ECOLOGY | BIOBANKING | OFFSETS | BUSHFIRE

ECOLOGICAL ASSESSMENT REPORT

FOR

PROPOSED RESIDENTIAL DEVELOPMENT

OF

8 FOREST ROAD WARRIEWOOD, NSW

Prepared for: **JACKSON TEECE**

October 2020

Rev: 1
AEP Ref: 1377.02

EXECUTIVE SUMMARY

Anderson Environment & Planning was commissioned by Jackson Teece to prepare an Ecological Assessment Report over land known as 8 Forest Road, Warriewood. The approx. 5.6ha site is proposed to be developed for residential purposes in accordance with its existing zoning.

The site occurs within the Northern Beaches LGA and is bounded to the north by Narrabeen Creek and to the east by residential dwellings associated with Bert Close. Mater Maria Catholic School occupies the southern boundary and there is direct connection to remnant native vegetation in the west.

The Subject Site comprises 5.68ha of which approximately, 3.47ha of which is vegetated including 0.2ha of exotic riparian vegetation. The remaining 2.2 ha being previously cleared and used for rural operations and a single dwelling. The proposal largely occupies this existing clearing with approx. 0.33ha to be cleared to accommodate Asset Protection Zones and other infrastructure.

Native vegetation adjacent to the Subject Site to the east (proposed 2 Stage) is identified as "Alluvial Floodplain Shrub Swamp Forest" as described by the *Wyong Shire Council, Vegetation Community Profiles* (Eco Logical 2016) and to which the Subject Site retains direct connectivity.

The Office of Environment and Heritage (OEH) Biodiversity Values Map (BV Map) showed that the site is not mapped as Biodiversity Value (BV) land, as defined by the *Biodiversity Conservation Regulation 2017*. The Biodiversity Offset Scheme (BOS) threshold of native vegetation clearing associated with the study area is >0.5ha. The proposal will result in the removal of approximately 0.33ha of vegetation, therefore this proposal does not trigger the requirements for production of a Biodiversity Development Assessment Report (BDAR).

The results of the EAR indicate that the site could provide a small amount of potential habitat for some threatened flora and fauna species, however, none were recorded on site during recent fieldwork or via other sources such as the NSW Bionet Atlas.

Investigations in accordance with the *State Environmental Planning Policy Coastal Management (2018)* found that the Subject Site is not identified within the Coastal Environment Area, or within any areas identified as Coastal wetlands, Littoral Rainforests and / or Coastal Vulnerability Areas. As such, no further provision of the policy applies to the study area. Warriewood Wetlands, a mapped Coastal wetland occur approx. one kilometre downstream and are given consideration via the proposed intensive improvements to Narrabeen Creek, a major tributary.

Assessment under the *Water Management Act 2000* identified works within the riparian lands, including proposed intensive improvements to Narrabeen Creek, detention basins, roads and other infrastructure requiring an Activities Approval under Section 91.

Assessment under the *State Environmental Planning Policy* (Koala Habitat Protection) 2019 (the Koala SEPP) revealed that the site is mapped on the Koala Development Application

map. However, ground-truthing by SAT and nocturnal surveys revealed no koala presence within the site. As such the site does not constitute "Core Koala Habitat" as defined within the policy, and no further provision of the Koala SEPP applies to the site.

Consideration of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) revealed that impacts on Matters of National Environmental Significance are considered unlikely to occur.

General recommendations are included at the end of this report for consideration to minimise localised impacts on biodiversity as a result of the development of the site. These focus on active restoration of Narrabeen Creek and management of residual bushland under a Vegetation Management Plan (VMP). Consideration is given to the extension and buffering qualities provided by the site for the neighbouring Ingleside Chase Reserve.

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1.0 Introduction

It is proposed that a community title residential development be undertaken within land identified as 8 Forest Road, Warriewood (the Subject Site).

At the request of Jackson Teece (the client), Anderson Environment & Planning (AEP) have undertaken necessary investigations to inform the production of a 5-part test assessment report addressing the proposed development.

Anderson Environment & Planning (AEP) were previously commissioned by Warriewood Vale Pty Ltd to prepare an Ecological Assessment Report to provide an updated "5 part test" to reflect the revised extent of the proposed development over land known as 8 Forest Road, Warriewood. The 5.68ha (approx.) site includes a proposed 2.5ha development footprint (the Subject Site) that is to be developed for residential purposes in accordance with its existing zoning, along with associated bushfire hazard reduction requirements.

AEP has previously prepared an Ecological Assessment Report of the study area; *Ecological Assessment Report for Proposed Residential Development of 8 Forest Road, Warriewood*, *NSW*, dated September 2015. The report herein utilises data from the previous assessment, updated database searches and the revised extent of the proposed development.

This report is specifically intended to indicate the likelihood of the proposed development having a significant effect on threatened species, populations or ecological communities. In this regard, the report aims to recognise the relevant requirements of the Environmental Planning and Assessment Act 1979 (EPA Act), the Biodiversity Conservation Act 2016 (BC Act) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Consideration of other relevant policies such as SEPP Koala Habitat Protection 2019 whilst taking into consideration biodiversity concerns listed under Clause 7.6 of the Pittwater Local Environment Plan (LEP) 2014.

The purpose of this report is to:

- Describe the ecological values of the study area;
- Explore the potential for threatened species to utilise the area; and
- Assess ecological impacts associated with the proposal against relevant legislation.

Potential ecological impacts on native species in general are also considered, as are recommendations for minimising any impacts within the scope of the development.

For the purposes of referencing, this document should be referred to as:

Anderson Environment & Planning (2020). *Ecological Assessment Report for Residential Development at 8 Forest Road Warriewood, NSW.* Unpublished report for Jackson Teece. August, 2020.

2.0 Site Particulars

- **Address** – 8 Forest Road Warriewood, NSW
- **LGA** – Northern Beaches Council
- **Title Details** – Lot 1 DP 5055
- **Subject Site** – The Subject Site covers approx. 5.68ha. It currently consists of an abandoned residence, 3.24ha of native remnant vegetation, a highly disturbed area that has been the subject of clearing and Narrabeen Creek runs along the northern boundary of the site.
- **Zoning** – Under the *Pittwater Local Environmental Plan 2014* (the LEP), the Subject Site area is zoned R3 – Medium Density Residential, RE1 – Public Recreation and RU2 – Rural Landscape.
- **Current Land Use** – is currently a residential lot with an abandoned dwelling with minor vegetation management (ie. slashing) and evidence of extracurricular use by locals for socialising or refuge.

  The majority of the development site is maintained (slashed) exotic grasses. The vegetation on the northern boundary is associated with Narrabeen Creek while the remaining vegetation is outside of the proposal area and will be retained as a single contiguous large patch.
- **Surrounding Land Use** – Narrabeen Creek runs along the northern boundary of the site with associated riparian vegetation and is zoned RE1 – Public Recreation, to the south and west exists a large area of contiguous native vegetation zoned E2 – Environmental Conservation. Also, to the south is Mater Maria Catholic College, to the east areas of residential development zoned R3 – Medium Density Residential and to the north is native vegetation adjoining the site, industrial development zoned IN2 – Light Industrial and land zoned B7 – Business Park.
- **Proposed Development** – The proposal is the development of high value residential apartments and townhouses.

Figure 1 depicts the extent of the site overlain on an aerial photograph of the locality.

AEP

Title: Figure 1 - Site Location

Date: August 2020

Location: Forest Road, Warriewood

Client: Jackson Teece

AEP Ref: 1377.02

3.0 Proposed Development

The proposed development will be undertaken in 2 stages:

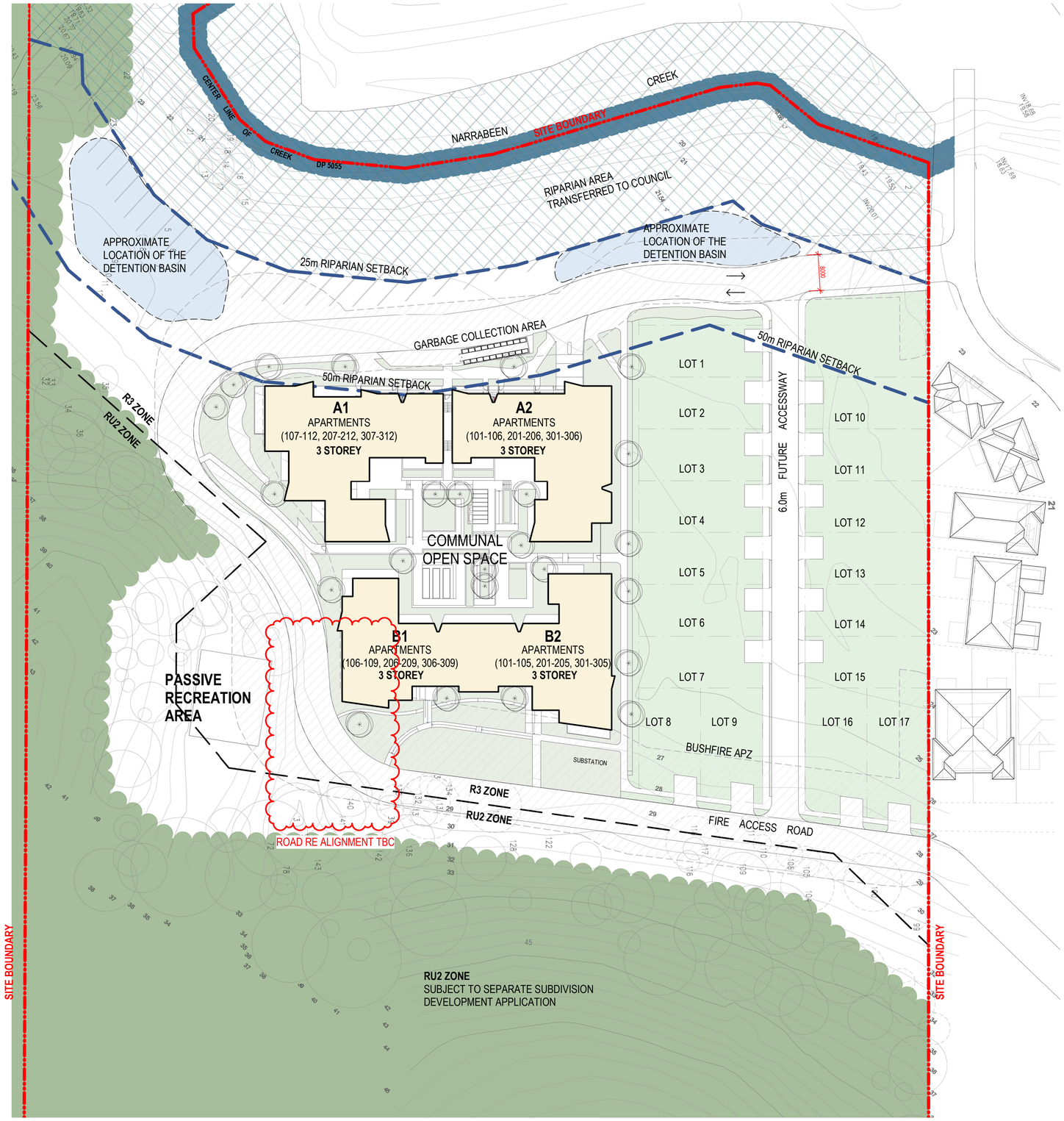
- **Stage 1**: demolition of the existing dwelling, construction of internal roads, and subdivision of land to provide 17 Torrens title residential lots, one superlot, two lots for the construction of private internal roads with associated civil and stormwater works and one community lot.
- **Stage 2**: construction of a residential flat building within the superlot. The proposed building comprises 64 residential apartment units with a single level basement car park.

Proposed development includes:

- A three-storey residential apartment building comprising 64 units with central courtyard and a single level basement carpark.
- Seventeen subdivision lots allocated for low density housing.
- Two above ground bioretention/detention basins and one below ground OSD tank.

Approximately 0.33ha of native vegetation is proposed to be totally cleared for development and Asset Protection Zone.

Figure 2 depicts an indicative proposed development plan within the Subject Site.



SITE SUMMARY

- TOTAL SITE AREA: 5.680 Ha
- RU2 SITE AREA: 2.823 Ha
- R3 SITE AREA: 2.855 Ha
- LANDSCAPE AREA: 2,354.7m^2
- TOTAL FOOTPRINT AREA: 9,306.4m^2
- PRIVATE OPEN SPACE: 1,353.9m^2

DEVELOPMENT SUMMARY

BUILDING A1

- 18 APARTMENTS
- 3 STOREYS
- MAX. HEIGHT 10.5m
- 15 x 2 BED
- 3 x 3 BED

BUILDING A2

- 18 APARTMENTS
- 3 STOREYS
- MAX. HEIGHT 10.5m
- 15 x 2 BED
- 3 x 3 BED

BUILDING B1

- 12 APARTMENTS
- 3 STOREYS
- MAX. HEIGHT 10.5m
- 9 x 2 BED
- 3 x 3 BED

BUILDING B2

- 15 APARTMENTS
- 3 STOREYS
- MAX. HEIGHT 10.5m
- 12 x 2 BED
- 3 x 3 BED

SUBDIVISIONS

- 17 SUBDIVISION LOTS FOR RESIDENTIAL USE
- MAX. HEIGHT 10.5m

- 63 UNITS
- 17 SUBDIVISION LOTS
- 1 EXISTING DWELLING HOUSE
- 77% SOLAR ACESS COMPLIANCE (46 UNITS)
- 85% NATURAL VENTILATION COMPLIANCE (46 UNITS)

81 TOTAL DWELLING UNITS

LEGEND

- SITE BOUNDARY
- RIPARIAN SETBACK
- PROPOSED APARTMENT BUILDINGS
- EXISTING DWELLINGS
- LANSCAPED AREA
- EXISTING VEGETATION TREES
- EXISTING NARRABEEN CREEK
- BUSHFIRE APZ
- 25M RIPARIAN ZONE

AMENDMENTS

ISSUE	DESCRIPTION	APPROVED	DATE
A	ISSUE FOR INFORMATION		15.05.20
B	PRE DA ISSUE		03.06.20
C	ISSUE FOR CO ORDINATION		17.07.20
D	ISSUE FOR DEVELOPMENT APPROVAL		21.08.20

Date generated: 21/08/2020 5:36:19 PM

THIS DRAWING ISSUE HAS BEEN REVIEWED FOR

PRELIMINARY

CHECKED BY:	APPROVED BY:	SIGNATURE:
MR	JS	

CLIENT

WARRIEWOOD VALE PTY LTD
8 FOREST ROAD WARRIEWOOD

SITE PLAN

DATE	SCALE @ A1	DRAWN
23/07/20	1 : 500	Author

PROJECT NUMBER	DISCP.	DRAWING NUMBER	ISSUE
2019068	A	DA-030	D

PROJECT

FOREST ROAD
WARRIEWOOD

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Walsh Bay New South Wales 2000 Australia
T 61 2 9290 2722 F 61 2 9290 1150
E sydney@jacksonteece.com
Jackson Teece Chesterman Willis Pty Ltd
Trading as Jackson Teece
ABN 15 085 837 290
Nominated Architects: Damian Barker (8192), John Gow (6790), Daniel Hudson (8315)

JACKSON TEECE

4.0 Scope and Purpose

Investigations were carried out in the study area and via literature / database searches to gather information required to adequately address the requirements of the *Biodiversity Conservation Regulation 2017* (BCR), to address BOS thresholds and address Section 7.3 of the BC Act (known as the "5-part test").

Also afforded consideration were the Commonwealth EPBC Act, and relevant State Environmental Planning Policies (SEPPs).

The assessment approach was tailored to ensure that legislative requirements were met relating to threatened species and native species in general for the proposed specific development. This was achieved by background research and literature review, database searches, consultation, targeted ecological fieldwork and mapping, detailed habitat assessment, and ultimately impact assessment consideration against the type and form of development proposed.

Field surveys were carried out with due reference to:

- Department of Environment and Conservation (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities. Working Draft.* NSW Department of Environment and Conservation 2004; and
- Biodiversity Assessment Method (BAM) and associated guidelines of the Biodiversity Conservation Act 2016.

Specifically, the scope of this study is to:

- Identify vascular plant species occurring within the site, including any threatened species listed under the BC Act or EPBC Act;
- Identify and map the extent of vegetation communities within the study area, including any Endangered Ecological Communities (EECs) listed under the BC Act or EPBC Act;
- Identify any fauna species, including threatened and migratory species, and populations or their habitats, which occur within the site and are known to occur in the wider locality;
- Assess the potential of the proposed development to have a significant impact on any threatened species, populations or ecological communities (or their habitats) identified from the site; and
- Describe measures to be implemented to avoid, minimise, manage or monitor potential impacts of the proposal.

In addition to the survey work conducted within the site boundary and its immediate surrounds, consideration has been afforded to the wider locality, via database searches within 10km of the site and via appreciation of habitat areas that may be linked ecologically to the site. This has included consideration of Pittwater Councils DCP 21 – Wildlife Corridors Mapping (2014).

Biodiversity Values Map

The Biodiversity Values Map (BV Map) identifies land with high biodiversity value, as defined by the BCR. The Biodiversity Offsets Scheme (BOS) applies to all local developments, major projects or the clearing of native vegetation where the State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017 applies. Any of these will require entry into the BOS if they occur on land mapped on the Biodiversity Values Map. Exempt and complying development or private native forestry are not subject to the Biodiversity Offsets Scheme.

The BV Map (**Appendix E**) shows that the site is not mapped as containing BV Land. As such no clearing of native vegetation is to be undertaken within a mapped BV area, therefore this proposal does not trigger the requirement for a Biodiversity Development Assessment Report (BDAR) under these criteria.

Area Clearing Threshold

"The area threshold varies depending on the minimum lot size (shown in the Lot Size Maps made under the relevant Local Environmental Plan (LEP)), or actual lot size (where there is no minimum lot size provided for the relevant land under the LEP). The area threshold applies to all proposed native vegetation clearing associated with a development proposal".

Table 1 – Area Clearing Thresholds (BC Act)

Minimum lot size	Threshold for clearing, above which the BAM and offsets scheme apply
< 1ha	>0.25ha
1ha to <40ha	**>0.5ha.**
40ha to <1000ha	>1.0ha
>1000ha	>2ha

In this case, a minimum lot size of 1ha is assigned and the area clearing threshold of >0.5ha applies. The vast majority development footprint within the Subject Site being composed of exotic paddocks, the area of native vegetation present is mostly retained within the riparian area and residual lot. It is estimated that the native vegetation to be removed totals approximately 0.33ha and therefore the 0.5ha threshold, does not trigger the BOS and as such the preparation of a (BDAR) is not required based on the clearing thresholds.

5.0 Study Certification and Licencing

This report was written by Natalie Black (BSc (Hons), Master Planning & Cert IV TA) and Brooke Corrigan (BEnvSc, Dip PM, BAAS 19061, CEnvP 656) of Anderson Environment & Planning.

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence SL101313;
- Animal Research Authority (Trim File No: 14/600(2)) issued by NSW Agriculture; and
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 14/600(2)) issued by NSW Agriculture.

Certification:

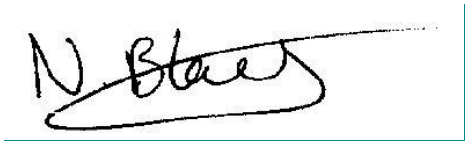
As the principal author, I, Natalie Black, make the following certification:

The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the Survey Area;

Commonwealth, state and local government policies and guidelines formed the basis of project surveying methodology, unless specified departures from industry standard guidelines are justified for scientific and/or animal ethics reasons; and

All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the Animal Research Act 1995, National Parks and Wildlife Act 1974 and the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.

Principal Author and Certifier:



NATALIE BLACK
Senior Environmental Manager
Anderson Environment & Planning
October 2020

6.0 Methods

The field surveys for the site have been prepared and performed with due recognition of the Threatened Biodiversity Survey Guidelines (DEC 2004) as well as standards relating to Amphibians (DECC 2009) and Threatened Plants (OEH 2016).

The size of the site, the type of native vegetation and habitats remaining, the status of existing and proposed surrounding land use, and the level and type of habitat linkages to proximate bushland areas were considered in formulating the methodology employed and described below.

The assessment approach was tailored to undertake sufficient works to ensure that legislative requirements were met relating to threatened species and native species in general for the proposed specific development.

To ensure a robust impact assessment approach, where any potential doubt remained over species impact, presence within the site was assumed to ensure a conservative approach was employed.

6.1 Information Sources

Information and spatial data provided within this EAR has been compiled from various sources including:

- Previous ecological assessment of the site by AEP *Ecological Assessment Report for Proposed Residential Development of 8 Forest Road, Warriewood, NSW* dated September 2015.
- Baseline flora surveys by Sclerophyll Flora Surveys and Research, June 2015.
- Aerial Photograph Interpretation (API) of the site and surrounding locality;
- *NSW Biodiversity Value Map* (2019);
- State survey guidelines (DEC 2004; DECC 2009; OEH 2016);
- OEH Threatened Species, Populations and Ecological Communities website (http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/);
- OEH (2016) *The Native Vegetation of the Sydney Metropolitan Area. Volume 1: Technical Report.* Version 3.0. Office of Environment and Heritage Sydney.
- Pittwater Council (2005). *Warriewood/Ingleside Escarpment (North) – Plan of Management.* Prepared by Gondwana Consulting for Pittwater Council, April 2005.
- Pittwater Council (2010). *Ingleside Chase Reserve – Plan of Management.* Prepared by EcoLogical Australia for Pittwater Council, December 2010.
- Pittwater Council (2014). *Pittwater 21 DCP – Wildlife Corridor Map.* Plan prepared by Pittwater Council Natural Environment & Education Unit, June 2014.
- Collective knowledge gained from previous ecological survey and assessment in the area over the past 20 years.

In addition, database searches were carried out, namely:

- Review of flora and fauna records held by the NSW Threatened Species Database within a 10km radius of the site (May 2015, May 2020); and
- Review of flora and fauna records held by the Commonwealth Department of Energy & Environment (DoEE) Protected Matters Search within a 5 km radius of the site (May 2015, May 2020).

6.2 Field Survey

6.2.1 Vegetation Communities

- Vegetation on site was surveyed by Sclerophyll Flora Surveys and Research. The full report including methodologies in presented in **Appendix A**; and,
- Study area inspection to ground truth the unit(s) identified by the flora report via identification of required dominant species in community structural layers

Consideration was given to the potential for the derived vegetation communities to constitute Endangered Ecological Communities (EEC's) as listed under the BC Act and/or EPBC Act. The floristic composition, geomorphological characteristics and geographical extent were important considerations in this process.

6.2.2 Flora

A general flora survey was undertaken to produce a flora species list for the study area, to search specifically for threatened flora species known from the wider area, and to gather data necessary to both derive vegetation community type(s) and to meet relevant survey guidelines by Sclerophyll Flora Surveys and Research in 2015. The full report including methodologies in presented in **Appendix A**.

Such works included:

- Identification of all vascular plant species encountered during fieldwork.
- Study area coverage was systematic to ensure all key points of the study area were checked, and the Random Meander Technique (Cropper, 1993) was also utilised to maximise species encountered.
- A systematic approach to target threatened plants species at the study area as per the NSW Guide to Surveying Threatened Plants (2016).

Follow up surveys in accordance with BC Act & the BAM were completed by AEP over the 18th & 19th of May 2020.

6.2.3 Habitat

An assessment of the relative habitat values present within the study area was carried out. This assessment focused primarily on the identification of specific habitat types and resources within the study area favoured by known threatened species from the region. The assessment also considered the potential value of the study area (and surrounding areas) for all major guilds of native flora and fauna.

The assessment was based on the specific habitat requirements of each threatened fauna species in regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements. Consideration was given to contributing factors including topography, soil, light and hydrology for threatened flora and assemblages.

In particular, focus was put on documenting the presence of key habitat features such as tree hollows. Hollows are an important resource utilised by a variety of forest fauna and are particularly relevant for several of the likely key threatened species in this locality. Vertebrate and invertebrate species use hollows as diurnal or nocturnal shelter sites, for rearing young, feeding, thermoregulation, and to facilitate ranging behaviour and dispersal.

Tree hollows were recorded and mapped within the study area utilising the methodology of tree hollow identification set by OEH in the BAM methodology, namely:

> *"A hollow is only recorded if: (a) the entrance can be seen; (b) the minimum entrance width is at least 5 cm across; (c) the hollow appears to have depth (i.e. you cannot see solid wood beyond the entrance); and (d) the hollow is at least 1 m above the ground (this omits hollows in cut stumps or at the base of trees)".*

6.2.4 Fauna

Fauna survey has been carried out utilising techniques as outlined below and All Fauna Survey technique locations are shown in **Figure 3.** Fauna survey work was undertaken with reference to relevant guidelines and to add additional information to the generated Expected Fauna Species List (**Appendix C**).

6.2.4.1 Small Terrestrial Mammal Trapping

Small mammals were targeted on the site via the use of Elliott Type 'A' traps. Twenty traps were employed in two curving trap lines within the site, sampling all habitat types present. The traps were baited with a mixture of rolled oats and honey with a smear of peanut butter. The traps were checked early each morning, and where necessary, reset and rebaited. The traps were left out for three nights, giving a total of 60 small terrestrial trap nights in 2015.

6.2.4.2 Medium Terrestrial Mammal Trapping

Medium sized terrestrial mammals were targeted by the use of Elliot Type 'B' traps (3). The traps were placed in suitable positions and baited with a mixture of rolled oats and honey and dry dog food. The traps were checked early each morning, and where necessary, reset and rebaited. The traps were left out for three nights, giving a total of 9 medium terrestrial trap nights in 2015.

6.2.4.3 Arboreal Mammal Trapping

Arboreal mammals were targeted on the site via the use of Elliott Type 'B' traps. Seven traps were placed on bracket mounted wooden supports attached to suitable trees throughout the site. Trees targeted were, where possible, those that had hollows, were flowering and/or had scratches on the hollows. The traps were baited with a mixture of rolled oats and honey, with a smear of peanut butter. Traps were also sprayed with a water and vanilla essence mix to help mask the smell of humans. The traps were checked early each morning, and where necessary, reset and rebaited. The traps were left out for three nights, giving a total of 21 arboreal trap nights in 2015.

6.2.4.4 Bat Call Recording

Bat echolocation calls were taped using an Anabat Detector within the site. Call recording was undertaken by stationary units set for full overnight recording over two nights. Transformed calls were analysed by Dr. Anna McConville of Echo Ecology using commercially available software.

6.2.4.5 Avifauna Surveys

The presence of avifauna on site was carried out via targeted diurnal and nocturnal surveys as well as incidental observations during all other phases of fieldwork.

For diurnal surveys, emphasis was placed on peak activity periods, i.e. early morning and late afternoon, to maximise chances of species encountered. Birds were identified by direct observation or by recognition of calls or distinctive features such as nests, feathers etc. Survey during May 2020 was supported by continuous acoustic recording of the site which was then analysed for species calls.

For nocturnal surveys, spotlighting attempted to identify any roosting birds, and similar methods were employed as per diurnal surveys. Additionally, pre-recorded calls of *Ninox strenua* (Powerful Owl), *N. connivens* (Barking Owl), *Tyto novaehollandiae* (Masked Owl) and *T. tenebricosa* (Sooty Owl) were broadcast through an amplification system designed to project the sound for at least 1km under still night conditions. The calls were repeated in the four compass directions for five minutes from suitable positions, and replies were listened for five minutes after broadcast, followed by short periods of spotlighting for owls that may have flown in following the calls.

Other techniques utilised to target owls included quiet listening at dusk and into first dark for calling birds, and also by utilising the 'squeak technique' (rubbing glass on styrofoam) to mimic injured prey species.

6.2.4.6 Herpetofauna Surveys

Specific herpetofauna (frog and reptile) searches were carried out in each of the habitat units present. Both diurnal and nocturnal searches were made in areas of appropriate habitat. Such habitat included areas of thicker vegetation, in ground litter, near and under fallen timber, around piles of refuse, and wet / damp areas such as drainage lines, dams and areas of poor infiltration capacity and / or periodic inundation.

Physical frog searches were augmented by call recognition. Any calls unable to be clarified in the field were recorded for later comparison with commercially available recordings.

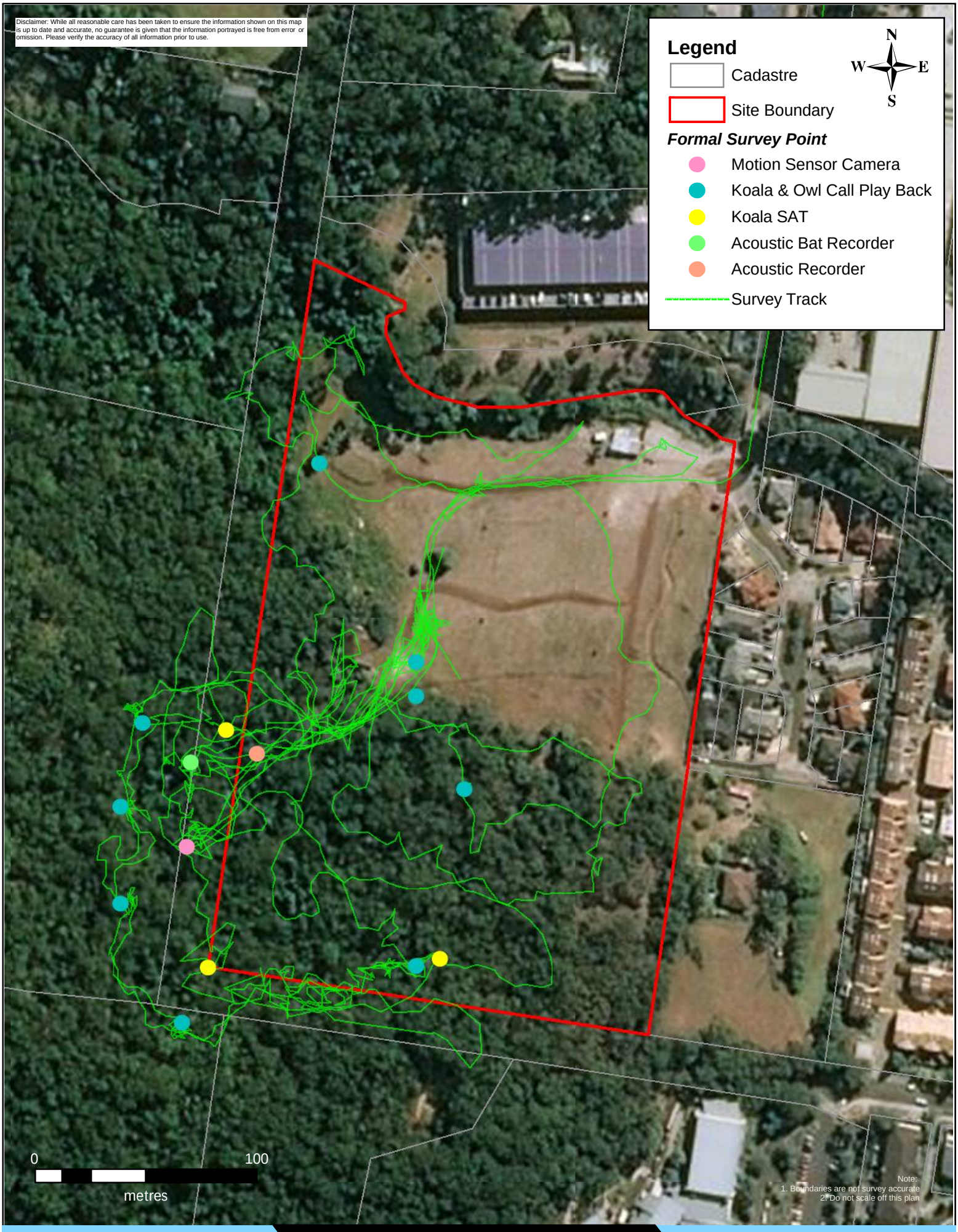
Opportunistic encounters during all other phases of fieldwork were also noted.

6.2.4.7 Spotlighting

Spotlighting was undertaken for over five hours on site over three nights during 2015 and a further five hours over two nights in 2020 via the use of a 100 Watt hand-held spotlight. Given the relatively small and open size of the proposed development area, comprehensive survey was achieved of this area, with all areas covered on foot. Spotlighting was also conducted in the forested section in the south of the site by foot where suitably safe access for nocturnal survey was available.

6.2.4.8 Incidental Observations & Secondary Indications

Incidental records of any fauna species observed during fieldwork were noted. This included opportunistic sightings of secondary indications (scratches, scats, diggings, tracks etc.) of any resident or migratory species. Searches were also conducted for whitewash, regurgitation pellets and prey remains from Owls, chewed *(Allo)Casuarina* cones from Black-Cockatoos, chewed fruit remains from frugivorous birds etc.



AEP

Title: Figure 3 - May 2020 Survey Effort

Date: August 2020

Location: Forest Road, Warriewood

Client: Jackson Teece

AEP Ref: 1377.02

6.2.5 Survey Dates, Times & Activity

Table 2 – Field Survey Periods

Date	Time	Weather Conditions	Field Activity
19/5/15	10:30am – 1:00pm	Fine, clear.	Initial site meeting and reconnaissance. General meander and observations.
19/5/15	10:00am – 12:30pm	Fine, clear.	Site inspection. Riparian survey. General observations elsewhere.
9/6/15	11:45am – 4:00pm.	Rain, cool, still.	Site investigations, fauna survey, set traps & bat detector, incidentals.
17/6/15	5:30pm – 8:00pm.	Patchy showers, clearing, cool, still.	Fauna survey, spotlighting, owl call broadcast, quiet listening, frogging, incidentals.
17/6/15	6:30am – 10:00am	Overcast, still, cool.	Check traps, fauna survey, incidentals.
18/6/15	3:30pm – 6:30pm	Weather deteriorating to persistent rain.	Fauna survey, incidentals, herp searches, spotlighting (aborted due to weather).
18/6/15	6:40am – 9:00am	Rain, cold.	Check traps, fauna survey, incidentals. Retrieve bat detector.
19/6/15	12:30pm – 4:00pm	Patchy showers, cold.	Habitat assessment / key features search, fauna survey, herp search, incidentals.
19/6/15	6:00pm – 8:30pm	Patchy showers, cool. Clearing.	Fauna survey, spotlighting, owl call broadcast, quiet listening, frogging, incidentals.
19/6/15	6:15am – 10:30am	Overcast, cool, still.	Check & collect traps. Incidental observations.
20/6/15	10:45am – 12:15pm	Clear & sunny, light breeze, mild.	Site inspection & meeting with Council. Incidental observations.
27/7/15	4:00pm - 5:30pm	Overcast, cool, still, damp.	Site inspection. Set camera trap, bat detector and song meter.
18/5/20	6:00pm - 8:00pm	Overcast, cool, still, damp.	Fauna survey, spotlighting, owl call broadcast, koala call broadcasting, quiet listening, frogging, incidentals.
18/5/20	11:30am- 3:30pm	Sunny, dry, light breeze.	Habitat assessment, koala SATs, threatened flora search, herp search, incidentals.
19/5/20	4:30pm - 8:30pm	Clear, cool, still.	Fauna survey, spotlighting, owl call broadcast, koala call broadcasting, quiet

			listening, frogging, incidentals, retrieve equipment.
19/5/20	10:30am – 1:00pm	Fine, clear.	Initial site meeting and reconnaissance. General meander and observations.

The survey effort during 2015 involved numerous site visits over a three-month period, however the survey period was largely conducted through the cooler winter months when many species may be less active. As such, a conservative approach involving assumed presence for more mobile species recorded previously within the locality means that all possible use of the site by notable species is considered, and hence accommodated within impact assessments. In addition, fauna records from a period of several years provided by residents of the site have been included within the assessment process dataset.

The 2020 survey incorporated remote recording devices as well as active searches to maximise the potential to detect fauna on or adjacent to the site. Methods were targeted for species which have had legislative changes, altered survey requirements or are likely to utilise the site

Given the highly disturbed condition of the site, the above survey effort is considered to provide sufficient understanding of the biodiversity of the site and wider study area.

In addition, by applying rigorous habitat assessment to more mobile species identified in Bionet Atlas records within the locality, it was ensured that all possible use of the site and wider study area by notable species was considered, and accommodated within subsequent biodiversity assessment and management recommendations.

7.0 Results

7.1 Literature Review and Database Searches

Targeted flora assessment was undertaken in by Sclerophyll Flora in 2015. This work underpinned further assessment conducted by AEP in 2020 which reviewed the conclusions and boundaries outlined in the original report and provided amendments to boundaries and updated community descriptions to *The Native Vegetation of the Sydney Metropolitan Area (Vol 3) 2016* describes the communities as;

- S_DSF04: Coastal Enriched Sandstone Dry Forest (PCT 1776);
- S_WSF02: Coastal Enriched Sandstone Moist Forest (PCT 1841);
- S_RF02: Coastal Sandstone Gallery Rainforest (PCT 1828); and
- S_RF07: Coastal Escarpment Littoral Rainforest EEC (1833).

Searches were undertaken of databases within a 10km radius of the study area for BC Act listings and 5km radius for EPBC Act listings. Note that any records considered erroneous, historic only, or obviously of no relevance to the site in regards to habitat (e.g. seabirds, marine species etc.) were omitted.

The potential for listed threatened species to occur within the Subject Site and the analysis undertaken to determine likelihood of occurrence is considered in **Table4**. Detailed ecological profiles of threatened species can be found at:

https://www.environment.nsw.gov.au/threatenedspeciesapp/

7.2 Vegetation Communities

Utilising the information from the previous assessment and the investigation undertaken by AEP the vegetation communities within the Subject site are currently:

- S_DSF04: Coastal Enriched Sandstone Dry Forest (PCT 1776);
- S_DSF04: Coastal Enriched Sandstone Dry Forest (derived) (PCT 1776);
- S_WSF02: Coastal Enriched Sandstone Moist Forest (PCT 1841);
- S_RF02: Coastal Sandstone Gallery Rainforest (PCT 1828);
- S_RF07: Coastal Escarpment Littoral Rainforest EEC (1833); and
- Exotic dominated Riparian Vegetation (**Figure 4**).

Changes include the addition of regrowth considered native vegetation under the BC Act 2016. The area contains colonising species from both wet and dry sclerophyll forest which can be ascribed to its proximity to the creek but exposed sunny aspect. Overall, the vegetation most closely resembles S_DSF04 in its composition and likely established community structure and so is classified as S_DSF04 (derived). Note that the Rainforest classifications differ somewhat from the SMA mapping which indicates the presence of S_RF03: Coastal Warm Temperate Rainforest (PCT 905) while S_RF07: Coastal Escarpment Littoral Rainforest EEC is not indicated as occurring in the immediate area. Areas of each vegetation type are detailed in **Table 3** below and an overview is provided in **Figure 4**.

Pictures of the site and vegetation are included in **Appendix A** and **D**.

Note that Littoral Rainforest EEC and EPBC listed Littoral Rainforest critically endangered ecological community (CEEC) but at less than 0.1ha does not require further assessment under EPBC legislation.

Table 3 Vegetation within the Subject Site

Vegetation Community	Area occurring (ha)
S_DSF04: Coastal Enriched Sandstone Dry Forest	1.89
S_DSF04: Coastal Enriched Sandstone Dry Forest (derived)	0.09
S_WSF02: Coastal Enriched Sandstone Moist Forest	1.13
S_RF02: Coastal Sandstone Gallery Rainforest	0.13
S_RF07: Coastal Escarpment Littoral Rainforest EEC	0.03
Exotic Dominated Riparian Vegetation	0.2
Sub-total	**3.47**
Disturbed / cleared	2.21
Total	**5.68**

7.2.1 Residue of the Subject Site

The remainder of the lot is classified as remnant native vegetation. This area will not be disturbed directly but formed part of the study area to determine the presence of threatened species which may utilise the development site.

7.3 Flora

Flora surveys have resulted in the identification of around 109 species within the site. Within the development area approximately 70% of these species are exotics, principally invasive weed species associated with edge effects.

A full list of flora species identified by surveys conducted within the site is included in **Appendix A**.

7.4 Threatened Plants

No threatened flora were recorded within the study area. Based on habitat assessment and disturbance history within the site it is considered unlikely that expected Subject Species would remain undetected during repeated surveys.

7.5 Habitat Assessment

The site offers some habitat features for native fauna as outlined below.

Shrubs – A shrub layer is largely absent except on the boundary of the development area. present and would provide foraging and breeding habitat for a wide range of fauna, however a large component is comprised of *Lantana camara* (Lantana), (a High Threat Exotic (HTE)) and other weeds both offering reduced resources compared with a native shrub layer. A diverse native shrub layer occurs within the residual lands.

Grasses – the site is dominated by exotic grasses that have been slashed, providing limited habitat for native fauna.

Native canopy – Canopy is largely absent, provided on the boundaries by a range of Angophora, Eucalypt, Allocasuarina and mesic species which would provide a range of roost, blossom, nectar, invertebrate and other habitat features suitable for a range of species.

Hollow Bearing Trees (HBTs) – No nest hollows were found within the development area.

Patch size / connectivity – The site contains approximately 3.5ha of vegetation of various composition (**Figure 4**). The western and southern boundary is directly connected to Ingleside Chase Reserve which is approx. 70ha of contiguous remnant bushland and retains connectivity to the wider Northern Beaches Landscape and associated national parks. The vegetation within the study area would comprise part of the home range or occasional habitat for various fauna species, of which the development proposes to remove a small amount along disturbed edges. This will retain all connectivity and provide improvements along Narrabeen Creek.

7.6 Narrabeen Creek Assessment

The existing riparian vegetation is approx. 0.38ha of which the following vegetation communities are present:

- S_RF02: Coastal Sandstone Gallery Rainforest;
- S_WSF02: Coastal Enriched Sandstone Moist Forest; and
- Exotic Dominated Riparian Vegetation.

Figure 4 depicts the dominate vegetation within the riparian are as exotic dominate riparian vegetation, however forms part of an existing wildlife corridor, hence it is high retention value in an urban environment.

The bank of Narrabeen creek, are mostly stable, portions of the banks show signs if undercutting, erosion and previous attempt at a crossing. The water quality is representative of an urban creek in decline, providing minimal habitat for aquatic flora and fauna.

