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Environmental Impact Statement – Appendix F1: Biodiversity Assessment Report – Upstream

Warragamba Dam Raising

Reference No. 30012078
Prepared for WaterNSW
10 September 2021

SMEC INTERNAL REF. 30012078

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In accordance with Section 6.15 of the *Biodiversity Conservation Act 2016*, it is hereby certified that:

- This assessment has been prepared by a person accredited under the *Biodiversity Conservation Act 2016*
- This assessment has been prepared in accordance with the brief provided by the client
- All field workers involved in the preparation of this Project were appropriately licensed under the *Biodiversity Conservation Act 2016*
- The information presented in this report is a true and accurate record of the study findings in the opinion of the authors
- As an accredited person, the author recognises the obligations of an accredited person detailed within the Accredited Person Code of Conduct
- This report has been prepared on the basis of the requirements of (and information provided under) the biodiversity assessment method required by the Secretary's Environmental Assessment Requirements as at a specified date and that date is within 14 days of the date the report is so submitted.

Signed: Kevin Roberts (BAM Assessor Accreditation No. BAAS17075)

NOTE: The transitional provisions of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 apply to this Project as the application for the Secretary's Environmental Assessment Requirements for the Project was made prior to the commencement of the *Biodiversity Conservation Act 2016*.

Abbreviations and Acronyms

ABBREVIATION/ACRONYM	DESCRIPTION
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
BAR	Biodiversity Assessment Report
BBAM	BioBanking Assessment Methodology
BBCC	BioBanking Credit Calculator
BC Act	*Biodiversity Conservation Act 2016*
BOS	Biodiversity Offset Strategy
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
DAWE	Department of Agriculture, Water and the Environment
DFS	NSW Department of Finance and Services
DoEE	Commonwealth Department of the Environment and Energy (Environment portfolio is now part of the Department of Agriculture, Water and the Environment)
DPIE	NSW Department of Planning, Industry and Environment
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FBA	Framework for Biodiversity Assessment
FESM	Fire extent and severity map
FM Act	NSW *Fisheries Management Act 1994*
FMZ	Flood mitigation zone – the airspace above the full supply level which is used to temporarily capture flood waters.
FSL	Full supply level – the maximum level of water in the dam for drinking water supply
GBMWHA	Greater Blue Mountains World Heritage Area
GDE	Groundwater Dependent Ecosystem
GEEBAM	Google Earth engine burnt area map
GIS	Geographic Information System
GL	Gigalitres
GPS	Global Positioning System
IBRA	Interim Biographic Regionalisation for Australia
LMBC	Land Management and Biodiversity Conservation
LGA	Local Government Area
LEP	Local Environmental Plan
MNES	Matters of National Environmental Significance

ABBREVIATION/ACRONYM	DESCRIPTION
NPWS	National Parks and Wildlife Service
NSW	New South Wales
OEH	NSW Office of Environment and Heritage (now Department of Planning, Industry and Environment – Environment, Energy and Science)
PCT	Plant Community Type
PMF	Probable Maximum Flood
RBGS	Royal Botanic Gardens Sydney
RFS	NSW Rural Fire Service
the Project	The current Warragamba Dam Raising Proposal
SCA	Sydney Catchment Authority
SEARs	Secretary's Environmental Assessment Requirements
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SMEC	SMEC Australia Pty Ltd
SoS	NSW Government's Saving our Species program.
SSI	State Significant Infrastructure
TEC	Threatened Ecological Community
TSPD	Threatened Species Profile Database
TSC Act	NSW *Threatened Species Conservation Act 1995*

Definitions

Abundance: the quantification of the population of the species or community

Activity: has the same meaning as in the EP&A Act

Annual Exceedance Probability (AEP): Probability of a flood event occurring in any given year. The probability is expressed as a percentage

Avoid: In the development planning process, potential impacts on biodiversity values and the environment are avoided though careful site selection and Project design.

Benchmarks: the quantitative measures of the range of variability in vegetation condition in vegetation with relatively little evidence of modification by humans since European (post 1750) settlement.

BioBanking Credit Calculator: the computer program that provides decision support to assessors and proponents by applying the FBA, and which calculates the number and type of biodiversity credits required to offset the impacts of a Major Project

Biodiversity Assessment Report: the report that must be prepared in accordance with Section 3.2 of the FBA

Biodiversity values: has the same meaning as at section 4A of the TSC Act but excludes marine mammals, wandering sea birds and biodiversity that is endemic to Lord Howe Island. Biodiversity values include the composition, structure and function of ecosystems, and includes (but is not limited to) threatened species, populations and ecological communities, and their habitats.

Broad condition state: areas of a PCT that are in relatively homogenous condition. Broad condition is used for stratifying areas of the same PCT into a vegetation zone for the purpose of determining the site value score

Clearing Native Vegetation (for the purposes of the FBA): has the same meaning as Section 60C of the Local Land Services Act 2013:

any one or more of the following:

(a) cutting down, felling, uprooting, thinning or otherwise removing native vegetation,

(b) killing, destroying, poisoning, ringbarking or burning native vegetation.

Connectivity: the measure of the degree to which an area(s) of native vegetation is linked with other areas of vegetation

Connectivity value: has the meaning given in Subsection 4.2.3 of the FBA

Conservation status: is regarded as the degree of representation of a species or community in formal conservation reserves

Critical habitat: has the same meaning as the TSC Act

Critically Endangered Ecological Community (CEEC): an ecological community specified in Part 2 of Schedule 1A of the TSC Act and/or listed under Part 13, Division 1, Subdivision A of the EPBC Act.

Development: has the same meaning as development in Section 4 of the EP&A Act and includes development as defined in Section 115T of the EP&A Act

Development footprint: In FBA the development footprint is defined as the area of land that is directly impacted by a proposed Major Project under the EP&A Act. The area of land assessed as being directly impacted for this Project occurs within the construction area only and is assessed within the Appendix F3 of the EIS.

Development site: The area of land that is subject to a proposed Major Project under the EP&A Act. For this assessment, the development site is Lot 1, DP 87998 and Lot 1124, DP1159978 as outlined within the SEARs.

Direct impact: an impact on biodiversity values that is a direct result of vegetation clearance from a development. It is predictable, usually occurs at or near to the development site and can be readily identified during the planning, design, construction, and operational phases of a development. Clearing of native vegetation is defined above.

Ecosystem credits: a measurement of the value of EECs, CEECs, and threatened species habitat for species that can be reliably predicted to occur within a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site.

EIS: an environmental impact statement referred to in Section 78A, 112 or 155Y of the EP&A Act

Expert: a person who is accredited by the Chief Executive under section 142B(1)(b) of the TSC Act, or if arrangements of accreditation under Section 142B(1)(b) are not in place, a person who has the relevant experience and/or qualifications to provide an expert opinion in relation to the biodiversity values to which an expert report relates

Exotic plant cover: exotic plants are vascular plants not native to Australia. Exotic plant cover is measured as total percentage foliage cover of all exotics in all strata

Habitat: an area or areas occupied, or periodically or occasionally occupied by a species, population, or ecological community, including any biotic or abiotic component

Habitat component: the component of habitat that is used by a species for either breeding, foraging, or shelter

Hollow bearing tree: a living or dead tree that has at least one hollow. A tree is considered to have a hollow if:

(a) the entrance can be seen

(b) the minimum entrance width is at least 5 centimetres across

(c) the hollow appears to have depth

(d) the hollow is at least 1 metre above the ground.

