed from site and disposed of at an appropriate green-waste facility. Woody weeds, such as *Lantana camara** and *Erythrina x sykesii* * should be removed offsite. Woody weed material will not be temporarily stored or piled on site and will be disposed of at an appropriate green waste facility.

3.3 Vegetation management zones

The subject site has been categorised into three management zones (MZs), based on the different management actions required to restore the vegetation within the subject site (**Figure 3.1** and **Figure 3.2**).

3.3.1 Management Zone 1 – Drainage line and riparian zone restoration – Coastal Swamp Oak Forest (MU36)

Management Zone 1 (MZ1) includes Hazelton Creek (3rd order watercourse) and associated riparian zone within the western portion of the subject site. This management zone comprises 1.10 ha or approximately 60.6% of the subject site.

Removal of weeds and revegetation in the riparian zone needs to be carefully implemented to avoid erosion to the bank and prevent bank collapse. The broad-scale removal of exotic vegetation should be followed by an application of mulch or jute matting (heavy weight, such as >850 g/m²) to stabilise the soil. More isolated occurrences of exotic species, including large areas of *Lantana camara**, along the watercourse should be cut-and-painted (possibly with a brush cutter) or drilled-and-painted (if stems are large enough) with herbicide suitable for use around waterways. Follow-up spot-spraying of regrowth should also be performed to manage resprouting. Additional installation of jute matting may be required for revegetation along any areas of the existing bank that are currently eroding.

This zone will be restored and revegetated, with the aim of removing the exotic vegetation, whilst retaining existing native vegetation and planting consistent with Coastal Swamp Oak Forest (MU36) along the watercourse. Planting in this zone should be supplementary to existing retained native species in order to achieve natural plant densities for these vegetation types.

3.3.2 Management Zone 2 - Drainage line and riparian zone restoration – Riparian River Oak Forest (MU37)

Management Zone 2 (MZ2) includes the two northern sections of the subject site that intersects Macquarie Rivulet (5th order watercourse) and the associated riparian zone. MZ2 comprises 0.18 ha, or approximately 9.9% of the subject site.

This zone will be restored and revegetated like MZ1, but with native vegetation that constitutes Riparian River Oak Forest (MU37). This zone includes a higher cover and abundance of woody weeds in comparison to MZ1. Given the extent of weed invasion in this zone, this zone should be planted out with native groundcover species outlined in **Appendix B** based on the planting densities outlined in **Section 3.4**.

Extensive weed management works within this zone focus on the mechanical removal and hand-removal of woody weeds, such as *Lantana camara** and *Erythrina x sykesii**. In some instances, it will be more time effective, or preferable, to cut-and-paint or drill-and-paint (if stems are large enough) the weeds or detangle the stolons from the native vegetation and place it in a pile in preparation for spraying. Occasional spot-spraying following primary works may be required if a dormant weed seed profile becomes apparent.

An area mapped as 'exotic grassland/infrastructure' in MZ2 and is highly unlikely to have an established native soil seedbank. Assisted natural regeneration is unlikely to result in the desired outcome for the MZ. Therefore, reconstruction of MZ2 will be achieved by mulching and revegetating the area with species representative of Riparian River Oak Forest (**Appendix B**).

Prior to revegetation exotic grasses and herbaceous weeds in the MZ will be blanket sprayed with 1% Roundup Biactive® at least two times prior to applying mulch over the entirety of the

MZ at a depth sufficient to inhibit the germination of exotic species. The zone should be planted out with a combination of native groundcover, midstorey and overstorey tubestock species based on the planting densities outlined in **Section 3.4** and should occur within one month of mulching.

3.3.3 Management Zone 3 – Revegetation – Floodplain Wetland (MU54)

Management Zone 3 (MZ3) includes areas consisting of Floodplain Wetland (MU54) within the eastern portion of the subject site. This management zone comprises 0.53 ha or approximately 29.5% of the subject site.

Weed invasion was less extensive in this zone compared to MZ1 and MZ2. The bush regenerator should consider a primary treatment of broad application of herbicide to reduce weedy grasses across MZ3. Planting will be required where there are denser infestation of weeds in order to achieve natural plant densities for the vegetation type. In other areas where spot spraying or hand weeding is conducted around native vegetation, planting will not be required if the zone naturally regenerates.

3.4 Revegetation

Revegetation (i.e. replanting) of the subject site will be necessary to achieve the objectives of the VMP. The densities for revegetation have been calculated based on the modified condition of the subject site and the low likelihood of natural regeneration following restoration works.