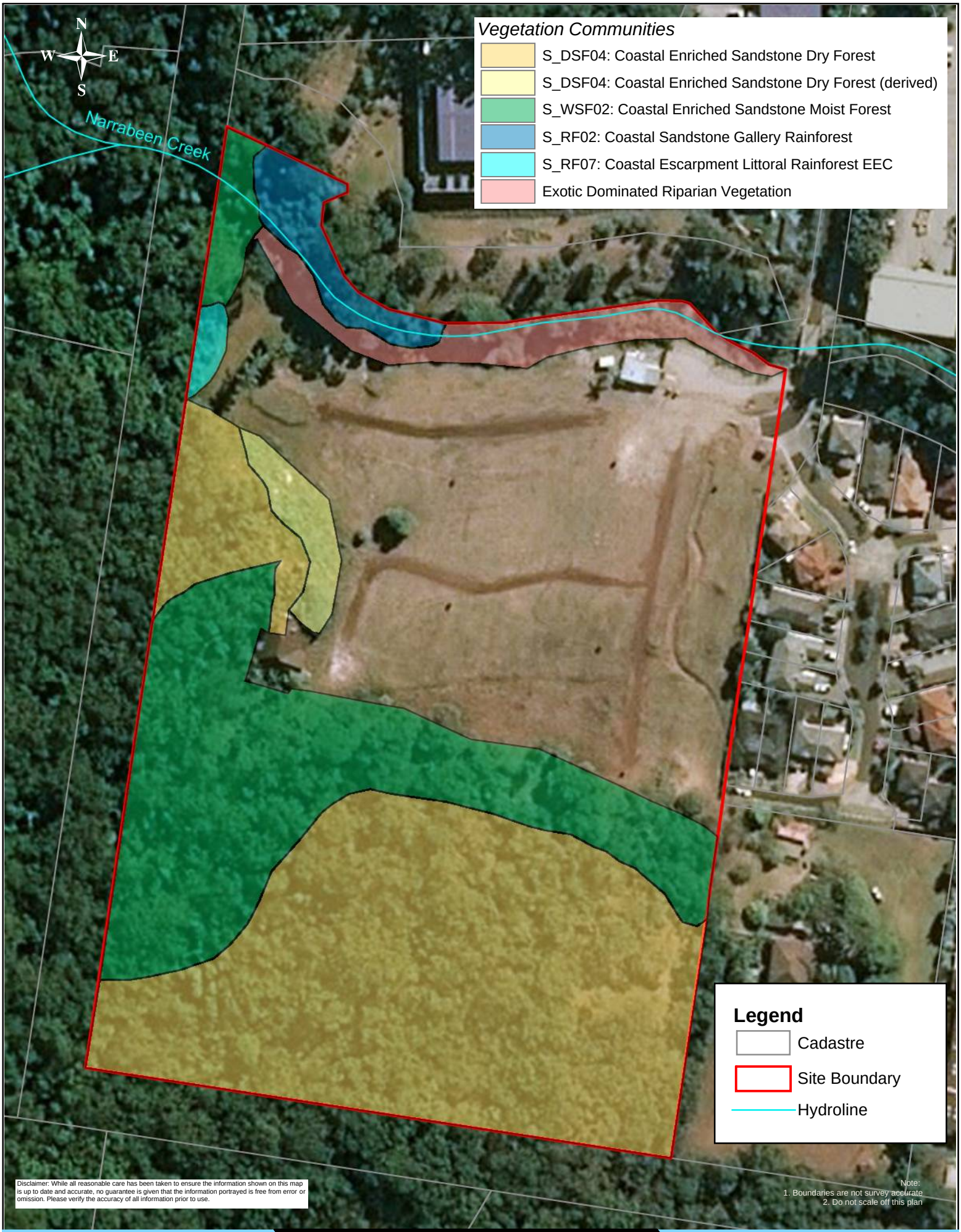
7.1 Fauna

Fauna surveys undertaken have identified 80 species within the site, including Glossy Black-Cockatoos, Powerful Owl and potential sighting of Rosenberg's Goanna by local residents.

The site contains potential foraging habitat for some of these species as well as some potential nesting habitat.

Other notable species, including mobile (flying) threatened species, are also considered to potentially utilise the site on an intermittent basis as part of a larger home range. Such species are considered further in following Sections.

An Expected Fauna Species List has been generated for the site and is included as **Appendix C**, and all fauna species recorded during fieldwork are noted therein.



Note:
1. Boundaries are not survey accurate
2. Do not scale off this plan

AEP

Title: Figure 4 - Vegetation Communities

Date: August 2020

Location: Forest Road, Warriewood

Client: Jackson Teece

AEP Ref: 1377.02

Table 4 – Threatened Species Appraisal

Scientific Name	Common Name	BC Act	EPBC Act	Likelihood of Occurrence
Flora				
Asterolasia elegans	-	E	E	No sign of this species during fieldwork. Site survey conducted outside of flowering period so may occur, however preferred habitat will largely be retained within the RU2 lands on site.
Caladenia tessellata	Thick Lip Spider Orchid	E	V	No sign of this species during fieldwork. Site survey conducted outside of flowering period so may occur, however no previous records within vicinity and preferred grassy woodland habitat to be retained within RU2 lands.
Callistemon linearifolius	Netted Bottle Brush	V		No sign of this species during fieldwork, however site survey conducted outside of flowering period so may occur. Preferred habitat will largely be retained within the RU2 lands on site.
Chamaesyce psammogeton	Sand Spurge	E		No sign of this species during fieldwork. Preferred habitat (coastal dunes) is absent from the site.
Cryptostylis hunteriana	Leafless Tongue-Orchid	V	V	No sign of this species during fieldwork. Site survey conducted outside of flowering period so may occur, however no previous records within vicinity and preferred habitat largely absent. Species prefers more open habitats including woodland and heath areas.
Epacris purpurascens	-	V		No sign of this species during fieldwork. Site survey conducted outside of flowering period so may occur, however potential habitat to be largely retained within RU2 lands.
Eucalyptus camfieldii	Camfield's Stringybark	V	V	No sign of this species during fieldwork. Preferred habitat is absent as the vegetation type on site is not known to support this species.
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	Not naturally occurring in the region, with local records a result of street planting. Indigenous to the northern tablelands of NSW and is not considered threatened in the region that includes the site.
Genoplesium bauera	Bauer's Midge Orchid	E	E	No sign of this species during fieldwork. Site survey conducted outside of flowering period so may occur, however the majority of preferred dry sclerophyll habitat to be retained within RU2 lands.
Grammitis stenophylla	Narrow-leaf Finger Fern	E		No sign of this species during fieldwork, however potential habitat to be largely retained within RU2 lands.
Grevillea caleyi	Caley's Grevillea	CE	E	No sign of this species during fieldwork, and suitable ridgetop habitat is lacking. Unlikely to occur, particularly within the lower slope and flats areas proposed for development.
Kunzea rupestris	-	V	V	No sign of this species during fieldwork, however potential habitat to be largely retained within RU2 lands.
Lasiopetalum joyceae	-	V	V	No sign of this species during fieldwork. Potential habitat will largely be retained within the RU2 lands on site.

Scientific Name	Common Name	BC Act	EPBC Act	Likelihood of Occurrence
Melaleuca biconvexa	Biconvex Paperbark	V	V	No sign of this species during fieldwork. Potential habitat present is limited, and for the most would be retained within the proposed riparian zones.
Melaleuca deanei	Deane's Melaleuca	V	V	No sign of this species during fieldwork. Preferred habitat is absent as the wet heath favoured by this species does not occur on site.
Microtis angusii	Angus' Onion Orchid	E	E	No sign of the species during fieldwork. Preferred habitat is difficult to ascertain for this species which often is found in disturbed locations. Not considered likely that a notable population of this species would be affected by development as proposed.
Persoonia hirsuta	Hairy Geebung	E	E	No sign of this species during fieldwork. Potential habitat will largely be retained within the RU2 lands on site.
Pimelea curviflora var. curviflora	-	V	V	No sign of this species during fieldwork, and suitable ridgetop and upper slope habitat is lacking. Unlikely to occur, particularly within the lower slopes and flats areas proposed for development.
Prostanthera densa	Villous Mint-bush	V	V	No sign of this species during fieldwork. Potential habitat will largely be retained within the RU2 lands on site.
Rhodamnia rubescens	Scrub Turpentine	E		No sign of this species during fieldwork. Potential habitat is to be retained within the riparian zone and Littoral Rainforest EEC on the site.
Syzygium paniculatum	Magenta Lilly Pilly	E	V	No sign of this species during fieldwork. Potential habitat is to be retained within the riparian zone and Littoral Rainforest EEC on the site.
Tetratheca glandulosa	-	V		No sign of this species during fieldwork, however surveys conducted outside of flowering period so may occur. Potential ridgetop, upper slope and mid slope sandstone bench habitat will be retained as part of the proposal.
Herpetofauna				
Heleioporus australiacus	**Giant Burrowing Frog**	**V**	**V**	Not recorded on the site during fieldwork, but records exist within the larger patch of bushland that includes the site. The site provides both breeding and non-breeding habitat for the species, the majority of which will be retained. **SUBJECT SPECIES**
Litoria aurea	Green and Golden Bell Frog	E	V	No sign of species during fieldwork, and records are lacking for the vicinity. It is considered unlikely to occur.

Scientific Name	Common Name	BC Act	EPBC Act	Likelihood of Occurrence
Pseudophryne australis	**Red-crowned Toadlet**	**V**		Not recorded on the site during fieldwork, but records exist within the larger patch of bushland that includes the site. The site provides both breeding and non-breeding habitat for the species, the majority of which will be retained. **SUBJECT SPECIES**
Varanus rosenbergi	**Rosenberg's Goanna**	**V**		Species previously noted on site by residents. Vast majority of habitat will be retained in RU2 lands. **SUBJECT SPECIES**
Avifauna				
Anthochaera phrygia	Regent Honeyeater	CE	E	No sign of species during fieldwork. Highly mobile species, so could possibly occur on a seasonal basis. Potential habitat largely retained within RU2 lands on site. Site is not considered to be of any significant value to the species in a landscape context.
Burhinus grallarius	Bush Stone-curlew	E		No sign of this species during fieldwork. The open woodland habitat preferred by this species is largely absent from the site. It is considered unlikely to occur.
Callocephalun fimbriatum	Gang-Gang Cockatoo	V		No sign of species during fieldwork. Highly mobile species so may occur on a seasonal basis. Potential habitat to be largely retained within the RU2 lands on site.
Calyptorhynchus lathami	**Glossy Black-Cockatoo**	V		Species recorded on site by residents. Development likely to remove a small amount of foraging habitat, however large areas of higher quality habitat will be retained within the site. **SUBJECT SPECIES**
Daphoenositta chrysoptera	**Varied Sitella**	V		Recent sightings at Warriewood Wetlands in comparable habitat. **SUBJECT SPECIES**
Dasyornis brachypterus	Eastern Bristlebird	E	E	No sign of species on site. Site outside of known distribution of the species and it is considered highly unlikely to occur.
Glossopsitta pusilla	**Little Lorikeet**	V		No sign of species during fieldwork. Highly mobile species which could possibly utilise the site during flowering of feed tree species as part of a larger foraging range, albeit the species preferentially utilises dryer forest types. Some potential nesting habitat likely to be removed, however larger areas of habitat will be retained. **SUBJECT SPECIES**
Haliaeetus leucogaster	**White-bellied Sea-Eagle**	V		No sign of species during fieldwork. A mobile species with records in the area primarily to the east and coastal fishing grounds. The vast majority of potential habitat for this species will be retained in the RU2 zone. **SUBJECT SPECIES**

Scientific Name	Common Name	BC Act	EPBC Act	Likelihood of Occurrence
Hieraaetus morphnoides	Little Eagle	V		No sign of the species during fieldwork. Highly mobile species that may utilise the site as part of a larger home range. Site is not considered to be of any significant value to the species in a landscape context.
Ixobrychus flavicollis	Black Bittern	V		No sign of species during fieldwork. Unlikely to occur due to type and size of habitats present.
Lathamus discolor	Swift Parrot	E	E	No sign of species during fieldwork. Winter migrant to Australian mainland which could possibly utilise the site as part of a larger foraging range. Potential habitat largely retained within RU2 lands on site. Site not considered to be of any significant value to the species in a landscape context.
Lophoictinia isura	Square-tailed Kite	V		No sign of species during fieldwork. Highly mobile species which could possibly traverse the site as part of a large home range.
Ninox connivens	**Barking Owl**	V		No sign of species during fieldwork. A mobile species, so could possibly occur, with multiple local records south of the site at Narrabeen Lakes. The vast majority of potential habitat for this species will be retained in the RU2 zone. **SUBJECT SPECIES**
Ninox strenua	**Powerful Owl**	V		Species recorded on the site by residents. Prey species observed at reasonable densities within the site and potential for nesting in larger hollow trees in the south of the site. The vast majority of potential habitat for this species will be retained in the RU2 zone. **SUBJECT SPECIES**
Pandion cristatus	Eastern Osprey	V		No sign of species during fieldwork. Highly mobile species which could possibly traverse the site as part of a large home range, however there is a lack of foraging habitat for the species on the site.
Petroica boodang	Scarlet Robin	V		No sign of species during fieldwork. A mobile species, so could possibly occur and records known from the wider locality. The vast majority of potential habitat for this species will be retained in the RU2 zone.
Rostratula australis	Australian Painted Snipe	E	E	No sign of species during fieldwork. Unlikely to occur due to type and size of habitats present.
Tyto novaehollandiae	**Masked Owl**	V		No sign of species during fieldwork. A mobile species, so could possibly occur and records known from the wider locality. The vast majority of potential habitat for this species will be retained in the RU2 zone. **SUBJECT SPECIES**
Tyto tenebricosa	**Sooty Owl**	V		No sign of species during fieldwork. A mobile species, so could possibly occur and records known from the wider locality. The vast majority of potential habitat for this species will be retained in the RU2 zone. **SUBJECT SPECIES**

Scientific Name	Common Name	BC Act	EPBC Act	Likelihood of Occurrence
Mammals				
Cercartetus nanus	**Eastern Pygmy Possum**	V		No sign of species during fieldwork, but local records exist within the adjacent Ingleside Park. Potential habitat for this species will predominantly be retained within the site. **SUBJECT SPECIES**
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Not recorded during bat call surveys. A mobile species, so could possibly utilise the site as part of a wider foraging range. Potential for caves to occur in the higher areas of the site, however these areas occur well outside of potential development footprint.
Dasyurus maculatus maculatus	Tiger Quoll (SE Mainland popn)	V	E	No sign of species during fieldwork. A mobile species, so could possibly occur, but reliance on bushland edges surrounded by development is highly unlikely. The vast majority of potential habitat for this species will be retained in the RU2 zone.
Falsistrellus tasmaniensis	**Eastern Falsistrelle**	V		Not recorded during bat call surveys. A mobile species, so could possibly utilise the site as part of a wider foraging range. Roosting habitat is available within the vegetated areas of the site, the majority of which will be retained. **SUBJECT SPECIES**
Isoodon oesulus obesulus	Southern Brown Bandicoot	E	E	Not recorded during fieldwork, and no records exist within the larger patch of bushland that includes the site. Preferred heathy or open forest habitat exists within the RU2 lands and will be retained.
Miniopterus australis	**Little Bent-winged Bat**	V		Bat call surveys identified the species as 'potentially' occurring on the site. A mobile species, so would utilise the site as part of a wider foraging range. Potential for caves used for roosting and/or breeding to occur in the higher areas of the site away from the proposed development, and tree hollows are available as potential standard roost sites. **SUBJECT SPECIES**
Miniopterus orianae oceanensis	**Large Bent-winged Bat**	V		Recorded on site during surveys. A mobile species, so would utilise the site as part of a wider foraging range. Potential for caves used for roosting and/or breeding to occur in the higher areas of the site away from the proposed development. **SUBJECT SPECIES**
Micronomus norfolkensis	**Eastern Coastal Free-tailed Bat**	V		Not recorded during bat call surveys. A mobile species, so could possibly utilise the site as part of a wider foraging range. Tree roost opportunities occur on the site, the majority of which will be retained. **SUBJECT SPECIES**

Scientific Name	Common Name	BC Act	EPBC Act	Likelihood of Occurrence
Myotis macropus	**Southern Myotis**	V		Not recorded during bat call surveys. A mobile species, so could possibly utilise the site as part of a wider foraging range. Tree roost opportunities occur on the site, the majority of which will be retained. **SUBJECT SPECIES**
Petaurus norfolcensis	Squirrel Glider	V		The species was not observed during field surveys, and local records are scarce. There is potential habitat on the site but it will largely be retained, and the species is considered unlikely to occur.
Phascolarctos cinereus	Koala	V	V	No sign of species during fieldwork, and does not constitute Core Koala Habitat.
Psedomys novaehollandiae	New Holland Mouse		V	No sign of this species during fieldwork. No preferred habitat present.
Pteropus poliocephalus	**Grey-headed Flying-fox**	V	V	Species observed foraging within the site. A mobile species, so would occur when suitable fruiting / flowering resources available on site and in the locality. Site offers a very small component of a much larger foraging range. No existing camp roosts are present, but parts of the site could have potential to be occupied in that regard. **SUBJECT SPECIES**
Saccolaimus flaviventris	**Yellow-bellied Sheathtail-bat**	V		Not recorded during bat call surveys. A mobile species, so could possibly utilise the site as part of a wider foraging range. Roosting habitat is available within the vegetated areas of the site, the majority of which will be retained. **SUBJECT SPECIES**
Scoteanax rueppellii	**Greater Broad-nosed Bat**	V		Not recorded on site during surveys. A mobile species, so could utilise the site as part of a wider foraging range. Roosting habitat is available within the vegetated areas of the site, the majority of which will be retained. **SUBJECT SPECIES**
Vespadelus troughtoni	**Eastern Cave Bat**	V		Not recorded on site during surveys. A mobile species, so could utilise the site as part of a wider foraging range. Roosting habitat is available within the vegetated areas of the site, the majority of which will be retained. **SUBJECT SPECIES**

Table Key - Status (BC Act & EPBC Act):

CE: Critically Endangered

E: Endangered

V: Vulnerable

Bold: Subject Species

From the above, the species listed in **Table 5** are considered as the key subject species / indicator species for this site due to either being recorded on site, potentially able to forage and roost on the site, or the site potentially forms an important part of a local home range for resident species.

Table 5 – Subject Species

Scientific Name	Common Name	BC Act	EPBC Act
Herpetofauna			
Heleioporus australiacus	Giant Burrowing Frog	V	V
Heleioporus australiacus	Giant Burrowing Frog	V	V
Litoria aurea	Green and Golden Bell Frog	E	V
Avifauna			
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	
Daphoenositta chrysoptera	Varied Sitella	V	
Glossopsitta pusilla	Little Lorikeet	V	
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	
Ninox connivens	Barking Owl	V	
Ninox strenua	Powerful Owl	V	
Tyto novaehollandiae	Masked Owl	V	
Tyto tenebricosa	Sooty Owl	V	
Mammals			
Cercartetus nanus	Eastern Pygmy Possum	V	
Falsistrellus tasmaniensis	Eastern Falsistrelle	V	
Miniopterus australis	Little Bent-winged Bat	V	
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	V	
Myotis macropus	Southern Myotis	V	
Pteropus poliocephalus	Grey-headed Flying-fox	V	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	
Scoteanax rueppellii	Greater Broad-nosed Bat	V	
Vespadelus troughtoni	Eastern Cave Bat	V	

Table Key - Status (BC Act & EPBC Act):
CE: Critically Endangered, E: Endangered, V: Vulnerable
(#) – Indicates number of Atlas Records within 10km of the Subject Site

These species are considered further in **Section 8**, and for the purposes of the study / impact assessment approach utilised, they are assumed as being present on site on an at least intermittent basis. Other species were not considered necessary to assess further due to lack of records, lack of or limited suitable habitat being affected by the proposed development, or wide ranging movement patterns that would be unaffected to any discernible degree by site development given the presence of large protected habitat areas nearby

8.0 Key Species Considerations

The species identified for further consideration have been categorised into guilds. By considering these species and their lifecycle needs, many other species are also inadvertently considered. The analysis below considers key lifecycle features for each guild of species in more detail, and assists in informing the subsequent 5-part test assessment. (refer **Table 6**).

Table 6 – Key Species Analysis

Species	Key Habitat Feature	Comment
Glossy Black-Cockatoo	Foraging Resources	Preferred forage trees include *Allocasuarina torulosa* (Forest Oak) and *A. littoralis* (Black She-Oak). Both of these species occur relatively commonly within the bushland areas of the site, including in at times dense stands on the mid and upper slope areas. Development as proposed will remove 10 notable specimens of these trees, but the vast majority will be retained. Foraging resources also occur commonly throughout the escarpment area.
	Nesting	Require large tree hollows for nesting. No specific nest hollows were identified during field surveys in the areas proposed for development. Recommendations have been made for preferential retention of any such hollow trees in APZ areas.
	Connectivity	Highly mobile species. Development will not affect connectivity to any notable degree.
Little Lorikeet	Foraging Resources	The site and wider escarpment area supports a variety of flowering trees and shrubs that would offer some seasonally suitable resources. The Little Lorikeet is a highly mobile species, and will access suitable foraging resources when available in the wider locality. The area of resources to be lost by development (i.e. removal of <40 trees considered potentially notable and suitable for this species) is unlikely to constitute a significant component of local foraging resources available for this species.
	Nesting	Potential nesting habitat would be limited to suitable small hollows occurring within the site and surrounds. No specific nest hollows were identified during field surveys in the areas proposed for development. Recommendations have been made for preferential retention of any such hollow trees in APZ areas.
	Connectivity	Highly mobile species. Development will not affect connectivity to any notable degree.

Species	Key Habitat Feature	Comment
Forest Owls Incl. Masked Owl Powerful Owl Barking Owl	Nesting	Require large tree hollows for nesting. No specific nest hollows were identified during field surveys in the areas proposed for development, despite searches for owl roost/nest trees. Recommendations have been made for preferential retention of any such hollow trees in APZ areas.
	Diurnal Roosts	Forest Owls may either roost in large tree hollows (see above), or within a suitable tree, often associated with thick vegetation / creeklines. Parts of the site, particularly the Narabeen Creek corridor and the denser south-west portion of the site, would offer some potential in this regard. No sign of roosting was found on site (usually indicated by regurgitation pellets, prey remains, feathers etc) despite searches on several occasions. Development as proposed unlikely to affect roosting potential to any discernible degree for this locality.
	Prey Species	The site has been shown contain suitable prey species such as possums, rats, antechinus and bandicoots, as evidenced by field survey results. The larger areas of connected habitat along the escarpment would also support prey species, given the noted similar forest habitat present. Prey availability not likely to be a limiting factor post development.
	Home Range & Connectivity	Forest Owls have a large home range, foraging principally within 2km of their nest site to meet their hunting requirements. For any local owls, the site would be a small component of a larger home range within the wider locality. The small area to be affected by development is not likely to be a significant component of such home range.
Eastern Pygmy-Possum	Nest sites	Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks. Given these varied nesting options, most of the bushland areas of the site and escarpment would provide suitable nest opportunities for this species. The relatively small area of habitat to be modified by development is unlikely to constitute a significant component of local resources available for this species.

Species	Key Habitat Feature	Comment
	Foraging	Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Most of the bushland areas of the site and escarpment would provide suitable foraging opportunities for this species. Areas containing Banksias would be preferred, which are more common in the south and to the west.
	Home Range & Connectivity	Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares. Connectivity post development will remain for any EPP's present on the site or escarpment area.
Hollow Dwelling Microbats Incl. Eastern Falsistrelle Little Bentwing-bat Eastern Bentwing-bat East-coast Freetail-bat Greater Broad-nosed Bat	Small Hollows & Fissures	Given the size and number of trees, there are undoubtedly some small hollows / fissures present that are suitable for microbats. This potential would be well represented throughout the bushland area and the adjacent escarpment area. No specific roost hollows were identified during field surveys in the areas proposed for development. Recommendations have been made for preferential retention of any hollow trees in APZ areas.
	Foraging	Whilst the various micro-bat species have differing micro-habitat preferences for foraging habitat, they all seek insects in and around forested areas, and may also at times forage around proximate developed areas. Site development will contribute to incremental foraging habitat loss / modification in the locality. The amount of area to be modified is small in a broader locality sense for mobile species like bats, and rehabilitation and landscaping will further reduce the scope of any loss.

Species	Key Habitat Feature	Comment
Cave Dwelling Microbats Incl Little Bentwing-bat Eastern Bentwing-bat	Caves	Caves are important for some bat species as diurnal roosts, but more importantly as potential maternity caves for rearing young. There is potential for such caves to be found within the broader escarpment area, and the south-western area of the site contains numerous high rock outcrop areas that may offer suitable cave structures. These areas will not be affected by development as proposed. The development zone is largely devoid of any rock outcrop areas, and any such areas of structural note are not proposed to be physically altered by development.
	Foraging	Whilst the various micro-bat species have differing micro-habitat preferences for foraging habitat, they all seek insects in and around forested areas, and may also at times forage around proximate developed areas. Site development will contribute to incremental foraging habitat loss / modification in the locality. The amount of area to be modified is small in a broader locality sense for mobile species like bats, and rehabilitation and landscaping will further reduce the scope of any loss.
Grey-headed Flying-fox	Roost Camp Areas	No roost camp is present on site. It is considered that the site, as with many other forested patches, would have some potential to be utilised as a roost camp. Best potential is located in areas that are not proposed to be developed.
	Foraging	The site offers suitable seasonal foraging potential in the form of fruiting and flowering trees. Given the species high mobility (up to 50km from camp for foraging at night), site development will contribute to incremental foraging habitat loss. The loss of 57 notable trees from the site is not considered a significant component of the foraging habitat available to this species within the locality, and rehabilitation and landscaping will offer alternate future resources for this species.
Rosenberg's Goanna	Home Range & Movement	Found in heath, open forest and woodland, where individuals require a large area of habitat. Records are well known from the adjacent escarpment areas, particularly in association with the heath communities therein. The site may be an edge component of the wider area occupied by the local population.

Species	Key Habitat Feature	Comment
	Nest Sites	Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. No termite mounds are found within the areas proposed for development.
Frogs Incl Giant Burrowing Frog Red-crowned Toadlet	Home Range & Movement	The Giant Burrowing Frog has a home range of approx. 0.04ha, and may move up to 300m from breeding areas into adjacent habitats to forage and burrow into sandy soils. The bushland areas of the site with connection to Narrabeen Creek offer potential in this regard. The areas to be modified by development are unlikely to be of note for this species. Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable breeding habitat. Red-crowned Toadlets are usually found as small colonies scattered along ridges coinciding with the positions of suitable refuges near breeding sites. Given that the development is not being proposed on ridgetop areas, impacts on this species or its habitat are considered unlikely.
	Breeding Habitat	The Giant Burrowing Frog breeding habitat is generally soaks or pools within first or second order streams. They are also commonly recorded from 'hanging swamp' seepage lines and where small pools form from the collected water. On site, breeding habitat would be limited to the upper stretches of Narrabeen Creek that are still relatively intact. These areas will not be disturbed by development, and breeding habitat is likely to be extended over time with the proposed rehabilitation of the Narrabeen Creek Corridor. The Red-crowned Toadlet inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. In these areas congregates for breeding occur in dense vegetation and debris beside ephemeral creeks and gutters. Red-crowned Toadlets have not been recorded breeding in waters that are even mildly polluted or with a pH outside the range 5.5 to 6.5. Eggs are laid in moist leaf litter, from where they are washed by heavy rain; a large proportion of the development of the tadpoles takes place in the egg. Preferred habitat for this species would be in the upper reaches below the ridgetops. Such areas are not proposed to be affected by development.

9.0 5-Part Test Assessment

Section 7.3 of the BC Act lists five factors that must be taken into account in determining the significance of potential impacts of proposed activities on threatened species, populations, ecological communities and/or their habitats as listed within the BC Act.

The 5-part test is used to determine whether there is likely to be a significant impact, and thus whether the Biodiversity Offsets Scheme (BOS) is triggered or a Species Impact Statement (SIS) is required.

For the purposes of the 5-part test assessment, the Subject Site is the area directly affected by the proposal. The study area covers the Subject Site and its immediate surrounds.

(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

Development of the Subject Site as proposed will directly impact approximately 0.5ha of native vegetation via clearing and modification to create an APZ (including roads therein), and may have indirect impacts in the form of edge effects upon adjacent vegetation. Such impacts may directly affect any individuals of resident threatened species (principally the identified species, plus others that may reside in hollow trees etc.), and affect other threatened species via a reduction in available foraging habitat in the locality. Impacts of clearing works is to be mitigated via the proposed rehabilitation of riparian areas totalling approximately 1ha, and general landscaping within the Subject Site.

Records of threatened species from recent or previous surveys within the site include:

- *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – seen by residents foraging in trees along the edge of the cleared area. The species is likely to utilise the Subject Site as part of a local home range. Nesting potential in the form of hollow trees occurs within the bushland area.

- *Ninox strenua* (Powerful Owl) – heard calling by residents, and remnants of gutted possums were found under trees. The species is likely to utilise the Subject Site as part of a local home range. Nesting potential in the form of hollow trees occurs within the bushland area.

- *Varanus rosenbergi* (Rosenberg's Goanna) – observed by nearby residents utilising the site, however some observations of this species using trees is unusual, and may be the result of confusion with the non-threatened Lace Monitor *Varanus varius*. Bushland areas offer suitable habitat for this species.

- *Pteropus poliocephalus* (Grey-headed Flying-fox) – observed by residents feeding in fig trees. Bushland areas offer suitable habitat for this species.

- *Miniopterus australis* (Little Bentwing-bat) – recorded by echolocation call. Species is likely to utilise the Subject Site as part of a local foraging range, and may roost in suitable hollow cavities. Potential also exists for caves used for maternity purposes to be present in higher reaches of the southern bushland area that is to be retained on the site.

- *Miniopterus schreibersii oceansis* (Eastern Bentwing-bat) - recorded by echolocation call. Species is likely to utilise the Subject Site as part of a local foraging range. Potential also exists for caves used for maternity purposes to be present in higher reaches of the southern bushland area that is to be retained on the site.

It is recognised that some potential exists for some other mobile threatened species to utilise the Subject Site and surrounds as part of a wider network of habitat resources. Such species included:

- *Anthochaera Phrygia;*
- *Lathamus discolour;*
- *Glossopsitta pusilla;*
- *Ninox connivens;*
- *Tyto novaehollandiae;*
- *Cercartetus nanus;*
- *Falsistrellus tasmaniensis;*
- *Mormopterus norfolkensis;*
- *Scoteanax rueppellii;*
- *Pteropus poliocephalus;*
- *Heleioporous australiacus; and*
- *Psuedophryne australis.*

No threatened plant species were identified within the site or Subject Site therein. It is recognised that some potential habitat is present for some of the considered species in the Subject Site, and as such presence cannot be totally discounted.

For all species considered, at a minimum the Subject Site is part of and connected viably to a larger area of habitat available to the west totalling several hundred hectares, including Ingleside Chase Reserve and other connected reserve and park areas. These areas would likely act as the core habitat for local populations of the considered threatened species. Highly mobile species would be able to access habitat resources even further afield.

<u>Glossy Black-Cockatoo</u>

Previously recorded by residents feeding on site (exact location unknown) as well as other recent Atlas records from the wider locality including Ingleside Chase Reserve, Narrabeen Lagoon and Chiltern Trail, Ingleside.

Development will remove about 10 specimens of preferred feed trees, but the vast majority will be retained within the residue of the site including areas of dense stands on the mid and upper slope areas. Foraging resources also occur commonly throughout the escarpment area.

Glossy Black-Cockatoos require large tree hollows for nesting. No specific nest hollows were identified during field surveys in the Subject Site. Recommendations have been made for preferential retention of any hollow trees in APZ areas.

Glossy Black-Cockatoos are a highly mobile species and development will not affect connectivity to any notable degree.

Given that the Subject Site is relatively small in area in a wider locale available habitat sense, and that it does not offer any resources that are not known to be available on other lands in the vicinity, there is not expected to be a significant impact on any individuals or population of Glossy Black-Cockatoos.

Nectivorous Birds:

No records exist for the Regent Honeyeater, Swift Parrot or Little Lorikeet on the Subject Site, however recent records exist for all species within the wider locality including Ingleside Chase Reserve and Chiltern Trail, Ingleside.

Swift Parrots breed in Tasmania, and there are no known breeding records for Regent Honeyeaters from the wider locality. Potential nesting habitat for Little Lorikeet is present in the form of suitable small hollows occurring within the study area and surrounds. There is potential for Little Lorikeets to breed in the Subject Site in such hollow trees in the area proposed to be modified to form an APZ, however no specific nest hollows were identified during field surveys, and hollows occur commonly in the wider study area and surrounds. It is considered an important safeguard measure that pre-clearance surveys of hollow trees are carried out within areas proposed to be cleared, and that a supervising ecologist is on hand during all clearing works to rescue any potentially affected native fauna. To mitigate impacts, a nest box installation program should be conducted within the retained vegetation at a minimum 1:1 ratio to offset any hollow loss.

Little Lorikeet, Regent Honeyeater or Swift Parrot will not be significantly impacted by the proposal given the small area of potential habitat to be removed (~0.5ha) given the vegetation to be retained within the residue of the site, proposed landscaping including suitable canopy feed trees and the availability of E2 zoned land to the west of the site. In addition, none of the dominant canopy trees within the Subject Site are considered to be of high value as a foraging resource to either the Regent Honeyeater or Swift Parrot in the region (Roderick *et al* 2013).

Forest Owls:

Powerful Owl has previously been heard calling by residents, and residents report signs of activity on the site (gutted possum remains etc), however no Powerful Owl were recorded during the field surveys and no specific nest hollows were identified during field surveys within the Subject Site despite targeted searches. It is therefore considered likely that the Subject Site is used as part of a hunting home range for a local population of Powerful Owl(s) that are nesting/roosting elsewhere in the broader local habitat matrix.

Given the absence of any specific evidence of use of, or residence within the site for Masked Owl and Barking Owl, and the relative abundance of habitat within the wider locality for these highly mobile species, it is not considered likely that these species will be significantly impacted upon by the proposal.

Forest Owls require large hollows for breeding, none of which were identified in the Subject Site. It is considered that there will be no significant impact on breeding habitat for Forest Owls.

The site has been shown to provide suitable prey species for Forest Owls, however given the small area of potential foraging habitat to be removed (~0.5ha) relative to the vegetation retained within the residue of the site and extensive E2 zoned land to the west, the proposal is not considered likely to result in a significant impact upon Forest Owl species. Foraging opportunities will be created and enhanced within the riparian area over the long term.

Eastern Pygmy Possum:

Eastern Pygmy Possum was not observed on site during previous site surveys, however there are recent Atlas records from the escarpment about 500m to the west of the site within Ingleside Chase Reserve, and suitable habitat is present within the native vegetation on the Subject Site.

Eastern Pygmy Possum are known to shelter in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum dreys or thickets of vegetation, (e.g. grass-tree skirts). Given these varied nesting options, the area to be impacted on site would provide some potentially suitable nesting opportunities for this species. Furthermore, given the home range for Eastern Pygmy Possum is relatively small, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares, the proposed modification of 0.5ha of vegetation could comprise a home range for one or two individuals. As a result, it is considered an important safeguard measure that pre-clearance surveys of habitat features are carried out within areas proposed to be cleared, and that a supervising ecologist is on hand during all clearing works to rescue any potentially affected native fauna. In addition, to mitigate impacts, a nest box installation program should be conducted within the retained vegetation at a minimum 1:1 ratio to offset any hollow loss.

Despite the small home range of individual Eastern Pygmy Possums, the relatively small area of habitat to be modified by development is unlikely to constitute a significant component of local resources available for the local population, given the occurrence of larger habitat areas in both the wider site and connected habitat areas in conservation reserves. Connectivity post development will remain for any individuals present within the site. Most of the bushland areas of the site would provide suitable foraging opportunities for this species, however areas containing a foraging resource within the shrub layer such as *Banksia* sp. would be preferred, which are more common in the south and to the west.

Given that vegetation will be retained within the residue of the site and the extensive E2 zoned land to the west of the site provides suitable habitat for Eastern Pygmy Possum it is considered that no significant impact will occur.

Hollow-dwelling Microbats:

The Little Bentwing-bat was recorded using echolocation recordings in the site, and other species of hollow dwelling microbats have the potential to occur, including species such as Eastern Falsistrelle, East-coast Freetail-bat and Greater Broad-nosed Bat. Given the size and number of trees in the site, there are undoubtedly small hollows / fissures present that are suitable and are utilised by microbats. This potential would be well represented throughout the bushland area and the adjacent escarpment area (i.e. outside the Subject Site). No specific roost hollows were identified during field surveys within the Subject Site, however the presence of very small fissures or exfoliating bark etc used as roost sites by microbat species cannot be entirely discounted.

To mitigate impacts upon resident hollow-dwelling microbats, recommendations have been made for preferential retention of any hollow trees in APZ areas. Furthermore, it is considered an important safeguard measure that pre-clearance surveys of habitat features are carried out within areas proposed to be cleared, and that a supervising ecologist is on hand during all clearing works to rescue any potentially affected native fauna. To mitigate impacts, a nest box installation program should be conducted within the retained vegetation at a minimum 1:1 ratio to offset any hollow loss.

Whilst the various micro-bat species have differing micro-habitat preferences for foraging habitat, they all seek insects in and around forested areas, and may also at times forage around proximate developed areas. Site development will contribute to incremental foraging habitat loss / modification in the locality. The amount of area to be modified is small in a broader locality sense for mobile species like microbats, and rehabilitation and landscaping will further reduce the scope of any loss.

Given that the Subject Site is relatively small in area in a wider locale available habitat sense, and that it does not offer any resources that are not known to be available on other lands in the vicinity, it is considered that no viable local population of threatened hollow dwelling microbats are likely to be placed at risk of extinction as a result of the proposed development.

Cave-dwelling Microbats:

For the cave dwelling species recorded on the site, namely Little Bentwing-bat and Eastern Bentwing-bat, the Subject Site is foraging habitat only. Caves are important for some bat species as diurnal roosts, but more importantly as potential maternity caves for rearing young. There is potential for such caves to be found within the broader escarpment area in the wider site, and the south-western area of the site contains numerous high rock outcrop areas that may offer suitable cave structures. These areas will not be affected by development as proposed. There will be no impact on potential cave structures as part of the proposed development.

Given the small amount of vegetation to be removed relative to the vegetation that will be retained within the residue of the study area and the extensive E2 zoned land to the west of the site, it is considered unlikely that a viable local population of threatened cave-dwelling microbats will be placed at risk of extinction as a result of the proposed development.

Grey-headed Flying-fox:

Despite evidence of utilisation of the site by this species via residents' observations, no roost camp was identified and potential riparian habitat preferred for roosting camps will be retained and improved as part of the proposed development. Improvement of the riparian area and proposed landscaping including suitable canopy feed trees will reduce the loss of foraging habitat. Given the relative abundance of habitat within the wider locality for this highly mobile species, and the continued availability of potential resources post development, it is not considered likely that the Grey-headed Flying-fox will be significantly impacted upon by the proposal.

Rosenberg's Goanna:

Rosenberg's Goanna has been previously recorded on the site via residents' observations, however some sightings of individuals climbing trees is unusual for this terrestrial species, and suggests it may have been confused with the common Lace Monitor *Varanus varius*. Despite this, records are well known from the adjacent escarpment areas, particularly in association with the heath communities therein, and it is considered likely to occur intermittently within the Subject Site.

The species is typically found in heath, open forest and woodland and individuals require a large area of habitat. They are typically associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. No termite mounds are found within the Subject Site.

The forested section of the Subject Site is relatively small in area in a wider locale available habitat sense and no termite mounds were present in the proposed development area. The Subject Site does not offer any resources that are not known to be available on other lands in the vicinity. As such there is not expected to be a significant impact on any specimens or population of Rosenberg's Goanna.

Frogs:

Neither the Giant Burrowing Frog nor the Red-crowned Toadlet have been recorded in the site during surveys, however there are Atlas records from the Ingleside Chase Reserve to the west and south-west.

The Giant Burrowing Frog breeding habitat is generally soaks or pools within first or second order streams. They are also commonly recorded from 'hanging swamp' seepage lines and where small pools form from the collected water. The Giant Burrowing Frog has a home range of approx. 0.04ha, and may move up to 300m from breeding areas into adjacent habitats to forage and burrow into sandy soils. On site, breeding habitat would be limited to the upper stretches of Narrabeen Creek that are still relatively intact. These areas will not be disturbed by development, and potential breeding habitat is likely to be extended over time with the proposed rehabilitation of the Narrabeen Creek Corridor.

The Red-crowned Toadlet inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. In these areas the species congregates for breeding, which occurs in dense vegetation and debris beside ephemeral creeks and gutters. Red-

crowned Toadlets have not been recorded breeding in waters that are even mildly polluted or with a pH outside the range pH 5.5 to pH 6.5. Eggs are laid in moist leaf litter, from where they are washed by heavy rain; a large proportion of the development of the tadpoles takes place in the egg. Preferred habitat for this species would be in the upper reaches below the ridgetops. Such areas are not proposed to be affected by development.

Given the habitat types proposed to be modified in the Subject Site do not align with the preferred requirements of these species, it is considered that no significant impact will occur as a result of the proposed development.

(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

Investigations of the Subject Site have shown that there are no EEC or CEEC within the study area, nor are they likely to be present.

(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

The G. ferdinandi/S. glandulosum Escarpment Littoral Rainforest occupies 0.03ha within the site, and is considered to align with the TSC Act listed Littoral Rainforest EEC and also the EPBC Act listed Littoral Rainforest CEEC. This community is not proposed to be modified by the proposed development, and hence no impacts will result.

(c) in relation to the habitat of a threatened species 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, and

Development of the site as proposed will directly impact approximately 0.5ha of native vegetation via clearing for road creation and modification to create an APZ, and may have indirect impacts in the form of edge effects upon adjacent vegetation. This vegetation offers suitable habitat resources for many native species, including some of the threatened fauna species as discussed above. No threatened species have been found likely to be significantly dependent on the resources in this area.

Clearing impact will be reduced via the proposed riparian rehabilitation and general landscaping programs proposed, which will cover approximately 1ha of the site as outlined in the BRMP (AEP 2015b).

(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

No area of habitat is likely to become isolated as a result of the proposed action, as the site sits at the eastern extent of the connected remnant forested habitat in this locality. Given the proposed development site is largely cleared, no fragmentation will occur.

All other vegetation to be conserved within the site occurs in the south and west and is directly linked with the adjacent, contiguous vegetation.

The proposed rehabilitation of the Narrabeen Creek riparian corridor will enhance downstream linkages.