IBRA region: a bioregion identified under the Interim Biogeographic Regionalisation for Australia (IBRA) system, which divides Australia into bioregions on the basis of their dominant landscape-scale attributes

IBRA subregion: a subregion of a bioregion identified under the IBRA system and based on major catchment areas

Impacts on biodiversity values: loss in biodiversity values from direct or indirect impacts of the Major Project

Important area: an area of a CEEC or EEC that is necessary for the entities' long-term persistence and recovery. This may include areas identified in recovery plans, and/or an CEEC or EEC at the limit of the communities' range.

Important wetland: a wetland that is listed in the Directory of Important Wetlands of Australia (DIWA), or is a wetland mapped under the State Environmental Planning Policy 14 Coastal Wetlands

Indirect impact on biodiversity values: an impact on biodiversity values that occurs when development related activities affect threatened species, threatened species habitat, populations or ecological communities in a manner other than direct impact. Compared to direct impacts, indirect impacts often:

- occur over a wider area than just the site of the development
- have a lower intensity of impact in the extent to which they occur compared to direct impacts
- occur off site
- have a lower predictability of when the impact occurs
- have unclear boundaries of responsibility

Section 8.4.1.4 of the FBA details the types of indirect impacts on biodiversity which may arise from a development.

Individual: in relation to organisms, a single, mature organism that is a threatened species defined in section 4(1) of the TSC Act, or any additional threatened species listed under Part 13 of the EPBC Act

Landscape value: the value given to landscape attributes of a development site after an assessment undertaken in accordance with Section 4.2 of the FBA

Life cycle: the series of reproduction, growth, development, aging, and death of an organism

Linear shaped development: development that is generally narrow in width and extends across the landscape for a distance greater than 3.5 kilometres in length

Local population: the population that occurs in the study area (DECC, 2007).

Local wetland: A wetland that is not identified as an important wetland

Loss: Loss of biodiversity values from the development site

LGA means Local Government Area

Locality is the area within a ten-kilometre radius of the development site. Note that the definition of locality as per DECC (2007) is defined differently and relates to Assessments of Significance.

Major Catchment Area: the area of operation of a former catchment management authority, as described in Schedule 2 of the Catchment Management Authorities Act 2003 before its repeal

Major Project: State Significant Development or Sate Significant Infrastructure projects

Minimise: a process applied throughout the development planning and design life cycle which seeks to reduce the avoidable impacts of development on biodiversity values

Mitchell Landscape: landscapes with relatively homogenous geomorphology, soils, and broad vegetation types, mapped at a scale of 1: 250,000

Native ground cover: all native vegetation below one metre in height, including all such species native to NSW (that is, not confined to species indigenous to the area)

Native vegetation: has the same meaning as Section 60B of the Local Land Services Act 2013: (in part) native vegetation means any of the following types of plants native to New South Wales:

a) trees (including any sapling or shrub or any scrub),

b) understorey plants,

c) groundcover (being any type of herbaceous vegetation),

d) plants occurring in a wetland.

Offset requirement: the number and type of biodiversity credits that are required to offset the remaining impacts of development on biodiversity values after all reasonable measures have been taken to avoid and minimise impacts

Onsite measures: reasonable measures and strategies that are taken, or are proposed to be taken, at a development site to avoid and minimise the direct and indirect impacts of the development on biodiversity values.

Patch Size: an area of native vegetation that

a) occurs on the development site or offset site, and

b) is in moderate to good condition, and

c) includes native vegetation that has a gap of less than 100 m from the next area of moderate to good condition native vegetation (or ≤30 m for non-woody ecosystems).

Patch size may extend onto adjoining land that is not part of the development site.

Percent cleared value: the percentage of a vegetation type that has been cleared within a major catchment area as a proportion of its pre-1750 extent, as identified in the VIS Classification database. The percent cleared value is assigned to the BVT equivalent.

Percent foliage cover: the percentage of ground that would be covered by a vertical projection of the foliage and branches and trunk of a plant or plants.

Percent native vegetation cover: the percent of native vegetation cover in the inner and outer assessment circle, or the development footprint buffer area. Cover estimates are based on the cover of native woody and non-woody vegetation relative to the approximate benchmarks for the PCT, taking into account vegetation condition and extent. Native over storey vegetation is used to determine the percent cover in woody vegetation types, and native ground cover is used to assess cover in non-woody vegetation types.

Plant community type (PCT): a NSW plant community type identified using the PCT classification system.

Plot: an area within a vegetation zone in which site attributes are assessed.

Regeneration: the proportion of over-storey species characteristic of the PCT that are naturally regenerating and have a diameter at breast height

Region has the same meaning as that contained within the TSC Act

Regionally significant biodiversity link: a biodiversity corridor that is important at a regional scale and is identified in a plan approved by the Chief Executive of OEH.

Remaining impact: an impact on biodiversity values after all reasonable measures have been taken to avoid and minimise the impacts of development. Under the FBA, an offset requirement is calculated for the remaining impacts on biodiversity values.

Riparian buffer: an area of land determined according to Appendix 2 of the FBA.

Risk of extinction: the likelihood that the local population or CEEC or EEC will become extinct either in the short term or in the long term as a result of direct or indirect impacts on the viability of that population or CEEC or EEC.

Site attributes: the matters assessed to determine site value. They include: native plant species richness, native over-storey cover, native mid-storey cover, native ground cover (grasses), native ground cover (shrubs), native ground cover (other), exotic plant cover (as a percentage of total ground and mid-storey cover), number of trees with hollows, proportion of over-storey species occurring as regeneration, and total length of fallen logs.

Site value: the condition of native vegetation assessed for each vegetation zone against the benchmark for the PCT.

Site value score: the quantitative measure of vegetation condition calculated in accordance with Equation 1 of the FBA (Determine the current site value score for a vegetation zone).

Significant species: means species not listed in the TSC Act but considered to be of regional or local significance

Special Area: Area of land round the water storages and infrastructure that supply Sydney, the Illawarra, Blue Mountains, Southern Highlands and Shoalhaven regions. Public access and activities are restricted to protect water quality in these areas.

Species credits: the class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Species Profile Database.

Species that cannot withstand further loss: a species identified in the Threatened Species Profile Database as a species that cannot withstand further loss in the major catchment area in which the species occurs because of one or more of the following:

- the species is naturally very rare, has few populations or a restricted distribution
- the species or population is critically endangered
- the species has threats that are beyond control (of the management actions undertaken on an offset site)
- the species' or its habitat's needs/response to management are poorly known.

State significant biodiversity link: a biodiversity corridor that is important at a state scale and is identified in a plan approved by the Chief Executive of OEH.

Stream order: has the same meaning as in Appendix 2 of the FBA.

Study area: the area directly affected by the development and any additional areas likely to be affected by the development, either directly or indirectly. The study area should extend as far as necessary to take all potential impacts into account, for the purpose of an assessment under Subsections 9.2.4 and 9.2.5. For this assessment, the PMF (no climate change) with Project is the study area.

Subject species: means those threatened species that are known or considered likely to occur in the study area.

Survey area: That area of land identified by WaterNSW/OEH to be surveyed for this assessment equivalent to the 1% AEP with Project and 9% climate change. The survey area is greater than the development footprint.

Tg value: the ability of a species to respond to improvement in site value or other habitat improvement at an offset site with management actions. TG is based on an assessment of effectiveness of management actions, life history characteristics, naturally very rare species, and very poorly known species.