Native shrub and canopy plantings will generally be avoided within the floor of the drainage area, which should be limited to suitable sedges and rushes with regard to the prevailing water levels. The ToB should have a tree and shrub cover that reflects natural vegetation structure and densities of the appropriate vegetation community.

3.4.1 Staging and logic

The bush regenerator selected to implement this VMP may vary the approach (i.e. treatment, techniques and staging) to best suit the condition of the site at the commencement of their work. However, the objective of the VMP to restore and manage the subject site, and the number of groundcover, midstorey and canopy species to be planted as described in this document will not change.

Management Zone 1 and 2

These MZs are heavily degraded, and thus will require extensive weed management and revegetation. Field validation identified Coastal Swamp Oak Forest (MU36) as previously occupying MZ1 and Riparian River Oak Forest (MU37) as previously occupying MZ2. As such, MZ1 and MZ2 will be revegetated to reflect each vegetation community, respectively.

Exotic grasses, particularly *Cenchrus clandestinus**, are currently stabilising the existing riparian zones. The abrupt removal of all the established exotic vegetation will likely increase the erosive potential of the watercourse and result in an influx in herbaceous weeds. Therefore, broad-scale removal of weed infestations must be immediately followed by soil stabilisation techniques, such as jute matting or mulch application. Coir logs may also be required to stabilise the slope.

Revegetation in MZ1 and MZ2 should initially consist of the establishment of 50 cm diameter weed free zones, where native midstorey and canopy tubestock will be installed. This will be achieved using herbicides, such as Roundup Biactive® at a solution suitable for the target species and will be conducted within the first 6 months of the contract. The extent of *Cenchrus clandestinus** and other exotic grasses will gradually be reduced, as the midstorey and canopy species become established. This will coincide with the installation of native groundlayer species. One planting event of native groundlayer species have been scheduled, mid-way through the first year of the contract. The timing of groundlayer species revegetation can differ from these recommendations, so long as the recommended number of plants are installed through the zones. Supplementary planting is recommended for mid-way through the second year of the contract and will account for a 10% attenuation rate of all plantings conducted in these MZs.

Maintenance works will mostly consist of a spray-preparation and spot-spray with 1-1.5% Roundup Biactive® within a 30 cm area of planted native tubestock. Spray-preparation will consist of ensuring the immediate vicinity of planted tubestock is clear of weeds and weed seed in order to minimise off-target spray impacts.

Management Zone 3

This MZ is moderately degraded, and thus will require revegetation. The native species used for revegetation will be consistent with the revegetation species list provided (**Appendix B**), with the aim of reconstructing the floristics of the site to be representative of Floodplain Wetland (MU54). Planting numbers will be consistent with **Table 3.1** based on the densities outlined in **Section 3**.

Revegetation in MZ3 should follow staging and logic as outlined in MZ1 and MZ2, however no canopy or shrub species will be planted. One planting event of native groundlayer species have been scheduled, mid-way through the first year of the contract. The timing of groundlayer species revegetation can differ from these recommendations, so long as the recommended number of plants are installed through the zones. Supplementary planting is recommended for mid-way through the second year of the contract and will account for a 10% attenuation rate of all plantings conducted in MZ3.