(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

As outlined above, the habitat present is not considered of significance for long term survival of threatened species or EECs in this locality. The development however will contribute to minor habitat loss on the edge of the urban fabric.

(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)

No area of outstanding biodiversity value is present.

(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 (KTP)

The following KTP's are considered against the proposed development:

- *Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands*

The riparian rehabilitation of Narrabeen Creek will have positive impacts on previous degradation caused on site. Stormwater engineering design has attempted to mimic post development flows into and down Dicks Creek in accordance with the existing pre-development flow regimes, and water quality control basins are proposed; hence proposed development should result overall in positive outcomes for the Narrabeen Creek system.

- *Anthropogenic Climate Change*

The development as proposed will contribute in a very small way to the processes causing Anthropogenic Climate Change via the removal of forest vegetation which acts as a carbon sink. It is not considered the contribution to this KTP in this instance is of a notable magnitude. Any impact will be largely negated via proposed rehabilitation works.

- *Clearing of native vegetation*

The development as proposed will involve the removal of some native vegetation. This loss is a direct contribution to this KTP, and contributes to incremental habitat loss in the locality. As such, it is recommended that vegetation clearing be limited as far as possible, and that post development landscaping be undertaken utilising suitable native species as is proposed. The proposed rehabilitation and landscaping programs when complete will lead to a net gain in native vegetation cover on the site.

- *Infection of frogs by amphibian chytrid causing the disease chytridiomycosis*

There is potential for development of the site to inadvertently introduce chytrid into the site. Whilst no threatened frog species were identified as being of specific concern for this site, it is recommended that appropriate hygiene controls are put in place for all construction related activity to limit such potential.

- *Infection of native plants by Phytophthora cinnamomi*

There is potential for development of the site to inadvertently introduce *Phytophthora cinnamomi* into the site, which may lead to infection and degradation of retained and adjacent vegetation areas. As such, it is recommended that appropriate controls are put in place for all construction related activity to limit such potential.

- *Loss of hollow bearing trees*

A small number of existing hollow-bearing trees would be lost as a result of the proposed development. To reduce impacts, a nest box installation program should be conducted within the retained vegetation at a minimum 1:1 ratio to offset any hollow loss.

- *Removal of dead wood and dead trees*

The development as proposed will remove areas that contain some dead wood and dead trees. Consideration could be given to relocating dead wood into retained and rehabilitated areas where suitable and compatible with the Site Landscape Masterplan.

- *Invasion and spread of aggressive weed species (several listed).*

The site already supports numerous weed species in infestation levels, and the development provides a catalyst vehicle for addressing this issue. It will be necessary to address this problem in retained areas as part of any riparian area & adjacent bushland management, as identified within the BRMP (AEP 2015b). Education of future residents will also be important to ensure that retained areas and adjacent Reserve areas are not mistreated, resulting in exacerbation of the weed problem.

10.0 SEPP CM Assessment

Investigations in accordance with the State Environmental Planning Policy Coastal Management (2018) found that the Subject Site is not identified within the Coastal Environment Area, or within any areas identified as Coastal wetlands, Littoral Rainforests and / or Coastal Vulnerability Areas. As such, no further provision of the policy applies to the study area.

Warriewood Wetlands, a mapped coastal wetland fed by Narrabeen Creek occurs approx. one (1) kilometre downstream.

11.0 Water Management Act 2000 Assessment

any works within 50 meters of the Narrabeen Creek require an Activities Approval in accordance with *Section* 91 of *Water Management Act* 2000.

To ensure protection of the riparian area within the Subject Site and to improve and enhance the water quality and quantity of water feeding into the downstream Warriewood Wetlands the *Water Cycle Management Report: 8 Forest Road, Warriewood, NSW* prepared by Martins Consulting Engineers (2020) (WCMP) demonstrates how the proposal will achieve Councils and other guidelines for both water quality and quantity.

Measure such as erosion and sedimentation controls are to be installed prior to construction commencing, and regularly inspected and maintained (weekly or after rain events) during construction works.

The WCMP meets the required flows and quality through the implementation of a treatment train utilising a range of treatment to control flow and improve the water quality as it moves through the Subject Site and into downstream waterbodies. These techniques include rainwater tanks, bioretention basins, stormfilter cartridges and pit inserts, details of which are provided in **Appendix G.**

WCMR was prepared to ensure the stormwater runoff from the proposed development is managed in accordance with Council Controls.

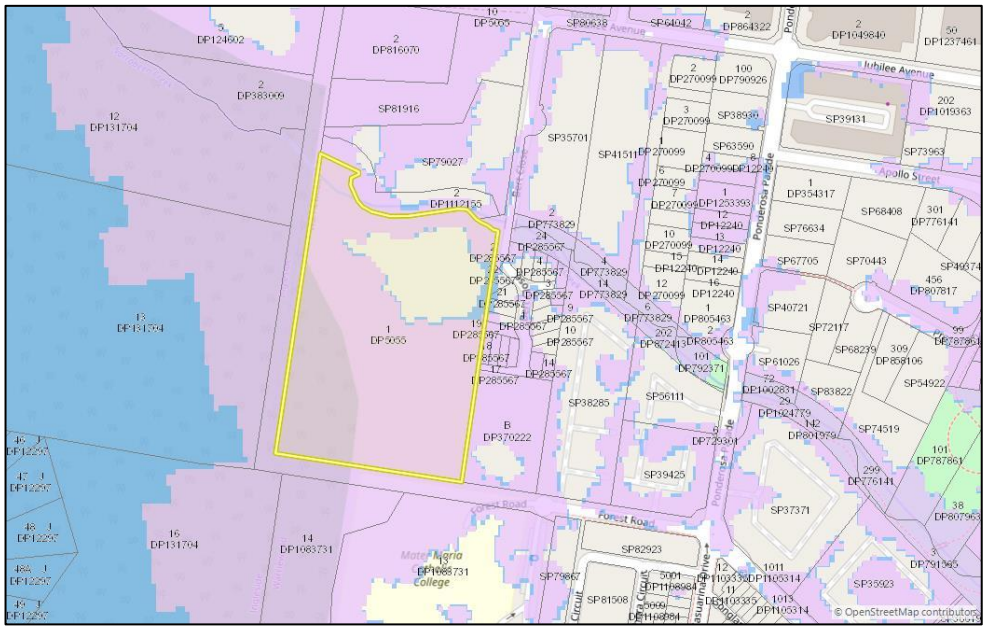
MUSIC modelling has been undertaken and the results show that the implementation of the proposed treatment train should minimise any adverse impacts upon the ecology of the downstream watercourses, stormwater treatment devices have been implemented into the design of the proposed development. The MUSIC modelling used stormwater quality targets defined within;

- BMT WBM (2015), NSW MUSIC Modelling Guidelines.
- Pittwater Council (2001), Warriewood Valley Urban Land Release: Water Management Specification (WMS).
- Pittwater Council (2019), Pittwater 21 Development Control Plan (DCP) - Part B: B5 Water Management and Part C: C6 Design Criteria for Warriewood Valley Release Area.

Martens Consulting Engineering (2020) states *results from the MUSIC model demonstrated that no increase compared to existing sediment, nitrogen and phosphorus loads (NorBe) is achieved with proposed water sensitive urban design devices*. Given these results it is unlikely that the proposed development will have a negative impact on the water catchment within the Subject Site and downstream.

12.0 SEPP Koala Protection 2019

State Environmental Planning Policy (Koala Habitat Protection) 2019 (the Koala SEPP) applies to land within the Northern Beaches Council LGA. As the Subject Site does not have a Koala Plan of Management (KPOM) over it and parts of the land are identified on the Koala Development Application Map as highly suitable Koala Habitat an assessment for "Core Koala Habitat" under the Koala SEPP is required.



Within the guidelines, **Core Koala Habitat** is defined as:

a) an area of land where koalas are present, or
b) an area of land –
    i. which has been assessed by a suitably qualified and experienced person in accordance with the Guideline as being highly suitable koala habitat, and
    ii. where koalas have been recorded as being present in the previous 18 years.

Noting that "**An area of land**" is defined as including both the development footprint and broader area of land on which the development is proposed (i.e. the Parent Lots).

A desktop search in the NSW BioNet Atlas of threatened species revealed 53 historical records of Koala within a 10km x 10km area around the Subject Site, six (6) in the last 18 years. These records lie a minimum of 3.6km from the Subject Site across a developed landscape. Only records to the west have a tenuous corridor or avenue of connectivity for Koala to the Subject Site.

Although surveys identified listed Koala feed trees within sufficient densities in particular areas of the site (therefore constituting highly suitable koala habitat under the Koala SEPP), targeted surveys for this and previous assessments, and past BioNet records have not identified the presence of Koalas on or near the site (within the last 18 years).

Subsequently, the site does not constitute "Core Koala Habitat" and as such no further provisions of the SEPP would apply.

13.0 EPBC Act Assessment

A search was conducted in May 2020 of Matters of National Environmental Significance (MNES) as relevant to the *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act). The following MNES are considered in this assessment.

World Heritage Properties:
The site is not a World Heritage area, and is not in close proximity to any such area.

National Heritage Places:
The site is not a National Heritage place, and it is not in close proximity to and such places.

Wetlands of International Significance (declared Ramsar wetlands);
The site is not a Wetland of International Significance, nor is it within close proximity of any such place.

Great Barrier Reef Marine Park:
The site is not part of, or within close proximity to, the Great Barrier Reef Marine Park.

Commonwealth Marine Areas:
The site is not part of, or within close proximity to, any Commonwealth Marine Area.

Threatened Ecological Communities:
The Protected Matters Search revealed that the Endangered Ecological Community "Coastal Upland Swamps in the Sydney Basin Bioregion" was found to be likely to occur within the search area (10km radius from the site). However, this ecological community was not found on site during a review of existing vegetation mapping for the area, or via extensive ground truthing on site during flora surveys.

Threatened Species:
One threatened species listed within the EPBC Act has been observed on site, namely the threatened *Pteropus poliocephalus* (Grey-headed Flying-fox). The Grey-headed Flying-fox roosts communally in large camps. No camp was recorded on site or has been previously known from the site. The species is a wide ranging forager, moving up to 50km at night from camp in search of flowering and fruiting trees and shrubs. The species is likely to occur on the site intermittently during seasonal foraging periods when suitable flowers / fruits are present on site.

Given that the area of vegetation (potential seasonal foraging habitat) to be removed is small, larger areas of suitable habitat resources will be retained within the site, and that larger areas offering similar resources remain within the broader locality, it is not considered that the development of this land as proposed is likely to significantly impact this species.

Other EPBC listed species such as *Anthochaera phrygia* (Regent Honeyeater) and *Lathamus discolor* (Swift Parrot) were also assessed as having some potential to visit the site, but the resources therein will predominantly be retained and are otherwise considered unexceptional and not significant in a regional context. As such it is not considered that the development of this land as proposed is likely to significantly impact these species.

Migratory Species:
A number of EPBC listed migratory species have some potential to visit the site on an irregular basis. However, it is not considered that the development of this land as proposed is likely to significantly affect the availability of potential habitat for such mobile species, or disrupt migratory patterns.

EPBC Act Assessment Conclusion:
No MNES (specifically in this instance threatened species, threatened ecological communities or listed migratory species) are expected to be impacted upon significantly as a result of the proposal**.**

14.0 Recommendations

The following general recommendations are made for consideration to minimise localised impacts on biodiversity in general as a result of the development of the site:

Tree Retention & Habitat

- Tree retention should be encouraged wherever feasible within the scope of the development, noting the limitations posed by residential construction and development. Such trees should be identified by finer design planning prior to construction and be clearly marked on site to ensure retention;
- An appropriately detailed Construction Environmental Management Plan (CEMP) should be developed that includes measures to protect retained and surrounding habitat areas from direct or indirect construction related impacts;
- Required clearing of any vegetation on site should be undertaken in the presence of a suitably experienced fauna handler to ensure any displaced native fauna can be taken into care and dealt with appropriately;
- Felled vegetation (trees) should be left *in situ* for at least 24 hours following felling to allow any unobserved fauna time to vacate the area during the next nocturnal period; and
- Exterior lighting to comply with *National Light Pollution Guidelines for Wildlife* (DoEE 2019), namely light only the object or area intended – keep lights close to the ground, directed and shielded to avoid light spill, Use the lowest intensity lighting appropriate for the task, and Use lights with reduced or filtered blue, violet and ultra-violet wavelengths. This is particularly relevant for Microbat, Glider and Owl species likely to forage within the remnant bushland and adjoining reserve.

To ensure minimisation of impacts on biodiversity and the requirements outlined in the Warriewood Valley Active Travel Masterplan it is recommended that the development of a comprehensive Vegetation and Fauna Management Plan (VFMP) be undertaken addressing and incorporating:

Habitat Augmentation

- Installation of a variety of nest box sizes and types within retained bushland should occur prior to removal of any hollow bearing trees (noting that retention of hollow bearing trees where possible in APZ areas is strongly recommended). Any felled sections of trees found to be hollow should likewise be utilised in this fashion thereafter where feasible;
- Sandstone blocks retained in situ from the original dwelling should be capped, but not infilled when repurposed as a recreational area. This will retain voids and cracks likely to be utilised as habitat by fauna, namely as microbat roosts.
- The remainder of the site is to be managed under a Vegetation and Fauna Management Plan (VFMP) developed and approved by Northern Beaches Council as per relevant guidelines.

- It is noted that a landscaping program is proposed, and is based on the principles outlined within the Warriewood Valley Landscape Masterplan. Appropriate landscaping should be encouraged to provide resources for native fauna, particularly birds via suitable flowering trees and shrubs.

Narrabeen Creek

- Erosion and sedimentation controls should be put in place to limit offsite movement of soils into the retained riparian area and adjoining remnant bushland;
- The VFMP should detailed the rehabilitation works within the riparian zone along Narrabeen Creek. It should clearly delineated the riparian management zones including but not limited to revegetation and weeding as well as location of detention basins. These areas should be clearly marked in the field prior to any construction activity commencing to ensure no inadvertent incursion occurs if rehabilitation works are occurring before or during site civil works;
- The VFMP need to specifically, consider;
    - Incorporation of a shared space path to provide access to Ingleside Chase Reserve as per Warriewood Valley Active Travel Masterplan (See Appendix F);
    - Comply with *Plant species for landscape development* - Creekline Corridors-Narrabeen Creek (refer **Appendix F);**
    - Footbridge reconstruction to comply with environmentally sensitive design including providing fauna under the structure and appropriate rock terracing to allow variable planting depths for vegetation (refer **Appendix F**);
    - Include water management features such as suitable rock armouring of scour risk areas, construction of rock plunge weir and rills and widening of creek waterbody where appropriate to slow water movement and provide additional environmental value (refer **Appendix F**).

Weed Management

- The objective of Weed Management within the VFMP lands should be to undertake control of Biosecurity Act (BA) listed weeds and site-specific priority weeds to prevent the risk of further incursion into areas of retained vegetation, and transportation off site.

Wildlife Management

- Provisions on management actions to minimise and mitigate potential impacts on native animal welfare;
- Methods of pre-clearance surveys and felling methods for HBTs; and
- Methods for controlling pest species, etc.

Other

- Water quality detention ponds to include planting of suitable aquatic species, maintain a minimum 500mm water depth, and enhance edges and outlets with natural stone (as per Warriewood Masterplan refer **Appendix F**);
- Incoming residents should be appropriately educated on the value of the retained riparian area and adjacent bushland areas, and should be made aware of the negative impacts of green waste dumping, uncontrolled run-off, incremental incursion etc;
- Disease and pathogen management; and
- All works to be undertaken by suitably qualified bush regeneration, landscape or waterway / natural area engineering professionals with proven ability to achieve works in keeping with the principles of environmental sustainability and the Warriewood Masterplan and Design Guidelines (**Appendix F**).

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Appendix A – Flora Report (Sclerophyll Flora, 2015)

Sclerophyll
FLORA SURVEYS AND RESEARCH
PTY LTD

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2 July 2015

Craig Anderson
Anderson Environment and Planning

RE: FLORA SURVEY, 8 FOREST ROAD, WARRIEWOOD, NSW

Introduction

Sclerophyll Flora Surveys and Research Pty Ltd ('Sclerophyll') was commissioned by Craig Anderson of Anderson Environment and Planning to undertake a baseline flora survey of a site described as 8 Forest Road, Warriewood, NSW, Lot 1 DP 5055, to assist in site redevelopment planning.

The site is located on the north-eastern edge of the Warriewood escarpment on Sydney's northern beaches within the Pittwater LGA. Narrabeen Creek forms the site's northern boundary which drains downstream to Mullet Creek, ultimately emptying into Narrabeen Lagoon.

The site is approximately 5.5 hectares in area, with the elevated southern half of the property supporting forested habitats and the lower lying northern half predominantly cleared of native vegetation with a dwelling and disused nursery houses. The study area is shown in **Figure 1**.

The site is mapped as being underlain by Hawkesbury Sandstone geology with minor shale lenses (Herbert 1983) and the Watagan (colluvial) soil landscape group, comprising the Narrabeen group of sediments supporting 'mostly interbedded laminate and shale with quartz to lithic quartz sandstone' (Chapman and Murphy 1989).

This letter serves as a description of the methods and results of the flora survey undertaken by Sclerophyll on the subject site in June 2015.

Methods

A search of the *BioNet* website (NSW Wildlife Atlas June 2015), a review of local and regional vegetation mapping and classification reports and a Commonwealth Protected Matters Search Report (June 2015) was undertaken as part of a desktop review to identify a reasonably comprehensive spectrum of Threatened species and native vegetation communities (including Endangered and Critically Endangered Ecological Communities, EECs/CEECs listed under the TSC/EPBC Acts) previously recorded in the Pittwater LGA in recent times.

A quadrat-based baseline botanical survey was undertaken to inventory vascular plants across the site on 22-23 and 25 June 2015. A total of 5 x 400 m^2 full floristic quadrats (quadrat dimension = 20m x 20m; 10m x 40m in Narrabeen Creek) were sampled in all four native vegetation types recorded across the site. All vascular taxa within and overhanging the quadrats were recorded on Sclerophyll proforma field data sheets and assigned a projected foliage cover class based on the Native Vegetation Interim Type Standard (Sivertsen 2009) along with other bio-physiographic attributes such as vegetative structure, soil colour and texture, geology, slope, aspect, topographic position, location, and general condition.

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The structural classification used for the vegetation community descriptions follows Specht (1981). Subformation names for vegetation types follows the classification proposed by Beadle and Costin (1952) and Floyd (1990) for rainforests. Botanical nomenclature follows Harden (1990-1993, 2000, 2002) and those published on the NSW National Herbarium '*PlantNET*' website. Classification of the native vegetation types recorded during the survey follows OEH (2013).

The quadrat based survey was supplemented with a total of 3 rapid data points (RDPs) in dry and moist sclerophyll forest types to assist in vegetation mapping of the site. Three dominant taxa from each strata were recorded at each RDP along with limited bio-physiographic information on Sclerophyll RDP proformas.

The quadrat-based baseline survey was also supplemented with opportunistic searches of both protected and Threatened (TSC/EPBC listed) taxa whilst traversing the site between quadrats and RDPs in all 4 native vegetation types.

Survey effort was in accordance with the Threatened Biodiversity Survey and Assessment Guidelines (Draft DEC 2004) and was heavily biased towards the forested habitats on the southern half of the property and along the western boundary (west of the dwelling). A detailed weed survey of the 'paddock' and garden plantings in the cleared northern half of the property was not undertaken (with the exception of the riparian habitat along Narrabeen Creek).

Survey site locations are shown in **Figure 2**.

An assessment of the conservation status of the native vegetation types recorded on site was made with reference to OEH (2013) as well as listings made under the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

All tracks and waypoints comprising flora quadrats, RDPs and search transects were referenced using a hand held Garmin GPS unit (projection GDA94 MGA56).

The flora survey was used to validate and refine the regional native vegetation mapping (OEH 2013) for the site. A native vegetation map for the site is provided as **Figure 3**.

A total of 10 hours was spent by Sclerophyll on the site during the flora survey.

Results – Vegetation Types

A total of 109 plant taxa from 54 families were recorded by Sclerophyll during the flora survey. This plant total included 1 non-vascular species and 2 introduced taxa. A floristic list with quadrat and RDP data is provided as **Attachment A**.

A total of 4 native vegetation types were recorded during the flora survey, as described below.

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Vegetation Type 1 - *A.costata/C.gummifera/E.piperita* Dry Sclerophyll Open Forest

Table 1 – Floristic/Structural Summary - Vegetation Type No. 1
(based on 2 quadrats, QDSF1, QDSF2 and 2 RDPs, RDPDSF1, RDPDSF2)

Growth Form	Height Range (metres)	% Cover Range	Typical Species
Tree	12	30-40	*Angophora costata, Corymbia gummifera, Eucalyptus piperita, Syncarpia glomulifera*
Small Tree	4-7	40-80	*Banksia serrata, Allocasuarina littoralis, Elaeocarpus reticulatus, Pittosporum undulatum*
Shrub	2-4	10-20	*Acacia ulicifolia, Persoonia levis, Persoonia pinifolia, Persoonia linearis, Lasiopetalum ferrugineum, Pultenaea flexilis, Leucopogon lanceolatus var lanceolatus, Myrsine variabilis (juv), Notelaea longifilia (juv), Correa reflexa, Zieria smithii*
Groundcover including low shrubs	<1.5	40-50	*Dianella caerulea, Entolasia stricta, Lomandra obliqua, Lomandra glauca, Lomandra longifolia, Lepidosperma laterale, Xanthorrhoea media, Xanthorrhoea arborea, Pteridium esculentum, Austrostipa pubescens, Aristida vagans, Pseuderanthemum variabile, Pratia purpurascens*.
Vine/Climber	N/A	N/A	*Billardiera scandens, Hibbertia dentata, Smilax glyciphylla*

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This vegetation type was recorded on sandstone-derived dry to moist loamy sands on the mid to upper escarpment slopes on site with varying levels of outcropping (extensive to minor). Substantial areas supporting this vegetation type on the site were in relatively poor condition, subject to canopy thinning, dense sub canopy regrowth of *Allocasuarina littoralis* (resulting in a thick carpet of Oak needles and extensive canopy shading) and Lantana thickets. The best condition of this vegetation type was recorded in the far south-western corner of the property where a dense monospecific *Allocasuarina* subcanopy was noticeably absent. This vegetation type is likely subject to minor clay enrichment of its sandy soils from shale lenses and colluvial washdown from possible upslope clay caps. This vegetation type graded downslope into Vegetation type 2 as the degree of shelter and soil moisture increased.

Vegetation type 1 is considered to most closely resemble Map Unit DSF04 ‘Coastal Enriched Sandstone Dry Forest’ and (to a lesser extent) DSF06 ‘Coastal Sandstone Foreshore Forest’ of OEH (2013). OEH (2013) note that map unit DSF04 is reserved in the metropolitan Sydney region within Garigal, Lane Cove, Georges River and Royal National Parks, with 70% of its total extant area of 1741 ha in the OEH Sydney metropolitan study area occurring in NPWS and non NPWS reserves.

OEH (2013) do not correlate this vegetation type with any EECs/CEECs currently listed under the TSC/EPBC Acts.

This vegetation type is mapped as having an extant area on site of 1.79 hectares.

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Vegetation Type 2 - *S.glomulifera/E.piperita/E.botryoides* Moist Sclerophyll Forest

Table 2 Floristic/Structural Summary - Vegetation Type No. 2 (based on 1 quadrat and 1 RDP, QMSF1, RDPMSF1)

Growth Form	Height Range (metres)	% Cover Range	Typical Species
Tree	to 15	40	*Eucalyptus piperita, Eucalyptus botryoides, Eucalyptus scias, Syncarpia glomulifera, Angophora costata*
Small tree	to 8	30	*Livistona australis, Allocasuarina torulosa, Callicoma serratifolia, Glochidion ferdinandi, Elaeocarpus reticulatus*
Shrub	2-4	30	*Astrotricha floccosa, Dodonaea triquetra, Breynia oblongifolia, Notelaea longifolia, Maytenus silvestris, Pittosporum revolutum*
Ground	to 1.5	40	*Gahnia sieberiana, Lepidosperma elatius, Oplismenus imbecillis, Calochlaeana dubia, Lomandra longifolia, Lantana camara**
Vine/Climber	-	-	*Geitonoplesium cymosum, Stephania japonica, Billardiera scandens, Hibbertia dentata, Cissus hypoglauca, Pandorea pandorana*

This vegetation type was recorded on sandstone-derived moist loamy sands on the lower escarpment slopes (abutting the cleared paddock) on site with minor to moderate levels of outcropping. Some areas supporting this vegetation type on the site were similarly in poor

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condition, subject to canopy thinning and Lantana thickets, ultimately impacting on species diversity. The escarpment midslope near the western boundary supported this vegetation type in the best condition. This vegetation type is similarly likely subject to minor clay enrichment of its sandy soils from shale lenses and colluvial washdown from possible upslope clay caps (as per vegetation type 1). This vegetation type graded into Escarpment Littoral Rainforest as shelter further increased near the site's north-western boundary, just south of Narrabeen Creek.

Vegetation type 2 is considered to most closely resemble Map Unit WSF02 'Coastal Enriched Sandstone Moist Forest' of OEH (2013). OEH (2013) note that map unit WSF02 is reserved in the metropolitan Sydney region within Lane Cove, Ku-ring-gai Chase, Royal and Sydney Harbour National Parks, with 68% of its total extant area of 1084 ha (within the OEH 2013 Sydney metropolitan study) present in NPWS and non NPWS reserves. Importantly, and unlike vegetation type 1, the OEH (2013) Sydney metropolitan study area encompasses the majority of the distribution of this vegetation type in the Sydney Basin bioregion. As a result, remaining stands outside the reserve system should be considered of high conservation value as the total extant area of this community is not high.

OEH (2013) note that this vegetation type may grade into moist/wet shale forests, such as the TSC listed EECs, Blue Gum High Forest and Sydney Turpentine Ironbark Forest. It is considered that vegetation type 2 has only a subtle shale influence on site and is not representative of either of these EECs based on floristics and location. This vegetation type also does not represent any of the vegetation types typical for Duffys Forest EEC which occur on ridgetop laterites (overlying sandstone) in the Duffys Forest/Ingleside/Frenchs Forest/Belrose/Terrey Hills district based on Smith and Smith (2000).

Vegetation type 2 does, however, hold some floristic affinities with River flat Eucalypt Forest and Swamp Sclerophyll Forest on Coastal Floodplain as well as Bangalay Sand Forest EECs listed under the NSW *Threatened Species Conservation Act* (TSC Act), particularly in relation to an area immediately south-east of the site dwelling where a small stand of Bangalay (*E.botryoides*) dominates along the foot of a minor lower escarpment slope gully, where drainage is likely to be slightly impeded during wet weather. This area is clearly however, a sandstone escarpment environment (ie. bedrock), by virtue of the presence of extensive sandstone outcropping at the foot of the escarpment slope, and not a fluvial depositional (floodplain) environment 'with level landform patterns with active erosion and aggradation by channelled and overbank stream flow', as defined in the Scientific Committee Determinations for the 2 coastal floodplain EECs. The small stand of Bangalay also does not occur on aeolian sands (dunal) with which the latter Bangalay Sand Forest EEC is intended to capture. Consequently, it is considered that this small stand of Bangalay that forms part of Vegetation type 2 is not intended to be captured under and does not form part of these 3 EECs. This is further demonstrated by the fact that the site is not mapped as occurring on either aeolian or fluvial depositional soil landscapes (Chapman and Murphy 1989).

This vegetation type is mapped as having an extant area on site of 1.18 hectares.

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Vegetation Type 3 - *G.ferdinandi/S.glandulosum* Escarpment Littoral Rainforest

Table 3 Floristic/Structural Summary - Vegetation Type No. 3 (based on 1 quadrat,QLRf1)

Growth Form	Height Range (metres)	% Cover Range	Typical Species
Emergent	to 12	5	*Eucalyptus botryoides, Angophora floribunda*
Small Tree	to 7	80	*Glochidion ferdinandi var ferdinandi, Synoum glandulosum*
Shrub	to 2.5	10	*Breynia oblongifolia*
Ground	to 1m	40	*Calochlaena dubia, Lomandra longifolia, Lepidosperma laterale*
Vines	-	-	*Smilax glyciphylla, Cissus hypoglauca, Geitonoplesium cymosum, Stephania japonica, Eustrephus latifolius*

This vegetation type was recorded on moist, dark loamy sands at the foot of the escarpment slope in the north-western corner of the site just south of Narrabeen Creek and is identifiable by its dense, small tree layer dominated by warm temperate/subtropical rainforest trees *Glochidion ferdinandi* and *Synoum glandulosum* with woody vines and a sparse groundcover of ferns. The majority of the occurrence of this community is located outside the site boundary (to the west).

Vegetation type 3 is considered to most closely resemble Map Unit RF07 ‘Coastal Escarpment Littoral Rainforest’ of OEH (2013) which forms a component of the TSC listed Littoral Rainforest EEC and EPBC listed Littoral Rainforest critically endangered ecological community (CEEC).

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OEH (2013) note that this vegetation type is reserved in the metropolitan Sydney region within Ku-ring-gai Chase, Royal and Sydney Harbour National Parks, with 76% of its total 64 ha extant area (within the OEH 2013 study area) present in NPWS and non NPWS reserves.

This vegetation type is mapped as having an extant area on site of 0.03 hectares.

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Vegetation Type 4 - *C.apetalum* Warm Temperate Rainforest (based on 1 quadrat, QGRf1)

Table 4 Floristic/Structural Summary - Vegetation Type No. 4

Growth Form	Height Range (metres)	% Cover Range	Typical Species
Emergent	to 12	5	*Eucalyptus botryoides*
Tree and small tree	to 10	80	*Ceratopetalum apetalum, Livistona australis, Cyathea australis, Phyllostachys sp.*, Acmena smithii, Synoum glandulosum*
Shrub	to 1.5	30	*Breynia oblongifolia, Lantana camara*, Wilkiea huegeliana*
Ground	to 1m	10	*Hypolepis muelleri, Sticherus flabellatus, Pseuderanthemum variabile, Gymnostachys anceps, Commelina cyanea*
Vines	-	-	*Geitonoplesium cymosum, Cissus hypoglauca*

This vegetation type was recorded as a narrow band along Narrabeen Creek on moist to wet alluvial sands and is identifiable by its dense tree layer dominated by the warm temperate rainforest tree, *Ceratopetalum apetalum* above a sparse to moderate groundcover of ferns. This vegetation type was subject to a high degree of disturbance on site due to the presence of Lantana and Bamboo infestations along the length of the creekline.

Vegetation type 4 supports elements of both Map Unit RF02 'Coastal Sandstone Gallery Rainforest' and RF03 'Coastal Warm Temperate Rainforest' of OEH (2013). This vegetation type forms part of Floyd's (1990) *Ceratopetalum apetalum* Warm Temperate Rainforest alliance and is **not** considered part of the Lowland Rainforest EEC listed under the TSC Act as it does not occur in conjunction with other Floyd (1990) subtropical and dry rainforest sub-alliances (listed in the EEC Final Determination) on the site.

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OEH (2013) note that this vegetation type (as RF02) is reserved in the metropolitan Sydney region within Ku-ring-gai Chase, Lane Cove, Royal, Garigal, Georges River and Sydney Harbour National Parks, with 87% of its extant area of 235 ha (within the OEH 2013 Sydney metropolitan study area) present in NPWS and non NPWS reserves.

This vegetation type is mapped as having an extant area on site of 0.11 hectares.

Results – Threatened Flora Species

No Threatened flora species were recorded during the flora survey. Those Threatened flora species (listed under the TSC/EPBC Acts) considered as possible occurrences on the site include *Epacris purpurascens* var *purpurascens*, *Tetratheca glandulosa*, *Callistemon linearifolius*, *Syzygium paniculatum* and *Microtis angusii*. All these taxa have been recorded in the Narrabeen/Warriewood/Mona Vale/Ingleside suburbs on Sydney's northern beaches. No Threatened flora species have been reported for the enriched sandstone communities recorded on the subject site by OEH as part of its Sydney metropolitan vegetation classification and mapping program (OEH 2013) although their presence should not be discounted.

The Bionet website shows a 2005 record for the TSC-listed *Eucalyptus nicholii*, a tree, either on or close to the site. It is noted that this tree is a common Sydney street/landscape planting and is indigenous only to the northern tablelands area of NSW. This tree is not considered as Threatened in the Sydney region and was not recorded on site in native bushland habitats.

Limitations

June is not an ideal time to survey for Threatened flora species on the northern beaches sandstone escarpments as some of those species considered as possible occurrences will not be flowering until late winter and early spring. Threatened species such as *Epacris purpurascens* var *purpurascens*, *Tetratheca glandulosa* and *Callistemon linearifolius* are difficult to detect and/or identify/distinguish from closely related taxon when not flowering. Furthermore, the orchid *Microtis angusii*, remains as a dormant subterranean tuber until flowering in spring. As such, it is recommended that targeted searches for these Threatened flora in all native habitats recorded on site (as well as the orchid in cleared habitats) be carried out in spring to increase the likelihood of detection and accurate identification.

As with any vegetation mapping, polygon linework should be treated as an approximation of vegetation type distribution. Subtle ecotones exist on the subject site (particularly between vegetation types 1 and 2) which are often difficult to incorporate into vegetation linework.

Lastly, a baseline flora survey conducted as a snapshot in one season only will not give a 'complete' inventory of flora across a site due to the presence of dormant species (eg. terrestrial orchids) and the dynamic nature of natural ecosystems.

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Yours Faithfully

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Figure 1 - Study Area

Figure 1: Study Area

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Figure 2 – Survey Site Locations

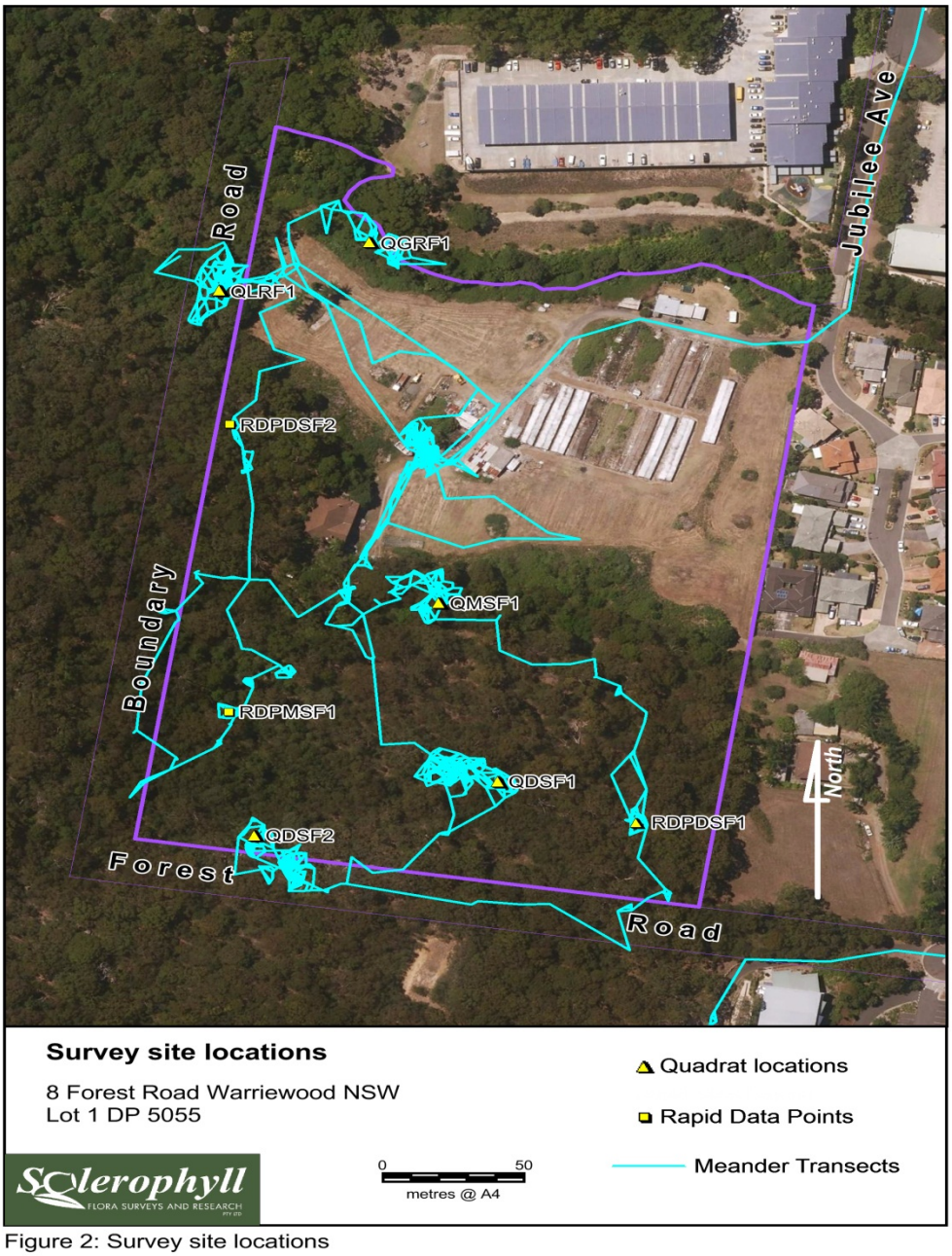

Figure 2: Survey site locations

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Figure 3 – Native Vegetation Map

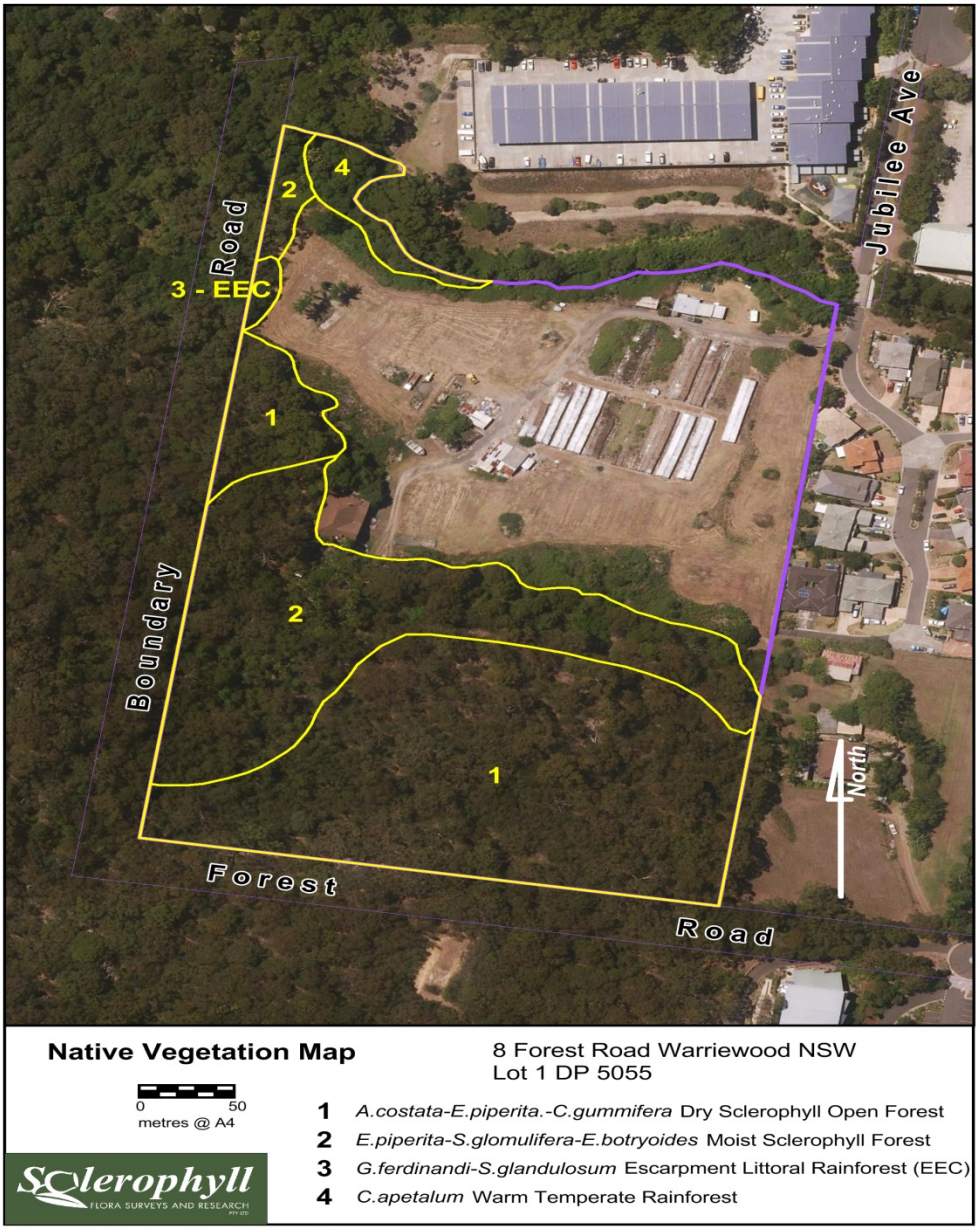


Figure 3: Native Vegetation Map

Attachment A - Floristic List and Quadrat Data for 8 Forest Road, Lot 1 DP5055, Warriewood, NSW (June 2015)

Class/Family	Scientific Name	Quadrat (PFC%)					Additional plants recorded opportunistically outside quadrats (veg type #)
		QDSF1	QDSF2	QMSF1	QLRf1	QGRf1	
CLASS LYCOPSIDA (Clubmosses and Quillworts)							
SELAGINELLACEAE	*Selaginella uliginosa*						(2)
CLASS CONIFEROPSIDA (Conifers)							
PODOCARPACEAE	*Podocarpus spinulosus*						(2)
CLASS FILICOPSIDA (Ferns)							
ASPLENIACEAE	*Asplenium flabellifolium*						(2)
BLECHNACEAE	*Blechnum ambiguum*				<5		
CYATHEACEAE	*Cyathea australis*						(4)
DENNSTAEDTIACEAE	*Pteridium esculentum*	20	30				
	Hypolepis muelleri				<5	30	
DICKSONIACEAE	*Calochlaena dubia*			15	30	5	
GLEICHENIACEAE	*Sticherus flabellatus*					10	
LINDSAEACEAE	*Lindsaea linearis*						(1)
CLASS MAGNOLIOPSIDA (Flowering Plants)							
Subclass Magnoliidae (Dicotyledons)							
ACANTHACEAE	*Pseuderanthemum variabile*	<5	<5			<5	