Threatening process: has the same meaning as that contained in the TSC Act; the definition is not limited to KTPs.

Threatened population: has the same meaning as in section 4(1) of the TSC Act.

Threatened species: critically endangered, endangered or vulnerable threatened species and populations as defined in section 4(1) of the TSC Act, or any additional threatened species listed under Part 13 of the EPBC Act as critically endangered, endangered or vulnerable.

Threatened Species Profile Database: is part the BIONET database, is maintained by OEH and can be accessed from the BIONET website at www.bionet.nsw.gov.au/.

Total length of fallen logs: the total length of logs present in a vegetation zone that are at least 10 cm in diameter and at least 0.5 m long.

Transect: a line or narrow belt along which environmental data is collected.

Unavoidable impact: an impact on biodiversity values that cannot be avoided and/or minimised.

Vegetation Benchmarks Database: a database of benchmarks for vegetation classes and some PCTs. The Vegetation Benchmarks Database is maintained by OEH and is part of the VIS Classification Database. It is available at www.environment.nsw.gov.au/research/Visclassification.htm.

Vegetation class: a level of classification of vegetation communities defined in Keith (2004). There are 99 vegetation classes in NSW.

Vegetation formation: a broad level of vegetation classification as defined in Keith (2004). There are 12 vegetation formations in NSW.

Vegetation zone: a relatively homogenous area of native vegetation on a development site that is the same PCT and broad condition state.

VIS Classification Database (NSW Vegetation Information System Classification Database): the master vegetation community-level classification for use in vegetation mapping programs and regulatory biodiversity impact assessment frameworks in NSW. The VIS Classification Database is maintained by OEH and available at www.environment.nsw.gov.au/research/Visclassification.htm.

Viability: the capacity of a species to successfully complete each stage of its life cycle under normal conditions so as to retain long-term population densities.

Wetland: an area of land that is wet by surface water or ground water, or both, for long enough periods that the plants and animals in it are adapted to, and depend on, moist conditions for at least part of their life cycle. Wetlands may exhibit wet and dry phases and may be wet permanently, cyclically or intermittently with fresh, brackish or saline water.

Woody native vegetation: native vegetation that contains an over-storey and/or mid-storey that predominantly consists of trees and/or shrubs.

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1 Introduction

1.1 Project application

WaterNSW, a New South Wales (NSW) state-owned corporation, is seeking planning approval for the Warragamba Dam Raising Project (the Project). The approval is sought under Part 5, Division 5.2 (State significant infrastructure) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

WaterNSW is proposing to raise the existing Warragamba Dam to facilitate flood mitigation and to install infrastructure to enable the release of downstream environmental flows. An Environmental Impact Statement (EIS) has been prepared to support the Project approval application. This report is part of the EIS and has been prepared to assess the Project's potential impacts on biodiversity within the upstream operational area of Warragamba Dam. The key objectives of this Biodiversity Assessment Report (BAR) are to address the requirements of the biodiversity matters raised in in the Secretary's Environmental Assessment Requirements (SEARs). The SEARs that this report addresses are discussed in Section 1.3. The background to the Project is described in the following section. A more detailed description of the Project is contained in Section 1.4 of this report.

1.2 Project background

The Hawkesbury-Nepean Valley (the valley) in western Sydney has the highest flood risk in New South Wales, if not Australia. The potential for significant flooding of the Hawkesbury-Nepean Valley was known by the local Aboriginal community before the first European settlement of the area in the 1790s. In the early years of European settlement, the risk of flooding was recognised, and a series of proclamations were issued that warned of the risk of flooding. This high flood risk arises from the river being confined by narrow sandstone gorges, creating rapid deep backwater flooding over extensive floodplains. The floodplains are home to a large existing population who would be impacted in a major flood.

During the 1980s and 1990s updated flood investigation techniques and new geological evidence predicted that floods significantly larger than any historically recorded could occur in the Hawkesbury-Nepean Valley. The dam was raised by five metres in the late 1980s to meet modern dam safety requirements. Further investigations into flooding and flood mitigation were undertaken and culminated in 1995 in a proposal to raise Warragamba Dam by 23 metres primarily for dam safety but also to provide for flood mitigation. The 1995 proposal did not proceed. In the late 1990s, major upgrades of Warragamba Dam were undertaken to prevent dam failure during extreme flooding events, to protect Sydney's water supply, and to prevent catastrophic downstream floods from dam failure. This resulted in the construction of the auxiliary spillway. However, these works only dealt with dam safety issues and did not address the major flood risks to the people and businesses in the Hawkesbury-Nepean Valley and the NSW economy.

In 2011, an approximately 1 in 100 chance in a year flood impacted Brisbane, resulting in significant damage, economic costs, and social disruption. The substantial impacts of the 2011 Brisbane flood led the NSW Government to recommence investigations into flood mitigation options for the Hawkesbury-Nepean Valley.

In 2013, the NSW Government in response to the State Infrastructure Strategy and community concerns, initiated the Hawkesbury-Nepean Valley Flood Management Review to consider flood planning, flood mitigation and flood response and recovery in the valley. The Review found that current flood management and planning arrangements could be improved, and no single mitigation option could address all the flood risks present in the valley (Department of Primary Industries (DPI) 2014a). The review concluded that raising Warragamba Dam to capture inflows is the most effective infrastructure measure that could have a major influence on flood levels during those events, when most of the damages occur. Other complementary and non-infrastructure options were also identified to mitigate flood risks (DPI 2014).

Under the direction of Infrastructure NSW (INSW), the Hawkesbury-Nepean Valley Flood Management Taskforce was established to investigate feasible flood options to reduce overall risk to the Hawkesbury-Nepean Valley. In June 2016, the former Premier and Minister for Western Sydney, Mike Baird MP, announced the NSW Government plan to raise Warragamba Dam to significantly reduce the risk of flooding in the Hawkesbury-Nepean Valley. A flood damages assessment for the Warragamba Dam Raising estimated that it would provide a 75 percent reduction in annual average flood damages and reduce current levels of flood damages from $5 billion to $2 billion (2016 dollars).

Raising Warragamba Dam would significantly reduce flood risk; however, it would not eliminate the risk completely. Regardless of the increase in the dam's height, flooding can be generated from catchments other than Warragamba Dam. The raising of Warragamba Dam would therefore be complemented with other non-infrastructure and policy actions. In May 2017, INSW released *Resilient Valley, Resilient Communities*, which outlines the Hawkesbury-Nepean

Valley Flood Risk Management Strategy (the Flood Strategy) (INSW 2017). The Flood Strategy covers the geographic region between Bents Bridge and the Brooklyn Bridge, encompassing areas within the local government areas (LGAs) of Liverpool City, Penrith City, Hawkesbury City, The Hills Shire, Blacktown City, Central Coast, and Hornsby Shire.

The Flood Strategy's objective is to reduce flood risk to life, property and social amenity from floods in the Hawkesbury-Nepean Valley. The strategy includes nine key outcomes; a combination of infrastructure and non-infrastructure initiatives to mitigate the flood risk to the Hawkesbury-Nepean Valley floodplain downstream of Warragamba Dam. Actions include:

- coordinated flood risk management across the Hawkesbury-Nepean Valley now and in the future
- strategic and integrated consideration of flood risk in land use and emergency planning
- engaging and providing flood risk information for an aware, prepared and responsive community.

The Flood Strategy provides the context and policy impetus to mitigate flood risk in the Hawkesbury-Nepean Valley.