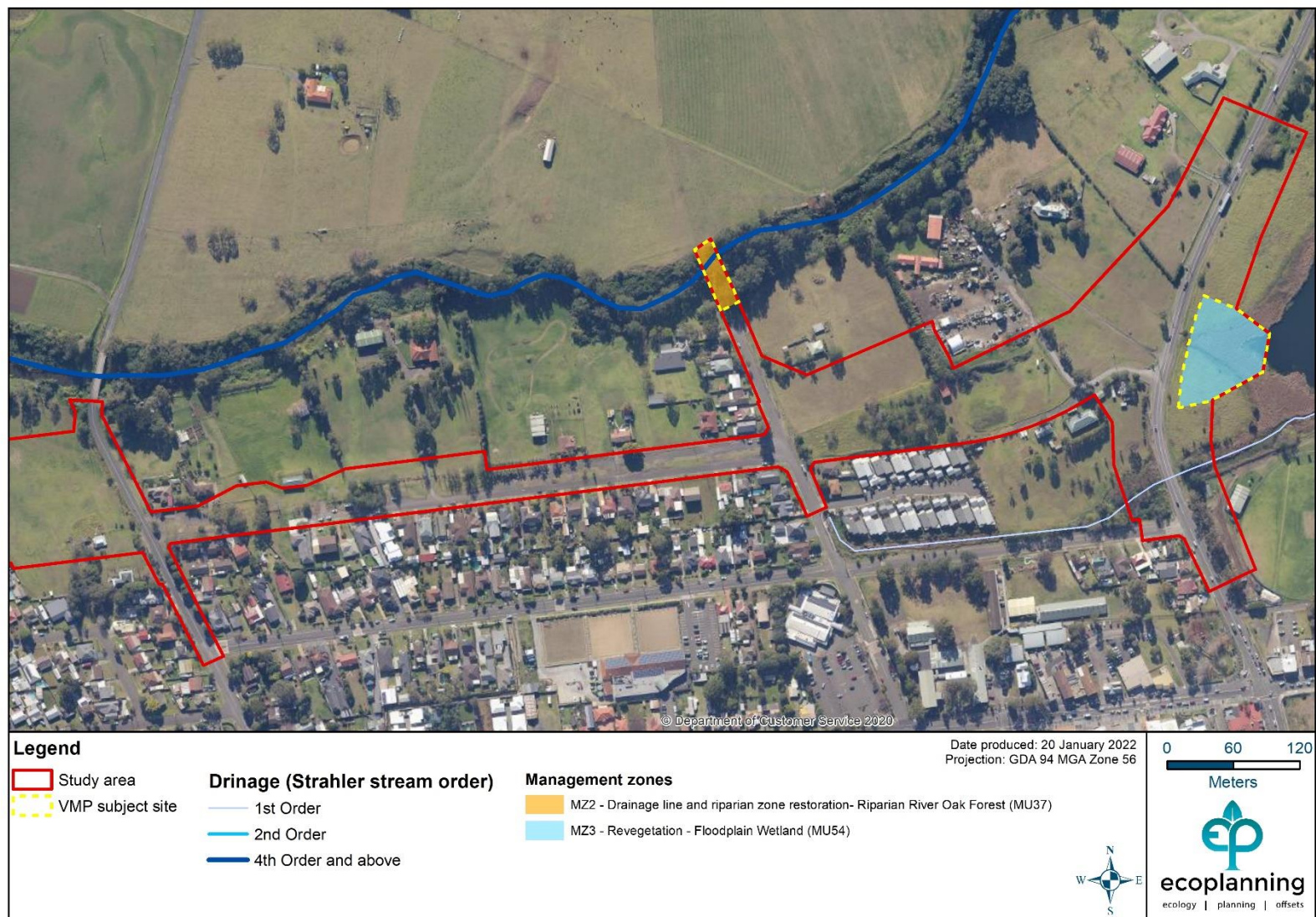


Figure 3.1: Management zones within the eastern VMP subject site.