Class/Family	Scientific Name	Quadrat (PFC%)					Additional plants recorded opportunistically outside quadrats (veg type #)
		QDSF1	QDSF2	QMSF1	QLRf1	QGRf1	
APIACEAE	*Actinotus minor*						(1)
	Actinotus helianthi						(1)
	Xanthosia pilosa		<5				
ARALIACEAE	*Astrotricha floccosa*			<5			
	Polyscias sambucifolia		<5				
ARECACEAE	*Livistona australis*	<5	<5	20	10	20	
BIGNONIACEAE	*Pandorea pandorana*			<5			
CASUARINACEAE	*Allocasuarina littoralis*	60	40				
	Allocasuarina torulosa	20					
CELASTRACEAE	*Maytenus silvestris*			<5			
CONVOLVULACEAE	*Dichondra repens*			<5			
CUNONIACEAE	*Ceratopetalum apetalum*					80	
	Ceratopetalum gumiferum						(1)
	Callicoma serratifolia			5			
DILLENIACEAE	*Hibbertia dentata*	5	<5	5			
	Hibbertia aspera	<5					
ELAEOCARPACEAE	*Elaeocarpus reticulatus*		<5				

Class/Family	Scientific Name	Quadrat (PFC%)					Additional plants recorded opportunistically outside quadrats (veg type #)
		QDSF1	QDSF2	QMSF1	QLRf1	QGRf1	
ERICACEAE: Styphelioideae	*Leucopogon lanceolatus* var. *lanceolatus*	<5	<5				
EUPOMATIACEAE	*Eupomatia laurina*						(2)
FABACEAE: Faboideae	*Glycine clandestina* complex			<5	<5		
	Hardenbergia violacea		<5				
	Platylobium formosum						(2)
	Pultenaea flexilis	<5					(2)
	Pultenaea daphnoides						(2)
FABACEAE: Mimosoideae	*Acacia ulicifolia*		<5				
	Acacia longissima						(2)
GOODENIACEAE	*Goodenia hederacea*						(1)
HALORAGACEAE	*Gonocarpus teucrioides*						(2)
LAMIACEAE	*Clerodendrum tomentosum*		<5	<5	5		
LAURACEAE	*Cassytha glabella*			<5			
	Cassytha pubescens						(1)
	Cryptocarya microneura						(2)
	Endiandra sieberi						(2)
LOBELIACEAE	*Pratia purpurascens*	<5			<5		

Class/Family	Scientific Name	Quadrat (PFC%)					Additional plants recorded opportunistically outside quadrats (veg type #)
		QDSF1	QDSF2	QMSF1	QLRf1	QGRf1	
	Lobelia dentata						(1,2)
MALVACEAE	*Lasiopetalum ferrugineum*						(1)
MELIACEAE	*Synoum glandulosum*			10	10	<5	
MENISPERMACEAE	*Stephania japonica* var *discolor*			5	5		
MONIMIACEAE	*Wilkiea huegeliana*					10	
MYRSINACEAE	*Myrsine variabilis*		<5				
MYRTACEAE	*Acmena smithii*					<5	
	Angophora floribunda				5		
	Angophora costata	10	40	10			
	Corymbia gummifera		10				
	Syncarpia glomulifera			30			(1)
	Eucalyptus botryoides		5				(2), (4)
	Eucalyptus resinifera subsp. *resinifera* (possible intergrade with *E.scias*)						(1,2)
	Eucalyptus piperita			40			
OLEACEAE	*Notelaea longifolia* f *longifolia*	<5		<5			
	*Ligustrum sinense**						(3)

Class/Family	Scientific Name	Quadrat (PFC%)					Additional plants recorded opportunistically outside quadrats (veg type #)
		QDSF1	QDSF2	QMSF1	QLRf1	QGRf1	
PHYLLANTHACEAE	*Glochidion ferdinandi* var. *ferdinandi*			20	80		
	Glochidion ferdinandi var. *pubens*						(1)
	Breynia oblongifolia			10	5	<5	
	Poranthera microphylla			<5			
	Phyllanthus hirtellus						(2)
PITTOSPORACEAE	*Billardiera scandens*	<5	<5	<5			
	Pittosporum undulatum			<5	10		
	Pittosporum revolutum			<5			
PROTEACEAE	*Banksia integrifolia*				<5		(1)
	Banksia serrata		20				
	Persoonia levis	<5	<5				
	Persoonia pinifolia	<5	5				X
	Persoonia linearis	<5					
RUBIACEAE	*Pomax umbellata*	<5	<5				
RUTACEAE	*Correa reflexa*						(1)
	Zieria smithii						(1)
SANTALACEAE	*Leptomeria acida*						(1)

Class/Family	Scientific Name	Quadrat (PFC%)					Additional plants recorded opportunistically outside quadrats (veg type #)
		QDSF1	QDSF2	QMSF1	QLRf1	QGRf1	
SAPINDACEAE	*Dodonaea triquetra*	<5		<5			
ULMACEAE	*Trema tomentosa* var. *aspera*						
VERBENACEAE	*Lantana camara**			30	15	40	
VITACEAE	*Cissus hypoglauca*				5	5	(2)
XANTHORRHOEACEAE	*Xanthorrhoea media*	<5	5				
	Xanthorrhoea arborea		20				
CLASS MAGNOLIOPSIDA (Flowering Plants)							
Subclass Liliidae (Monocotyledons)							
ARACEAE	*Gymnostachys anceps*					5	
COMMELINACEAE	*Commelina cyanea*				5	<5	
CYPERACEAE	*Lepidosperma laterale*	15	5	<5			
	Lepidosperma elatius						(2)
	Lepidosperma gunnii						(1)
	Gahnia sieberiana						(2)
LOMANDRACEAE	*Lomandra obliqua*						(1)
	Lomandra cylindrica						(1)
	Lomandra filiformis subsp. *filiformis*		<5				

Class/Family	Scientific Name	Quadrat (PFC%)					Additional plants recorded opportunistically outside quadrats (veg type #)
		QDSF1	QDSF2	QMSF1	QLRf1	QGRf1	
	Lomandra glauca	<5					
	Lomandra longifolia subsp. *longifolia*	5	5	5	10		
	Lomandra multiflora subsp. *multiflora*	5	<5	<5			
LUZURIAGACEAE	*Eustrephus latifolius*				<5		
	Geitonoplesium cymosum			<5		<5	(1)
PHORMIACEAE	*Dianella caerulea*	15	<5	5	5		
POACEAE	*Poa affinis*						(2)
	Aristida vagans	<5					
	Austrostipa pubescens	50	5				
	Entolasia stricta	20	30	20	<5		
	Entolasia marginata	<5					
	Imperata cylindrica var *major*		<5	<5	<5		
	Oplismenus imbecillis			10	20		
	*Phyllostachys sp.** (Bamboo)					30	
	Themeda australis						(1)
SMILACACEAE	*Smilax glyciphylla*		<5	5	5		

Note: Projected Foliage Cover (PFC) classes for all taxa are based on NVITS (2010).

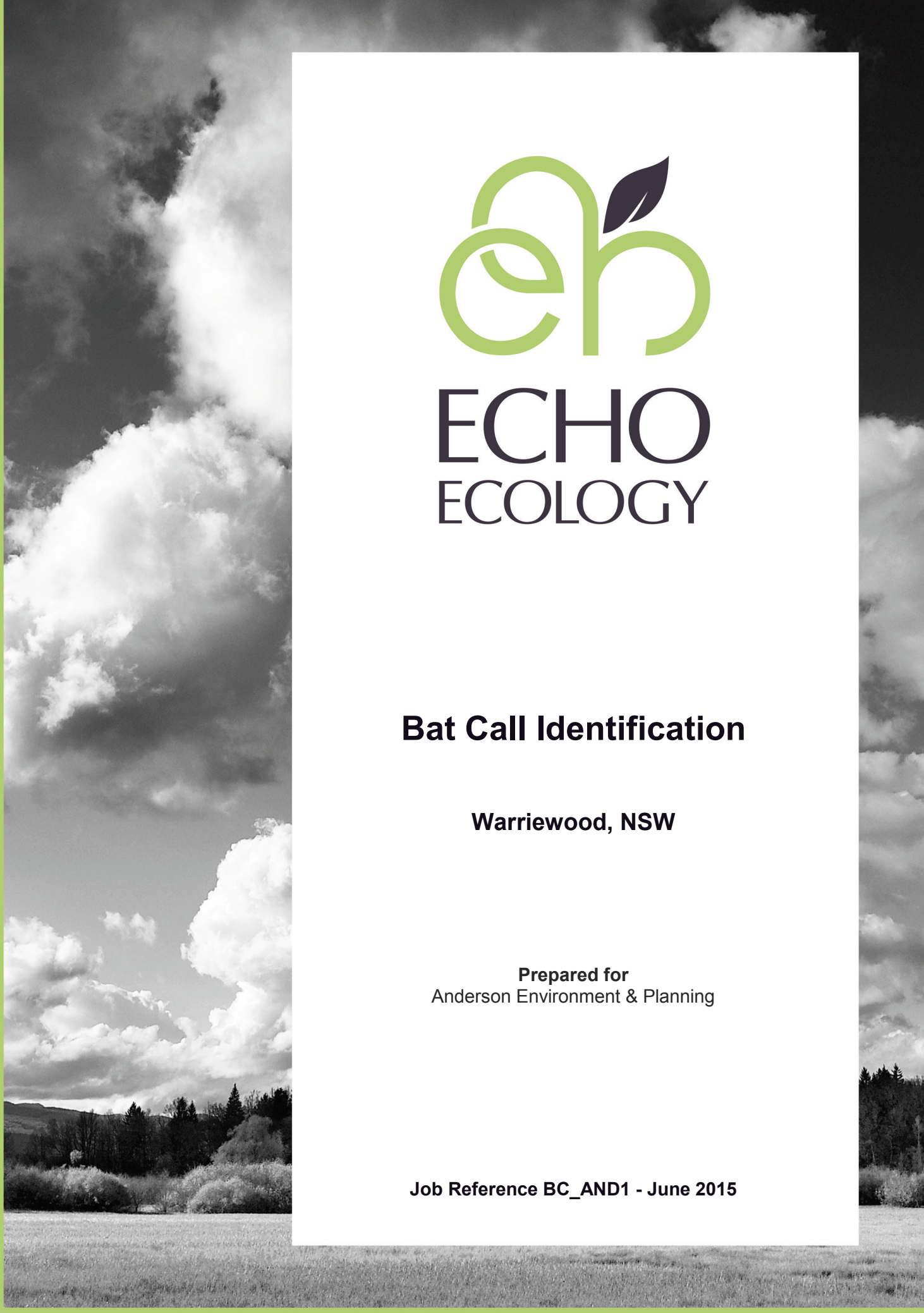
Vegetation Type Legend

Veg Type 1 – *A.costata/C.gummifera/E.piperita* DSF
Veg Type 2 – *E.piperita/S.glomulifera/E.botryoides* MSF
Veg Type 3 – *Glochidion ferdinandi/Synoum glandulosum* Escarpment Littoral Rainforest
Veg Type 4 – *Ceratopetalum apetalum* Gallery Rainforest

Rapid Data Point Summary
8 Forest Road Lot 1 DP5055 Warriewood, NSW
Jun-15

Site name	Projection	Easting	Northing	Canopy	Mid	Ground	Topopos	Slope (o)	Aspect	Elevation	Veg Type (OEH 2013)
RDPDSF1	GDA94 MGA56	340992	6271755	A.costata	A.littoralis, G.ferdinandi, P.pinifolia	P.esculentum, E.stricta, L.laterale	upper slope	0-5	NW	62m	DSF04
RDPDSF2	GDA94 MGA56	340843	6271925	A.costata, C.gummifera, E.botryoides	A.floccosa, A.littoralis, L.camara*	X.arborea, E.stricta, C.reflexa G.sieberiana,	lower slope	0-5	NE	58m	DSF04
RDPMSF1	GDA94 MGA56	340845	6271798	A.costata, E.scias/resinifera, E.piperita	C.serratifolia, N.longifolia, E.reticulatus	C.dubia, L.elatius, P.esculentum	midslope	5 to 10	N/NW	59m	WSF02

Appendix B – Bat Call Analysis Report (Echo Ecology)



ECHO ECOLOGY

Bat Call Identification

Warriewood, NSW

Prepared for
Anderson Environment & Planning

Job Reference BC_AND1 - June 2015

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This report has been prepared to document the analysis of digital ultrasonic bat echolocation calls received from a third party. The data was not collected by the author and as such no responsibility is taken for the quality of data collection or for the suitability of its subsequent use.

This report was authored by

Dr Anna McConville
PhD, B.Env.Sc.

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1.0 INTRODUCTION

This report has been commissioned by Anderson Environment & Planning to analyse bat echolocation call data (Anabat Express, Titley Electronics) collected from Warriewood, NSW. Data was provided electronically to the author. This report documents the methods involved in analysing bat call data and the results obtained only.

2.0 METHODS

The identification of bat echolocation calls recorded during surveys was undertaken using AnalookW (Version 4.1t) software. The identification of calls was undertaken with reference to Pennay *et al*. (2004) and through the comparison of recorded reference calls from the Sydney Basin. Reference calls were obtained from the NSW database and from the authors personal collection.

Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- Definite - Pass identified to species level and could not be confused with another species
- Probable - Pass identified to species level and there is a low chance of confusion with another species
- Possible - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species
- Species group - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality
- Unknown - Either background 'noise' files or passes by bats which are too short and/or of poor quality to confidently identify.

Call sequences that were less than three pulses in length were not analysed and were assigned to 'Unknown' and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar shape of plotted calls and in these cases calls were assigned to species groups.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

It should be noted that the activity levels recorded at different sites may not be readily able to be compared. Such comparisons are dependent on many variables which need to be carefully controlled during data collection and statistically analysed. Influential variables include wind, rain, temperature, duration of recording, season, detector and microphone sensitivity, detector placement, weather protection devices etc.

2.1 Characteristics Used to Differentiate Species

Miniopterus schreibersii oceanensis was differentiated by *Vespadelus* sp. by a combination of uneven consecutive pulses and the presence of a down-sweeping tail.

Chalinolobus gouldii was differentiated from other species by the presence of curved, alternating call pulses.

3.0 RESULTS

A total of 63 call sequences were recorded, of which 15 call sequences were able to be analysed (ie were not 'noise' files or bat calls of short length). Of the bat calls, two call sequences (13 %) were able to be confidently identified (those classified as either definite or probable identifications) to species level (Table 3-1). Species recorded confidently within the site include:

- *Chalinolobus gouldii* (Gould's wattled bat)
- *Miniopterus schreibersii oceanensis* (Eastern bentwing bat)

Additionally, the following bat species potentially occurred within the site, but could not be confidently identified (those calls classified as possible or as a species group):

- *Miniopterus australis* (Little bentwing bat)
- *Vespadelus darlingtoni* (Large forest bat)
- *Vespadelus pumilus* (Eastern forest bat)
- *Vespadelus regulus* (Southern forest bat)

It should be noted that additional bat species may be present within the site but were not recorded by the detectors and habitat assessment should be used in conjunction with these results to determine the likelihood of occurrence of other bat species.

Table 3-1 below summarises the results of the bat call analysis.

Table 3-1: Results of bat call analysis (number of passes per site per night)

IDENTIFICATION	Anabat 19/06/2015
PROBABLE	
Chalinolobus gouldii	1
Miniopterus schreibersii oceanensis	1
SPECIES GROUPS	
Miniopterus australis / Vespadelus pumilus	1
Miniopterus schreibersii oceanensis / Vespadelus darlingtoni / Vespadelus regulus	8
Vespadelus darlingtoni / Vespadelus regulus	4
UNKNOWN	
'Noise' files	45
Unknown	3
TOTAL	**63**

4.0 SAMPLE CALLS

A sample of the calls actually identified from the site for each species is given below.

Figure 4-1: *Chalinolobus gouldii* probable call

Figure 4-2: *Miniopterus schreibersii oceanensis* probable call

5.0 REFERENCES

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Appendix C – Expected Fauna Species List

EXPECTED FAUNA SPECIES LIST

The following list includes fauna species that could be reasonably expected to occur on the study site at some point, given site attributes and location.

"#" - species observed or indicated by scats, tracks etc. within the study area by AEP (2019).

* - Introduced species

? - Unconfirmed record, anecdotal records etc.

A - NSW Atlas of Wildlife record of threatened species for the site.

R - Additional site records provided by residents

Threatened species listed under the *Biodiversity Conservation Act 2016* (BC Act), the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are indicated in **bold font**.

BIRDS

Family Megapodiidae - Mound Builders

#	Australian Brush-Turkey	*Alectura lathami*	

Family Phasianidae - True Quails

R	Brown Quail	*Coturnix ypsilophora*	

Family Anatidae - Ducks, Swans and Geese

#	Pacific Black Duck	*Anas superciliosa*	
#	Wood Duck	*Chenonetta jubata*	

Family Ardeidae - Herons, Egrets and Bitterns

	Great Egret	*Ardea alba*	
	Intermediate Egret	*Ardea intermedia*	
R	White-necked Heron	*Ardea pacifica*	
R	White-faced Heron	*Egretta novaehollandiae*	
	Black Bittern	***Ixobrychus flavicollis***	**(V)**

Family Threskiornithidae - Ibises and Spoonbills

	Sacred Ibis	*Threskiornis molucca*	
	Straw-necked Ibis	*Threskiornis spinicollis*	

Family Accipitridae - Osprey, Hawks, Eagles and Harriers

#	Brown Goshawk	*Accipiter fasciatus*	
	Collared Sparrowhawk	*Accipiter cirrhocephalus*	

	Grey Goshawk	*Accipiter novaehollandiae*	
	Wedge-tailed Eagle	*Aquila audax*	
	Crested Hawk	*Aviceda subcristata*	
	Swamp Harrier	*Circus approximans*	
R	Black-shouldered Kite	*Elanus notatus*	
R	White-bellied Sea-eagle	*Haliaeetus luecogaster*	
#	Whistling Kite	*Haliastur sphenurus*	
	Little Eagle	***Hieraaetus morphnoides***	**(V)**
	Eastern Osprey	***Pandion cristatus***	**(V)**

Family Falconidae - Falcons

R?	Brown Falcon	*Falco berigora*	
	Nankeen Kestrel	*Falco cenchroides*	
#	Australian Hobby	*Falco longipennis*	
R	Peregrine Falcon	*Falco peregrinus*	

Family Rallidae - Crakes, Rails and Gallinules

	Dusky Moorhen	*Gallinula tenebrosa*	
	Purple Swamphen	*Porphyrio porphyrio*	
R	Buff-banded Rail	*Gallirallus philippensis*	
	Lewins Rail	*Rallus pectoralis*	

Family Burhinidae - Stone-Curlews

	Bush Stone-Curlew	***Burhinus grallarius***	**(V)**

Family Charadriidae - Plovers, Dotterels and Lapwings

#	Masked Lapwing	*Vanellus miles*	

Family Columbidae - Pigeons, Doves

	Emerald Dove	*Chalcophaps indica*	
	White-headed Pigeon	*Columba leucomela*	
	*Feral Pigeon	*Columba livia*	
	Bar-shouldered Dove	*Geopelia humeralis*	
	Peaceful Dove	*Geopelia striata*	
#	Wonga Pigeon	*Leucosarcia melanoleuca*	
	Topknot Pigeon	*Lopholaimus antarcticus*	

R	Brown Cuckoo-Dove	*Macropygia amboinensis*	
R	Crested Pigeon	*Ocyphaps lophotes*	
	Wompoo Fruit-Dove	***Ptilinopus magnificus***	**(V)**
	Superb Fruit-Dove	***Ptilinopus superbus***	**(V)**
	*Spotted Dove	*Streptopelia chinensis*	

Family Cacatuidae - Cockatoos and Corellas

#	Sulphur-crested Cockatoo	*Cacatua galerita*	
#	Galah	*Cacatua roseicapilla*	
R	Little Corella	*Cacatua sanguinea*	
	Long-billed Corella	*Cacatua tenuirostris*	
	Gang-Gang Cockatoo	***Callocephalon fimbriatum***	**(V)**
R	Yellow-tailed Black-Cockatoo	*Calyptorhyncus funereus*	
R	**Glossy Black-Cockatoo**	***Calyptorhynchus lathami***	**(V)**

Family Psittacidae - Parrots, Rosellas and Lorikeets

#	King Parrot	*Alisterus scapularis*	
	Little Lorikeet	***Glossopsitta pusilla***	**(V)**
R	Musk Lorikeet	*Glossopsitta concinna*	
	Swift Parrot	***Lathamus discolour***	**(E, EE)**
	Crimson Rosella	*Platycercus elegans*	
#	Eastern Rosella	*Platycercus eximius*	
	Red-rumped Parrot	*Psephotus haematonotus*	
#	Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	
#	Rainbow Lorikeet	*Trichoglossus haematodus*	

Family Cuculidae - Cuckoos

	Horsefield's Bronze-Cuckoo	*Chrysococcyx basalis*	
R	Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	
	Pallid Cuckoo	*Cuculus pallidus*	
R	Fan-tailed Cuckoo	*Cuculus pyrrhophanus*	
	Brush Cuckoo	*Cuculus variolosus*	
R	Common Koel	*Eudynamis scolopacea*	
R	Channel-billed Cuckoo	*Scythrops novaehollandiae*	

Family Centropodidae - Pheasant Coucal			
R	Pheasant Coucal	*Centropus phasianinus*	
Family Tytonidae - Barn Owls			
	Barn Owl	*Tyto alba*	
	Masked Owl	***Tyto novaehollandiae***	**(V)**
Family Strigidae - Hawk-Owls			
#	Southern Boobook	*Ninox novaeseelandiae*	
	Barking Owl	***Ninox connivens***	**(V)**
R	**Powerful Owl**	***Ninox strenua***	**(V)**
Family Podargidae - Frogmouths			
	Tawny Frogmouth	*Podargus strigoides*	
Family Aegothelidae - Owlet Nightjars			
R	Australian Owlet Nightjar	*Aegotheles cristatus*	
Family Apodidae - Swifts			
	Fork-tailed Swift	*Apus pacificus*	
	White-throated Needletail	*Hirundapus caudacutus*	
Family Alcedinidae - River Kingfishers			
	Azure Kingfisher	*Ceyx azurea*	
Family Halcyonidae - Tree Kingfishers			
#	Laughing Kookaburra	*Dacelo novaeguineae*	
R	Sacred Kingfisher	*Todiramphus sancta*	
Family Meropidae - Bee-eaters			
	Rainbow Bee-eater	*Merops ornatus*	
Family Coraciidae - Rollers			
R	Dollarbird	*Eurystomus orientalis*	

Family Pittidae - Pittas		
	Noisy Pitta	*Pitta versicolor*
Family Menuridae – Lyrebirds		
#	Superb Lyrebird	*Menura novaehollandiae*
Family Climacteridae - Treecreepers		
#	White-throated Treecreeper	*Cormobates leucophaea*
Family Maluridae - Fairy-Wrens and Emu-Wrens		
	Variegated Fairy-Wren	*Malurus assimilis*
#	Superb Fairy-Wren	*Malurus cyaneus*
	Southern Emu-Wren	*Stipiturus malachurus*
Family Pardalotidae - Pardalotes, Gerygones, Scrubwrens, Heathwrens and Thornbills		
	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
	Striated Thornbill	*Acanthiza lineata*
#	Yellow Thornbill	*Acanthiza nana*
#	Brown Thornbill	*Acanthiza pusilla*
	Buff-rumped Thornbill	*Acanthiza reguloides*
#	Brown Gerygone	*Gerygone mouki*
R	Spotted Pardalote	*Pardalotus punctatus*
	Striated Pardalote	*Pardalotus striatus*
#	White-browed Scrubwren	*Sericornis frontalis*
Family Meliphagidae - Honeyeaters		
#	Red Wattlebird	*Anthrochaera carunculata*
#	Eastern Spinebill	*Acanthorhynchus tenuirostris*
#	Little Wattlebird	*Anthrochaera chrysoptera*
	Blue-faced Honeyeater	*Entomyzon cyanotus*
	Yellow-faced Honeyeater	*Lichenostomus chrysops*
	White-eared Honeyeater	*Lichenostomus leucotis*
	Brown Honeyeater	*Lichmera indistincta*
#	Noisy Miner	*Manorina melanocephala*
	Bell Miner	*Manorina melanophrys*
#	Lewin's Honeyeater	*Meliphaga lewinii*

	Brown-headed Honeyeater	*Melithreptus brevirostris*	
	White-naped Honeyeater	*Melithreptus lunatus*	
	Scarlet Honeyeater	*Myzomela sanguinolenta*	
	Noisy Friarbird	*Philemon corniculatus*	
R	New Holland Honeyeater	*Phylidonyris novaehollandiae*	
	White-cheeked Honeyeater	*Phylidonyris nigra*	
	Striped Honeyeater	*Plectorhyncha lanceolata*	
	Regent Honeyeater	***Anthochaera phrygia***	**(CE, EE)**

Family Petroicidae - Robins and Jacky Winter

#	Eastern Yellow Robin	*Eopsaltria australis*
	Jacky Winter (Brown Flycatcher)	*Microeca leucophaea*
	Rose Robin	*Petroica rosea*

Family Cinclosomatidae - Whipbird and Quail-thrushes

#	Eastern Whipbird	*Psophodes olivaceus*

Family Pachycephalidae - Whistlers, Shrike-tit and Shrike-thrushes

#	Grey Shrike-thrush	*Colluricincla harmonica*
#	Golden Whistler	*Pachycephala pectoralis*
	Rufous Whistler	*Pachycephala rufiventris*
	Crested Shrike-tit	*Falcunculus frontatus*

Family Dicruridae - Monarchs, Flycatchers, Fantails, Drongo and Magpie-Lark

#	Spangled Drongo	*Dicrurus megarhynchus*
#	Magpie-lark	*Grallina cyanoleuca*
	Black-faced Monarch	*Monarcha melanopsis*
	Spectacled Monarch	*Monarcha trivirgatus*
	Restless Flycatcher	*Myiagra inquieta*
	Leaden Flycatcher	*Myiagra rubecula*
#	Grey Fantail	*Rhipidura fuliginosa*
#	Willie Wagtail	*Rhipidura leucophrys*
R	Rufous Fantail	*Rhipidura rufifrons*

Family Campephagidae - Cuckoo-shrikes and Trillers

#	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*

	Cicadabird	*Coracina tenuirostris*

Family Oriolidae - Orioles and Figbird

R	Olive-backed Oriole	*Oriolus sagittatus*
	Figbird	*Sphecotheres viridus*

Family Artamidae - Wood-swallows, Butcherbirds, Magpie and Currawongs

	Dusky Woodswallow	*Artamus cyanopterus*
	White-breasted Woodswallow	*Artamus leucorhynchus*
	Pied Butcherbird	*Cracticus nigrogularis*
#	Grey Butcherbird	*Cracticus torquatus*
	Australian Magpie	*Gymnorhina tibicen*
#	Pied Currawong	*Strepera graculina*

Family Corvidae - Crows, Raven

#	Australian Raven	*Corvus coronoides*

Family Corcoracidae - Mudnest-builders

	White-winged Chough	*Corcorax melanorhamphos*

Family Ptilnorhynchidae - Bowerbirds

	Satin Bowerbird	*Ptilinorhynchus violaceus*
	Regent Bowerbird	*Sericulus chrysocephalus*

Family Motacillidae - Pipits and Wagtails

	Australian Pipit	*Anthus novaseelandiae*

Family Passeridae - Sparrows, Grassfinches, Mannikins

#	Red-browed Firetail	*Aegintha temporalis*
	*House Sparrow	*Passer domesticus*
	Double-barred Finch	*Poephila bichenovii*

Family Dicaeidae - Flowerpeckers

	Mistletoebird	*Dicaeum hirundinaceum*

Family Hirundinidae - Swallows and Martins			
	Fairy Martin	*Cecropis ariel*	
	Tree Martin	*Cecropis nigricans*	
#	Welcome Swallow	*Hirundo neoxena*	
Family Zosteropidae - White-eyes			
#	Silvereye	*Zosterops lateralis*	
Family Sylvidae - Old World Warblers			
	Clamorous Reed-Warbler	*Acrocephalus stentoreus*	
	Golden-headed Cisticola	*Cisticola exilis*	
	Little Grassbird	*Megalurus gramineus*	
Family Sturnidae - Starlings and Mynas			
	*Common Myna	*Acridotheres tristis*	
	*Common Starling	*Sturnus vulgaris*	

AMPHIBIANS

Family Myobatrachidae - 'Southern' Frogs			
#	Common Eastern Froglet	*Crinia signifera*	
	Giant Burrowing Frog	***Heleioporus australiacus***	**(V, EV)**
	Eastern Banjo Frog	*Limnodynastes dumerilii*	
	Striped Marsh Frog	*Limnodynastes peronii*	
	Spotted Grass Frog	*Limnodynastes tasmaniensis*	
	Red-crowned Toadlet	***Pseudophryne australis***	**(V)**
	Brown Toadlet	*Pseudophryne bibronii*	
#	Smooth Toadlet	*Uperoleia laevigata*	
Family Hylidae - Tree Frogs			
	Green Tree Frog	*Litoria caerulea*	
	Bleating Tree Frog	*Litoria dentata*	
	Dwarf Tree Frog	*Litoria fallax*	
	Freycinet's Frog	*Litoria freycineti*	
	Broad-palmed Frog	*Litoria latopalmata*	
	Lesueur's Frog	*Litoria lesueuri*	
	Peron's Tree Frog	*Litoria peronii*	

	Leaf Green Tree Frog	*Litoria phyllochroa*	
	Tyler's Tree Frog	*Litoria tyleri*	
	Verreaux's Tree Frog	*Litoria verreauxii*	

REPTILES

Family Chelidae - Tortoises

	Eastern Snake-necked Tortoise	*Chelodina longicollis*	

Family Gekkonidae - Geckoes

	Wood Gecko	*Diplodactylus vittatus*	
	Lesueur's Velvet Gecko	*Oedura lesueurii*	
R	Southern Leaf-tailed Gecko	*Phyllurus platurus*	
	Thick-tailed Gecko	*Underwoodisaurus milii*	

Family Pygopodidae - Legless Lizards

	Burton's Snake Lizard	*Lialis burtonis*	
	Common Scaly-foot	*Pygopus lepidopus*	

Family Agamidae - Dragons

	Jacky Lizard	*Amphibolurus muricatus*	
#	Eastern Water Dragon	*Intellagama lesuerii*	
	Eastern Bearded Dragon	*Pogona barbata*	

Family Varanidae - Monitors

R?	**Rosenberg's Goanna**	***Varanus rosenbergi***	**(V)**
	Lace Monitor	*Varanus varius*	

Family Scinidae - Skinks

	Red-throated Skink	*Acritoscincus playnota*	
	Wall Lizard	*Cryptoblepharus virgatus*	
	Striped Skink	*Ctenotus robustus*	
	Copper-tailed Skink	*Ctenotus taeniolatus*	
	Cunningham's Skink	*Egernia cunninghami*	
R	Eastern Water Skink	*Eulamprus quoyii*	
		Eulamprus tenuis	
	Grass Skink	*Lampropholis delicata*	

	Garden Skink	*Lampropholis guichenoti*
	White's Skink	*Liopholis whitii*
	Three-toed Skink	*Saiphos equalis*
	Weasel Skink	*Saproscincus mustelinus*
	Eastern Blue-tongued Lizard	*Tiliqua scincoides*
Family Typhlopidae - Blind Snakes		
	Blackish Blind Snake	*Ramphotyphlops nigrescens*
		Ramphotyphlops wiedii
Family Boidae - Pythons		
#	Carpet (Diamond) Python	*Morelia spilota*
Family Colubridae		
R	Brown Tree Snake	*Boiga irregularis*
R	Green Tree Snake	*Dendralaphis punctulata*
Family Elapidae - Venomous Snakes		
	Common Death Adder	*Acanthophis anarcticus*
	Golden-crowned Snake	*Cacophis squamulosus*
	Yellow-faced Whip Snake	*Demansia psammophis*
	Black-bellied Swamp Snake	*Hemiaspis signata*
R	Red-bellied Black Snake	*Pseudechis porphyriacus*
	Eastern Brown Snake	*Pseudonaja textilis*
	Bandy-bandy	*Vermicella annulata*

Appendix D – Site Photos

Above: Looking into site from the Jubilee Avenue Access Point

Below: Looking north towards Narrabeen Creek

Above: Looking west towards moist forest and rainforest, with drier vegetation upslope on the left. Previously cleared lands in the foreground.

Below: Established native groundcover below Coastal Sandstone Gully Forest on the right, looking east towards adjoining residential development.

Above: The existing dwelling and substantial sandstone footings which will be retained to support passive recreational space.

Below: Dense exotic grasses and weeds occupy the flats approaching lower slopes of the southern remnant forest.

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Above: Coastal Enriched Sandstone Moist Forest

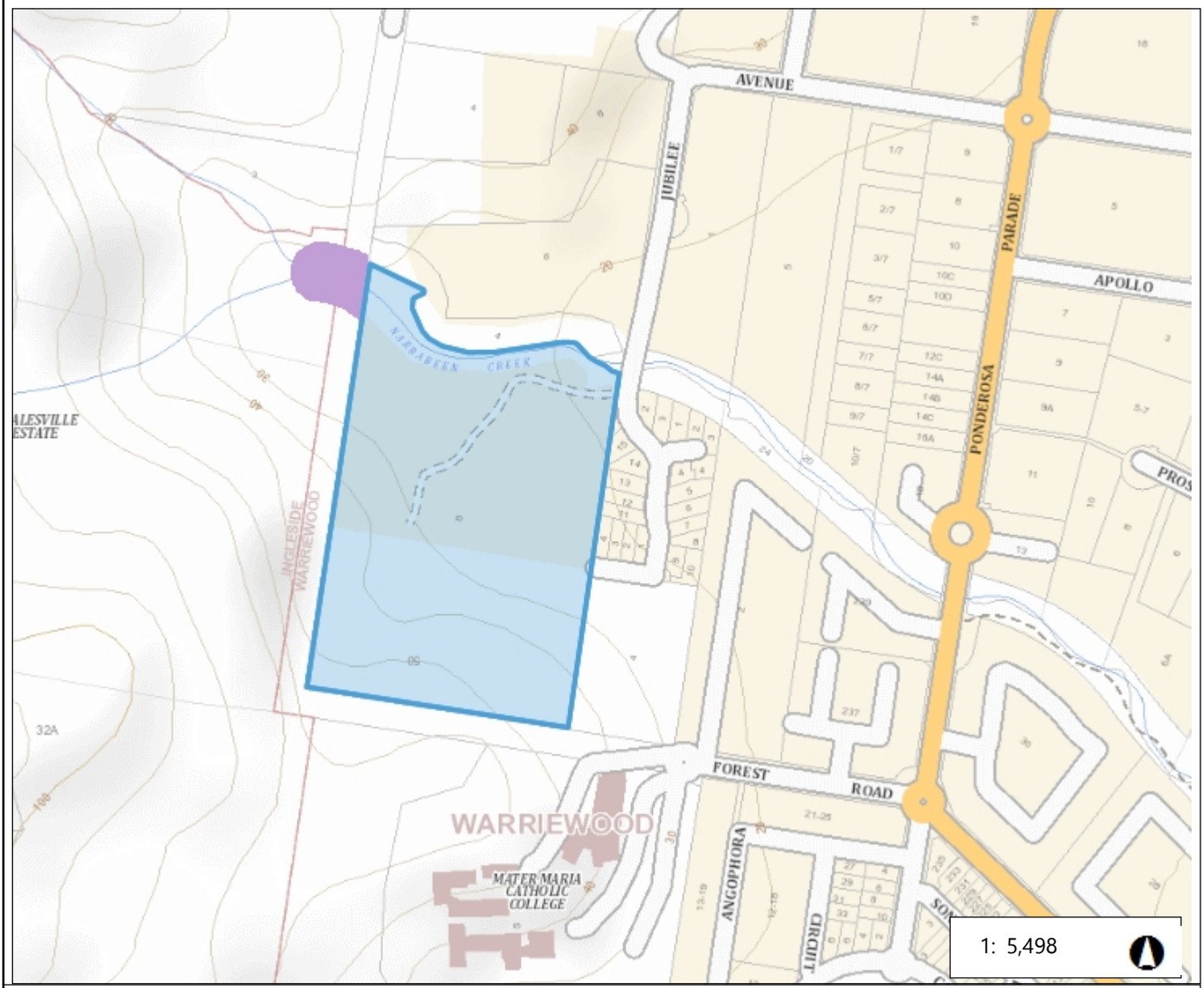
Below: The southernmost edge of which will be cleared for an APZ

Above: An accessible area of Narrabeen Creek

Below: The density of weed infestation along some sections of the creek.

Appendix E – BOSET Report

Biodiversity Offset Scheme (BOS) Entry Threshold Map



279.3 0 139.64 279.3 Metres

WGS_1984_Web_Mercator_Auxiliary_Sphere

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

Legend

- Biodiversity Values that have been mapped for more than 90 days
- Biodiversity Values added within last 90 days

Notes

Biodiversity Values Map and Threshold Report

Results Summary

Date of Calculation	27/07/2020 2:14 PM		**BDAR Required***
Total Digitised Area	5.58	ha	
Minimum Lot Size Method	Lot size		
Minimum Lot Size	0.52	ha	
Area Clearing Threshold	0.25	ha	
Area clearing trigger Area of native vegetation cleared	Unknown #		Unknown #
Biodiversity values map trigger Impact on biodiversity values map(not including values added within the last 90 days)?	no		no
Date of the 90 day Expiry	N/A		

*If BDAR required has:

- at least one 'Yes': you have exceeded the BOS threshold. You are now required to submit a Biodiversity Development Assessment Report with your development application. Go to https://customer.lmbc.nsw.gov.au/assessment/AccreditedAssessor to access a list of assessors who are accredited to apply the Biodiversity Assessment Method and write a Biodiversity Development Assessment Report
- 'No': you have not exceeded the BOS threshold. You may still require a permit from local council. Review the development control plan and consult with council. You may still be required to assess whether the development is '"likely to significantly affect threatened species' as determined under the test in s. 7.3 of the Biodiversity Conservation Act 2016. You may still be required to review the area where no vegetation mapping is available.

Where the area of impact occurs on land with no vegetation mapping available, the tool cannot determine the area of native vegetation cleared and if this exceeds the Area Threshold. You will need to work out the area of native vegetation cleared - refer to the BOSET user guide for how to do this.

On and after the 90 day expiry date a BDAR will be required.

Disclaimer

This results summary and map can be used as guidance material only. This results summary and map is not guaranteed to be free from error or omission. The State of NSW and Office of Environment and Heritage and its employees disclaim liability for any act done on the information in the results summary or map and any consequences of such acts or omissions. It remains the responsibility of the proponent to ensure that their development application complies will all aspects of the *Biodiversity Conservation Act 2016.*

The mapping provided in this tool has been done with the best available mapping and knowledge of species habitat requirements. This map is valid for a period of 30 days from the date of calculation (above).

Acknowledgement

I as the applicant for this development, submit that I have correctly depicted the area that will be impacted or likely to be impacted as a result of the proposed development.

Signature_____ Date:27/07/2020 02:14 PM

Appendix F –Warriewood Valley Release Area Masterplan and Design Guidelines

Warriewood Valley Landscape Masterplan and Design Guidelines (Public Domain)

2018

northern beaches council

Guidelines Contents

DISCLAIMER

NOTE:
The facilities and features on this plan are diagramatic only and the actual location will be subject to regular reviews of the Contributions Plan by Council, and will also be dependant on survey, site considerations and compliance with all relevant standards and requirements.

All internal Sector Road Layouts/ Landscaping/ Open Space (Apart from Sectors 1, 2, 8, 10, 11 and 12) are indicative only and reflect submissions by the Developers at the time of preparation of this Plan.

Council does not endorse or otherwise the proposals by the Developer in each Sector

1.1 Generally

The Warriewood Release Area Landscape Masterplan and Design Guidelines (Public Domain) have been prepared to provide Northern Beaches Council and the development community with a coordinated basis upon which planning and design of streetscape, open space and creekline corridor improvements can be undertaken through out staged development of the release area.

The design guidelines are aimed to provide minimum standards upon which site specific design development of sustainable landscape strategies can be undertaken. Landscape elements include:

- Setbacks of street tree planting to road corridors
- Standards for street tree planting materials and size
- Standards for open space and creekline landscape enhancement and key design principles

The Warriewood Valley Release Area project is a significant initiative which aims to establish a coordinated framework for integrated development to occur in the valley focusing upon the “green” corridors provided by creekline corridors and related open space and roadway links.

The Landscape Masterplan and Design Guidelines (Public Domain) build upon the planning controls in place for the Warriewood Valley Release Area which are amended from time to time and should be read in conjunction with the specifications within the Warriewood Valley Roads Masterplan.

The recommendations and principles established by the masterplan/design guidelines supplement the landscape controls provided in these documents and should be read in conjunction with them.

The development of site specific design solutions by development consortiums must take into account detailed site conditions including soil conditions and preparation, utilities, levels, existing vegetation, etc. The solutions must integrate and respond to the requirements outlined in this document and the preceding planning controls identified above. Design solutions must also encompass the opportunities for innovative and stimulating landscape design which can enhance the lifestyles of permanent and workforce residents, and develop a sustainable and attractive environment for Warriewood Valley.

1.2 Structure of the Report

This report is presented in three principal sections:

Section 2 **Landscape Masterplan**
Describes the overall landscape strategies for the release area incorporating creekline corridors, open space areas (Central Local Park, Neighbourhood Parks, and Sport Fields), and road corridors (Avenues, Industrial Avenues, and Sector Roads).

Section 3 **Streetscape Planting Guidelines**
Landscape plan and sectional guidelines for design development of street corridor plantings.

Section 4 **Creekline Planting Guidelines**
Landscape plan and sectional guidelines for design development of creekline corridors landscape treatments. Guidelines provide design principles which must be subject to site specific Hydraulic and Civil Engineering design.

Section 5 **Central Local Park and Active Sportsfield**
Schematic plans of generic active sportsfield and schematic design of the Central Local Park.





2.1 Generally

The Landscape Masterplan on the following page summarises the landscape related components of the Warriewood Valley Release Area Planning Controls (including the DCP's, Warriewood Valley Contributions Plan, and Warriewood Valley Roads Masterplan specifications as amended from time to time). These include:

Street Corridors Street tree planting themes to avenues, industrial avenues, and sector streets. Street trees species for sector shareways and accessways are also identified.