1.3 Purpose

This BAR has been prepared by SMEC Australia Pty Ltd (SMEC) on behalf of WaterNSW (the Proponent).

The assessment of potential biodiversity impacts of the Project has been divided into three areas based upon the different types of impacts and different assessment methodologies applied in each area. These three areas are:

- Upstream of Warragamba Dam: some areas upstream of Warragamba Dam would experience an increase in the extent and duration of temporary inundation during the operation of the Project. This is in addition to the areas subject to temporary inundation with the existing dam.
- At Warragamba Dam: the area in and around the existing dam would be subject to clearing, disturbance and other indirect impacts to allow for the construction of the Project.
- Downstream of Warragamba Dam: floodplain areas downstream of Warragamba Dam would experience a decrease in the depth, extent and duration of flooding during the operation of the Project. Some areas downstream, particularly within the banks of the main channel, would experience an increase in the duration of temporary flooding due to the discharge of water from the flood mitigation zone (FMZ) after the flood peak had passed.

This BAR assesses the operational impacts of the Project related to temporary inundation upstream of Warragamba Dam.

The key objective of this BAR is to meet the requirements of the Framework for Biodiversity Assessment (FBA) (OEH 2018b), developed for Major Projects, and to address the biodiversity matters raised in the Secretary's Environmental Assessment Requirements (SEARs) (refer Table 1-1). The former Office of Environment and Heritage (OEH[1]) has been consulted during the assessment process, through direct meetings and teleconferences. This report aims to conform to the requirements of OEH and relevant guidance documents.

Table 1-1. Secretary's Environmental Assessment Requirements: Biodiversity assessment

Desired performance outcome	Secretary's Environmental Assessment Requirements	Where addressed
6. Biodiversity The Project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of Project construction and operation.	1. The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA), unless otherwise agreed by OEH, by a person accredited in accordance with s142B(1)(c) of the *Threatened Species Conservation Act 1995*.	Sections 3-7
	2. The proponent must assess the downstream impacts on threatened	Not relevant for this Upstream BAR, however, this item has been

1 The assessment for the Warragamba Dam Raising formally commenced in 2017 with the issue of the SEARs for the Project. On 1 July 2019 OEH was dissolved, with its biodiversity related functions transferred to DPIE Environment, Energy and Science (EES). For the sake of convenience 'OEH' is used to refer to OEH in the historic context unless otherwise specifically noted.

Desired performance outcome	Secretary's Environmental Assessment Requirements	Where addressed
	biodiversity, native vegetation and habitats resulting from any changes to hydrology and environmental flows. This assessment should address the matters in Attachment B.	addressed within Appendix F2 – Downstream Ecological Assessment Report.
	3. The Proponent must assess impacts on the following: endangered ecological communities (EECs), threatened species and/or populations, and provide the information specified in s9.2 of the FBA. Specific environmental requirements are provided in Attachment C.	Section 7
	4. The Proponent must identify whether the Project as a whole, or any component of the Project, would be classified as a Key Threatening Process in accordance with the listings in the *Threatened Species Conservation Act 1997* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environment Protection and Biodiversity Conservation Act 2000* (EPBC Act).	Section 7

1.4 Project description

1.4.1 Location

Warragamba Dam is located about 65 kilometres west of Sydney in a narrow gorge on the lower section of the Warragamba River, 3.3 kilometres before it joins the Nepean River. The Nepean River then becomes the Hawkesbury River at the junction of the Grose River at Yarramundi. The entire river is referred to as the Hawkesbury-Nepean River.

This BAR provides a biodiversity assessment of the Project in the area upstream of Warragamba Dam. The study area includes:

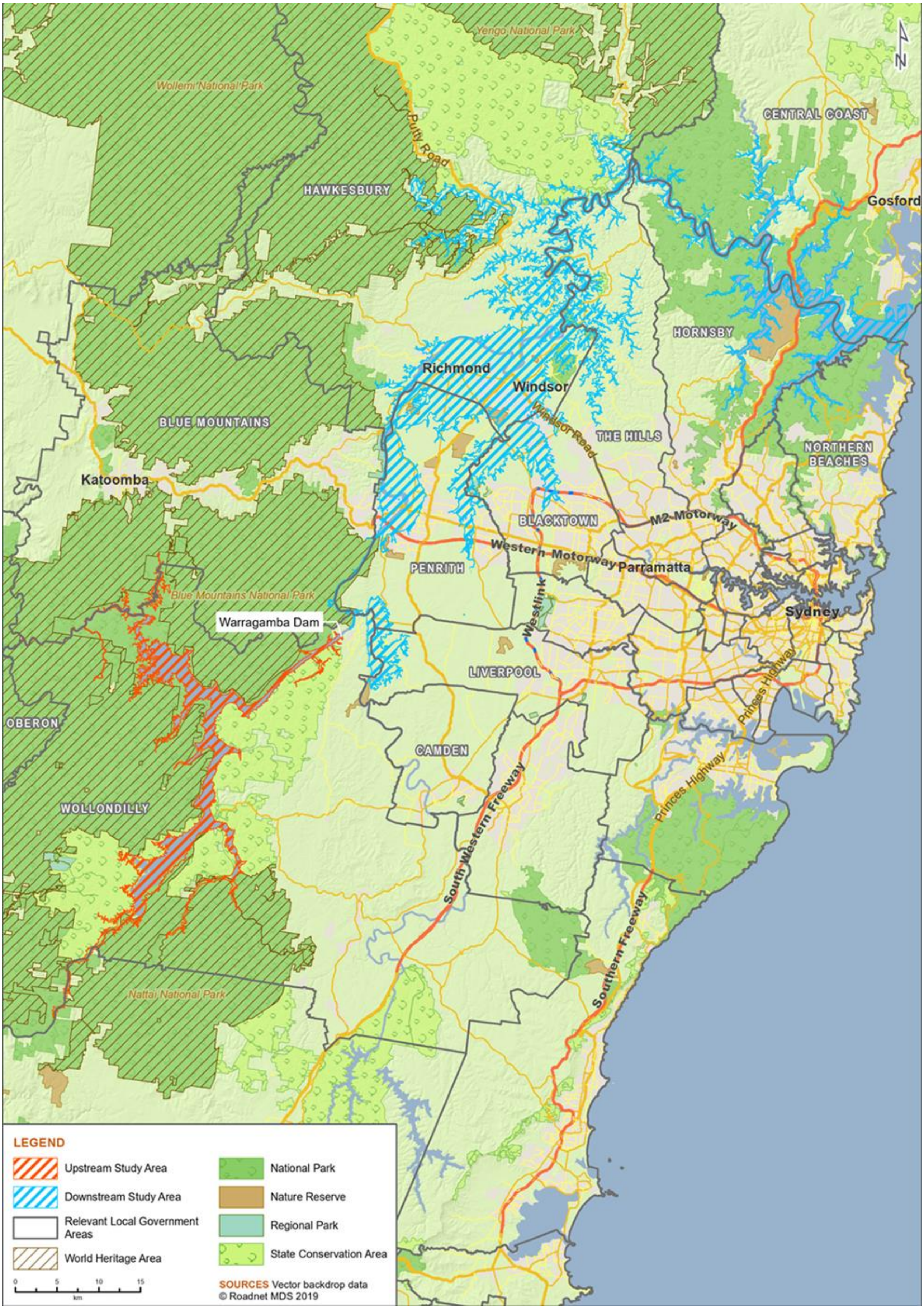
- Lake Burragorang (that is, the reservoir formed by Warragamba Dam) and its tributaries
- portions of a number of protected areas:
  - Kanangra-Boyd and Nattai wilderness areas
  - Blue Mountains and Nattai national parks
  - Burragorang, Yerranderie and Nattai state conservation areas
  - Warragamba Conservation Area.