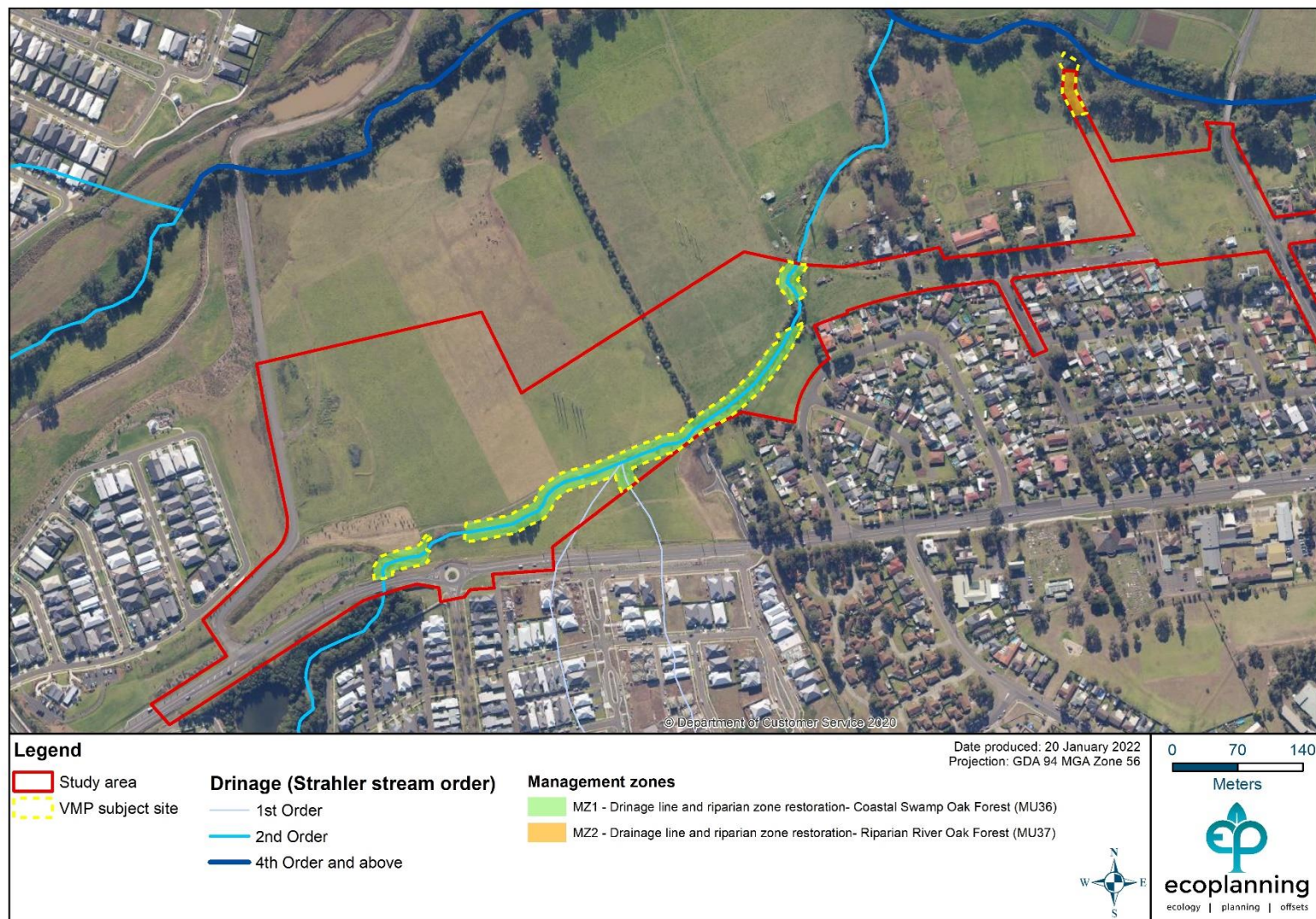


Figure 3.2: Management zones within the western VMP subject site.

3.4.2 Planting densities and species

The native species used for revegetation should be consistent with the planting palettes provided (**Appendix B**), with the aim of reconstructing the floristics of the subject site to be representative of the appropriate vegetation community. Revegetation should aim to recreate the densities of each community in an 'unmodified' condition.

Plantings will be installed at a density resembling the vegetation community indicated by the management zone. Planting densities have been determined for each MZ based on site condition/flooding capacity of the study area, and is guided by NPWS (2002) and the SDCP 2013, as follows:

Management Zone 1 and 2 – riparian zone revegetation

- 1 canopy per 25 m²
- 1 shrub species per 10 m²
- 1 groundcover (grass, fern, forb or sedge) per 3/m²

Management Zone 3 – wetland revegetation

- Groundcover only (rushes or sedge) at a density of 5/m²

Table 3.1. Planting density table for revegetation works.

Zone	Area (m ²)	Revegetation densities			Zone total
		Canopy	Shrub	Groundcover	
MZ1 & MZ2	12,800	512	1,280	38,400	40,192
MZ3	5,300	0	0	26,500	26,500

3.4.3 Equipment, installation and timing

Prior to any revegetation works, fencing should be installed to ensure access is restricted to the subject site (refer to **Section 3.1.2**). Plantings should be planned for late summer into autumn where regular rainfall is naturally occurring in Albion Park, and growth conditions are ideal. Planting of tubestock for tree and shrub species will be with 75 m tubes or Hiko cells, and Hiko or viro cells for grasses and other groundcover species. This technique will be favoured over broad-scale seed application, such as direct seeding or brush matting.

A water retaining and fertilising product (e.g. Terraform™) should be applied to each hole, to assist in the establishment of the plants. Each plant should be planted into a dish-shaped depression to aid water retention and sufficiently watered-in on the same day as installation. Watering-in on the day of installation is vital to collapse soil around the root-ball of the plant and regular watering should continue in lieu of rainfall for a period of 6 weeks, or until plantings have established. A deep soaking, perhaps twice a week in dry periods, is preferable to minor daily watering in order to establish adequate root establishment.

3.5 Concurrent works

Vegetation management works will potentially be carried out concurrently with civil construction works, therefore, planning between the bush regeneration contractor and civil works supervisor must be undertaken.

If works are concurrent, the civil works team will install environmental management controls across the site including exclusion zone fencing and erosion and sediment control. It is the responsibility of the bush regeneration contractor not to damage these controls and if any damage is observed or inadvertently caused it must be notified to the civil works supervisor immediately.

3.6 Maintenance

The maintenance phase must continue for 3 years, after the first 2 years of plantings has occurred. Regular inspections of site condition will be conducted, including general site monitoring for potential new weed incursions and subsequent weed treatments, if required. Given the scale of infestations in some areas, site monitoring must occur every month. These inspections should be conducted during a site walkover and documented in a letter report every 6 months. This schedule could be revised depending on performance criteria recorded.