Creekline Corridors, Open Space and Buffer Zones Indicate the 50 m wide multi-use open space reservation to the Narrabeen and Fern Creek Corridors to incorporate pedestrian/cycleway access, creekline rehabilitation and bank stabilisation, weed removal and native revegetation, and passive use recreation.

Open Space and Buffer Zones The Masterplan incorporates an indicative open space scheme for district and neighbourhood parks incorporating development conservation proposals. Buffer zones as indicated represent proposed location of dual purpose (buffer and access link) zones adjoining sensitive areas or required setbacks and screening.

Service and Recreation Identify the indicative location of off road pedestrian and cycleway linkages, playground facilities and public transport nodes.

The aim of the masterplan is to provide a consolidated reference document encompassing all landscape related objectives and requirements of the planning controls for the release area.

Key Public Domain Principles outlined in the DCP which underpin the masterplan and design guidelines following include:

Safety Provision of safe pedestrian and cycle access through road corridors, creek corridors, and open space areas.

Connectivity Vehicular and pedestrian access is efficiently managed through a hierarchy network of attractive and clearly defined links.

Bush in the Valley A minimum of 40% of creekline corridor area is to comprise native vegetation (existing and new) to establish interconnected flora and fauna corridors. The corridors are to support multi-use objectives including pedestrian/cycle access, and passive recreation.

Recreation in the Valley Distribution of open space / parkland areas to cater for a variety of functions and user types including playground facilities and park furniture.

Streetscape guidelines have been prepared to guide those responsible for planning and development of the public domain in the Warriewood Valley in the implementation of Council's objectives for a coordinated, functional and attractive landscape image.

A key consideration in the development of guideline has been the objective of establishing common themes for the layout of streetscape elements such as tree planting, shared pedestrian/cycle paths and street lighting.

The presence of underground services and utilities places a significant constraint on the ability to provide meaningful street tree canopy. Street trees of adequate scale (height and spread) are the fundamental strategy by which Council's objectives of "Bushland in the Valley" and quality of living and working environment can be realised.

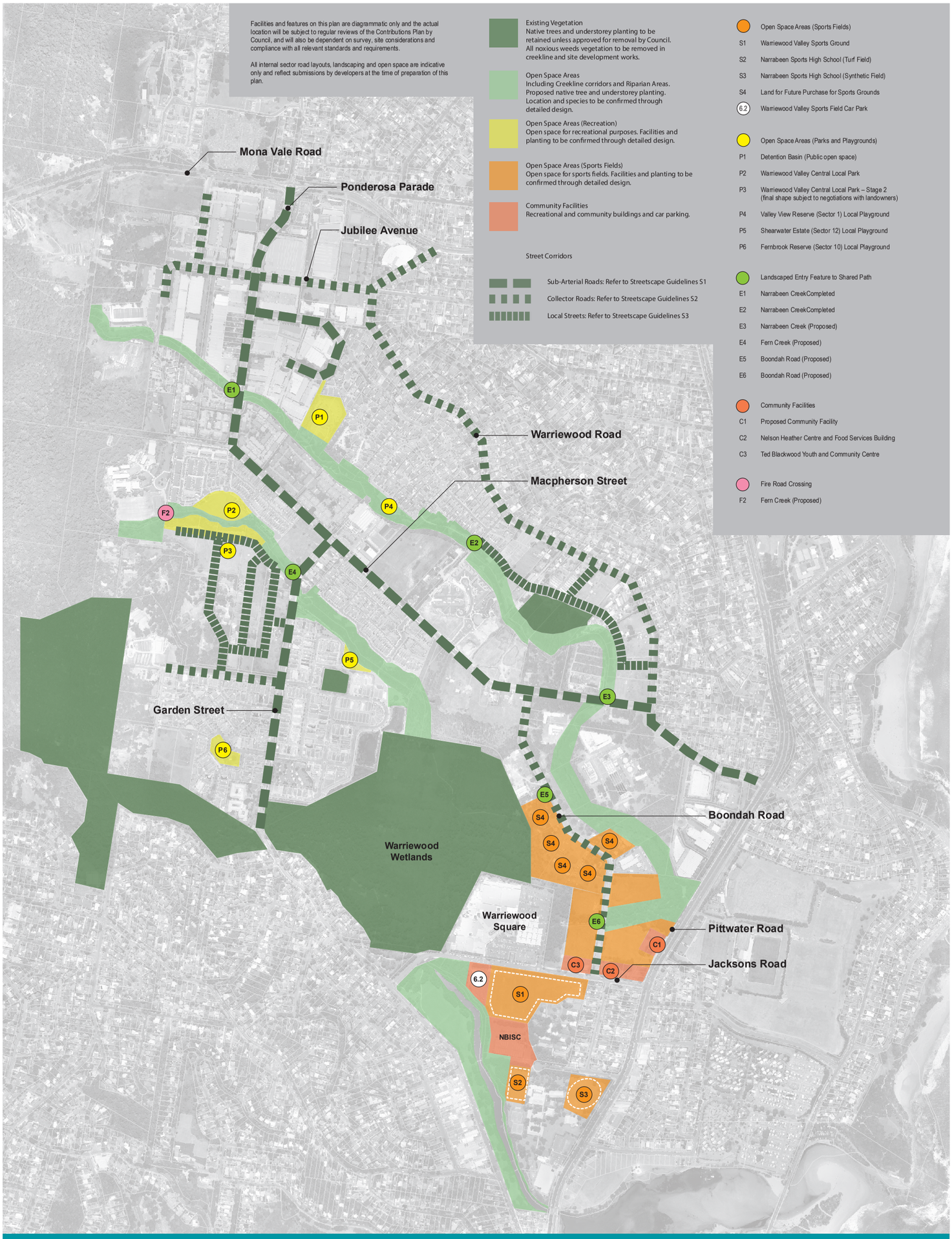
The cross sections shown on the streetscape guidelines indicate the options available for incorporation of street tree planting in the typical footpath reserve situation identified by Council's Masterplan.

These options indicate that for Sub Arterials a consistent setback 0.55 metres from the property boundary is preferred. To Avenues incorporating existing kerb and footpath formations and services/ utilities (eg. section of Macpherson Street) this may require adjustment based on exact location of Ausgrid Ultilities.

For Collector Roads, a centred carriageway, enabling a tree alignment of 2.0 metres from property boundary is preferred.

Liaison will be required with Ausgrid (Avenues) and Telstra (Collector Roads) to ensure that tree alignments can be achieved for these corridor types.



WARRIEWOOD VALLEY RELEASE AREA

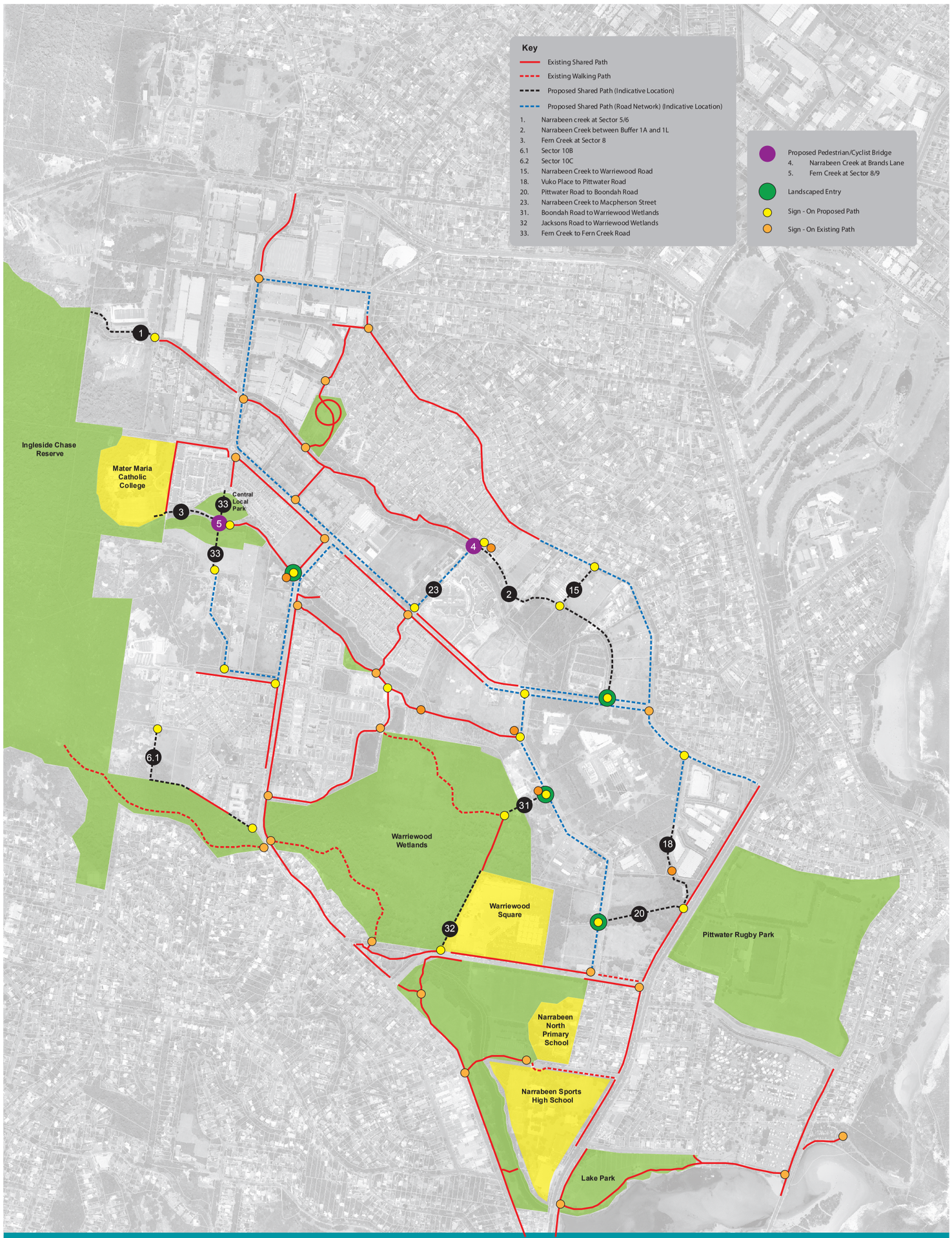
WARRIEWOOD VALLEY OPEN SPACE & STREETSCAPE MASTERPLAN Update Aug 2016

NORTHERN BEACHES COUNCIL

Landscape Masterplan

2.0
2018

NORTHERN BEACHES COUNCIL



WARRIEWOOD VALLEY RELEASE AREA

WARRIEWOOD VALLEY ACTIVE TRAVEL MASTERPLAN

Update Nov 2016

NORTHERN BEACHES COUNCIL

Landscape Masterplan

2.0

2018

Warriewood Valley Release Area

MASTERPLAN AND DESIGN GUIDELINES

Plant species for landscape development

STREET CORRIDORS

LARGE CANOPY TREES	ANGOPHORA COSTATA
	ANGOPHORA FLORIBUNDA
	EUCALYPTUS PUNCTATA
	LOPHOSTEMON CONFERTUS
	SYNCARPIA GLOMULIFERA
	SYZYGIUM PANICULUTUM
	WATERHOUSIA FLORIBUNDA
MEDIUM CANOPY TREES	BANKSIA INTEGRIFOLIA
	CALLISTEMON 'HANNAH RAY'
	CORYMBIA FICIFOLIA
	EUCALYPTUS HAEMASTOMA
	SYZYGIUM LEUHMANNII
	MELALEUCA STYPHELOIDES
	TRISTANIOPSIS LAURINA
	XANTHOSTEMON CHRYSANTHUS
SMALL CANOPY TREES	ACMENA SMITHII 'CULTIVARS'
	BACKHOUSIA MYRTIFOLIA
	BUCKINGHAMIANA CELSISSIMA
	CALLISTEMON 'ENDEAVOUR'
	CALLITRIS RHOMBOIDEA
	CERATOPETALUM GUMMIFERUM
	ELAEOCARPUS RETICULATUS
	HYMENOSPORUM FLAVUM
	LEPTOSPERMUM PETERSONII
	MELALEUCA LINARIIFOLIA
	METROSIDEROS EXCELSA
	SYZYGIUM PANICULATUM 'SMALL CULTIVARS'
	TRISTANIA LAURINA
	* ACER PALMATUM
	* LAGERSTROEMIA 'CULTIVARS'
	* MURRAYA PANICULATA (not hedged)
	* PHOTINIA 'CULTIVARS'
	* VIBURNUM TINUS (not hedged)
PALM TREES	LIVISTONA AUSTRALIS
SHRUBS	CALLISTEMON 'SMALL CULTIVARS' to 1m
	CORREA ALBA
	WESTRINGIA 'SMALL CULTIVARS' to 1m
GROUNDCOVERS	DIANELLA SP.
	LOMANDRA 'SMALL CULTIVARS'.

* Selected exotic small trees to be used for small lots less than 6m wide and front setbcak of 3m only.

CREEKLINE CORRIDORS
(CENTRAL 50M PUBLIC CORRIDOR)

AQUATIC PLANTS	ALISMA PLANTAGO-AQUATICA
(0.0 TO 0.3M WATER DEPTH)	BAUMEA ARTICULATA
	BAUMEA JUNCEA
	BAUMEA RIBIGNOSA
	BOLBOSCHOENUS FLUVIATILIS
	BOLBOSCHOENUS CADWELLII
	ELEOCHARIS SPHACELATA
	PHILYDRUM LANGUINOSUM
	PHRAGMITIES AUSTRALIA
	SCHENOPLECTUS VALIDUS
	TRIGLOCHIN PROCERA
LITTORIAL PLANTS	CAREX APPRESSA
FREQUENTLY INUNDATED	JUNCUS KRAUSSII
	JUNCUS USITATUS
	CYPERUS BREVIFOLIUS
	ISCAHNE GLOBOSA
	PHILYDRUM LANGUINOSUM
GRASSES INFREQUENTLY	CAREX APPRESSA
INUNDATED	DIANELLA CAERULEA
	GAHNIA SIEBERANA
	ISOLEPIS NODOSA
	LOMANDRA LONGIFOLIA
	JUNCUS USITATUS
	PLUS LOCALLY NATIVE GRASSESS
SHRUBS	ACACIA ELONGATA
	ACACIA LONGIFOLIA
	ACACIA SUAVEOLENS
	ACACIA IMPLEXA
	ACACIA DECURRENS
	CALLISTEMON CITRINUS
	CALLISTEMON LINEARIS
	GOODENIA PANICULATA
	LEPTOSPERMUM JUNIPERINUM
	KUNZEA AMBIGUA
	MELALEUCA ERICIFOLIA
	PULTANAEA VILLOSA
	PITTOSPORUM REVOLUTUM
TREES	ACMENA SMITHII
	ANGOPHORA COSTATA (ON SAND RIDGES)
	ANGOPHORA FLORIBUNDA
	BACKHOUSIA MYRTIFOLIA
	CALLITRIS RHOMBOIDEA
	CASUARINA GLAUCA
	CERATOPETALUM APETALUM
	CERATOPETALUM GUMMIFERUM
	EUCALYPTUS ROBUSTA
	EUCALYPTUS BOTRYOIDES
	GIOCHIDION FERDINAND
	SYNCARPIA GLOMULIFERA
	LIVISTONA AUSTRALIS

CREEKLINE CORRIDORS
(25M PRIVATE CREEKLINE BUFFER STRIP)

			NARRABEEN CREEK	FERN CREEK	MULLET CREEK
CANOPY TREES	SWAMP MAHOGANY	EUCALYPTUS ROBUSTA	X		X
	PORT JACKSON FIG	FICUS RUBIGINOSA		X	X
	SANDERPAPER FIG	FICUS CORONATA		X	
	WATER GUM	TRISTANIOPSIS LAURINA		X	X
	SMOOTH BARKED APPLE	ANGOPHORA COSTATA		X	X
	ROUGH BARKED APPLE	ANGOPHORA FLORIBUNDA		X	
	SWAMP SHE-OAK	CASUARINA GLAUCA	X		X
	SNOW-IN-SUMMER	MELALEUCA LINEARIFOLIA			X
	SWAMP PAPERBARK	MELALEUCA ERICIFOLIA	X		X
	CABBAGE TREE PALM	LIVISTONIA AUSTRALIS	X	X	X
	COAST BANKSIA	BANKSIA INTEGRIFLORA	X		X
	TURPENTINE	SYNCARPIA GLOMULIFERA			
	GREY GUM	EUCALYPTUS PUNCTATA	X		X
	BANGALAY	EUCALYPTUS BOTRYOIDES		X	X
	LILLY PILLY	ACMENA SMITHII		X	
	CHEESE TREE	GLOCHIDION FERDINANDI		X	X
	PAPAREBARK	MELALEUCA QUINQUENERVIA	X		
	COACHWOOD	CERATOPETALUM APETALUM		X	X
	ROUGH TREE FERN	CYATHEA AUSTRALIS	X	X	X
UNDERSTOREY/SHRUBS	ROUGH TREE FERN	CYATHEA AUSTRALIS	X	X	X
	SWEET WATTLE	ACACIA SUAVEOLENS	X	X	X
	HONEYSUCKLE BANKSIA	BANKSIA SPINULOSA	X		X
	COAST BANKSIA	BANKSIA INTEGRIFOLIA	X		X
	NSW CHRISTMAS BUSH	CERATOPETALUM GUMMIFERUM	X	X	X
	PINK SPIDER FLOWER	GREVILLEA SERICEA	X		X
	CYCAD	MACROZAMIA COMMUNIS	X		X
	RED FLOWERING PAPERBARK	MELALEUCA HYPERICIFOLIA	X		X
	BLACK WATTLE	CALLICOMA SERRATIFLOLIA		X	
	GOLDEN GUINEA FLOWER	HIBBERTIA SCANDENS	X	X	X
NATIVE GRASS & AQUATICS	GRASS TREE	XANTHORRHOEA SPP	X		X
	DOG ROSE	BAUERA RUBIODES		X	X
	KANGAROO GRASS	THEMEDA AUSTRALIS		X	X
	WATER VINE	CISSUS HYPOGLAUCA	X	X	X
	RUSH	JUNCUS SPP	X	X	X
	WATER SEDGE	GAHNIA SIEBERANA	X		
	MAT RUSH	LOMANDRA LONGIFOLIA	X	X	X
	WEEPING GRASS	MICROLAENA STIPOIDES	X	X	X

RECREATION OPEN SPACES

FERN CREEK DISTRICT PARK	REFER CREEKLINE CORRIDOR PLANTING - FERN
APOLLO RESERVE WETLAND	REFER CREEKLINE CORRIDOR PLANTING - NARRABEEN
SECTOR 1 N'BHOOD PARK	REFER CREEKLINE CORRIDOR PLANTING - NARRABEEN
SECTOR 8 N'BOURH'D PARK	REFER CREEKLINE CORRIDOR PLANTING - FERN
SECTOR 10 N'BOURH'D PARK	REFER CREEKLINE CORRIDOR PLANTING - MULLET
BOONDAH RD SPORTSFIELDS	REFER CREEKLINE CORRIDOR PLANTING - NARRABEEN

BUFFER PLANTINGS

SECTOR ONE	REFER CREEKLINE CORRIDOR PLANTING - NARRABEEN
SECTOR THREE	REFER CREEKLINE CORRIDOR PLANTING - FERN
WARRIEWOOD WETLAND	REFER CREEKLINE CORRIDOR PLANTING - MULLET

3.0

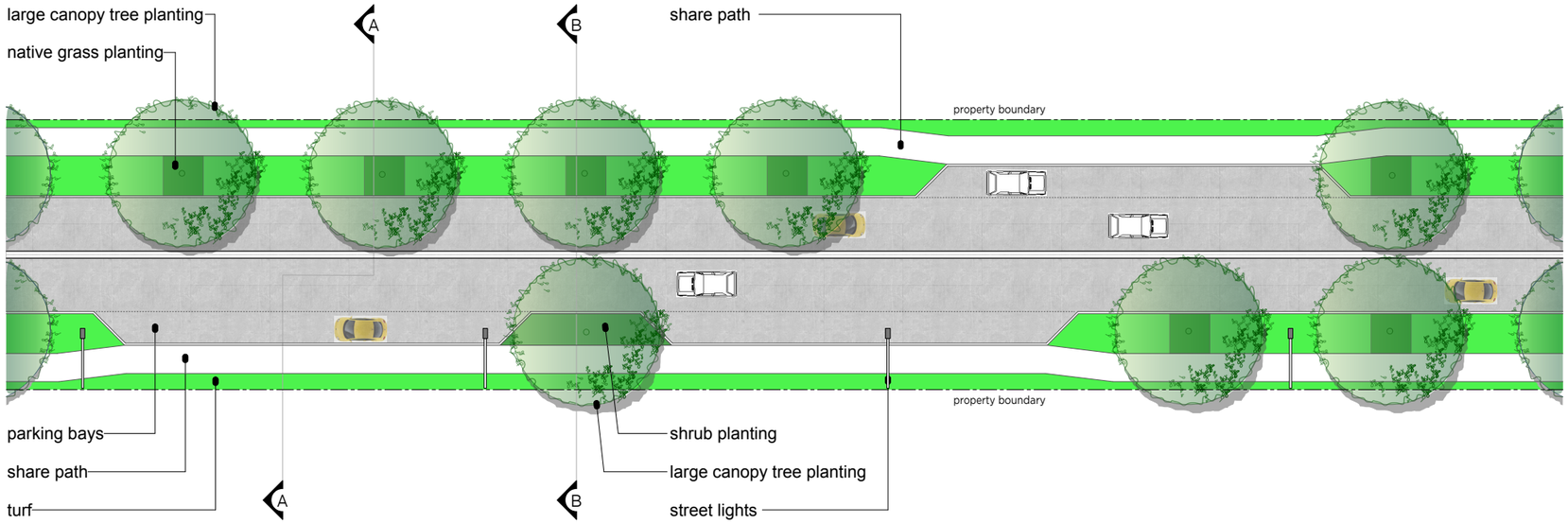
2018

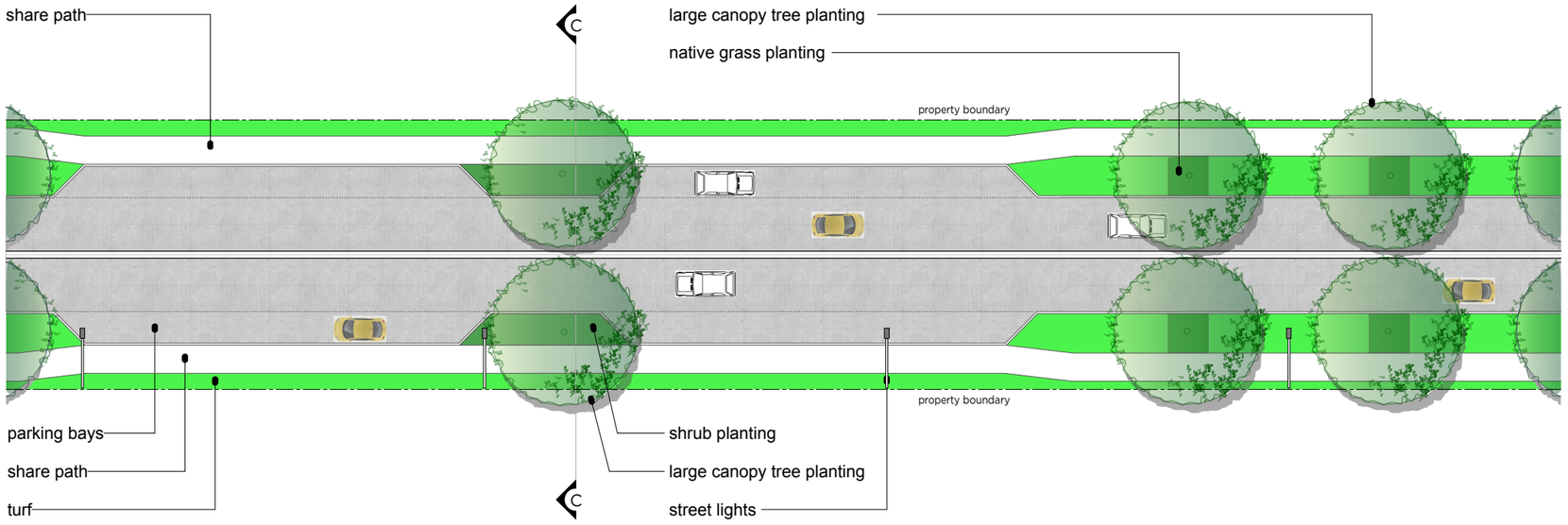
Streetscape Guidelines

Sub Arterial Street

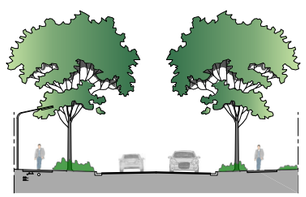
S-1

2018

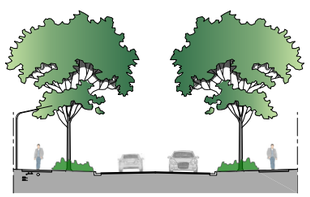




section A-A



section B-B



section C-C

Landscape Materials Schedule

S-1

SHARE PATH	2.1m wide min. concrete construction with broom surface finish to Australian Standards
TURF AREAS	Existing subgrade shall be excavated to loosen the ground conditions to 200mm depth
	Retain all quality existing topsoil in place, subject to approval from Council
	Poor existing soils shall be replaced with minimum 100mm depth imported soilmix as nominated, subject to approval from Council
SOIL PREPARATION: GARDEN AREAS and TREE PLANTING	Existing subgrade shall be excavated to loosen the ground conditions to 400mm depth and at least 600mm for tree planting
	Retain all quality existing topsoil in place, subject to approval from Council
	Poor existing soils shall be replaced with minimum 400mm depth for garden areas and 700mm depth for tree planting with imported soilmix as nominated, subject to approval from Council
PLANTING	All trees installed shall be certified as compliant to Natspec's Specifying Trees
□ tree pits 400 litre stock	Tree pits shall be a minimum of 700mm depth x 2.5m wide
□ soilmix and mulch	Backfilling soilmix shall consist of approved existing site topsoil or replacement soilmix subject to Council approval
	All tree pit backfilling shall consist of 100% sandy loam, followed by a 100mm depth toplayer of organic humus mix
	Mulch shall consist of 75mm coarse hardwood chip mulch
□ tree guards	All street trees shall include hardwood tree guards as follows, and subject to final approval by Council:
	Hardwood timber construction consisting of 4 x 75x75 posts into a concrete slurry base set at 1 metre apart, to sit 1.5m above the ground and 1m into the ground, with top and mid rails 25x75, fastened to the posts. Details are to be submitted on all plans.
□ tree selection 400 litre stock	Shall be selected as listed under section 2.0 Plant Species, for all Medium and Large Canopy Trees, or as advised by Council.
	Specification: 400 litre container, 4m overall height above ground, 1.8m clear trunk, 60mm caliper, and to be approved by Council.

REFER TO CURRENT WARRIEWOOD VALLEY ROADS MASTER PLAN FOR ROAD RESERVE AND CARRIAGEWAY WIDTHS

Guidelines

Location

Ponderosa Parade, MacPherson Street, Warriewood Road (east of MacPherson Street), Garden Street

Principles

Street tree planting to be installed as per masterplan generally at 6-12m intervals dependant of the species characteristics, mature size and location.

All street trees to be minimum 400 litre stock for S-1 (large canopy trees), and subject to final approval by Council. All street trees shall be subject to pre-order of plant material. All trees to be grown by recognised nursery under natspec growing guidelines. Alternative street tree container sizes may be considered only when existing services or road infrastructure limit the available soil volume where a large rootball will not be possible, subject to Council approval.

Existing trees over 3 metres in height are to be retained where possible, with consideration to health and condition, within the road reserve. Such trees are to be protected through perimeter 1.8 metre high temporary fencing during the construction of works.

All kerb widenings to incorporate mass planted areas of suitable low height shrubs and groundcovers. Planting should be selected relative to sight lines required for specific locations.

Street tree plantings should generally include underplantings of native grasses as noted for S-1.

Garden area planting to be at a high density (ie. 4 per m2 for shrubs and 9 per m2 for groundcovers) and generally include drought tolerant native species up to 1m in ultimate height. All shrub planting should be a minimum 5 litre pot size and groundcobers shall be 200mm pot size.

Water points to be provided to verge planting areas at 50-100m centres dependent on ultimate street layout.

All pram or disabled access ramps to be in accordance with Austroad, DDA and Australian Standards.

All proposed works must be liaised with utility authorities (via Dial Before You Dig) with utility location drawings kept on site at all times.

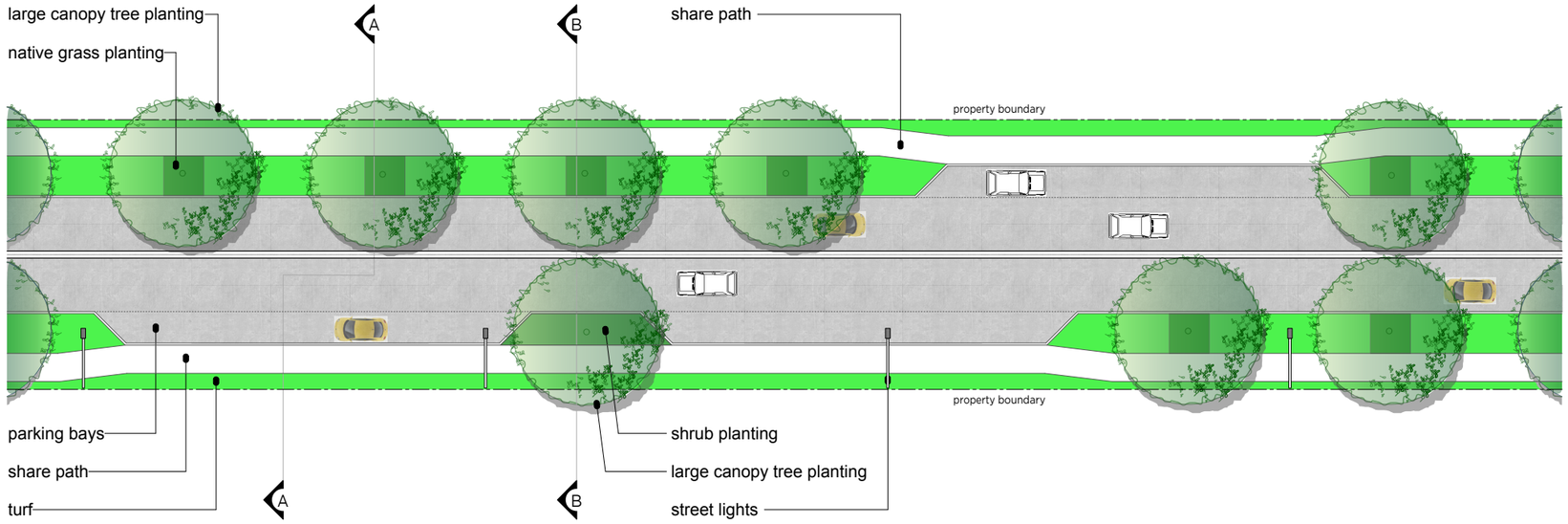
Generally all plant material is to be endemic to the area. Plant material not endemic to the area may be used to accent planting for nominated entries or features but kept to a design minimum.

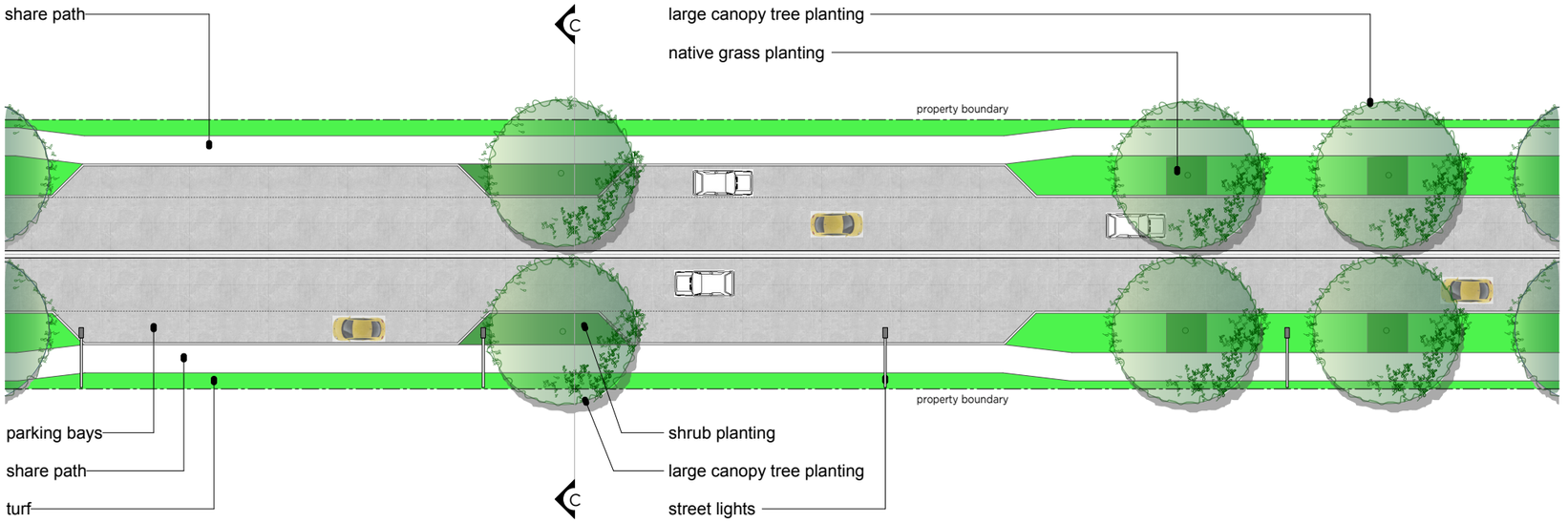
Street lighting poles must be conventional Energy Australia, i.e. either Decorative Style No.1 or Style No.2.

Collector Street

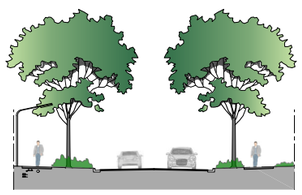
S-2

2018

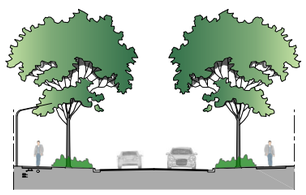




section A-A



section B-B



section C-C

Landscape Materials Schedule

S-2

SHARE PATH	2.1m wide min. concrete construction with broom surface finish to Australian Standards
TURF AREAS	Existing subgrade shall be excavated to loosen the ground conditions to 200mm depth
	Retain all quality existing topsoil in place, subject to approval from Council
	Poor existing soils shall be replaced with minimum 100mm depth imported soilmix as nominated, subject to approval from Council
SOIL PREPARATION:	Existing subgrade shall be excavated to loosen the ground conditions to 400mm depth and at least 700mm for tree planting
GARDEN AREAS and	
TREE PLANTING	Retain all quality existing topsoil in place, subject to approval from Council
	Poor existing soils shall be replaced with minimum 400mm depth for garden areas and 700mm depth for tree planting with imported soilmix as nominated, subject to approval from Council
PLANTING	All trees installed shall be certified as compliant to Natspec's Specifying Trees
□ tree pits 400 litre stock	Tree pits shall be a minimum of 700mm depth x 2.5m wide
□ soilmix and mulch	Backfilling soilmix shall consist of approved existing site topsoil or replacement soilmix subject to Council approval
	All tree pit backfilling shall consist of 100% sandy loam, followed by a 100mm depth toplayer of organic humus mix
	Mulch shall consist of 75mm coarse hardwood chip mulch
□ tree guards	All street trees shall include hardwood tree guards as follows, and subject to final approval by Council:
	Hardwood timber construction consisting of 4 x 75x75 posts into a concrete slurry base set at 1 metre apart, to sit 1.5m above the ground and 1m into the ground, with top and mid rails 25x75, fastened to the posts. Details are to be submitted on all plans.
□ tree selection 400 litre stock	Shall be selected as listed under section 2.0 Plant Species, for all Medium and Large Canopy Trees, or as advised by Council
	Specification: 400 litre container, 4m overall height above ground, 1.8m clear trunk, 60mm caliper, and to be approved by Council.

REFER TO CURRENT WARRIEWOOD VALLEY ROADS MASTER PLAN FOR ROAD RESERVE AND CARRIAGEWAY WIDTHS

Guidelines

Location

Foley Street, Jubilee Avenue, Vineyard Street, Orchard Street, Daydream Street, Boondah Road

Principles

Street tree planting to be installed as per masterplan generally at 6-12m intervals dependant of the species characteristics, mature size and location.

All street trees to be minimum 400 litre stock for S-2 (large canopy trees), and subject to final approval by Council. All street trees shall be subject to pre-order of plant material. All trees to be grown by recognised nursery under natspec growing guidelines. Alternative street tree container sizes may be considered only when existing services or road infrastructure limit the available soil volume where a large rootball will not be possible, subject to Council approval.

Existing trees over 3 metres in height are to be retained where possible, with consideration to health and condition, within the road reserve. Such trees are to be protected through perimeter 1.8 metre high temporary fencing during the construction of works.

All kerb widenings to incorporate mass planted areas of suitable low height shrubs and groundcovers. Planting should be selected relative to sight lines required for specific locations.

Street tree plantings should generally include underplantings of native grasses as noted for S-2.

Garden areas planting to be at a high density (ie. 4 per m2 for shrubs and 9 per m2 for groundcovers) and generally include drought tolerant native species up to 1m in ultimate height. All shrub planting should be a minimum 5 litre pot size and groundcobers shall be 200mm pot size.

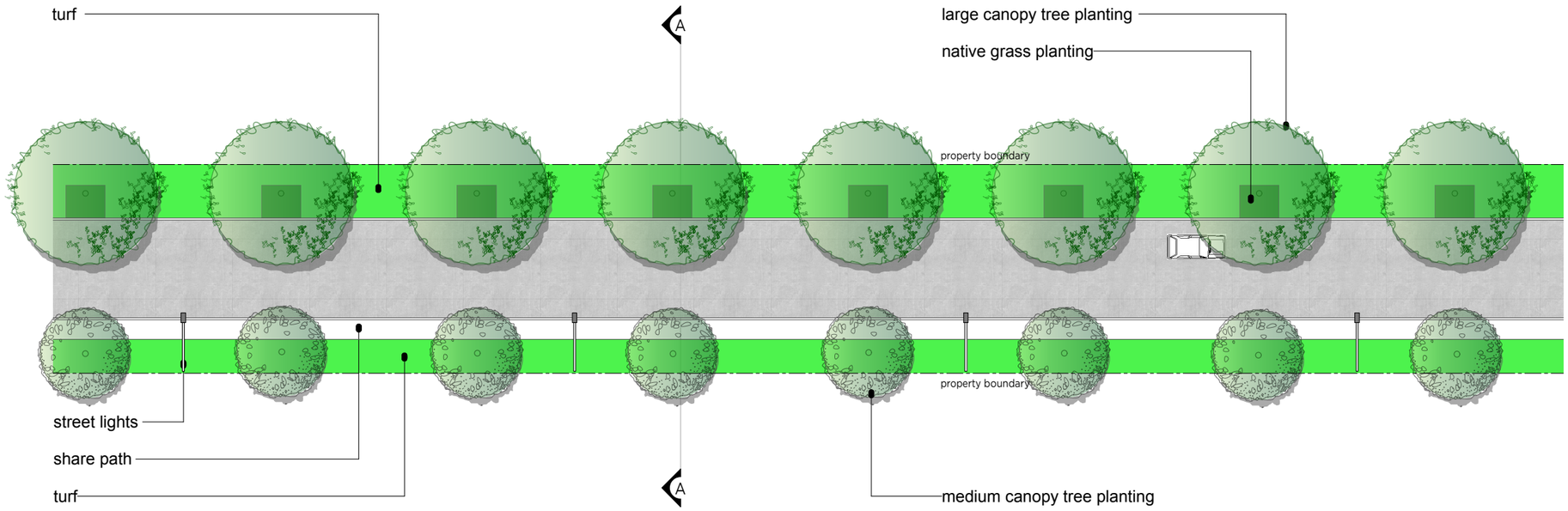
Water points to be provided to verge planting areas at 50-100m centres dependent on ultimate street layout.

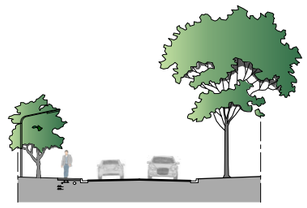
All pram or disabled access ramps to be in accordance with Austroad, DDA and Australian Standards.

All proposed works must be liaised with utility authorities (via Dial Before You Dig) with utility location drawings kept on site at all times.

Generally all plant material is to be endemic to the area. Plant material not endemic to the area may be used to accent planting for nominated entries or features but kept to a design minimum.

Street lighting poles must be conventional Energy Australia, i.e. either Decorative Style No.1 or Style No.2.





section A-A

Landscape Materials Schedule

S-3

SHARE PATH	1.5m wide min. concrete construction with broom surface finish to Australian Standards
+ Note	The exception to this provision for a 1.5m sharepath applies to Fern Creek Road, which in accordance with the Active Travel Masterplan requires a 2.1m wide sharepath along Fern Creek Road
TURF AREAS	existing subgrade shall be excavated to loosen the ground conditions to 200mm depth retain all quality existing topsoil in place, subject to approval from Council poor existing soils shall be replaced with minimum 100mm depth imported soilmix as nominated, subject to approval from Council
SOIL PREPARATION: GARDEN AREAS and TREE PLANTING	Existing subgrade shall be excavated to loosen the ground conditions to 400mm depth and at least 600mm for tree planting Retain all quality existing topsoil in place, subject to approval from Council Poor existing soils shall be replaced with minimum 400mm depth for garden areas and 700mm depth for tree planting with imported soilmix as nominated, subject to approval from Council
PLANTING	All trees installed shall be certified as compliant to Natspec's Specifying Trees Tree pits shall be a minimum of 700mm depth x 2.5m wide Tree pits shall be a minimum of 700mm depth x 2.0m wide Backfilling soilmix shall consist of approved existing site topsoil or replacement soilmix subject to Council approval All tree pit backfilling shall consist of 100% sandy loam, followed by a 100mm depth toplayer of organic humus mix Mulch shall consist of 75mm coarse hardwood chip mulch
□ tree pits 400 litre stock □ tree pits 200 litre stock □ soilmix and mulch	
□ tree guards □ tree selection 400 litre stock and 200 litre stock	All street trees shall include hardwood tree guards as follows, and subject to final approval by Council: Hardwood timber construction consisting of 4 x 75x75 posts into a concrete slurry base set at 1 metre apart, to sit 1.5m above the ground and 1m into the ground, with top and mid rails 25x75, fastened to the posts. Details are to be submitted on all plans. Shall be selected as listed under section 2.0 Plant Species, for all Medium and Large Canopy Trees, or as advised by Council Specification: 400 litre container, 4m overall height above ground, 1.8m clear trunk, 60mm caliper, and to be approved by Council. 200 litre container, 3m overall height above ground, 1.8m clear trunk, 40mm caliper, and to be approved by Council.