Some of these protected areas are located in the Greater Blue Mountains World Heritage Area (GBMWHA) and some small areas of the GBMWHA would be potentially impacted by increased temporary inundation. It is overwhelmingly comprised of temperate eucalypt forest with sandstone cliffs and slot canyons (NPWS 2019).

A site locality map is shown on Figure 1-1. Warragamba township is located around one kilometre east of the dam and attracts tourists from Sydney and its surrounds to the dam's visitor centre.

The study area is located mainly in the Wollondilly and Blue Mountains LGAs, and with very small parts in the Oberon and Wingecarribee LGAs.

Figure 1-1. Location of Project



of the central spillway crest by around 12 metres and the auxiliary spillway crest by around 14 metres above the existing full supply level for temporary storage of inflows. The spillway crest levels and outlets control the extent and duration of the temporary upstream inundation. There would be no change to the existing maximum volume of water stored for water supply.

The NSW Government announcement in 2016 proposed that the dam wall be raised by 14 metres. Subsequently, the revised SEARs required the Project to be designed, constructed and operated to be resilient to the future impacts of climate change and incorporate specific adaptation actions in the design.

Peer reviewed climate change research found that by 2090 it was likely an additional three metres of spillway height would be required to provide similar flood mitigation outcomes as the current flood mitigation proposal. Raising the dam side walls and roadway by an additional three metres may not be feasible in the future, both in terms of engineering constraints and cost. The current design includes raising the dam side walls and roadway by 17 metres now to enable adaptation to projected climate change. Any consideration of raising spillway heights is unlikely before the mid to late 21st century and would be subject to a separate planning approval process.

The 17-metre raising height of the dam abutments (side walls) and roadway have been considered and accounted for in the EIS and design. The potential maximum height and duration of upstream inundation remains consistent with what was originally proposed in 2016.

The Project also includes providing infrastructure to facilitate variable environmental flows to be released from Warragamba Dam.

The Project would include the following main activities and elements:

- demolition or removal of parts of the existing Warragamba Dam, including the existing drum and radial gates,
- thickening and raising of the dam abutments
- thickening and raising of the central spillway
- new gates or slots to control discharge of water from the flood mitigation zone (FMZ)
- modifications to the auxiliary spillway
- operation of the dam for flood mitigation
- environmental flow infrastructure.

The Project would take the opportunity during the construction period for the dam raising to install the physical infrastructure to allow for management of environmental flows as outlined in the NSW Government *2017 Metropolitan Water Plan*. However, the actual environmental flow releases themselves do not form part of the Project and are subject to administration under the *Water Management Act 2000*.

1.4.2 Construction

Figure 1-2 shows the construction area for the Project including:

- ancillary facilities such as coffer dams, batch plants, material storage areas, and worker facilities
- areas that require clearing of vegetation to allow for construction and access
- areas directly impacted by construction works
- areas that would be used for construction activities but would not be modified by the Project (for example, existing roads, Lake Burragorang).

Other infrastructure and elements include:

- a new bridge to be built above the auxiliary spillway crest to provide access to the raised dam
- the raised abutments and central spillway bridge allowing vehicle and pedestrian access across the top of the dam, connecting to the approaches and road network on either side of the dam
- new control and instrumentation equipment including mechanical, electrical and communications elements
- new landscaping and urban design features for areas disturbed by construction and for other areas that require improved integration to the new dam structure
- ancillary works to tie existing services into the raised dam
- the existing two lift towers being modified to suit the raised dam
- the eel passageway on the left bank would be modified to continue to allow the migration of eels from the river to Lake Burragorang

- e-flow infrastructure, including:
  - a multi-level offtake tower on the upstream face of the dam wall to draw water from Lake Burragorang
  - the use of an existing pipeline, formerly for the hydro-electric power station, to transfer the water to a valve house
  - a new valve house, downstream of the existing hydro-electric power station, to discharge water into the river for environmental flows.

Figure 1-3, Figure 1-4 and Figure 1-5 show the modified dam after the Project works have been completed.

1.4.3 Operation of the dam for flood mitigation

Operational objectives in order of priority are to:

- maintain the structural integrity of the dam
- minimise risk to life
- maintain Sydney's water supply
- minimise downstream impact of flooding to properties
- minimise environmental impact
- minimise social impact.

There would be two different modes of operation for the Project: normal and flood operations. In both modes Warragamba Dam would continue to store and supply up to 80 percent of Sydney's drinking water. The storage capacity, which is the dam's full supply level (FSL), would not change. The current and future operation of the dam is shown on Figure 1-6 and Figure 1-7 respectively.

1.4.3.1 Normal operations

Normal operations would occur when the dam storage level is at or lower than FSL.

Normal operations mode for the modified dam would be essentially the same as current operations, apart from environmental flow releases for improved river health. Inflows would be captured up until the FSL, after which environmental flow releases would cease and flood operation procedures would be implemented.

Since 1960 the dam storage level has been above 80 percent full for most of the time, however the level has dropped to less than 60 percent full on several occasions, and in the early 2000s the dam water level dropped below 40 percent. The dam was at about 60 percent capacity in late 2018. The dam has also exceeded 100 percent capacity and spilled on numerous occasions during the 1960s and 1970s. Recent dam spills occurred in 2012, 2013, 2015, 2020 and 2021.

1.4.3.2 Flood operations

During large rainfall events when the storage level rises above FSL, flood operations mode would commence. In this mode, inflows to Lake Burragorang would be captured and temporarily stored (increasing water levels in Lake Burragorang and upstream tributaries). The raised dam would provide capacity (the FMZ) to temporarily capture around 1,000 gigalitres of water during a flood event.

Water would be discharged in a controlled manner via the gated conduits or slots[2] until the dam level returns to FSL. Flood mitigation zone operating protocols would guide this process and be developed for approval by the relevant regulatory authorities.

The raised dam would not be able to fully capture inflows from all floods. For floods that exceed the capacity of the FMZ, water would spill firstly over the central spillway and then, depending on the size of the flood, the auxiliary spillway.

[2] Modelling is based on discharge through gated conduits.