Weed maintenance will include:

- removal (spray-prep and spray) of all herbaceous weeds prior to establishment and seeding, which will be achieved by hand-weeding. Care is required in the riparian zone to use herbicides approved for use near watercourses,
- careful spot spraying of exotic grasses and herbaceous weeds amongst plantings in all management zones,
- regular sweeps for woody weeds, which will be cut-and-painted or drill-and-inject (if large enough) with neat Roundup Biactive® prior to establishment.

Revegetation maintenance works will include:

- replacement of poorly growing or diseased individuals consistent with the prescribed planting,
- management of insect damage, if necessary,
- watering during dry periods,
- augmenting past planting areas where attenuation has occurred.

3.7 Cost of implementation

The costing for the VMP has been calculated over a 5-year period and is estimated at a total of \$359,774.00 (**Table 3.2**), including the cost of monthly and annual reporting. Monthly and annual reporting costs over the five-year period add up to a total of \$11,000. The costs have been calculated based on the employment of trained bush regenerators at a rate of \$480 pp/day (\$60 pp/hr for an 8-hour working day), which covers crew and supervisor wages, equipment, herbicides, and all other associated business costs.

The costing indicates how many crew members are required to attend subject site monthly visits over the 5-year contract, based on the size of the site, extent of weed infestation and

expected timeframes for the completion of primary and secondary weed treatments and commencement of the maintenance phase. The costs are indicative of commercial bush regeneration charge-out rates, and some variation is expected depending on the bush regeneration company used and their associated charge-out rates.

Costs for fencing and signage have not been included in this VMP but would be required.

Plantings

The cost of revegetation was based on \$4.00 per 1 m² of jute matting, \$4.00 per tree and shrub, and \$3.00 per groundcover, including purchasing and installation costs such as watering and plant guards (for shrubs and canopy species). Replacement plantings have been calculated based on a 10% attenuation rate from original installation numbers.



Table 3.2: Cost of VMP Implementation over the 5 year contract period

Timing	Task	Cost
Year 1	<u>Primary and secondary weed control</u> based on the cost of employing a team of 4 bush regenerators at \$480 (\$60 per hour for 8 hours) pp/day to attend site monthly.	\$23,040
	<u>Revegetation of MZ1 and MZ2</u> with a total of 1,792 midstorey and canopy plants (see Table 3.1) at \$4.00 per plant.	\$7,168
	<u>Revegetation of MZ3</u> with a total of 26,500 groundcover plants (see Table 3.1) at \$3.00 per plant.	\$79,500
Year 1 total		\$109,708
Year 2	<u>Secondary weed control</u> based on the cost of employing a team of 4 bush regenerators at \$480 (\$60 per hour for 8 hours) pp/day to attend site monthly.	\$23,040
	<u>Revegetation of MZ1 and MZ2</u> with 38,400 groundcover species (see Table 3.1) at \$3.00 per plant.	\$115,200
Year 2 total		\$138,240
Year 3	<u>Maintenance weed control</u> based on the cost of employing a team of 4 bush regenerators at \$480 (\$60 per hour for 8 hours) pp/day to attend site monthly.	\$23,040
	<u>Revegetation of MZ1 and MZ2</u> site based on a ~10% attenuation of the total plantings (~179 plants) at \$4.00 per plant for shrubs and canopy and (~3,840 plants) at \$3 per plant for groundcovers.	\$12,236
	<u>Revegetation of MZ3</u> site based on a ~10% attenuation of the total plantings (~2,650) at \$3.00 per plant for groundcovers.	\$7,950
Year 3 total		\$43,226
Year 4	<u>Maintenance weed control</u> based on the cost of employing a team of 5 bush regenerators at \$480 (\$60 per hour for 8 hours) pp/day to attend site monthly.	\$28,800
Year 4 total		\$28,800
Year 5	<u>Final year of maintenance weed control</u> based on the cost of employing a team of 5 bush regenerators at \$480 (\$60 per hour for 8 hours) pp/day to attend site monthly.	\$28,800
Year 5 total		\$28,800
Monthly	Cost of <u>monthly reporting</u> over the 5-year contract period. Report should consist of a one to two page report detailing the works conducted on site (\$100 per month).	\$6,000
Annually	<u>Annual report</u> detailing all works conducted on site, weed treatment methods, planting success and failures etc. (\$1,000 annually)	\$5,000
Reporting costs total		\$11,000
Grand Total		\$359,774.00

4 Performance criteria and monitoring

4.1 Performance criteria

The progress and compliance with the VMP will be monitored and reviewed every six months. This process will involve the bush regeneration contractor and landowner assessing the site and analysing works carried out onsite, as documented in the six-monthly reports.