REFER TO CURRENT WARRIEWOOD VALLEY ROADS MASTER PLAN FOR ROAD RESERVE AND CARRIAGEWAY WIDTHS

Local Street

S-3

2018

Guidelines

Principles

Street tree planting to be installed as per masterplan generally at 6-12m intervals dependant of the species characteristics, mature size and location.

All street trees for S-3 are to be a minimum 400 litre stock for large canopy trees and 200 litre stock for medium canopy trees, and subject to final approval by Council. All street trees shall be subject to pre-order of plant material. All trees to be grown by recognised nursery under natspec growing guidelines. Alternative street tree container sizes may be considered only when existing services or road infrastructure limit the available soil volume where a large rootball will not be possible, subject to Council approval.

Existing trees over 3 metres in height are to be retained where possible, with consideration to health and condition, within the road reserve. Such trees are to be protected through perimeter 1.8 metre high temporary fencing during the construction of works.

All kerb widenings to incorporate mass planted areas of suitable low height shrubs and groundcovers. Planting should be selected relative to sight lines required for specific locations.

Street tree plantings should generally include underplantings of native grasses as noted for S-3.

Garden area planting to be at a high density (ie. 4 per m2 for shrubs and 9 per m2 for groundcovers) and generally include drought tolerant native species up to 1m in ultimate height. All shrub planting should be a minimum 5 litre pot size and groundcobers shall be 200mm pot size.

Water points to be provided to verge planting areas at 50-100m centres dependent on ultimate street layout.

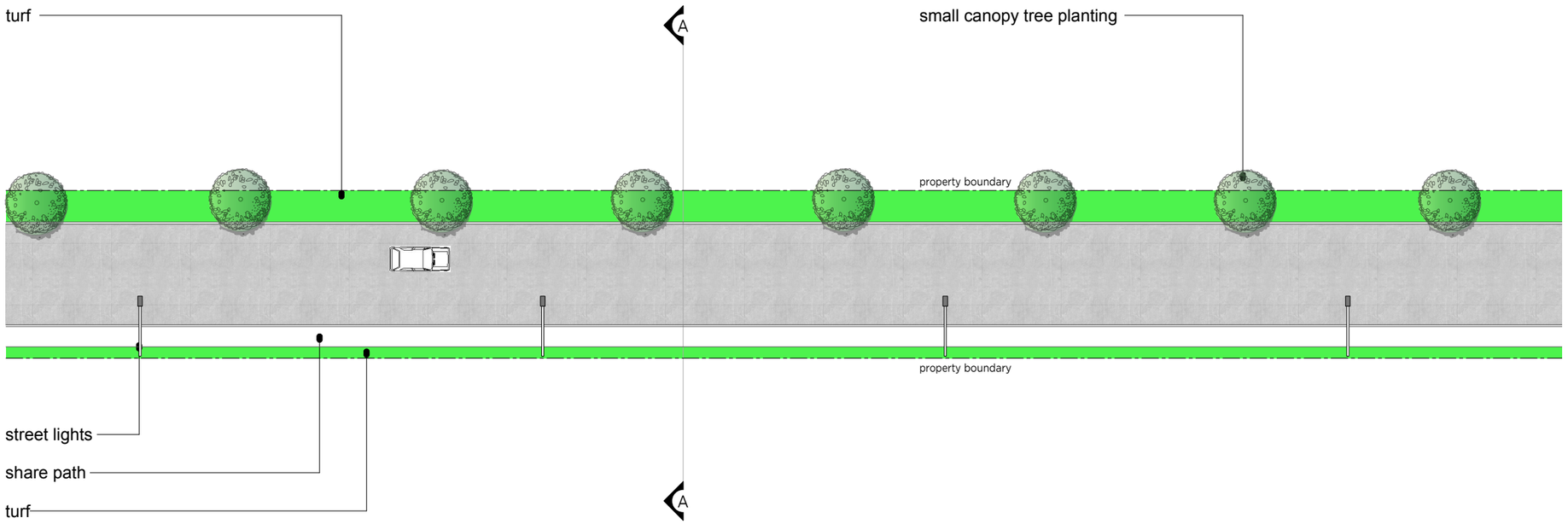
All pram or disabled access ramps to be in accordance with Austroad, DDA and Australian Standards.

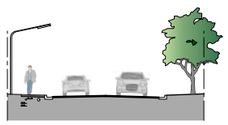
All proposed works must be liaised with utility authorities (via Dial Before You Dig) with utility location drawings kept on site at all times.

All trees planted in turf shall include timber edges with min. 2m x 2m hardwood edging and mulched pit

Generally all plant material is to be endemic to the area. Plant material not endemic to the area may be used to accent planting for nominated entries or features but kept to a design minimum.

Street lighting poles must be conventional Energy Australia, i.e. either Decorative Style No.1 or Style No.2.





section A-A

Landscape Materials Schedule

S-4

SHARE PATH	1.5m wide min. concrete construction with broom surface finish to Australian Standards	SOIL PREPARATION:	Existing subgrade shall be excavated to loosen the ground conditions to at least 700mm for tree planting	PLANTING	All trees installed shall be certified as compliant to Natspec's Specifying Trees	□ tree guards	All street trees shall include hardwood tree guards as follows, and subject to final approval by Council:
TURF AREAS	existing subgrade shall be excavated to loosen the ground conditions to 200mm depth	TREE PLANTING	Retain all quality existing topsoil in place, subject to approval from Council	□ tree pits 200 litre stock	Tree pits shall be a minimum of 700mm depth x 2.0m wide		Hardwood timber construction consisting of 4 x 75x75 posts into a concrete slurry base set at 1 metre apart, to sit 1.5m above the ground and 1m into the ground, with top and mid rails 25x75, fastened to the posts. Details are to be submitted on all plans.
	retain all quality existing topsoil in place, subject to approval from Council		Poor existing soils shall be replaced with minimum 700mm depth for tree planting with imported soilmix as nominated, subject to approval from Council	□ soilmix and mulch	Backfilling soilmix shall consist of approved existing site topsoil or replacement soilmix subject to Council approval	□ tree selection 200 litre stock	Shall be selected as listed under section 2.0 Plant Species, for Small Canopy Trees, or as advised by Council
	poor existing soils shall be replaced with minimum 100mm depth imported soilmix as nominated, subject to approval from Council				All tree pit backfilling shall consist of 100% sandy loam, followed by a 100mm depth toplayer of organic humus mix		Specification:
					Mulch shall consist of 75mm coarse hardwood chip mulch		200 litre container, 3m overall height above ground, 1.8m clear trunk, 40mm caliper, and to be approved by Council.

REFER TO CURRENT WARRIEWOOD VALLEY ROADS MASTER PLAN FOR ROAD RESERVE AND CARRIAGEWAY WIDTHS

Access Street

S-4

2018

Guidelines

Principles

Street tree planting to be installed as per masterplan generally at 6-12m intervals dependant of the species characteristics, mature size and location.

All street trees for S-3 are to be a minimum 200 litre stock for medium canopy trees, and subject to final approval by Council. All street trees shall be subject to pre-order of plant material. All trees to be grown by recognised nursery under natspec growing guidelines. Alternative street tree container sizes may be considered only when existing services or road infrastructure limit the available soil volume where a large rootball will not be possible, subject to Council approval.

Existing trees over 3 metres in height are to be retained where possible, with consideration to health and condition, within the road reserve. Such trees are to be protected through perimeter 1.8 metre high temporary fencing during the construction of works.

Water points to be provided to verge planting areas at 50-100m centres dependent on ultimate street layout.

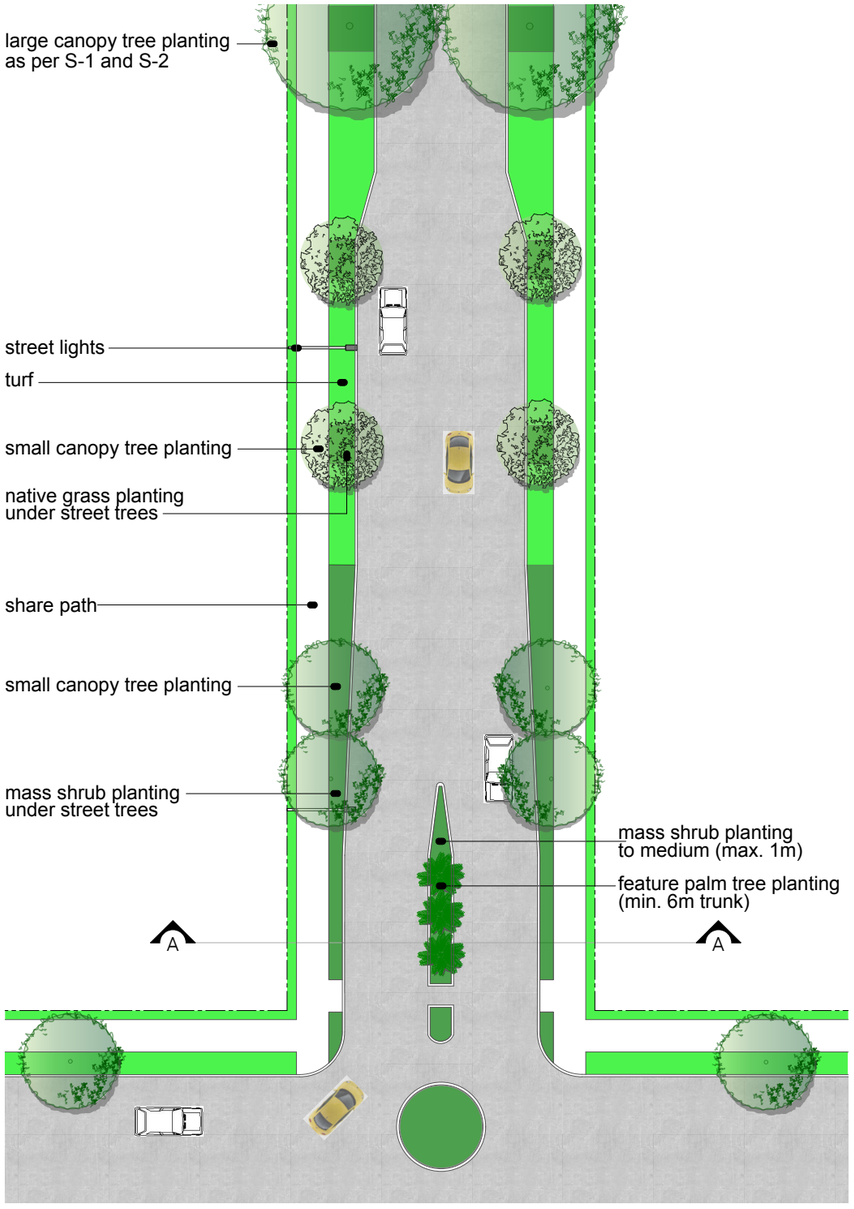
All pram or disabled access ramps to be in accordance with Austroad, DDA and Australian Standards.

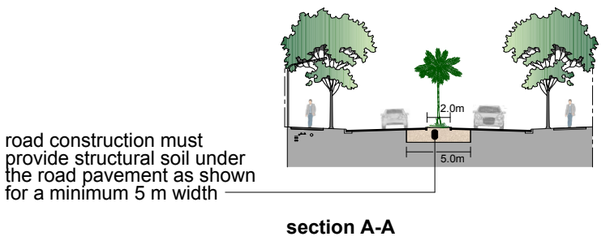
All proposed works must be liaised with utility authorities (via Dial Before You Dig) with utility location drawings kept on site at all times.

All trees planted in turf shall include timber edges with min. 2m x 2m hardwood edging and mulched pit

Generally all plant material is to be endemic to the area. Plant material not endemic to the area may be used to accent planting for nominated entries or features but kept to a design minimum.

Street lighting poles must be conventional Energy Australia, i.e. either Decorative Style No.1 or Style No.2.





section A-A

REFER TO CURRENT WARRIEWOOD VALLEY ROADS MASTER PLAN FOR ROAD RESERVE AND CARRIAGEWAY WIDTHS

Sector Entry

S-5

2018

Landscape Materials Schedule

S-5

SHARE PATH	2.1m wide min. concrete construction with broom surface finish to Australian Standards
TURF AREAS	Existing subgrade shall be excavated to loosen the ground conditions to 200mm depth Retain all quality existing topsoil in place, subject to approval from Council Poor existing soils shall be replaced with minimum 100mm depth imported soilmix as nominated, subject to approval from Council
SOIL PREPARATION: GARDEN AREAS and TREE / PALM PLANTING	Existing subgrade shall be excavated to loosen the ground conditions to 400mm depth and at least 700mm for tree and palm planting Retain all quality existing topsoil in place, subject to approval from Council Poor existing soils shall be replaced with minimum 400mm depth for garden areas and 700mm depth for tree and palm planting with imported soilmix as nominated, subject to approval from Council
PLANTING	All trees / palms installed shall be certified as compliant to Natspec's Specifying Trees
□ tree / palm pits 400 litre stock	Tree / palm pits shall be a minimum of 700mm depth x 2.5m wide
□ soilmix and mulch	Backfilling soilmix shall consist of approved existing site topsoil or replacement soilmix subject to Council approval All tree pit backfilling shall consist of 100% sandy loam, followed by a 100mm depth toplayer of organic humus mix Mulch shall consist of 75mm coarse hardwood chip mulch
□ tree guards	All street trees shall include hardwood tree guards as follows, and subject to final approval by Council: Hardwood timber construction consisting of 4 x 75x75 posts into a concrete slurry base set at 1 metre apart, to sit 1.5m above the ground and 1m into the ground, with top and mid rails 25x75, fastened to the posts. Details are to be submitted on all plans.
□ tree / palm selection 400 litre stock palm stock	Shall be selected as listed under section 2.0 Plant Species, for all Medium and Large Canopy Trees, or as advised by Council. Specification: Trees- 400 litre container, 4m overall height above ground, 1.8m clear trunk, 60mm caliper, and to be approved by Council. Palms-6m clear trunk, and approved by Council.

Guidelines

Principles

Street tree planting to be installed as per masterplan generally at 6-12m intervals dependant of the species characteristics, mature size and location.

Feature palms at the Sector Entry shall be Livistona australis and shall be a minimum clear trunk height of 6 metres tall.

All street trees at Sector Entry to be minimum 400 litre stock for S-5 (large, medium, and small canopy trees), and subject to final approval by Council. Alternative street tree container sizes may be considered only when existing services or road infrastructure limit the available soil volume where a large rootball will not be possible, subject to Council approval. , with nominated tree species subject to final approval by Council.

All palms and street trees shall be subject to pre-order of plant material. All palms and trees to be grown by recognised nursery under natspec growing guidelines.

The feature palms within the median must be installed within a structural soil zone 5m in width requiring the road pavement to be designed to facilitate structural soil under the pavement as detailed.

Existing trees over 3 metres in height are to be retained where possible, with consideration to health and condition, within the road reserve. Such trees are to be protected through perimeter 1.8 metre high temporary fencing during the construction of works.

All kerb widenings to incorporate mass planted areas of suitable low height shrubs and groundcovers. Planting should be selected relative to sight lines required for specific locations.

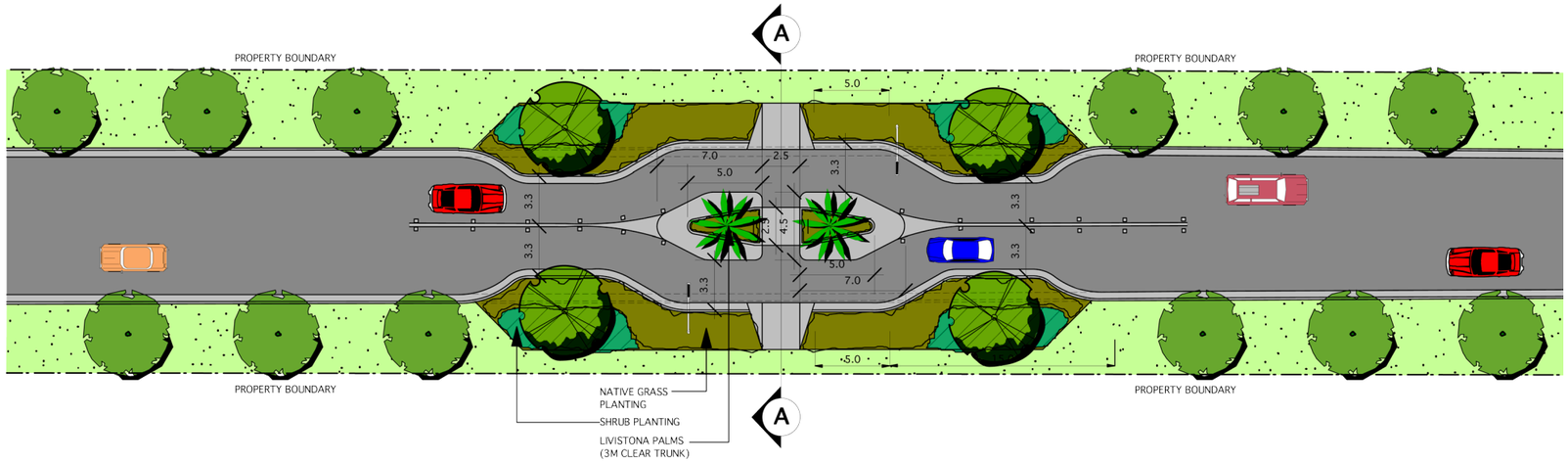
Garden area planting to be at a high density (ie. 4 per m2 for shrubs and 9 per m2 for groundcovers) and generally include drought tolerant native species up to 1m in ultimate height. All shrub planting should be a minimum 5 litre pot size and groundcobers shall be 200mm pot size.

Water points to be provided to verge planting areas at 50-100m centres dependent on ultimate street layout.

All pram or disabled access ramps to be in accordance with Austroad, DDA and Australian Standards.

All proposed works must be liaised with utility authorities (via Dial Before You Dig) with utility location drawings kept on site at all times.

Street lighting poles must be conventional Energy Australia, i.e. either Decorative Style No.1 or Style No.2.



Plan (Not to scale)

Section A-A (Not to scale)

Landscape Materials Schedule

S-6

SHARE PATH	concrete construction with broom surface finish to Australian Standards
TURF AREAS	existing subgrade shall be excavated to loosen the ground conditions to 200mm depth retain all quality existing topsoil in place, subject to approval from Council poor existing soils shall be replaced with minimum 100mm depth imported soilmix as nominated, subject to approval from Council
SOIL PREPARATION: GARDEN AREAS and TREE / PALM PLANTING	Existing subgrade shall be excavated to loosen the ground conditions to 400mm depth and at least 700mm for tree and palm planting Retain all quality existing topsoil in place, subject to approval from Council Poor existing soils shall be replaced with minimum 400mm depth for garden areas and 700mm depth for tree and palm planting with imported soilmix as nominated, subject to approval from Council
PLANTING	All trees / palms installed shall be certified as compliant to Natspec's Specifying Trees
□ tree / palm pits 400 litre stock	Tree / palm pits shall be a minimum of 700mm depth x 2.5m wide
□ soilmix and mulch	Backfilling soilmix shall consist of approved existing site topsoil or replacement soilmix subject to Council approval All tree pit backfilling shall consist of 100% sandy loam, followed by a 100mm depth toplayer of organic humus mix Mulch shall consist of 75mm coarse hardwood chip mulch
□ tree guards	All street trees shall include hardwood tree guards as follows, and subject to final approval by Council: Hardwood timber construction consisting of 4 x 75x75 posts into a concrete slurry base set at 1 metre apart, to sit 1.5m above the ground and 1m into the ground, with top and mid rails 25x75, fastened to the posts. Details are to be submitted on all plans.
□ tree / palm selection 400 litre stock palm stock	Shall be selected as listed under section 2.0 Plant Species, for all Medium and Large Canopy Trees, or as advised by Council. Specification: Trees- 400 litre container, 4m overall height above ground, 1.8m clear trunk, 60mm caliper, and to be approved by Council. Palms-6m clear trunk, and approved by Council.

REFER TO CURRENT WARRIEWOOD VALLEY ROADS MASTER PLAN FOR ROAD RESERVE AND CARRIAGEWAY WIDTHS

Refuge Island

S-6

2018

Guidelines

Principles

Nodal planting of specific canopy trees to identify pedestrian refuge crossing points.

All street trees to be minimum 35-400 litre stock, dependant of species selection and location, and this is subject to final approval by Council. All street trees shall be subject to pre-order of plant material. All trees to be grown by recognised nursery under natspec growing guidelines.

Existing trees over 3 metres in height are to be retained where possible, with consideration to health and condition, within the road reserve. Such trees are to be protected through perimeter 1.8 metre high temporary fencing during the construction of works.

All kerb widenings to incorporate mass planted areas of suitable low height shrubs and groundcovers. Planting should be selected relative to sight lines required for specific locations.

Street tree plantings to footpath should generally include underplantings of native grasses.

Garden area planting to be at a high density (ie. 4 per m2 for shrubs and 9 per m2 for groundcovers) and generally include drought tolerant native species up to 1m in ultimate height. All shrub planting should be a minimum 5 litre pot size and groundcobers shall be 200mm pot size.

Water points to be provided to verge planting areas at 50-100m centres dependent on ultimate street layout.

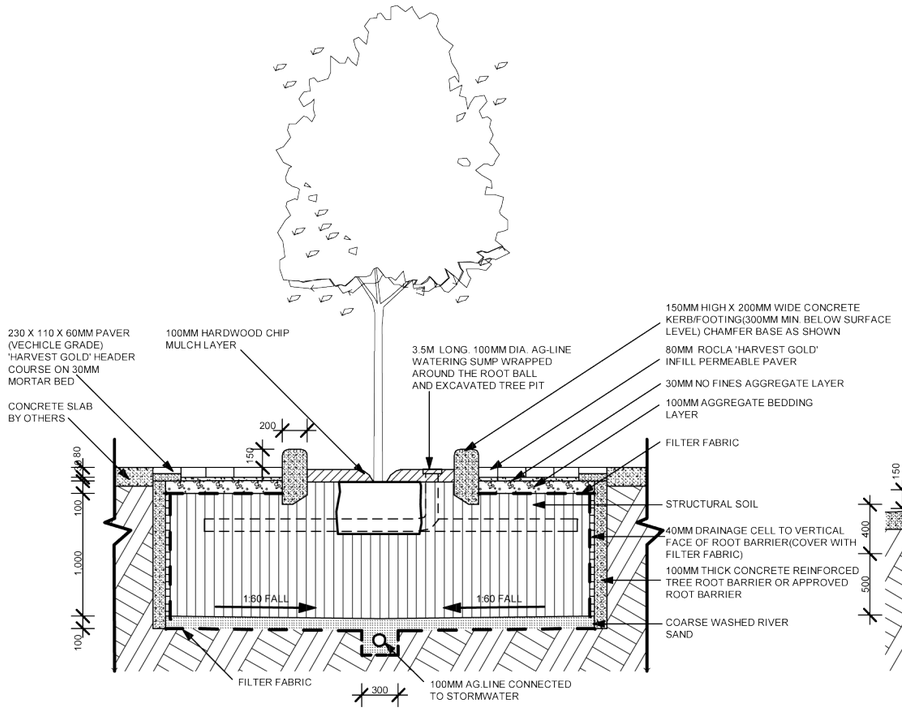
All pram or disabled access ramps to be in accordance with Austroad, DDA and Australian Standards.

All proposed works must be liaised with utility authorities (via Dial Before You Dig) with utility location drawings kept on site at all times.

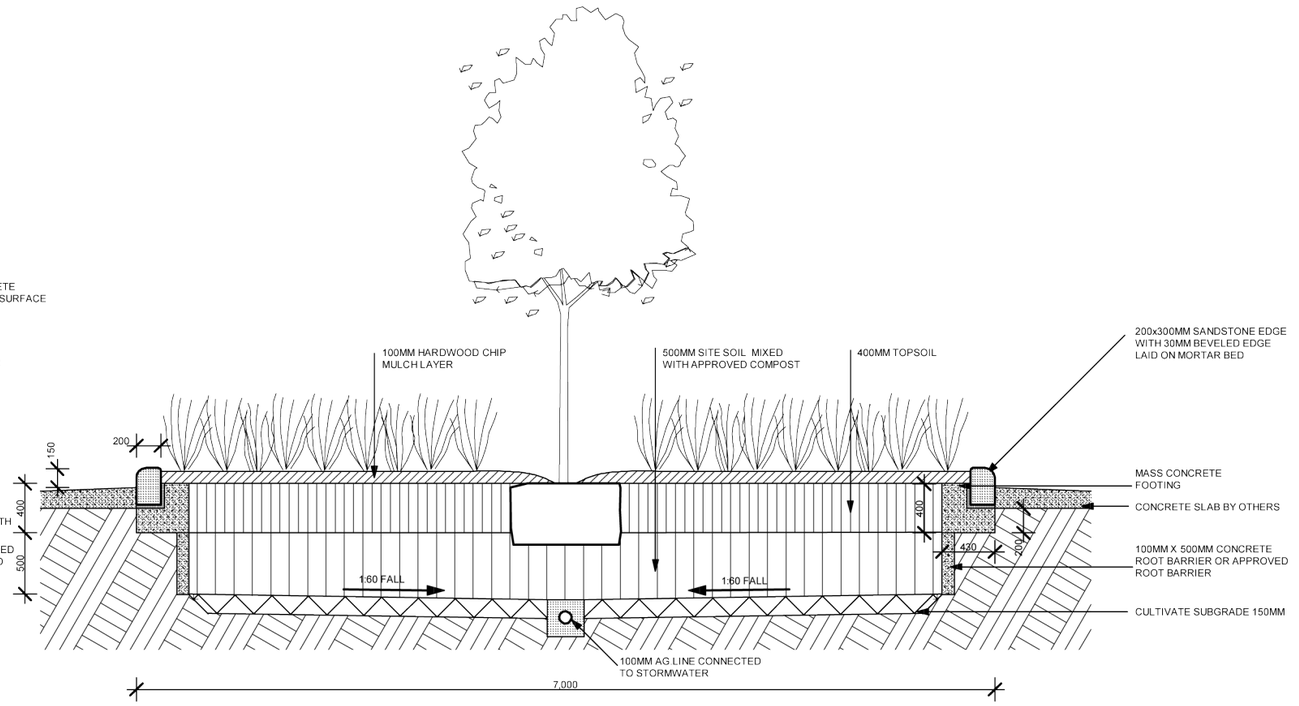
All trees planted in turf shall include timber edges with min. 2m x 2m hardwood edging and mulched pit

Generally all plant material is to be endemic to the area. Plant material not endemic to the area may be used to accent planting for nominated entries or features but kept to a design minimum.

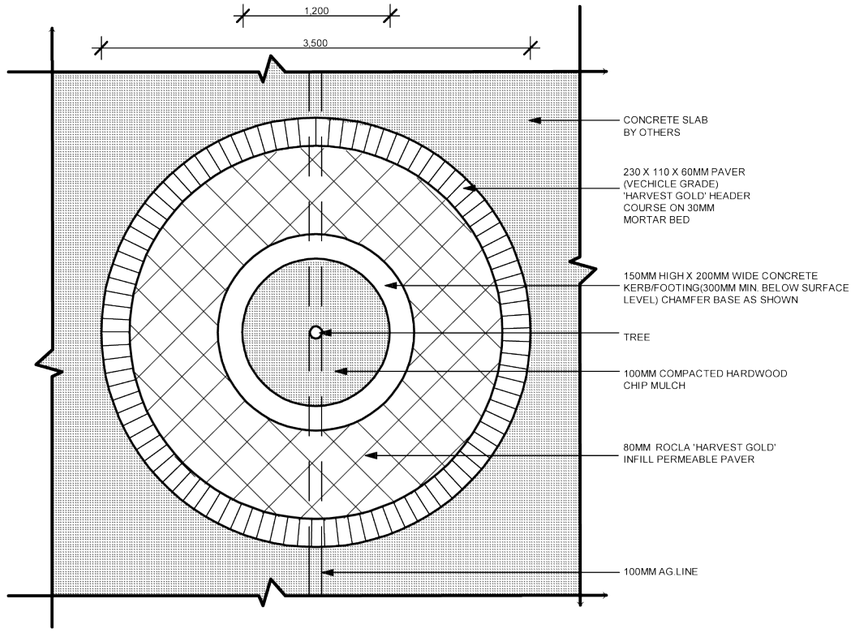
Street lighting poles must be conventional Energy Australia, i.e. either Decorative Style No.1 or Style No.2.



SECTION Scale 1:50

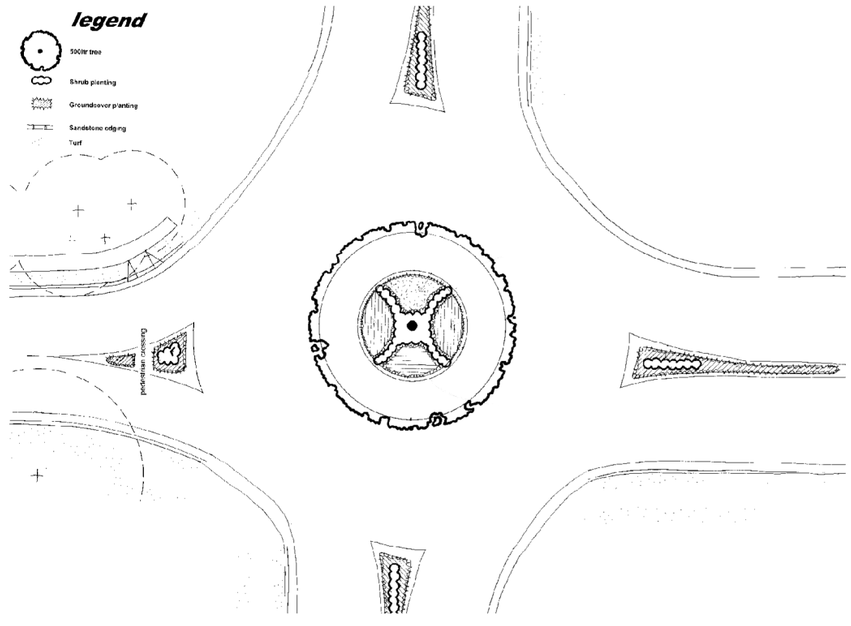


SECTION Scale 1:50



PLAN Scale 1:50

TYPICAL ROUNDABOUT Structural Soils



PLAN Not To Scale

TYPICAL ROUNDABOUT Non Structural Soils

Roundabout

S-7

2018

Guidelines

Principles

Where traffic templates allow for softworks in the roundabout, construct according to the adjacent detail, 'Typical Roundabout – Non Structural Soils'. Note all dimensions are a minimum.

Where traffic templates don't allow for softworks, plant a tree in the centre of the roundabout using structural soils and permeable paving. Construct according to the adjacent detail, 'Typical Roundabout – Structural Soils'. Note all dimensions are a minimum.

All kerb widenings to incorporate mass planted areas (rather than turf) that is able to be hedged or easily manicured. Planting should be selected relative to sight lines required for specific locations.

Garden areas to include minimum 400mm cultivated soil (compost added) and mulched with 100mm hardwood chip. Planting to be at a high density (ie. 4 per m2) and generally include drought tolerant native species up to 1m n ultimate height. All shrub / groundcover planting to be minimum 5 litre size.

All proposed works must be liaised with utility authorities (via Dial Before You Dig) with utility location drawings kept on site at all times.

Generally all plant material is to be endemic to the area. Plant material not endemic to the area may be used to accent planting for nominated entries or features but kept to a design minimum.

Materials

PLANTS

Min pot size – Trees: 500 litre, Shrubs: 5 litre, Groundcovers: 2.5 litre.

SOILS

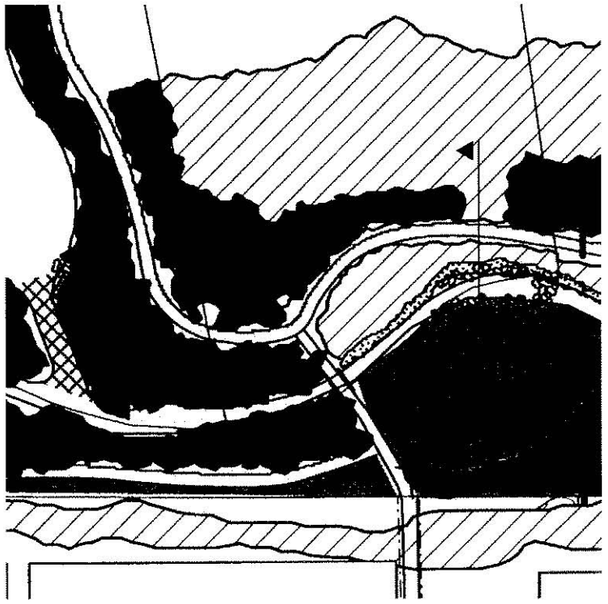
Topsoil – Orgaic Garden Mix.

Structural Soil – 40mm Structural Soil.

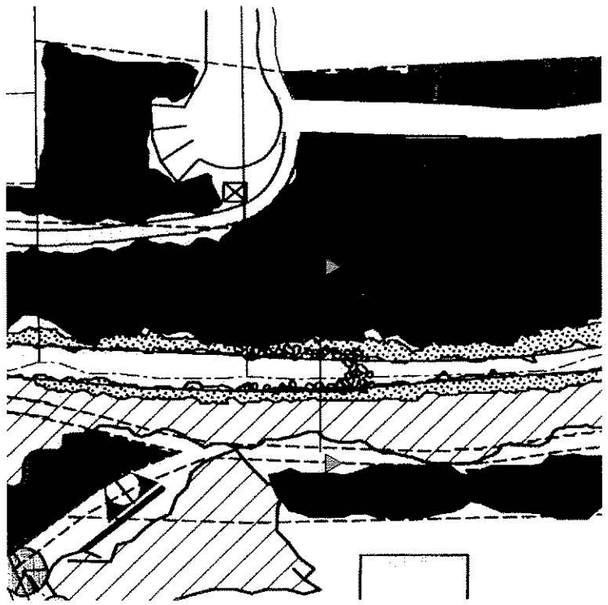
4.0

2018

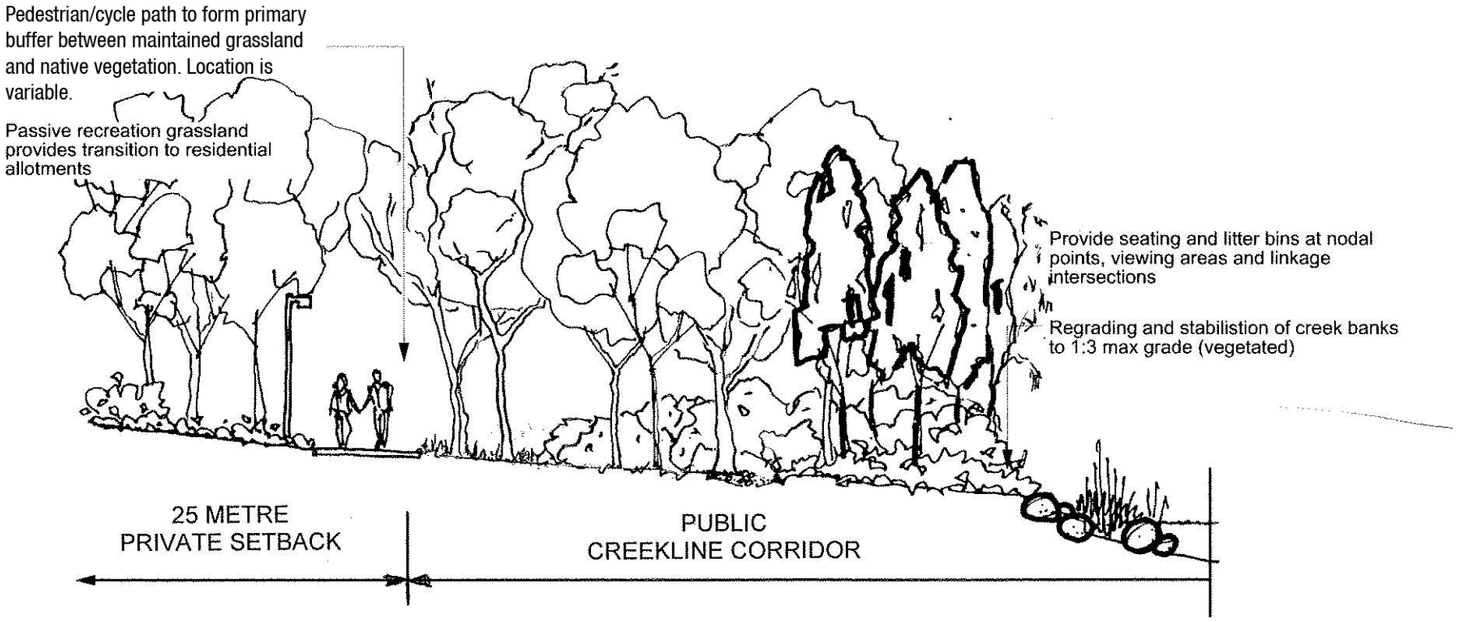
Creekline Guidelines



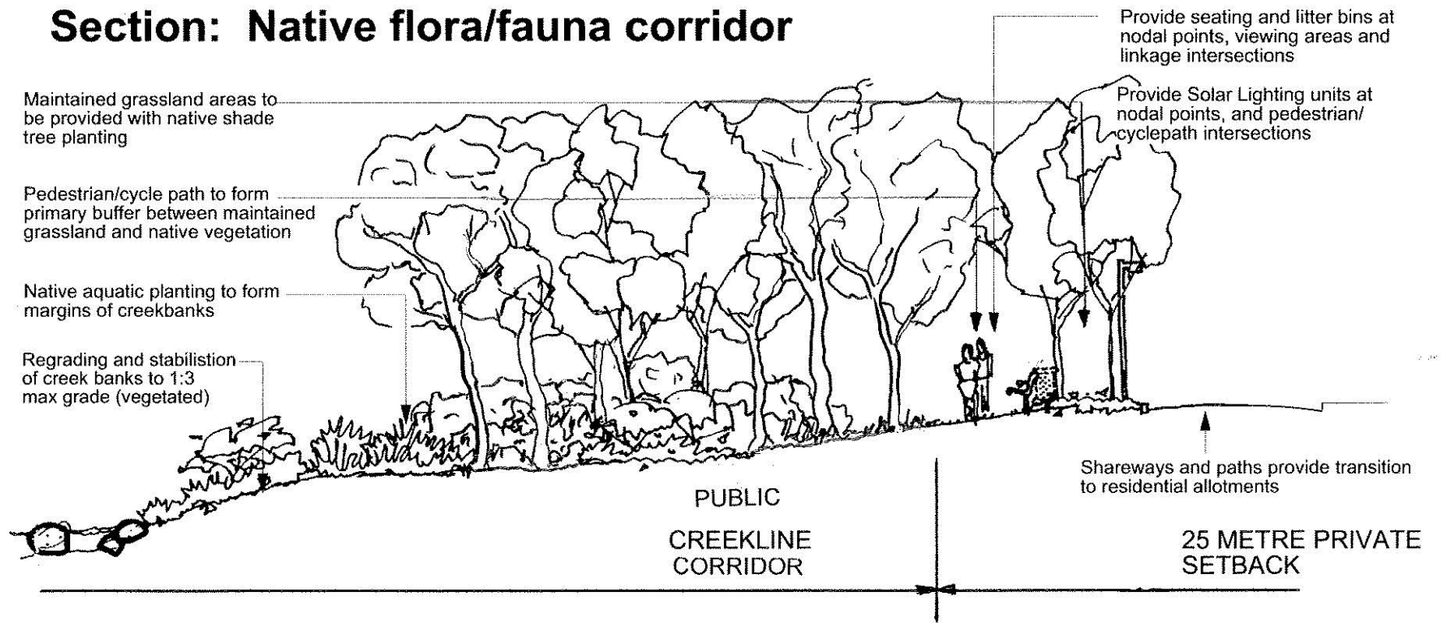
Plan: Vegetated corridor



Section: Multiuse corridor areas



Section: Native flora/fauna corridor



Creekline: Integrated Multiuse Corridor

C-1

2018

Guidelines

Location:

The 50 metre creekline reservation of Narrabeen and Fern Creek.

Principles:

50 metre creekline reservation to be planned and implemented as multi-use open space corridors to incorporate:

Creekline rehabilitation;regrading and stabilistion of creek banks to 1:3 max grade (vegetated) and 1:6 max grade (at water access points, see C-2)

Rock armouring of waterline to reduce propensity for erosion. Weed removal and native revegetation

Recreational amenity; Pedestrian/ cycle linkages to residential areas and for district access.

Integrate corridors with Neighbourhood Park areas where possible to consolidate open space area, share facilities (eg. Playgrounds)

Flora and Fauna Habitat; Provide for native vegetation or revegetation to a minimum of 40% of areas as interlinked vegetation corridor creekline reserve.

Locate pedestrian/cycle path to form edge between maintained grassland and native vegetation. Where alternate edge is required provide timber edge (150x50mm Band) with 1.5mtr width of Nepean River gravel margin as maintenance barrier.

Pedestrian/cycle paths to be located above the 20% AEP flood level for that specific location. It is preferred the pedestrian/cycle path acts as a transition between the Inner 25 metre Creekline Corridor and the Outer 25 metre Creekline Corridor, The location is variable to ensure connectivity with existing sections of the path and vegetation conservation.

Maintained grassland areas to be provided with native shade tree planting.

Provide widenings to creek waterbody where possible to slow water movement and provide additional environmental feature.

Maintain adequate sightlines to pedestrian/cycle path alignment to meet Austroads standards.