Figure 1-2. Construction area

Figure 1-3. Aerial view of modified dam from the Project works

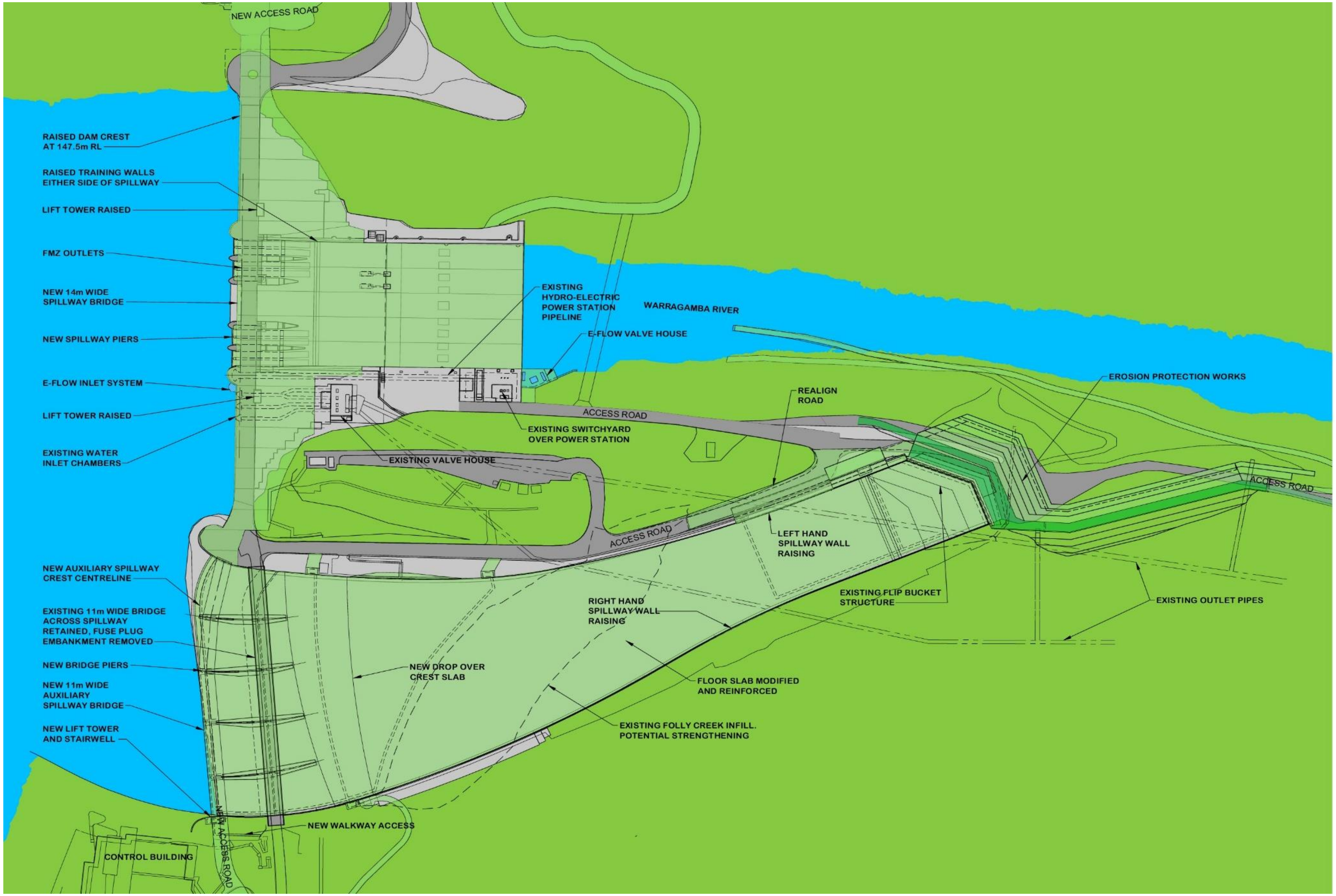


Figure 1-4. Cross section of modified auxiliary spillway crest

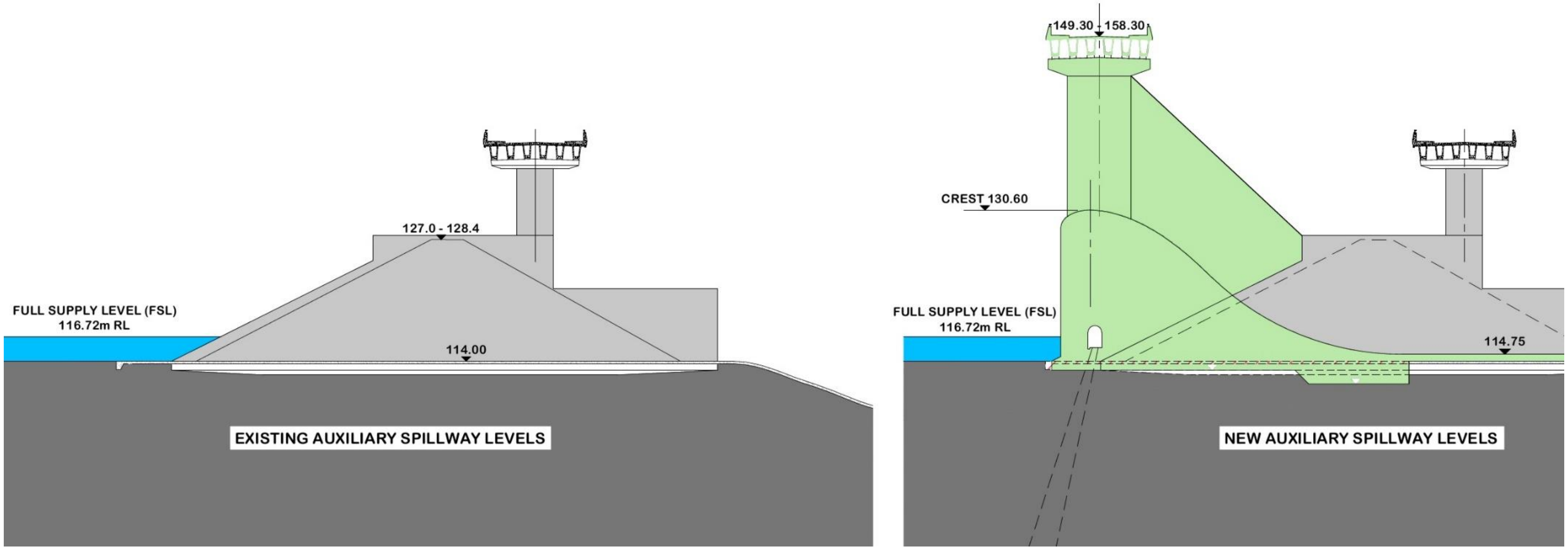