The bush regeneration contractor and landowner will assess the Key Performance Indicators (KPIs) for the target species in Appendix C through a site assessment and analysis of works carried out onsite, as documented in the six monthly reports. The success of revegetation will be measured based on the establishment of plantings in accordance with the densities recommended in **Table 3.1**.

4.2 Monitoring reports

A monitoring report will be provided to Shellharbour Council every six (6) months, which will shortly be followed by an inspection of the subject site with relevant Council staff (i.e. Natural Areas Coordinator) and the contractor(s) implementing the VMP. The aim of the inspection will be to ensure that reporting is consistent with the on-ground implementation of the VMP and to revise the costings accordingly. An example report is detailed in **Table 4.1**, the report should include:

- works carried out, including weed species targeted and their location,
- an approximation of the time spent on each task,
- any observations, such as the occurrence of new weed species,
- results from photo monitoring points,
- rates of regeneration and herbivory of native species,
- a description of any problems encountered and how they were overcome,
- a summary of how the site-specific objectives have been met (or not),
- herbicide and other chemicals used, including quantity, dilution rate and other relevant information,
- weed treatments and techniques used during the period,
- climatic conditions which may have influenced weed germination and growth,
- performance criteria and success,
- if required, maps of weed distribution and density.

4.3 Bush regeneration contractors

Suitably qualified and experienced bush regeneration contractors that are members of the Australian Association of Bush Regenerators or fulfil the membership criteria must undertake all vegetation management works. In addition to this, team leaders should hold a Certificate III in Conservation & Land Management or possess equivalent field experience and certification. The contractor should carry out best practice bush regeneration techniques as described by Buchanan (2000, 2009) or as accepted by the bush regeneration industry in general.

Table 4.1: Example monitoring report template.

Date			
Name of Contractor:			
Hours worked on site since last monitoring report:			
Site Condition:	Zone		
	Weed cover %		
	Seedling survival %		
	Planting numbers		
	Herbicide used (in Litres)		
	Other		
Describe relevant weed management techniques:			
Describe problems; e.g. weed invasions, damage to planted material, etc.:			
Photographic evidence:			
Planned work before next monitoring report:			

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Appendix A Flora inventory

Family	Scientific Name	Common name	Native/Exotic
Alismataceae	<i>Alisma plantago-aquatica</i>	Water Plantain	Forb (FG)
Apiaceae	<i>Cyclospermum leptophyllum</i>	Slender Celery	Exotic
Apiaceae	<i>Foeniculum vulgare</i>	Fennel	Exotic
Araceae	<i>Colocasia esculenta</i>	Taro	Exotic
Araliaceae	<i>Hedera helix</i>	English Ivy	Exotic
Asparagaceae	<i>Asparagus aethiopicus</i>	Asparagus Fern	Exotic
Asparagaceae	<i>Asparagus virgatus</i>	Asparagus Fern	Exotic
Asteraceae	<i>Bidens pilosa</i>	Cobbler's Pegs	Exotic
Asteraceae	<i>Conyza</i> sp.	A Fleabane	Exotic
Asteraceae	<i>Hypochaeris radicata</i>	Catsear	Exotic
Asteraceae	<i>Onopordum acanthium</i> subsp. <i>acanthium</i>	Scotch Thistle	Exotic
Asteraceae	<i>Senecio madagascariensis</i>	Fireweed	Exotic
Asteraceae	<i>Sonchus oleraceus</i>	Common Sowthistle	Exotic
Asteraceae	<i>Cichorium intybus</i>	Chicory	Exotic
Azollaceae	<i>Azolla</i> sp.		Fern (EG)
Basellaceae	<i>Anredera cordifolia</i>	Madeira Vine	Exotic
Bignoniaceae	<i>Jacaranda mimosifolia</i>	Jacaranda	Exotic
Bignoniaceae	<i>Pandorea pandorana</i>	Wonga Wonga Vine	Other (OG)
Brassicaceae	<i>Nasturtium officinale</i>	Watercress	Exotic
Buxaceae	<i>Buxus microphylla</i>		Exotic
Casuarinaceae	<i>Casuarina cunninghamiana</i>	River oak	Tree (TG)
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak	Tree (TG)
Commelinaceae	<i>Commelina cyanea</i>	Native Wandering Jew	Forb (FG)
Commelinaceae	<i>Tradescantia fluminensis</i>	Trad	Exotic
Convolvulaceae	<i>Ipomoea indica</i>	Morning Glory	Exotic
Cupressaceae	<i>Cupressus x leylandii</i>	Leyland's Cyperus	Exotic