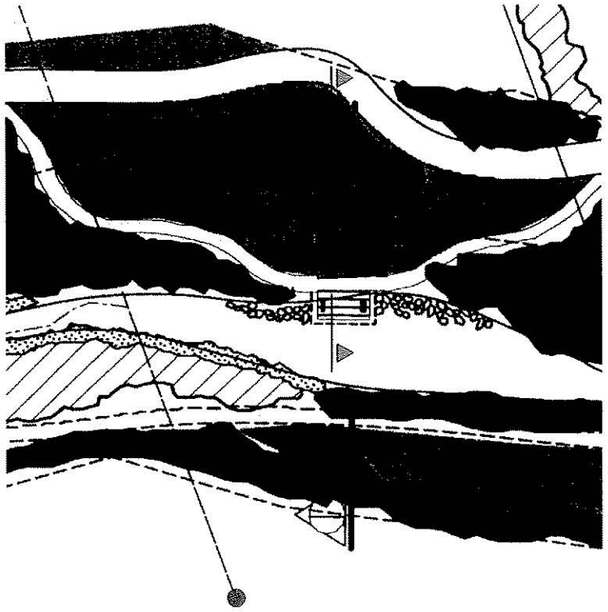
Provide seating and litter bins at nodal points, viewing areas and linkage intersections.

-Seats at litter bins at nominal 250 metre spacing

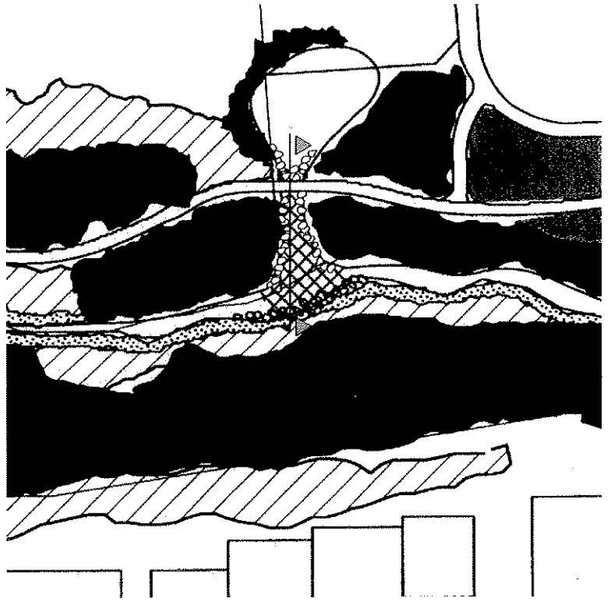
-Signs at nominal 100 metre spacings

- Solar lights at nominal 50 metre spacings

-Refer to Water Management Specification

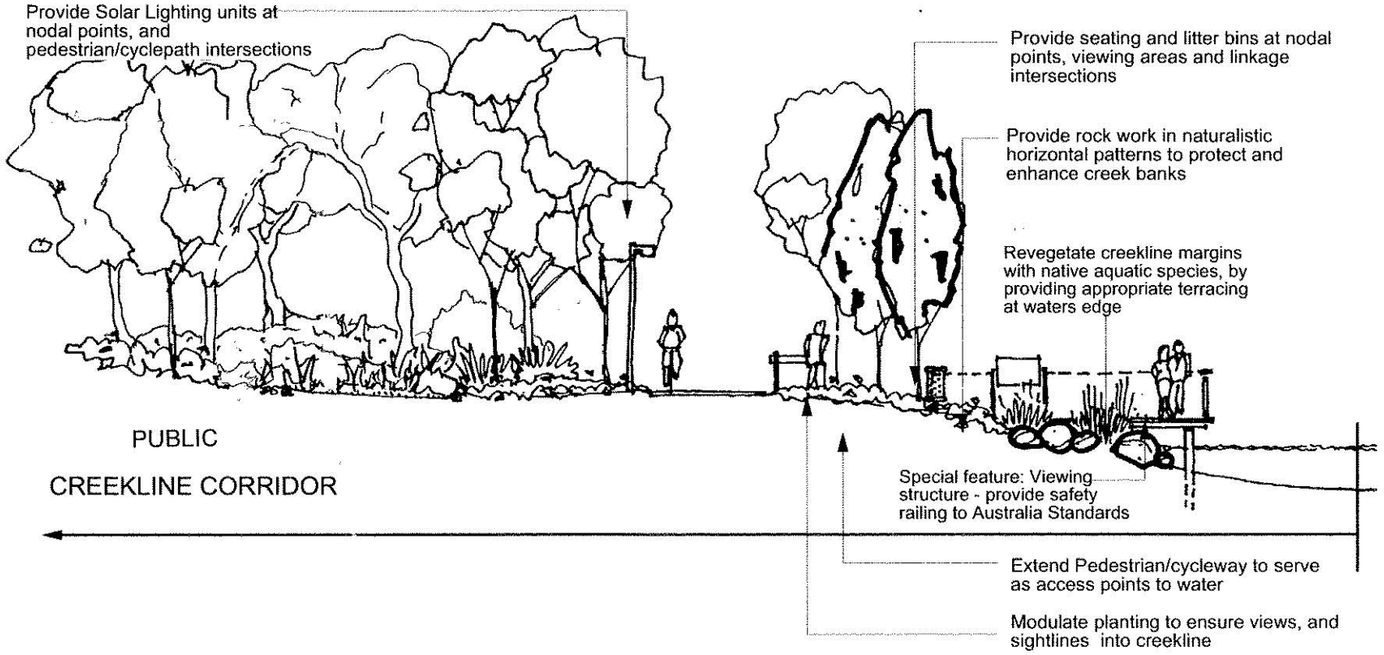


Plan: Accessible water

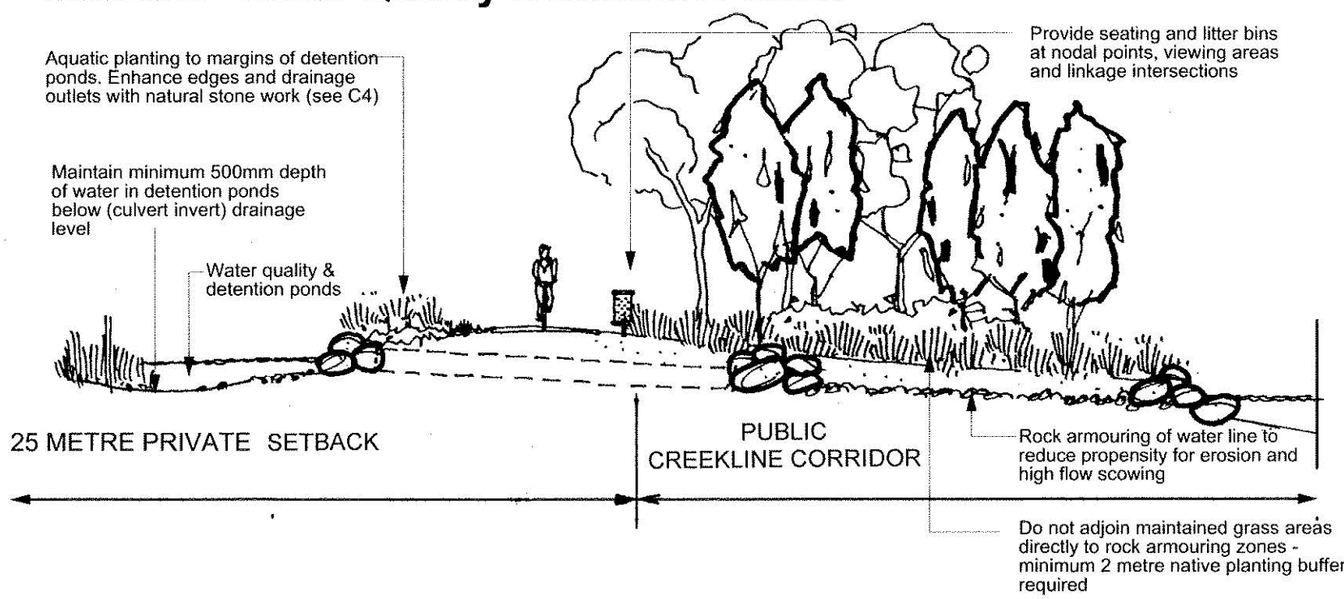


Plan: Water Management bodies

Section: Water bodies and viewing area



Section: Water Quality Detention Ponds



Guidelines

Location:

Adjacent Water Quality Detention ponds, and at creek waterbody widenings

Principles:

Provide varied and safe access to creekline and waters edge at select locations.

Extend Pedestrian/cycleway to serve as access points to water.

Modulate planting to ensure views, and sightlines into creekline.

Revegetate creekline margins with native aquatic species. Provide

appropriate terracing at waters edge to provide viable planting depths, and where bank gradients require.

Provide rock work in naturalistic horizontal patterns protect and enhance creek banks.

Do not adjoin maintained grass areas directly to rock armouring zones - minimum 2 metre native planting buffer required.

Refer to DCP No.20 for recommended creekline species for vegetation precincts.

Maintain Pedestrian/cycle sightlines and security surveillance through alignment of path and planting design.

Pedestrian/cycle paths to be located above the 20% AEP flood level for that specific location. It is preferred the pedestrian/cycle path acts as a transition between the Inner 25 metre Creekline Corridor and the Outer 25 metre Creekline Corridor, The location is variable to ensure connectivity with existing sections of the path and vegetation conservation.

Provide seating and litter bins at nodal points, viewing areas and linkage intersections.

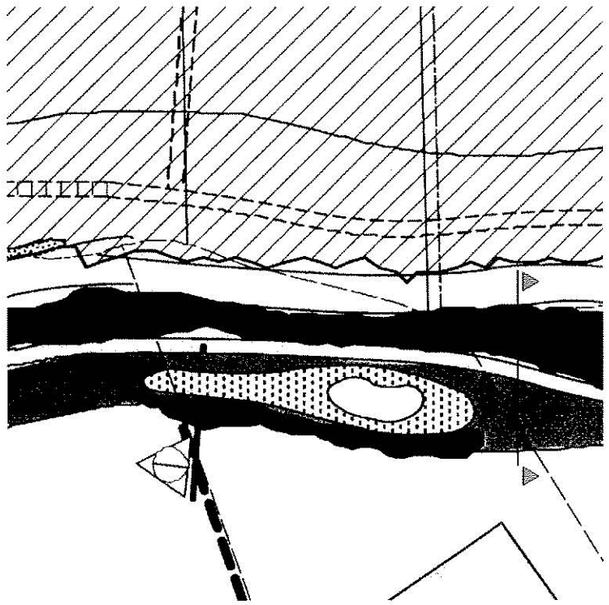
-Seats at litter bins at nominal 250 metre spacing

-Signs at nominal 100 metre spacings

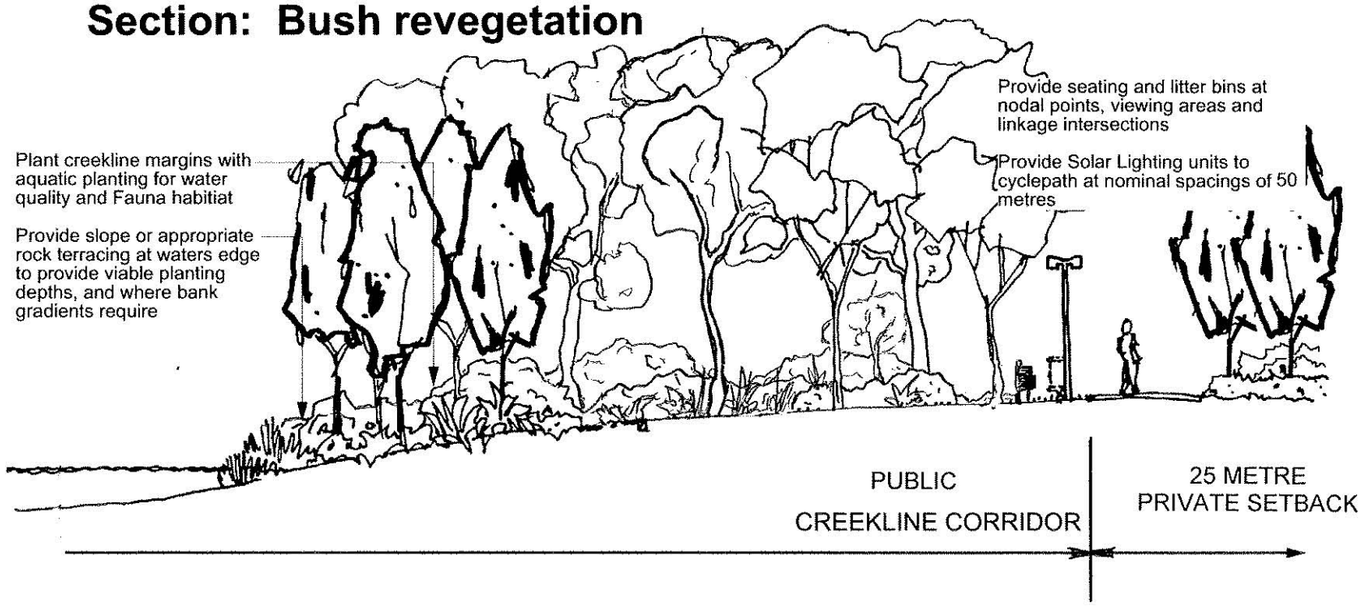
- Solar lights at nominal 50 metre spacings

Lights to conform with Category B2 for minor streets and cycleways.

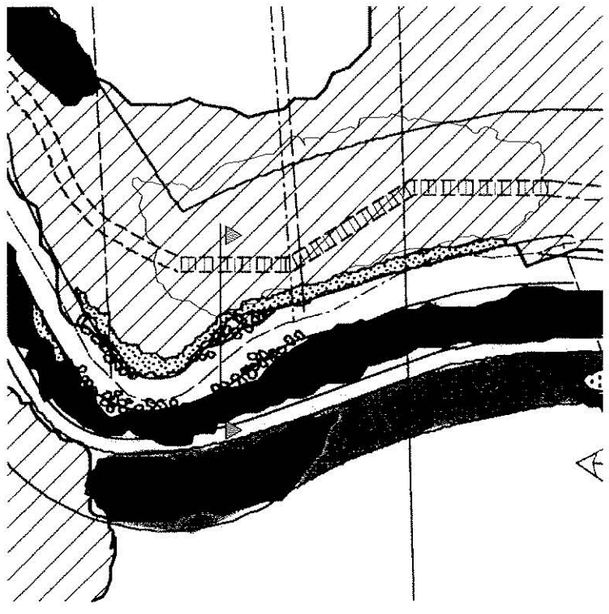
Plan: Remnant Bush

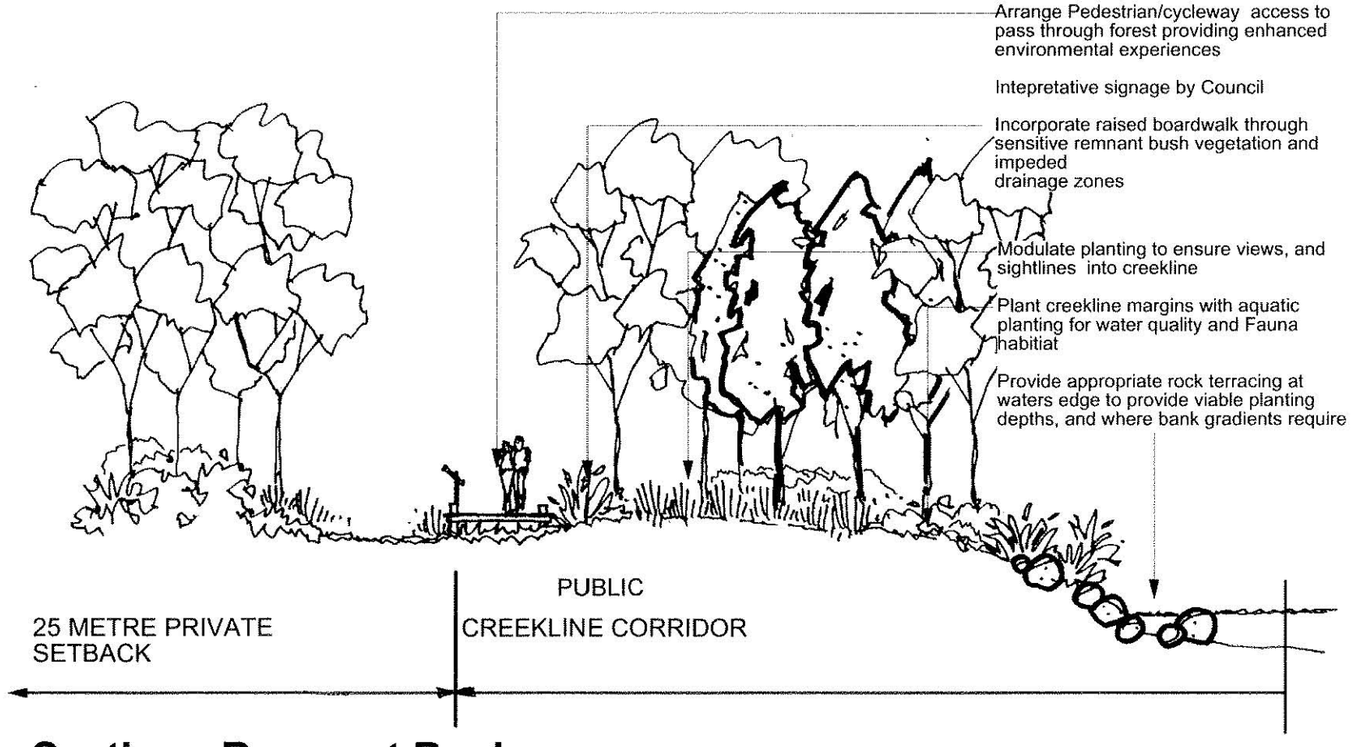


Section: Bush revegetation



Plan: Bush revegetation





Section: Remnant Bush

Guidelines

Location:

Adjacent remnant stands of native bush land vegetation, and revegetation zones along creeklines reservations.

Principles:

Protect stands of Swamp Mahogany Forest to creekline margin.

Extend Pedestrian/cycleway to serve as access points to water. This maybe in the form of boardwalks

Arrange Pedestrian/cycleway access to pass through forest providing enhanced environmental experiences.

Incorporate raised boardwalk through impeded drainage zones.

Extend Swamp Mahogany vegetation community through natural bushland revegetation techniques, to appropriate areas. Provide Bushland revegetation strategy.

Provide Environmental Impact Assessment of design proposals with Development Application (DA).

Plant creekline margins with aquatic planting for water quality and Fauna habitiat. Provide appropriate terracing at waters edge for viable planting depths.

Provide appropriate rock terracing at waters edge to provide viable planting depths, and where bank gradients require.

Maintain Pedestrian/cycle sightlines and security surveillance through alignment of path and planting design. Modulate planting to ensure views, and sightlines into creekline.

Pedestrian/cycle paths to be located above the 20% AEP flood level for that specific location. It is preferred the pedestrian/cycle path acts as a transition between the Inner 25 metre Creekline Corridor and the Outer 25 metre Creekline Corridor, The location is variable to ensure connectivity with existing sections of the path and vegetation conservation.

Provide seating and litter bins at nodal points, viewing areas and linkage intersections

Creekline: Typical Landscape Treatment

C-4

2018

Outlet to be setback, from the waterway, a minimum of 13 multiplied by the diameter of the outlet pipe. e.g. 200mm pipe is setback 2.6 metres from the toe of the creek bed.

Create densely planted sedge area in front of outlet.

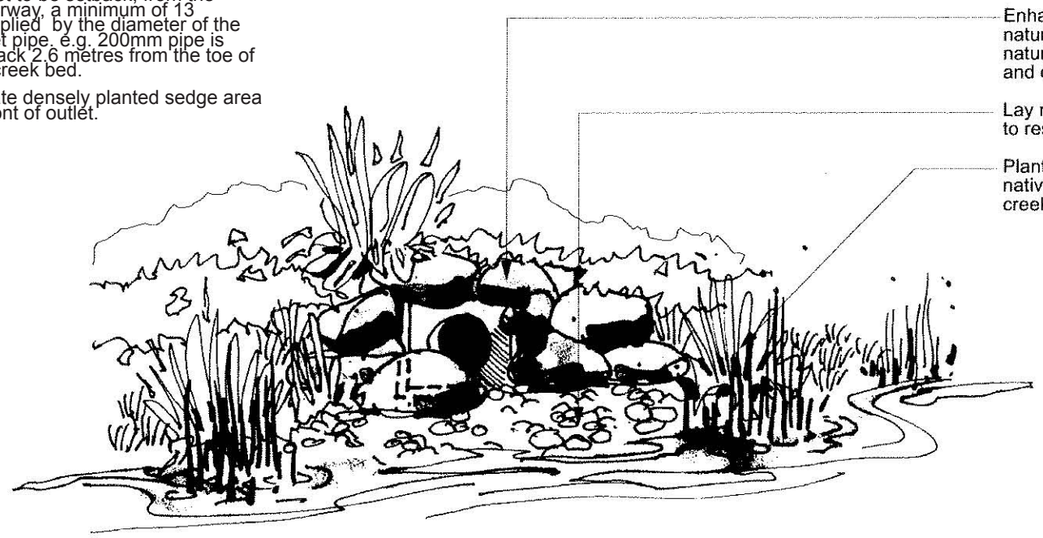
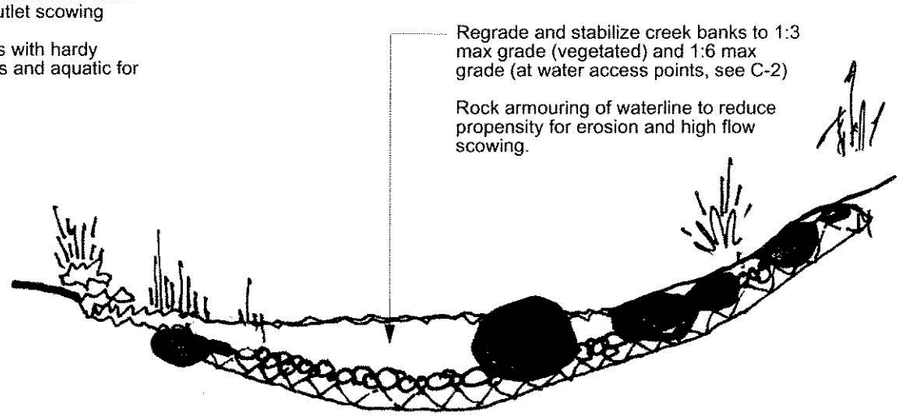


Illustration: Stormwater outlet



Section: Rock armouring

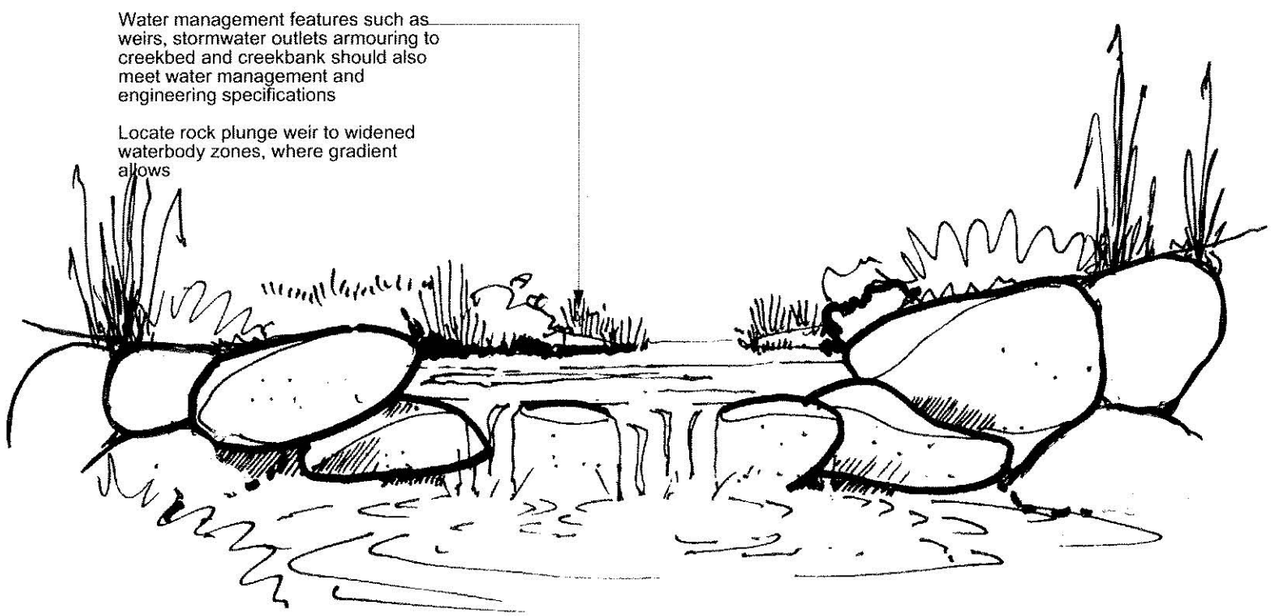
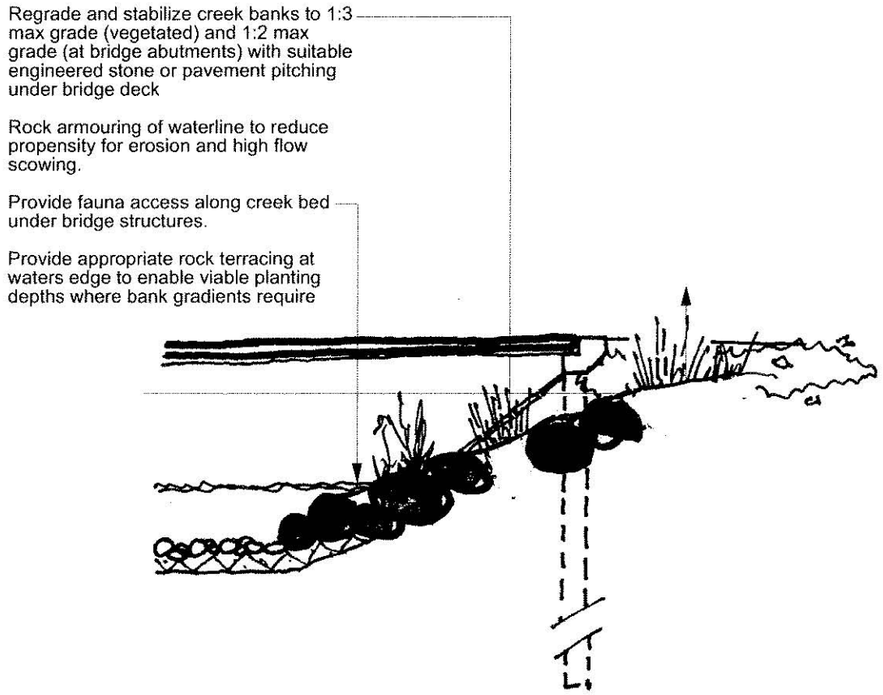


Illustration: Natural weir and rills



Section: Bridge abutments

Guidelines

Location:

The 50 metre creekline reservation of Narrabeen and Fern Creek generally.

Adjacent Detention ponds, stormwater outlets and at creek waterbody widenings

Principles:

50 metre creekline reservation to be planned and implemented as multi-use open space corridors to incorporate water management

features:

Locate rock plunge weir to widened waterbody zones, where gradient allows.

Rock work to be natural sandstone, placed and arranged in naturalistic patterns. Water management features such as weirs, stormwater outlets armouring to creekbed and creekbank should also meet water management and engineering specifications.

Incorporate raised boardwalk through impeded drainage zones.

Plant creekline margins with aquatic planting for water quality and Fauna habitiat.

Provide appropriate rock terracing at waters edge to provide viable planting depths, and where bank gradients require.

Do not adjoin maintained grass areas directly to rock armouring zones - minimum 2 metre native planting buffer required.

Provide widenings to creek waterbody where possible to slow water movement and provide additional environmental feature.

Provide seating and litter bins at nodal points, viewing areas and linkage intersections.

-Seats at litter bins at nominal 250 metre spacing

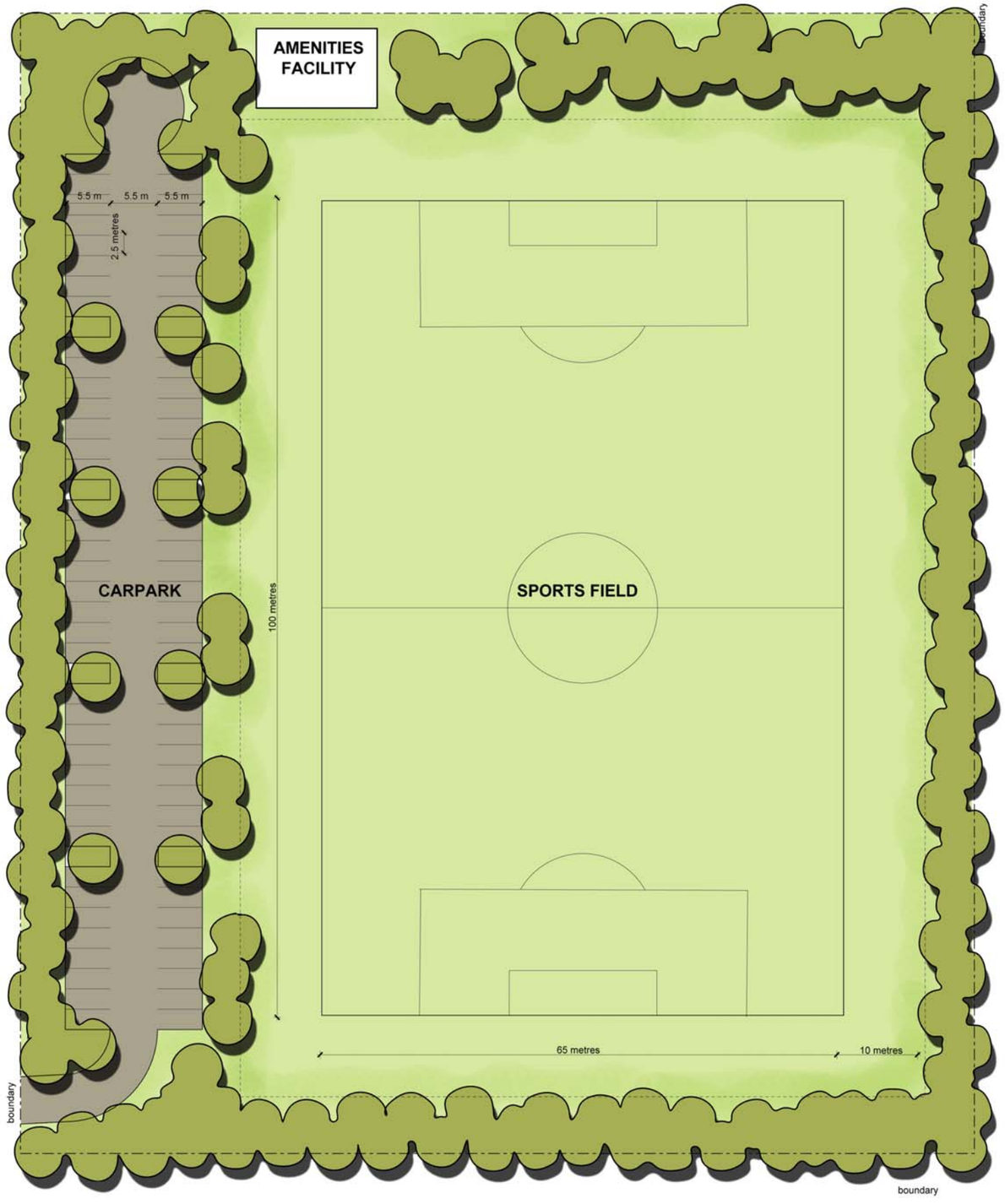
-Signs at nominal 100 metre spacings

- Solar lights at nominal 50 metre spacings

5.0

2018

Central Local Park and Active Sportfields



Active Sportsfield

P-1

2018

Guidelines

Typical Infrastructure:

- Earthworks (incl re-contouring, levelling & sub-grade preparation)
- Drainage (incl sub-soil drainage)
- Water Service/Irrigation (bayonet fittings)
- Sealed Carpark (50 spaces incl kerb/edging, surfacing & planting bays)
- Access/Pathways
- Lighting (Solar [10])
- Turfing (incl topsoiling & laying turf)
- Landscaping (incl topsoil, tree/shrub planting, mulching, staking & edging)
- Fencing (painted timber post & rail/log barriers)
- Signage & Furniture (incl bench seats & litter bins)

DISCLAIMER

NOTE:
The facilities and features on this plan are diagramatic only and the actual location will be subject to regular reviews of the Contributions Plan by Council, and will also be dependant on survey, site considerations and compliance with all relevant standards and requirements.

All internal Sector Road Layouts/ Landscaping/ Open Space (Apart from Sectors 1, 2, 10, 11 and 12) are indicative only and reflect submissions by the Developers at the time of preparation of this Plan.

Council does not endorse or otherwise the proposals by the Developer in each Sector

Central Local Park
P-2 & P-3

2018

Guidelines

Concept plan for southern component of park was adopted by Council in March 2016. Final design of southern component of park to be developed in consultation with community.

Typical Infrastructure:

- Earthworks (incl re-contouring, levelling & sub-grade preparation)
- Structural Work (eg retaining walls)
- Drainage (incl sub-soil drainage)
- Water Service/Irrigation (bayonet fittings)
- Sealed Carpark (incl kerb/ edging, surfacing & planting bays)
- Access: Pathways/Bikepaths
- Lighting
- Turfing (incl topsoiling & laying turf)
- Landscaping (incl topsoil, tree/shrub planting, mulching, staking & edging)
- Fencing (painted timber post & rail/log barriers)
- Shelter (including electric BBQs/tables and seating)
- Signage & Furniture (incl bench seats, picnic tables & litter bins)
- Shade Structure (over playground)


Turf
Field
Synthetic
Field


NAMONA
STREET
PITTWATER
ROAD
0.7% EFFECTIVE FALL
LATERAL FALL 0.5%
BRICK
BUILDING

Appendix G – Water Cycle Management Plan, Martins Consulting Engineers (2020)

WarriewoodVale Pty Ltd
C/ - Jackson Teece

Water Cycle Management Report:
8 Forest Road,
Warriewood, NSW

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P1504988JR05V02
October 2020

Limitations Statement

The sole purpose of this report and the associated services performed by Martens & Associates Pty Ltd is to prepare a water management report in accordance with the scope of services set out in the contract / quotation between Martens & Associates Pty Ltd and WarriewoodVale Pty Ltd (hereafter known as the Client). That scope of works and services were defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

Martens & Associates Pty Ltd derived the data in this report primarily from a number of sources which may include for example site inspections, correspondence regarding the proposal, examination of records in the public domain, interviews with individuals with information about the site or the project, and field explorations conducted on the dates indicated. The passage of time, manifestation of latent conditions or impacts of future events may require further examination / exploration of the site and subsequent data analyses, together with a re-evaluation of the findings, observations and conclusions expressed in this report.

In preparing this report, Martens & Associates Pty Ltd may have relied upon and presumed accurate certain information (or absence thereof) relative to the site. Except as otherwise stated in the report, Martens & Associates Pty Ltd has not attempted to verify the accuracy of completeness of any such information (including for example survey data supplied by others).

The findings, observations and conclusions expressed by Martens & Associates Pty Ltd in this report are not, and should not be considered an opinion concerning the completeness and accuracy of information supplied by others. No warranty or guarantee, whether express or implied, is made with respect to the data reported or to the findings, observations and conclusions expressed in this report. Further, such data, findings and conclusions are based solely upon site conditions, information and drawings supplied by the Client *etc*. in existence at the time of the investigation.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between Martens & Associates Pty Ltd and the Client. Martens & Associates Pty Ltd accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

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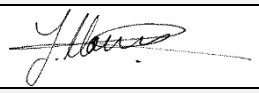
Sayana Sorourian		Stanley Leung		Terry Harvey		
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2	For DA submission	Final	06/10/2020	1P	1P	

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Background

1.1 Scope

This report has been prepared by Martens & Associates Pty Ltd (MA) to support a development application (DA) for the proposed residential development at 8 Forest Road, Warriewood, NSW. It provides an assessment of the proposed development with respects to stormwater management, including water quality and quantity.

We understand the proposed development will be undertaken in 2 stages:

Stage 1: demolition of the existing dwelling, construction of internal roads, and subdivision of land to provide 17 Torrens title residential lots, one superlot, two lots for the construction of private internal roads with associated civil and stormwater works and one community lot.

- Stage 2: construction of a residential flat building within the superlot. The proposed building comprises 64 residential apartment units with a single level basement car park.

We note that all the proposed stormwater detention and quality infrastructures required for the ultimate development including both of the residential subdivision lots and residential flat buildings will be constructed as part of Stage 1 works. Modelling approach undertaken in this report is based on the ultimate stage development, which would be consider appropriate for both Stage 1 and Stage 2 developments.

1.2 Relevant Guidelines

This report has been prepared in accordance with the following standards/guidelines:

- BMT WBM (2015), *NSW MUSIC Modelling Guidelines*.
- Pittwater Council (2001), *Warriewood Valley Urban Land Release: Water Management Specification (WMS)*.
- Pittwater Council (2019), *Pittwater 21 Development Control Plan (DCP) - Part B: B5 Water Management and Part C: C6 Design Criteria for Warriewood Valley Release Area*.

2 Site Description

Site description summary is provided in Table 1.

Table 1: Site description summary.

Element	Site Details
Site Area	56,806 m^2
Address	8 Forest Road, Warriewood, NSW
Lot/DP	Lot 1, DP 5055
Flood Hazard	Category 1 – High Flood Risk (from online Pittwater Council database)
Existing site development	Rural residential
Neighbouring environment	Light industrial/commercial to north, low density residential to east and bushland to west and south.
Site elevation	17.2 – 65.7 mAHD
Site grading & Aspect	Approx. 5 – 38%, NNE aspect.
Local Government Area	Pittwater Council / Northern Beaches Council

We note the following regarding site and upstream catchment conditions:

- Existing site maintains a rural residential land use which is primarily grassed at lower elevations and bushland at higher elevations.
- Narrabeen Creek runs through the northern section of the site.
- Total upstream catchment area for the overland flow path is primarily bushland and rural residential, approximately 81.6 ha.
- Site is located within a minor overland flow path for the Narrabeen Creek catchment.

Proposed development includes:

- A three-storey residential apartment building comprising 64 units with central courtyard and a single level basement carpark.
- Seventeen subdivision lots allocated for low density housing.
- Two above ground bioretention/detention basins and one below ground OSD tank (refer to MA planset PS05-E100 for details).

3 Stormwater Quality Assessment

3.1 Water Quality Objectives

Pittwater Council's (now Northern Beaches Council) Warriewood Valley Urban Land Release Water Management Specification (2001) requires the following objectives be achieved:

- Water cycle assessment, based on modelling (for wet, dry and average years, with no statement of underlying assumptions about water reuse for the proposed dwellings).
- Water quality assessment and monitoring.
- Water quality management based on local conditions and local water acceptance criteria.
- Demonstration of modelling to support the derivation of the stormwater quantity designs (for wet, dry, and average years and for the appropriate pre-development condition).

3.2 Modelling Methodology

3.2.1 Overview

Model for Urban Stormwater Improvement Conceptualisation (*MUSIC*, Version 6.3) developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH) was used to evaluate the following two scenarios for water quality improvements:

- *Scenario 1: Pre-development (modelled as existing insitu) VS post-development to achieve at least a zero net change.*
- *Scenario 2: Pre-development (modelled as forest with a 20% increase in pollutant load) VS post-development to achieve zero net change in pollutant loads.*
- *Scenario 3: Post-development (modelled with no treatment) VS Post-development (modelled with treatment) also referred to as Treatment Train Effectiveness (TTE) and used in 31 local councils across NSW. Furthermore, TTE objectives were set to:*

i. *Total Suspended Solids – 85%*

ii. *Total Phosphorus – 65%*

iii. *Total Nitrogen – 45%*

The existing site condition was set to be prior to carrying out demolition works.

A MUSIC model was also used to provide an assessment of the water balance. For this an existing water balance was determined using locally sourced long-term data and compared with the modelled post-development conditions.

3.2.2 Approach

An iterative approach was used for post-development modelling to determine appropriate types and sizes of stormwater treatment devices and for modelling scenarios to achieve the stated objectives.

3.2.3 Rainfall Data

It is understood that council requires long-term rainfall data acquired from a local source. Daily rainfall data was sourced the Bureau of Meteorology (BOM) from the gauge located at Ingelside (Animal Welfare League), station number 066183 (1984 - 2013). This was determined to be the closest suitable station to obtain appropriate rainfall information. The data from three different years was modelled to consider:

- A wet year which occurred in 1998 with an annual rainfall of 2078.0 mm
- A dry year which occurred in 2000 with an annual rainfall of 1118.4 mm
- A typical year which occurred in 1984 with an annual rainfall of 1477.0 mm

Daily rainfall data was extracted for each year and used in individual models to comply with council requirements, rainfall data is available in Attachment A.

3.2.4 Input Parameters

Input parameters for source and treatment nodes are consistent with BMT WBM (2015) NSW MUSIC modelling guidelines.

3.2.5 Catchment Parameters

Pre-development and post-development percentage of impervious and pervious catchment areas are provided in MA planset PS05-E100.

3.2.6 Model Parameters

Section 4.3.3 of the Warriewood WMS (2001) provides the suggested event mean concentrations to be used for modelling water quality management. The event mean concentrations (EMC) were converted to a logarithm base and input into MUSIC as the storm flow concentration parameters.

The Warriewood WMS (2001) does not provide values for base flow concentrations which are necessary for MUSIC modelling. The values from BMT WBM (2015) guidelines were adopted for base flow concentrations.

The combination of adopted values for modelling from the Warriewood WMS (2001) and BMT WBM (2015) are presented below in Table 2.

Table 2: Adopted pollutant concentrations for MUSIC modelling

		Base Flow Concentrations		Event Mean Concentrations	
Land use	**Parameter**	**Log (mean)**	**Log (stdev)**	**Log (mean)**	**Log (stdev)**
Urban	TN	0.110	0.12	0.176	0.19
	TP	-0.850	0.19	-0.523	0.25
	TSS	1.200	0.17	2.000	0.32
Forest	TN	-0.52	0.13	-0.495	0.24
	TP	-1.22	0.13	-1.523	0.22
	TSS	0.78	0.13	1.000	0.20
Rural	TN	-0.05	0.12	0.000	0.19
	TP	-1.22	0.19	-1.00	0.25
	TSS	1.15	0.17	1.544	0.32
Roof	TN	N/A	N/A	0.176	0.19
	TP	N/A	N/A	-0.523	0.25
	TSS	N/A	N/A	2.000	0.32

Notes:

1. Base flow concentrations obtained from BMT WBM (2015)
2. Event mean concentrations obtained from Warriewood WMS (2001)

3.3 Treatment Train Philosophy

The preferred stormwater treatment strategy for the site utilises roof water capture and reuse as well as end source controls to ensure treatment

objectives are satisfied. Individual stormwater quality improvement devices (SQIDs) are outlined in the following sections.