Figure 1-5. Cross-section of environmental flows infrastructure

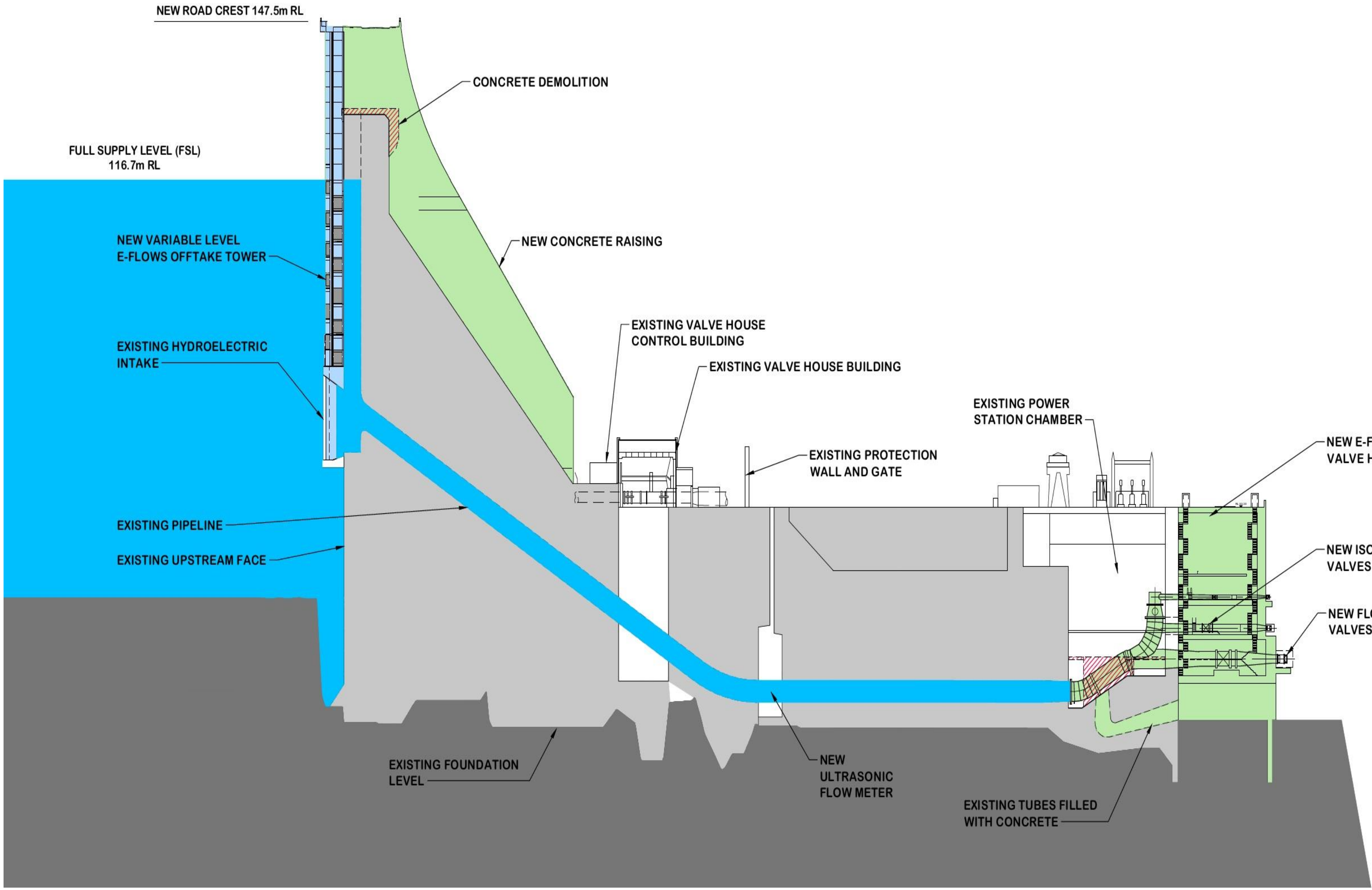


Figure 1-6. Existing operation of the dam

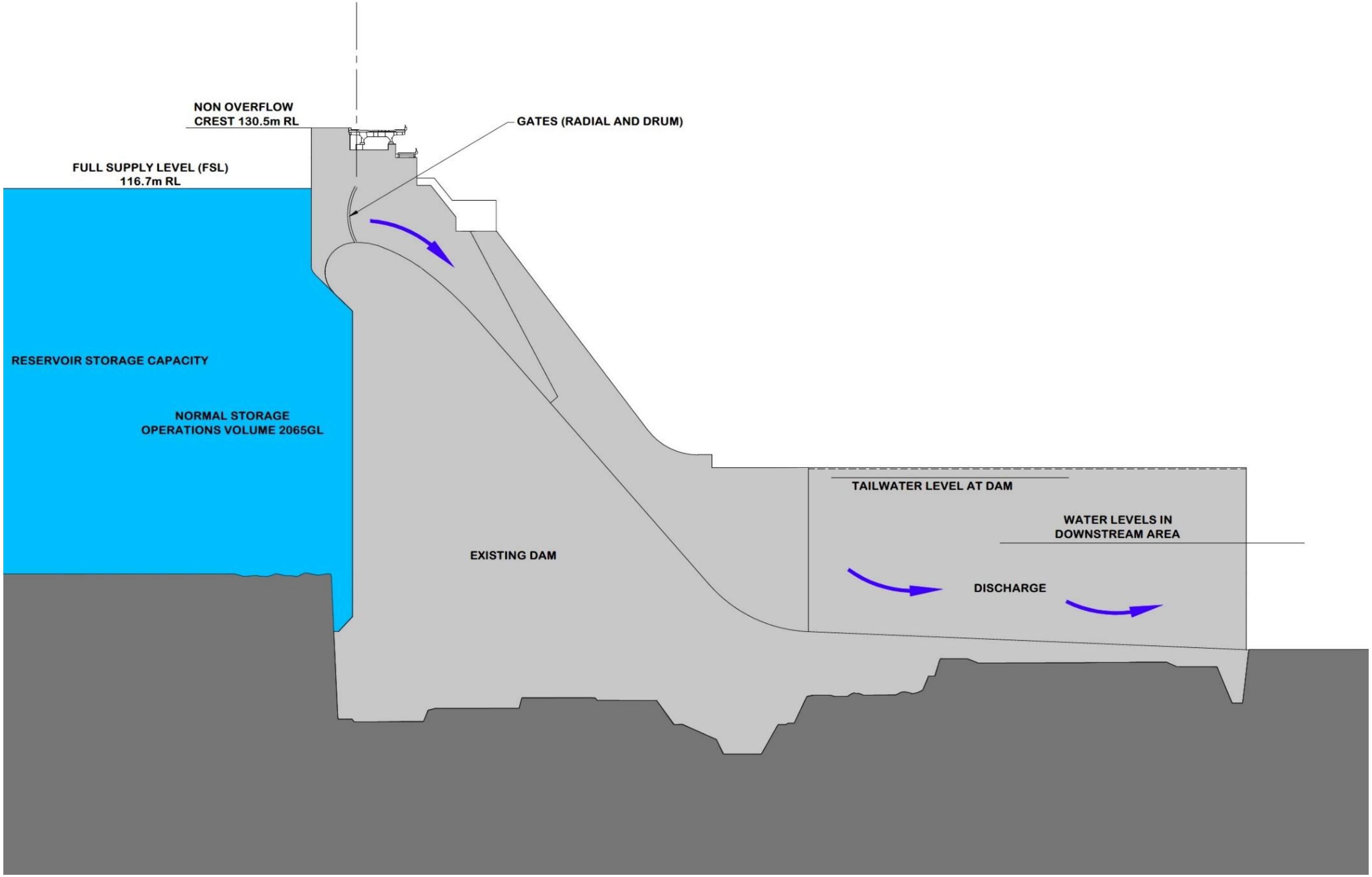
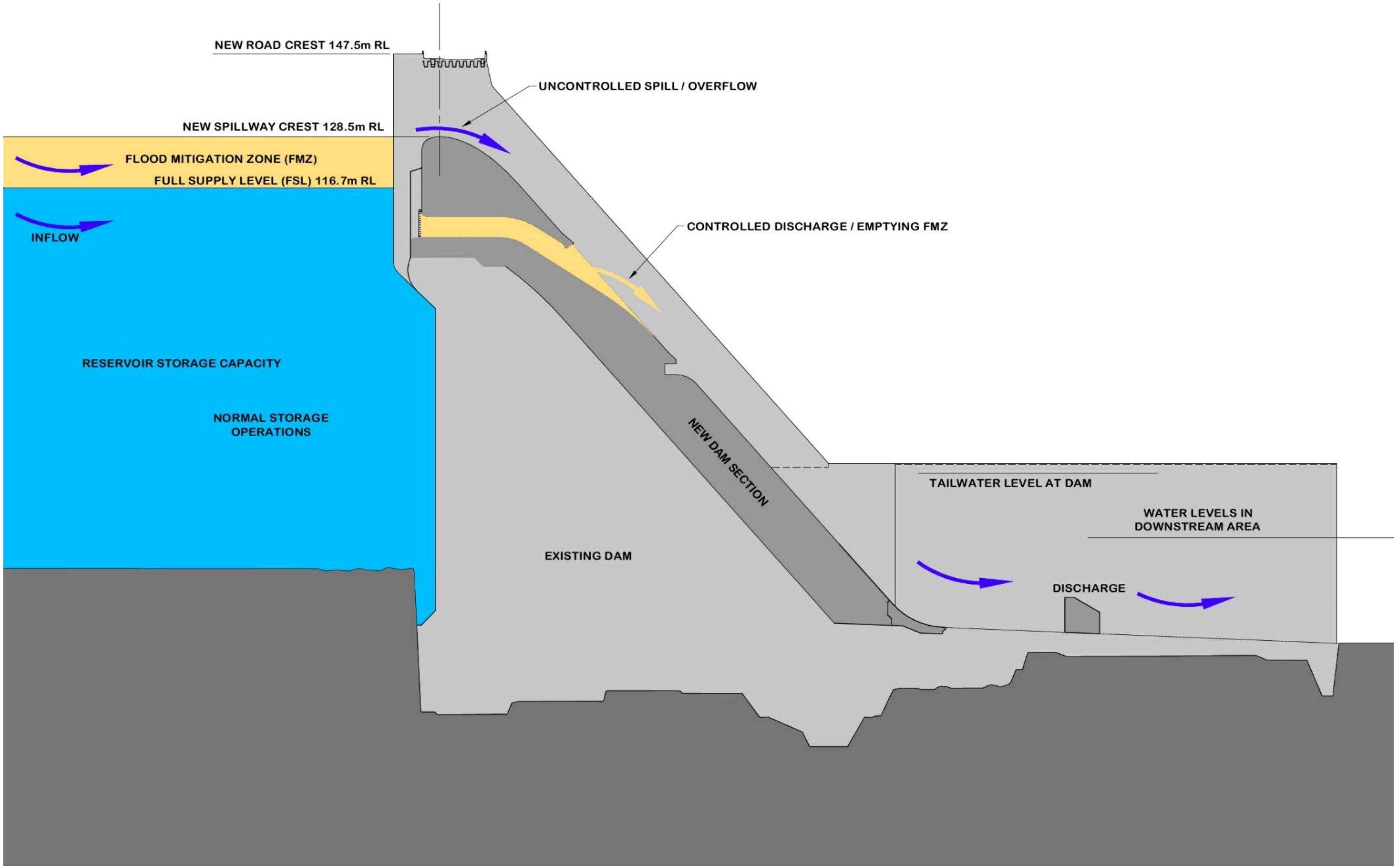