Family	Scientific Name	Common name	Native/Exotic
Cyperaceae	<i>Cyperus eragrostis</i>	Umbrella Sedge	Exotic
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Common Bracken	Fern (EG)
Elaeocarpaceae	<i>Elaeocarpus reticulatus</i>	Blueberry Ash	Shrub (SG)
Euphorbiaceae	<i>Ricinus communis</i>	Castor Oil Plant	Exotic
Fabaceae (Faboideae)	<i>Erythrina x sykesii</i>	Coral tree	Exotic
Fabaceae (Faboideae)	<i>Medicago sativa</i>	Lucerne	Exotic
Fabaceae (Faboideae)	<i>Trifolium repens</i>	White Clover	Exotic
Fabaceae (Mimosoideae)	<i>Acacia binervia</i>	Coast Myall	Tree (TG)
Fabaceae (Mimosoideae)	<i>Acacia mearnsii</i>	Black Wattle	Shrub (SG)
Juncaceae	<i>Juncus usitatus</i>		Grass & grasslike (GG)
Hamamelidaceae	<i>Liquidambar styraciflua</i>	Sweetgum	Exotic
Lemnaceae	<i>Lemna disperma</i>	Duck Weed	Forb (FG)
Lemnaceae	<i>Lemna sp.</i>		Forb (FG)
Lythraceae	<i>Lagerstroemia indica</i>	Crape Myrtle	Exotic
Malvaceae	<i>Sida rhombifolia</i>	Paddy's Lucerne	Exotic
Meliaceae	<i>Melia azedarach</i>	White Cedar	Tree (TG)
Myrtaceae	<i>Backhousia myrtifolia</i>	Grey Myrtle	Shrub (SG)
Myrtaceae	<i>Callistemon viminalis</i>	Weeping Bottlebrush	Tree (TG)
Myrtaceae	<i>Corymbia citriodora</i>	Lemon-scented Gum	Exotic
Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum	Tree (TG)
Myrtaceae	<i>Eucalyptus botryoides</i>	Bangalay	Tree (TG)
Myrtaceae	<i>Eucalyptus microcorys</i>	Tallowwood	Tree (TG)
Myrtaceae	<i>Eucalyptus pilularis</i>	Blackbutt	Tree (TG)
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum	Tree (TG)
Myrtaceae	<i>Lophostemon confertus</i>	Brush Box	Tree (TG)
Myrtaceae	<i>Melaleuca armillaris</i> subsp. <i>armillaris</i>	Bracelet Honey-myrtle	Shrub (SG)

Family	Scientific Name	Common name	Native/Exotic
Myrtaceae	<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark	Shrub (SG)
Myrtaceae	<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree	Shrub (SG)
Myrtaceae	<i>Syzygium australe</i>	Brush Cherry	Shrub (SG)
Oleaceae	<i>Ligustrum lucidum</i>	Large-leaved Privet	Exotic
Oleaceae	<i>Ligustrum sinense</i>	Small-leaved Privet	Exotic
Onagraceae	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Water Primrose	Forb (FG)
Pittosporaceae	<i>Pittosporum undulatum</i>	Sweet Pittosporum	Shrub (SG)
Plantaginaceae	<i>Plantago lanceolata</i>	Lamb's Tongues	Exotic
Poaceae	<i>Bromus catharticus</i>	Prairie Grass	Exotic
Poaceae	<i>Cenchrus clandestinus</i>	Kikuyu Grass	Exotic
Poaceae	<i>Paspalum dilatatum</i>	Paspalum	Exotic
Poaceae	<i>Paspalum urvillei</i>	Vasey Grass	Exotic
Poaceae	<i>Phragmites australis</i>	Common Reed	Grass and grasslike (GG)
Poaceae	<i>Polypogon monspeliensis</i>	Annual Beardgrass	Exotic
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed	Forb (FG)
Polygonaceae	<i>Persicaria</i> sp.	Knotweed	Forb (FG)
Polygonaceae	<i>Persicaria strigosa</i>		Forb (FG)
Polygonaceae	<i>Rumex crispus</i>	Curled Dock	Exotic
Proteaceae	<i>Banksia ericifolia</i>	Heath-leaved Banksia	Shrub (SG)
Proteaceae	<i>Grevillea robusta</i>	Silky Oak	Tree (TG)
Proteaceae	<i>Grevillea</i> sp.	Honey Gem	Shrub (SG)
Sapindaceae	<i>Cardiospermum grandiflorum</i>	Balloon Vine	Exotic
Solanaceae	<i>Solanum nigrum</i>	Black-berry Nightshade	Exotic
Typhaceae	<i>Typha orientalis</i>	Broad-leaved Cumbungi	Grass & grasslike (GG)
Verbenaceae	<i>Lantana camara</i>	Lantana	Exotic
Verbenaceae	<i>Verbena bonariensis</i>	Purpletop	Exotic