3.3.1 Rainwater Tanks

Results from a BASIX certificate were used to determine the minimum rainwater tank volumes and connections for reuse. However, modelling to maintain the water balance necessitated an overall increase in the volume and reuse of the rainwater tanks. These changes will increase the water efficiency of the development above the BASIX threshold.

In terms of rainwater tanks, the following assumptions were made:

- Low density housing:
    i. We propose 2 kL tanks for each of the anticipated dwelling.
- Residential flat building:
    i. The BASIX certificate indicated that 5kL rainwater tanks or reuse was necessary to meet BASIX targets.
    ii. For our MUSIC models, we propose that the residential flat building has a communal tank of 114kL.

In terms of rainwater tank reuse, the following assumptions were made:

i. Dwellings were modelling with an external reuse rate of 0.151 kL/year/dwelling and an internal reuse rate of 0.08 kL/day/dwelling, based on indoor use for toilets in accordance with Table 6-2 for 3 occupants of BMT WBM (2015).

ii. Residential flat building was modelled with a reuse rate of 0.2 kL/day/units, based on all indoor reuse (toilets, washing machine and hot water) in accordance with Table 6-2 for 2.35 occupants of BMT WBM (2015).

It is recommended that the roof drainage system be fitted with first flush devices, gutter mesh and be connected directly to the rainwater tank. Further details of devices to be used can be provided at the design stage.

3.3.2 Bioretention Basins

Two bioretention structures have been proposed to treat water before leaving the site. The basins provide treatment of water through filtration,

biological uptake of nutrients, infiltration, evapotranspiration and detention. The basins have been appropriately sized to provide the necessary treatment to meet Council requisites.

3.3.3 StormFilter Cartridges

This treatment system uses rechargeable, self-cleaning, media-filled cartridges to absorb and retain pollutants from stormwater runoff. 6 StormFilter cartridges are used on the site. The indicative location of these devices is provided in MA planset.

3.3.4 Pit Inserts

Pit inserts are proposed to be implemented in the pits immediately upstream of the bioretention basins. This gross pollutant trap (GPT) device will be used to capture litter, debris and other pollutants. Pit inserts are not required to meet water quality targets and thus have not been included in the MUSIC models. However, they have been proposed to reduce the burden and ease maintenance requirements of the bioretention basins.

3.4 MUSIC Water Quality Results

3.4.1 Scenario 1: Pre-development (Existing) vs Post-development.

Modelling against the NorBE criteria for the site has been undertaken with the results provided in Table 3.

Table 3: Scenario 1 - Pre-development VS Post-development (NorBE).

	Dry Year		Average Year		Wet Year	
Parameter	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
TSS (kg/year)	354	106	558	164	1360	630
TP (kg/year)	1.3	0.85	1.69	1.26	3.61	3.0
TN (kg/year)	10.2	8.12	16.9	12.8	29.5	23.6
GP (kg/year)	285	21.6	352	26	371	27.5

These results demonstrate that the NorBE criteria are achieved for all climate scenarios considered. Water quality controls proposed reduce developed site pollutant loads below pre-development loads.

3.4.2 Scenario 2: Pre-development (Forest) vs Post-development

Assessment of the pre-development modelled as forest with a 20% increase in pollutant loads against post-development has been undertaken with results provided in Table 4.

Table 4: Scenario 2 - Pre-development (forest) VS Post-development.

	Dry Year		Average Year		Wet Year	
Parameter	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
TSS (kg/year)	26.6	106	80.1	164	221	630
TP (kg/year)	0.12	0.85	0.33	1.26	0.86	3.0
TN (kg/year)	0.894	8.12	3.39	12.8	10.1	23.6
GP (kg/year)	0	21.6	0	26	0	27.5

MUSIC results show that the criteria for pre-development loads equivalent to that of a forest node with 20% increase in pollutant load, is unachievable for the site.

3.4.3 Scenario 3: Post-development Treatment Train Effectiveness (TTE)

Results of post-development with no treatment devices against post-development with treatment devices is provided in Table 5.

Table 5: Scenario 3 - Post-development Treatment Train Effectiveness.

	Dry Year			Average Year			Wet Year		
Parameter	**PRE TTE**	**Post TTE**	**% Diff**	**PRE TTE**	**Post TTE**	**% Diff**	**PRE TTE**	**Post TTE**	**% Diff**
TSS (kg/year)	1780	106	-94	2580	164	-93.6	4230	630	-85.1
TP (kg/year)	5.51	0.85	-84.6	8.15	1.26	-84.5	12.8	3.0	-76.6
TN (kg/year)	26.9	8.12	-69.8	38.7	12.8	-66.9	58.6	23.6	-59.7
GP (kg/year)	475	21.6	-95.5	569	26	-95.4	605	27.5	-95.5

MUSIC results demonstrate that the TTE criteria are achievable for all years. The treatment train measures applied to the model demonstrate compliance with Warriewood Valley WMS (2001) in reducing gross pollutant loads.

3.5 MUSIC Water Balance Results

An assessment of the water balance of the existing site against the proposed developed site has been conducted and the results are provided in Table 6.

Table 6: Water balance – Pre-development VS Post-development.

	Dry Year		Average Year		Wet Year	
Parameter	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Runoff (ML/yr)	9.0	11.5	16.5	18.9	31.2	32.2

The volumetric runoff coefficient was determined as a ratio of runoff volume to the amount of yearly precipitation. The runoff volumes were derived from MUSIC modelling while the precipitation volume was

calculated using the site area and annual precipitation for the respective wet, dry and average years. The results are contained within Tables 7.

Table 7: Pre-development VS Post-development.

	Runoff Volume		Precipitation Volume		Volumetric Runoff Coefficient	
	Pre (m^3/year)	Post (m^3/year)	Annual Rainfall (m)	Site Area (m^2)	Pre	Post
Dry Year	9000	11500	1.118	21100	0.38	0.49
Average Year	16500	18900	1.477	21100	0.53	0.61
Wet Year	31200	32200	2.078	21100	0.71	0.73

3.6 Discussion and Conclusions

Results from the MUSIC model demonstrated that no increase compared to existing sediment, nitrogen and phosphorus loads (NorBe) is achieved with proposed water sensitive urban design devices. The proposed water quality improvement devices are also able to comply with the objectives of post-development treatment train effectiveness. These outcomes were achieved for all three rainfall conditions (wet, dry and average year) as outlined by Council.

If the site is modelled as though it were a forest with 20% pollutant increase, the proposed development was found to increase sediment and nutrient loads. This is inconsistent with Warriewood WMS (2001) objectives, however, to not achieve this is consistent with local practice. Other developments that are subject to the Warriewood WMS (2001) regulation have been accepted by Council provided they achieve sediment and nutrient loads demonstrating compliance to NorBe.

The Warriewood WMS (2001) does not provide a performance standard for changes between the pre- and post-development water balance, however, Section 4.6.4. states that:

> A second objective is to keep the total volume of runoff after development as close to pre-development levels as possible, in order to keep the overall water balance to a similar level.

In terms of the changes to site water balances, the percentage changes are +28% in dry years, +14% in average years and +3% in wet years. These changes are similar to the existing creek flow regime and will not result in any material impact to the downstream riparian corridor or ecosystem. The increase in base flow during dry and average years will ultimately be beneficial to the receiving environment. We note that further reuse could be undertaken by way of irrigation of communal landscaped areas within the site should this be required.

4 Stormwater Quantity Assessment

4.1 Overview

This assessment has been completed to determine onsite detention (OSD) requirements for the proposed development. DRAINS hydrological and hydraulic modelling package was used to perform hydraulic analysis.

4.2 Water Quantity Objectives

Stormwater quantity management is to comply with the objectives of Warriewood Valley WMS (2001). The site is located within Sector 501 and requires that the OSD satisfies the following criteria:

- Minimum site storage requirements (SSR) are achieved, from Table A.1.
- Permissible site discharges (PSD) not to be greater than those nominated in Table A.2.
- The post-development hydrograph is not more than 10% greater than the pre-development hydrograph.

Further to the requirements of the Warriewood Valley WMS (2001), Pittwater Council's Development Control Plan (2015) *Part B5 Water Management* includes the following objectives:

- The drainage system is to be designed to carry all flows during the minor storm event (5% AEP flood event), by way of the pit and pipe network.
- The drainage system is to be designed to carry all flows during the major storm event (1% AEP storm event), by way of overland flow paths.

4.3 Modelling Methodology and Approach

4.3.1 Approach

The Warriewood WMS (2001) provides a minimum OSD requirement of 368 kL/ha for sites in Sector 5 (now Sector 501). Site specific modelling has been completed to ensure that the design for OSD is able to achieve prescriptive PSDs. For reference, the minimum OSD volume for site would be 776 kL.

An iterative approach was used for post-development modelling to determine appropriate types, sizes and location for an on-site detention configuration.

4.3.2 Rainfall/IFD Data

IFD data that was used for the model was sourced from the Bureau of Meteorology (BOM). The 1% AEP storms were examined with current rainfall intensities and also with rainfall intensities increased by 30% as a result of climate change. These increases in rainfall intensity were modelled by manually increasing the rainfall intensities for each storm by a factor of 1.3. This represents a 30% increase in rainfall intensities due to potential future climate change.

4.3.3 Catchments

The site naturally grades to the north, towards Narrabeen Creek. In the post-development scenario, discharge from the development area will be directed to either of two separate bioretention and OSD basins to be constructed outside the riparian zone of Narrabeen Creek. For this reason, post-development discharge has been compared to the pre-development discharge of the same area and to Council's prescriptions. Refer to MA planset PS05-E600 for the catchment plan.

4.4 Results

Based on the storage requirements specified in the Warriewood Valley WMS (2001) permissible site discharge requirements and results have been provided in Table 9.

Table 8: Peak 1% AEP & 1% AEP + 30% rainfall intensity event site discharge values.

Storm Duration (hr)	Council PSD requirement[1] (l/s/ha)	Site PSD (l/s)	Pre-Development (l/s)	Post-Development with OSD[2] (l/s)	Climate Change Post-Development with OSD (l/s)
0.5	229	483	903	401	482
1	331	698	935	428	608
2	390	823	933	426	614
3	279	589	685	368	449
6	235	496	463	306	377

Notes:

1. Values obtained from Warriewood Valley WMS (2001) Table A.2.
2. Values obtained from DRAINS modelling.

The results in Table 8 demonstrate that the PSD requirement for all storm durations is achievable and that post-development flow rates were less than pre-development flow rates.

When considering the impacts of climate change, the DRAINS modelling shows that the OSD is adequately sized to account for increases in rainfall intensity. The proposed basins are able to limit discharge to Council's prescribed PSD and the pre-development discharge.

As shown in Attachment B, It is observed that the site PSD prescribed in the Warriewood WMS (483 L/s for 30 minute storm) is not within the range of ±10% in the rising or falling limb of the pre-development hydrograph, thus the post-development hydrograph is not able to be within the 10% range either, if Council's prescribed PSD is to be maintained.

4.5 Conclusion

Hydraulic modelling shows that the proposed OSD system complies with the SSR and PSD objectives outlined by the Warriewood Valley WMS (2001).

The OSD design criteria were based on limiting peak post-development flows discharges for the storm durations from 30 minutes to 6 hours. This assessment found that two detention basins with a volume of approximately 830 kL and 200 kL and a detention tank with approximate volume of 260 kL are required to contain peak flows. Compliance with Council's prescribed PSD was achieved.

Assessment was undertaken to identify the rising and falling limb of the pre-development and post-development hydrograph. Compliance with Council's prescribed PSD was achieved however this means that the pre-development hydrograph is unable to be maintained.

5 References

BMT WBM (2015). *NSW MUSIC Modelling Guidelines*

EPA (1997). *Managing Urban Stormwater: Treatment Techniques*

FAWB (2009). *Adoption Guidelines for Stormwater Biofiltration Systems*, Facility for Advancing Water Biofiltration, Monash University, June 2009.

LANDCOM (2009). *Water Sensitive Urban Design: Book 4 - Maintenance,* Parramatta

Pittwater Council (2001). *Warriewood Valley Urban Land Release: Water Management Specification.*

Pittwater Council (2019). *Pittwater 21 DCP Part B – General Controls*.

6 Attachment A – Rainfall Data

Monthly Rainfall (millimetres)

INGLESIDE (ANIMAL WELFARE LEAGUE NSW)

Station Number: 066183 · State: NSW · Opened: 1984 · Status: Open · Latitude: 33.67°S · Longitude: 151.27°E · Elevation: 160 m

Statistics for this station calculated over all years of data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	119.4	180.4	116.8	170.1	115.9	120.3	77.3	96.3	66.3	81.2	122.4	96.0	1440.7
Lowest	10.0	39.4	24.4	8.0	4.2	8.0	2.8	2.2	2.8	3.0	31.8	22.6	945.8
5th percentile	18.6	43.3	33.9	12.7	7.0	15.3	15.9	4.2	5.6	16.9	36.9	34.5	960.6
10th percentile	45.7	54.8	37.7	27.0	28.7	28.3	22.2	8.6	9.8	21.1	43.0	49.2	1071.4
Median	109.1	133.4	102.6	94.0	87.0	108.4	72.4	58.9	49.4	51.0	124.8	85.9	1336.8
90th percentile	192.1	374.3	234.1	411.0	211.3	257.1	155.8	237.9	135.2	201.9	195.2	184.6	2094.5
95th percentile	295.1	501.8	261.6	439.3	257.5	337.1	166.9	312.4	149.2	278.0	256.0	200.6	2137.3
Highest	351.8	720.8	299.0	645.2	373.0	360.8	184.0	556.0	196.0	304.0	312.7	216.4	2160.8

Daily Rainfall (millimetres)

INGLESIDE (ANIMAL WELFARE LEAGUE NSW)

Station Number: 066183 · State: NSW · Opened: 1984 · Status: Open · Latitude: 33.67°S · Longitude: 151.27°E · Elevation: 160 m

2000	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	0.8	36.0	6.4	0	0	0	0.4	0	0	0	0	18.8
2nd	19.4	0	0	4.6	24.0	0	0.4	1.6	12.8	0	0	10.6
3rd	2.2	0	0	1.4	3.6	1.4	1.0	0	0	0	1.2	0
4th	0	0	0	0	0.4	0	3.0	0	0	0	0	0
5th	0	0	0	17.6	3.2	0	4.4	0	0	0	0	0
6th	0	0	5.2	7.0	12.4	0	0	2.2	0	0	0.2	0
7th	0	1.8	34.0	0.6	0	0	1.2	1.6	0	0	3.0	6.8
8th	6.8	0	25.6	0	0	0	0.6	0	1.0	0	1.0	0.6
9th	17.2	0	101.0	0.2	0	0	0	1.2	0	38.4	0	0
10th	0.4	0	1.0	0	0.4	0	0.6	0	0	20.0	0	0
11th	1.2	0	9.8	0	9.4	0	0	0	0	7.8	0	0
12th	3.6	0.6	6.6	0	0	5.2	0	0	0.8	0	0.2	0
13th	2.8	26.0	0	0	0	0.8	0	↓	0	0.4	4.2	0
14th	4.0	0	1.6	0	0	0	0	22.6	0	15.6	8.0	15.4
15th	1.0	0	4.6	0.6	0	0	0	0	0	0	53.4	1.6
16th	0	0	0	0	0	0	0	0.4	0	0	51.0	0
17th	3.0	0	0.4	14.0	0	0	3.0	3.0	0	2.0	17.4	0
18th	7.4	0	0	0	0	0	0	0	0	0.8	0.2	0
19th	0	0	0	0	0	24.6	0.4	0.6	0	7.8	8.6	0.2
20th	0.4	0	0	1.8	0	2.6	0	0	0	1.6	1.6	0.6
21st	0	0	51.0	0	5.4	1.4	0	0	0	1.8	14.0	0
22nd	0	0	35.2	0	0	1.8	0	0	0.2	0	0	0
23rd	0	0	12.6	0	0	0	0	0	0	0	0	0
24th	0	0	4.0	0	0	0	0	0	0	0	0	4.2
25th	2.2	0	0	1.2	1.6	0	0	0	4.8	4.4	0	0
26th	1.4	0	0	3.8	0.6	0	5.2	0	2.0	0	0	0
27th	13.0	1.4	0	2.2	0.4	0	0	0	21.6	0.8	3.2	0
28th	5.8	4.6	0	0.6	0	3.8	25.0	1.0	8.4	0	0	1.6
29th	0.6	0	0	0.8	0	1.0	0	7.2	0	1.0	0	0
30th	0		0	0.2	0	17.0	0	0	0	0	0.8	7.4
31st	1.2		0		0		0	0.6		0		0
Highest daily	19.4	36.0	101.0	17.6	24.0	24.6	25.0	7.2	21.6	38.4	53.4	18.8
Monthly Total	94.4	70.4	299.0	56.6	61.4	59.6	45.2	42.0	51.6	102.4	168.0	67.8

Annual total for 2000 = 1118.4mm

DATA: DRY YEAR (2000)

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	SS	**RAINFALL DATA**	DRAWING **FIGURE 1**
Approved:			
Date:	08.09.2020		
Scale:	NA		Job No: P1504988

martens

Daily Rainfall (millimetres)

INGLESIDE (ANIMAL WELFARE LEAGUE NSW)

Station Number: 066183 · State: NSW · Opened: 1984 · Status: Open · Latitude: 33.67°S · Longitude: 151.27°E · Elevation: 160 m

1984	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	2.0	0.1	0	0	0	0	0	0	0	0.8	0	0.4
2nd	13.0	0.4	1.2	0	0	0	0	0	6.0	0	0	0
3rd	0	0	0	0	0	0	0	0	0	0	0	0.2
4th	0	0	0	1.6	0	0	7.8	0	0	1.2	8.2	0
5th	8.0	5.2	0	20.0	3.6	0	36.4	0	3.0	0	0.2	0
6th	0.2	10.4	0	0	26.0	0	0	2.6	0.2	1.2	19.8	0
7th	0	0	0	0	10.6	0	0	1.0	0	0	67.6	0.6
8th	0	4.0	0	14.4	19.4	0	0	0	0	0	56.4	17.0
9th	11.2	8.2	0	33.4	0	0	0.2	0	0	0	57.8	2.4
10th	0.4	4.0	0.2	1.6	2.4	0	3.2	0.1	0	0.2	0.1	2.4
11th	0	0	0	0.8	0.1	0.2	3.6	3.4	0	0	0	6.2
12th	0	0	0	0	0	0	0	0	1.0	0	68.6	13.4
13th	16.4	0	0	29.0	0	0	0	0	0	0	17.6	0
14th	13.0	0	4.4	1.6	0	0	1.8	0	0.2	0.8	0	0
15th	7.0	2.4	0	0	0	0.8	4.0	0	0.6	0	0	0.2
16th	11.4	2.2	0.4	0	0	4.0	4.6	0	0	0	4.6	0
17th	5.6	0	3.6	0	0	0.4	3.4	0.1	0	0	0	0
18th	0	3.6	0.8	0	2.8	0.2	1.2	0.2	16.4	0	0	0.1
19th	0	27.0	0	0	1.4	0	0	0	0.5	0	0	0
20th	0	0.1	16.0	30.6	8.0	30.4	0	0.1	0.4	0	0	0
21st	0	0	77.4	6.8	4.2	24.2	0	1.2	2.6	0.4	0	0
22nd	4.0	19.8	19.6	0	0.1	0	0.6	0	0	13.6	0	0
23rd	0	5.2	23.4	0	0	0	9.8	0	0.8	0.2	9.0	0
24th	0	1.4	74.2	0.4	0	0	0	0	1.0	0	0	0
25th	0	15.4	2.4	0	0	0	0	0	0	0	2.8	0
26th	0.2	5.6	5.2	0	0	0	2.2	0	0	1.0	0	5.0
27th	0	0	0	0	0	0	52.2	0	0	6.4	0	0
28th	0	0	2.0	0	0	8.2	53.0	0.4	0	2.0	0	0
29th	0.1	0.8	2.2	0	0.4	2.0	0	0.4	0	6.6	0	22.3
30th	60.4		0	0	0	0	0	0	0	12.8	0	17.6
31st	0		0		0.2		0	0		5.4		6.2
Highest daily	60.4	27.0	77.4	33.4	26.0	30.4	53.0	3.4	16.4	13.6	68.6	22.3
Monthly Total	152.9	115.8	233.0	140.2	79.2	70.4	184.0	9.5	32.7	52.6	312.7	94.0

Annual total for 1984 = 1477.0mm

DATA: AVERAGE YEAR (1984)

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	SS	**RAINFALL DATA**	DRAWING **FIGURE 2**
Approved:			
Date:	08.09.2020		
Scale:	NA		Job No: P1504988

Daily Rainfall (millimetres)

INGLESIDE (ANIMAL WELFARE LEAGUE NSW)

Station Number: 066183 · State: NSW · Opened: 1984 · Status: Open · Latitude: 33.67°S · Longitude: 151.27°E · Elevation: 160 m

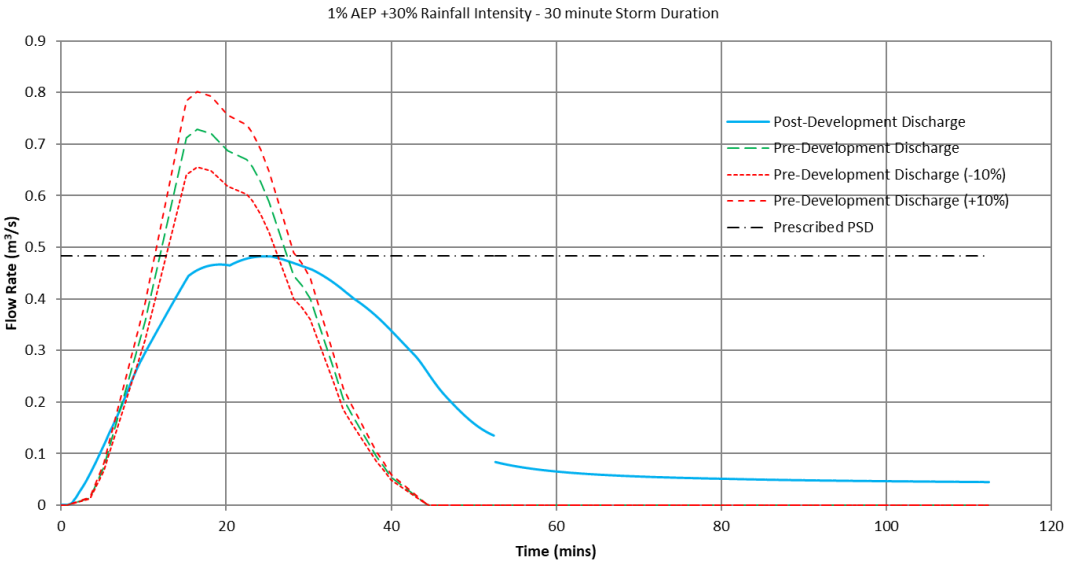
1998	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	0	0	0.6	0	0.8	0	9.8	0	0	0	3.8	9.6
2nd	0	0	0	2.4	16.2	1.4	0	0	0	0	2.8	1.8
3rd	0	0	0	0	19.0	35.0	0	0	0	0	1.8	0
4th	4.6	0	0	0	10.6	27.4	0	0	0	0	0	0
5th	1.0	0	0.4	0	64.0	8.2	0	1.0	3.8	0	0	2.0
6th	13.0	0	1.8	0	34.2	0	0	132.0	7.8	0.2	0	2.0
7th	1.8	0	0	0	0	0.4	0	126.0	0	1.4	3.2	0
8th	0	11.2	4.2	0	0	2.2	0	127.0	0	1.4	9.6	32.0
9th	4.6	1.4	0	0	0	0	0	4.2	0	0	8.8	0.2
10th	2.6	0.4	0	48.0	0	3.6	0	0	0	13.8	0	0
11th	0	2.4	0	250.0	0	4.2	4.4	0	0	0.2	0	0
12th	0	0	0	0.2	0	0.4	0	0	4.8	0	0	0
13th	0	0	0	0.4	0	0	0.2	0	10.0	0	10.0	0
14th	0	0	0	0	7.8	0	0.2	0	0	0	0	0
15th	2.2	0	7.0	0	0.6	0	0	0	0	0	0	5.0
16th	0.4	3.6	13.6	59.0	4.4	0	0	47.6	1.6	0	0	12.4
17th	0	0	0	1.0	19.6	0.6	0	55.8	0	0	1.8	2.2
18th	0	0	0	0.2	97.4	17.4	0.2	28.4	0	0	3.0	0
19th	2.2	0	0	0	83.8	0	13.6	0	0	5.0	8.8	0.2
20th	6.4	0	0	0	14.6	0	16.4	17.8	4.4	15.0	3.2	0
21st	11.0	0.8	0	0.4	0	0.2	0	2.6	2.4	0	0	1.4
22nd	0	0	0	4.8	0	0.6	0.2	0	1.6	0	0	1.4
23rd	0	0	0	60.6	0	26.0	0	6.4	0	3.2	0	0
24th	1.8	0.2	0	15.2	0	1.6	7.0	0	2.2	0	21.0	0.2
25th	45.6	0	0.6	0.2	0	0	18.6	0.4	3.6	0	0.4	0
26th	14.0	0	1.8	0	0	0	17.4	2.2	2.0	0	44.0	0
27th	0	0	3.4	0	0	0	7.6	0.2	0	8.2	1.0	0
28th	0	19.4	0	0	0	0	7.6	4.4	0	1.8	0.4	0
29th	0		0	0	0	0	0.2	0	0	0	1.2	0
30th	0		0	0	0	0	0	0	0	0	0	0
31st	0		0		0		0	0		0.2		0.2
Highest daily	45.6	19.4	13.6	250.0	97.4	35.0	18.6	132.0	10.0	15.0	44.0	32.0
Monthly Total	111.2	39.4	33.4	442.4	373.0	129.2	103.4	556.0	44.2	50.4	124.8	70.6

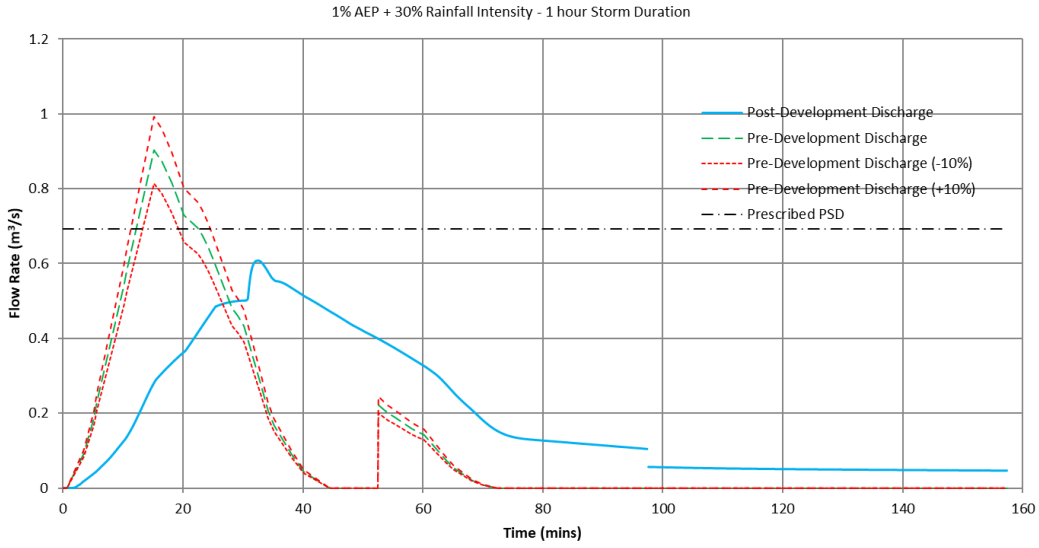
Annual total for 1998 = 2078.0mm

DATA: WET YEAR (1998)

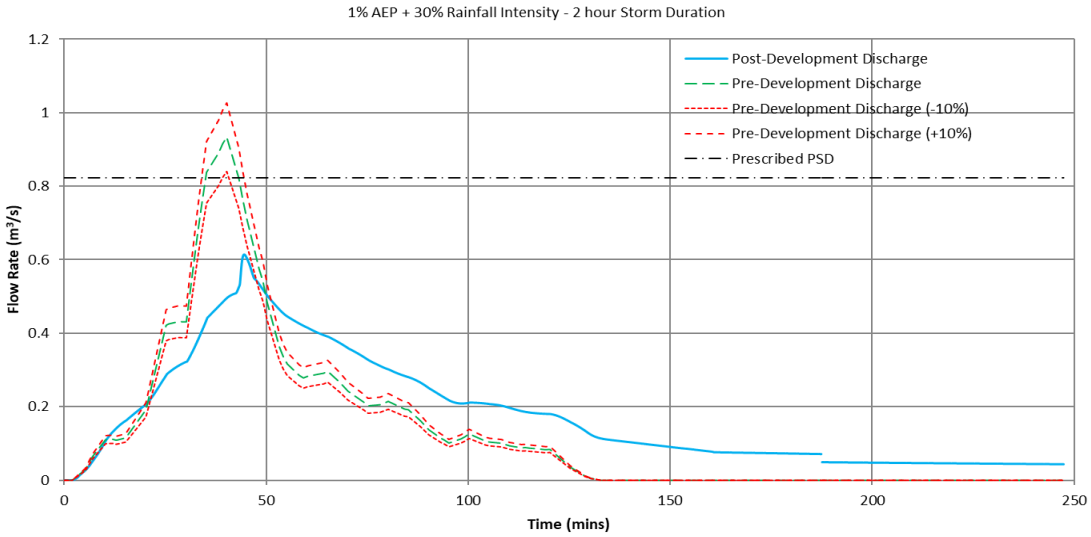
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	EZ	**RAINFALL DATA**	DRAWING **FIGURE 3**
Approved:			
Date:	13.05.2020		
Scale:	NA		Job No: P1504988

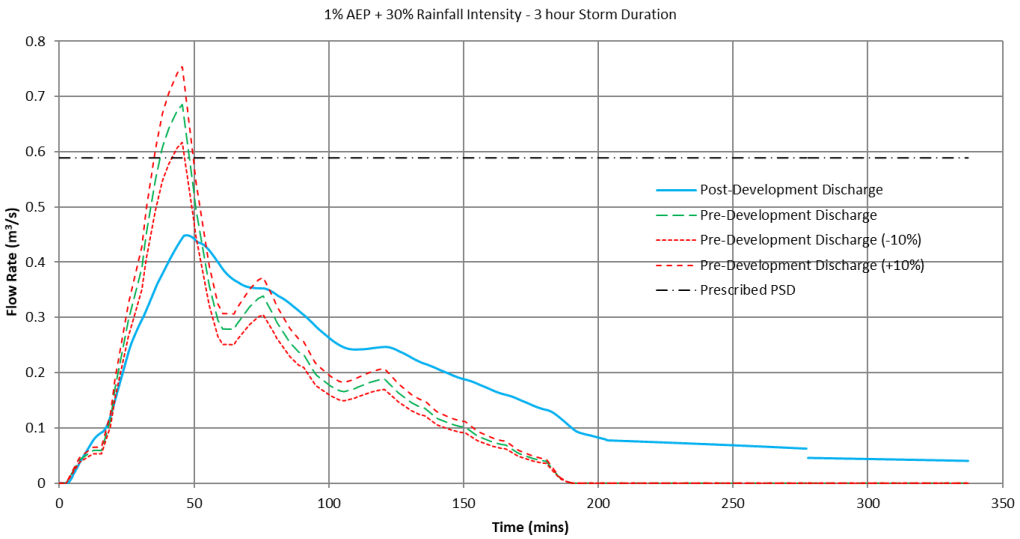
7 Attachment B – 1% AEP event +30% Rainfall Intensity Pre and Post-Development Hydrographs



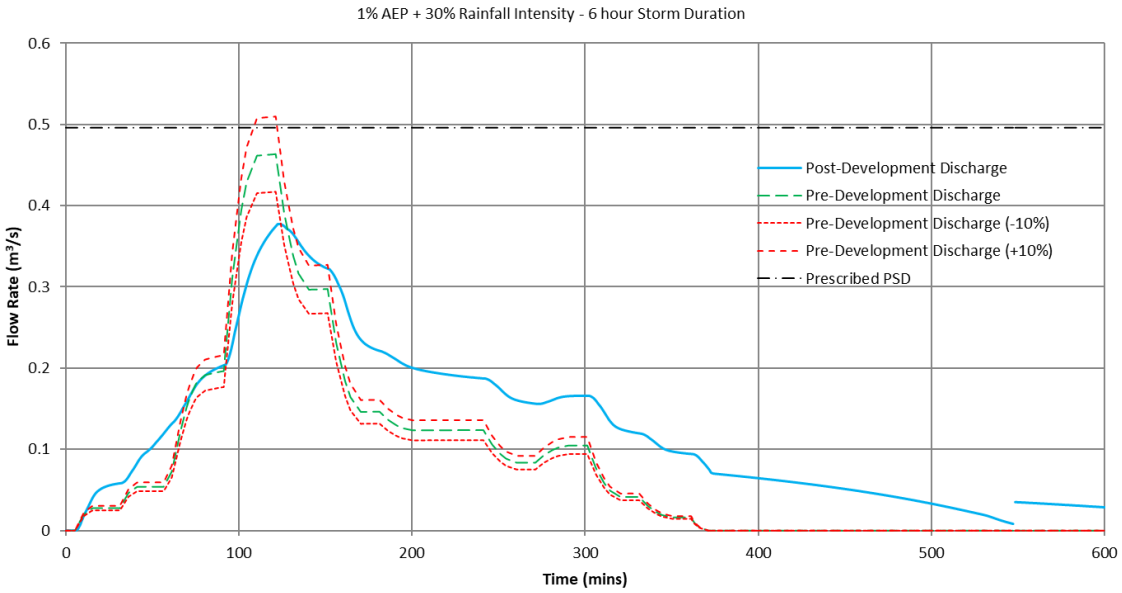


Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	AVG	**DRAINS HYDROGRAPHS**	DRAWING **FIGURE 4**
Approved:	SL		
Date:	09.02.2017		
Scale:	NA		Job No: P1504988





Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	SS	**DRAINS HYDROGRAPHS**	DRAWING **FIGURE 5**
Approved:	SL		
Date:	08.09.2020		
Scale:	NA		Job No: P1504988



Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	SS	**DRAINS HYDROGRAPHS**	DRAWING **FIGURE 6**
Approved:	SL		
Date:	08.09.2020		
Scale:	NA		Job No: P1504988

Appendix H – Author CV's

BROOKE CORRIGAN
Curriculum Vitae

Brooke works with AEP in the role of Senior Ecologist as a Biodiversity Accredited Assessor. She is an experienced bush regenerator and a regular supervisor of Landcare groups. Brooke has a successful career as an ecosystem restoration specialist focusing on landscape wide management and reconstruction projects, as a project manager with a local firm. Her background in project management and restoration planning combined with her ecological knowledge is utilised in a diverse array of applications in her current role.

Qualifications

- Biodiversity Accredited Assessment Scheme (BAAS# 19061)
- Graduate Diploma in Project Management University of New England (2010)
- Bachelor Environmental Science University of Newcastle (2004)

Fields of Special Competence

- Biodiversity Offset Commissions – initial scoping and feasibility, BAM impact assessments and BDAR reporting, biobank calculations, Stewardship site creation
- Ecological field survey, covering terrestrial and aquatic flora and fauna including population analysis for species such using the Scat Assessment Technique to detect Koala
- Highly proficient at botanical surveys, including challenging remote and isolated environs
- Project Management
- Restoration Science
- Land Management – vegetation and biodiversity offset plans, measurable and achievable programs, quantitative and procedural approaches to management obligations to achieve effective ecological outcomes.

Further Education & Training (select summary)

- NSW Class C Driver's Licence. Experienced 4WD operator.
- Occupational Health & Safety Training
- Mine Industry Worker (uninterrupted presence on Coal and Allied and Glencore operations over a nine-year period)
- Chainsaw Operation – fell trees, trim and crosscut
- Certificate 3 in Chemical Application (AQF3)

Professional Affiliations / Memberships (past / present)

- Certified Environmental Practitioner Program (CEnvP) (mem# 0656)
- Environment Institute of Australia and New Zealand (EIANZ) (mem# 208228)

Relevant Employment History

2017-present **Ecologist, Senior Ecologist**
Anderson Environment & Planning, Newcastle

Currently employed by Anderson Environment & Planning as Senior Ecologist after commencing in an Ecologist role to oversee the provision of consulting services to land, property, mining industry, legal and government sectors. Covering ecological, project management, environmental, planning services, advices, strategy and representation. Special provision of technical advice and strategic approaches for land restoration and management in biodiversity offsets and vegetation associated with project sites.

2014-2017 **Special Projects Crew Supervisor**
Toolijooa, Hunter Region

As a crew supervisor with Toolijooa I was responsible for supervising large environmental rehabilitation planting and weed management programs on mine, power station and suburban development offset and rehabilitation areas. I was responsible for providing technical direction on appropriate bush regeneration methods and chemical application and accurate Flora and Fauna identification, vital in EEC works. I was required to liaise with clients regarding project requirements, project goals and deadlines. I was responsible for the development and implementation of Work Health and Safety Plans as well enforcing company compliance with mining sector and civil clients. This included the development of safe work procedures, safety inspections on site and implementing improved safety procedures with staff. I was responsible for ensuring projects were completed on time and on budget whilst meeting the clients' expectations and achieving quality assurance standards.

2008-2014 **Rehabilitation and Weed Control Consultant**
Hunter Land Management, Maitland.

As a consultant and project manager for Hunter Land Management I was involved in the planning and implementation of environmental restoration projects for a wide range of landholders in the Hunter Valley area. I was primarily involved in development of Vegetation Management Plans, Weed Action Plans, Riparian Management Plans, Seed Collection Strategies, Land Management Plans and intensive site survey. My role also included supervision and management of on-ground crews to implement weed control, landscape, planting and fencing projects and all associated documentation.

Relevant Ecological Experience

2016 - 2019 **Landcare Supervisor**
Central Coast Council

Paid group support for Wamberal Dune Care and Three Creek Landcare groups providing professional guidance and heaving lifting/chemical application.

Natalie Black
Curriculum Vitae

Natalie works with AEP in the role of Senior Environmental Manager. She has extensive knowledge in environmental management, environmental planning, and report writing and assessment. With a detail understanding of planning, catchment management, coastal management and rehabilitation. Natalie has had a successful career with both state and local government in conservation, planning and field investigation roles. Natalie has also gained extensive communication skills and project management through her previous career in lecturing. Her background and experience in the ecological and planning fields is utilised in a diverse array of application in her current role.

Qualifications

- B.Sc (Hons), University of Newcastle, 2002 Sustainable Resource Management and Marine Science.
- Master Planning, University of Technology Sydney 2007.
- Certificate IV Training and Assessment at NSW TAFE 2012.
- BAM Assessor; accreditation number: BAAS19076.

Certification

- Evidence Gathering and Legal Process (Australian Institute of Environmental Health).
- Conflict Resolution Course (LGSA).
- Report Writing Course (LGSA).
- Powerful Presentation (LGSA).
- NSW Rural Fire Services Bush Fire Assessment
- Relocation of Threatened Species (Botanical Gardens Sydney).
- Sustainable Home Assessment Reduction Revolution.
- Flora and Fauna Survey Assessments Niche Environment and Heritage.
- First Aid TAFE.

Fields of Special Competence

- Environmental Planning
- Environmental Management and rehabilitation of catchments coastal waterways. Statement of Environmental Effects (preparation and assessing).
- Fish Passage
- Marine ecosystems including; mangroves, seagrasses, algae, Fauna and habitat assessment.
- vegetation.
- Communicating with a wide range of stakeholders.
- Development Application.
- Education in both Environmental and Planning industries.
- Koala Plans of Management.
- Policy Development.

Employment History

2019 to present AEP Senior Environmental Manager

2010 to 2019

Natalie Black is the Principal Environmental Planner for Black EARTH Environmental. Working a a range of projects, Bush Fire Assessments, Landscaping, Development Applications, Statements of Environmental Effect's, Environmental Management Plans, Sustainability Assessment of both private and businesses, sustainable gardens, environmental assessments for proposed projects and environmental advice and volunteering for local Sustainable Community Group and Landcare. During this time Natalie also lectured at Hunter TAFE teaching a range of environmental units both face to face and on-line to a varying range of qualification and levels.

2003 to 2010
Natalie was the Natural Resource Manager and Development Assessment Officer at Lismore City Council working with diverse range of professions such as engineers, town planners, environmental health officer, accountants, building surveyors, arborists, councillors. During this time the main projects were grants application, restoration projects, flora and fauna assessments, environmental legal adviser, bush fire assessments, strategic work, development application assessment (ranging from sheds to Designated Developments) and council development application team for internal projects, Council's for climate change, water wise programs and others.

2002 to 2003 was a step into the Policy unit within DPI where Natalie was part of the team working on the Jervis Bay Indigenous Fishing Strategy, and the closure of Port Botany. Dealing with many stakeholders and running workshops with Ministers and community. During 2003 with Natalie was the North Coast Fish Passage Officer. Managing an Environmental Trust Grant of $1 million to remove 50 structures that block fish passage within the catchments of the North Coast. This project had all 50 sites contracted by the end of the 12 months with 70% of these projects commenced. This role allowed for the development of field assessments, independent work and communication with a range of stakeholders.

2000 saw the commencement of Natalie's career with NSW Department of Primary Industries (Fisheries Unit) in the Office of Conservation in Sydney. Natalie was part of the Conservation team that reviewed integrated development applications in the Sydney Region, with a focus on the seagrasses present within the estuaries. The assessments ranged from jetties to the Lane Cove Tunnel, North West T-Way and the expansion of the M7 and fish ladders.

BSc Honours Project was research paper into the variations of *Zostera capricorni* wrack located within the Tuggerah Lakes system in comparison to Brisbane Waters and Lake Macquarie.