Appendix B Planting palette

Coastal Swamp Oak Forest (MU36)

Scientific Name	Common Name
Tree	
<i>Casuarina glauca</i>	Swamp Oak
Shrub	
<i>Pittosporum undulatum</i>	Sweet Pittosporum
Groundcover species	
<i>Phragmites australis</i>	Common Reed
<i>Juncus kraussii</i> subsp. <i>australiensis</i>	Sea Rush
<i>Cynodon dactylon</i>	Common Couch
<i>Commelina cyanea</i>	Native Wandering Jew
<i>Samolus repens</i>	Creeping Brookweed
<i>Alternanthera denticulata</i>	Lesser Joyweed
<i>Apium prostratum</i>	Sea Celery
<i>Atriplex australasica</i>	
<i>Calystegia sepium</i>	
<i>Crinum pedunculatum</i>	Swamp Lily
<i>Selliera radicans</i>	Swamp Weed
<i>Sporobolus virginicus</i>	
<i>Tetragonia tetragonioides</i>	New Zealand Spinach
<i>Eustrephus latifolius</i>	Wombat Berry
<i>Geitonoplesium cymosum</i>	Scrambling Lily
<i>Marsdenia rostrata</i>	Milk Vine
<i>Notelaea venosa</i>	Veined Mock-olive
<i>Oplismenus imbecillis</i>	
<i>Pandorea pandorana</i> subsp. <i>pandorana</i>	Wonga Wonga Vine
<i>Pseuderanthemum variable</i>	Pastel Flower

Riparian River Oak Forest (MU37)

Scientific Name	Common Name
Tree	
<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>	River Oak
<i>Eucalyptus tereticornis</i>	Forest Red Gum
Shrub	
<i>Alphitonia excelsa</i>	Red Ash
<i>Pittosporum undulatum</i>	Sweet Pittosporum
<i>Ficus coronata</i>	Creek Sandpaper Fig
<i>Acacia mearnsii</i>	Black Wattle
<i>Acacia binervata</i>	Two-veined Hickory
Groundcover species	
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush
<i>Dichondra repens</i>	Kidney Weed
<i>Urtica incisa</i>	Stinging Nettle

Floodplain Wetland (MU54)

Scientific Name	Common Name
Groundcover species	
<i>Typha orientalis</i>	Broad-leaved Cumbungi
<i>Phragmites australis</i>	Common Reed
<i>Eleocharis sphacelata</i>	Tall Spike Rush
<i>Juncus usitatus</i>	-
<i>Triglochin procera</i>	Water Ribbons
<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Water Primrose
<i>Themeda triandra</i>	-
<i>Wahlenbergia gracilis</i>	Sprawling Bluebell

Appendix C Weed treatment KPI's

Zone	Objective	Key Performance Indicators (KPI)
MZ1 and MZ2	Control and suppress exotic grasses.	<ul style="list-style-type: none"> • A 20% reduction in exotic grass cover by the end of year 1. • A 40% reduction in exotic grass cover by the end of year 2. • A 60% reduction in exotic grass cover by the end of year 3. • A 70% - 80% reduction in exotic grass cover by the end of year 4. • Exotic grasses maintained at <5% cover by the end of year 5.
MZ3		<ul style="list-style-type: none"> • A 40% reduction in exotic grass cover by the end of year 1 • A 60% reduction in exotic grass cover by the end of year 2. • An 80% reduction in exotic grass cover by the end of year 3. • Exotic grasses maintained at <5% cover by the end of year 4. • Exotic grasses maintained at <5% cover by the end of year 5.
All	Control and suppress herbaceous weeds.	<ul style="list-style-type: none"> • A 40% reduction in herbaceous weed cover by the end of year 1. • A 60% reduction in herbaceous weed cover by the end of year 2 and 3. • A 70% - 80% reduction in herbaceous weed cover by the end of year 4. • Herbaceous weed cover maintained at <5% cover by the end of year 5.
MZ1 and MZ2	Treatment of all woody weeds.	<ul style="list-style-type: none"> • A 90% reduction in woody weed cover by the end of year 1. • No woody weeds >10 cm in height remaining, with low cover (<5%) and abundance throughout the site from year 2 onwards.