Figure 1-7. Future operations of the dam



1.4.4 Flood modelling and extent of Project study area

The existing and Project flooding extents were based on flood modelling, which is discussed in Chapter 15 of the EIS. Modelling of flood extents was extended further upstream than the cross-sections at which differences between the existing and with Project flooding impacts occurred, and included areas impacted by existing local catchment flooding.

Height/duration curves for modelled cross sections were used to identify the upstream cross-sections at which there were no longer any differences between the existing and Project flood events. Consequently, the modelled layers were truncated at cross sections along the Nattai River, Wollondilly River, Coxs River and Kowmung River.

1.5 Overview of methodology for upstream biodiversity assessment

The purpose of this section of the report is to provide a comprehensive overview of the approach taken to assess the impacts of the Project on biodiversity upstream of Warragamba Dam.

Impacts on biodiversity values would be principally associated with the effects of inundation from operation of the flood mitigation zone. The specific nature of impacts would depend on:

- the frequency of events
- the duration and depth of inundation for an individual event.
- the predicted change in vegetation integrity as a result of the differing responses of individual plant species to different inundation regimes.

The Project is a challenging project for application of standard assessment methodologies, primarily because the specific impacts are difficult to predict (due to both the unpredictability of the scale and timing of flood events and a lack of detailed knowledge of the response of biodiversity to temporary inundation). Because of this the methodology for the upstream biodiversity assessment has been developed based on an understanding of the impacts of the project from survey, literature review, risk assessment and modelling consistent with the requirements of the FBA. Development of the methodology has involved consultation with the former OEH particularly on application of the FBA for the Project.

It is important to appreciate that the upstream area is already potentially affected by flooding associated with the existing dam. It is also important to appreciate that the Probable Maximum Flood (PMF) is primarily used to inform design development and, given the size of the Warragamba catchment, is highly unlikely to actually ever occur in nature.

As discussed in Section 1.5.4, for the purpose of the FBA and calculation of offset requirements a precautionary approach has been adopted which assumes a 100 percent loss of vegetation/habitat within the area between the likely inundation level with the Project (2.78 m above FSL, RL 119.5 mAHD) and the likely inundation level for the existing dam 10.25 m above FSL, 126.97 mAHD).

1.5.1 Framework for Biodiversity Assessment

The FBA is the mechanism for the implementation of the *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014), and the SEARs (6.1) make specific reference with regard to assessing the impacts of the Project in accordance with the FBA.

The FBA prescribes the methodology for the impact assessment and provides guidance for offsetting impacts. The FBA also sets out measures required to offset unavoidable impacts through a Biodiversity Offset Strategy, which is submitted with the BAR as part of the EIS and application for development consent or infrastructure approval.

The FBA is undertaken in three stages:

- Stage 1: Identification of the biodiversity values that would be impacted, both directly and indirectly, by the Project focussing on affected landscape values, native vegetation, and threatened species. This is addressed in Sections 3, 4 and 5 of this report.
- Stage 2: Assessment of impacts on identified biodiversity values considering opportunities to avoid and minimise impacts, identification of thresholds for assessing and offsetting of unavoidable impacts and determining required offsets. This is addressed in Sections 6, 7 and 8 of this report.
- Stage 3: Development of a biodiversity offset strategy (BOS). This is documented separately in Appendix F6 of the EIS.

1.5.2 Assessment definitions

The FBA establishes specific definitions for elements of the FBA, which inform the spatial extent of the assessment and associated methodology.

In addition, the Project has adopted a defined 'survey area' which, for the purposes of this assessment, is the 1 in a 100 chance in a year event with the Project plus nine percent climate change (that is, a nine percent increase in rainfall under a climate change scenario). The 'survey area' was delineated with input from the former Department of Environment and Energy (DoEE)[3] prior to surveys commencing. It should be noted that 'survey area' is not a defined concept within the FBA.

Assessment definitions are described in Table 1-2 and shown on Figure 1-1.

Table 1-2. Adopted Project definitions for upstream biodiversity assessment

Element	FBA definition	Adopted Project definition
Development site	An area of land that is subject to a proposed Major Project that is under the EP&A Act.	1 Production Ave, Warragamba NSW 2752 Lot 1, DP87998 and Lot 1124, DP1159978 This aligns with the required information under clause 228(c) of the EP&A Regulation.
Development footprint	The area of land that is directly impacted on by a proposed Major Project that is under the EP&A Act, including access roads, and areas used to store construction materials.	This generally equates to the construction footprint for the raising of the dam wall and adjoining/nearby land affected by construction activities, refer to Appendix F3 (Biodiversity assessment report – construction area). The area of the development footprint is about 105 ha.
Study area	The area directly affected by the development and any additional areas likely to be affected by the development, either directly or indirectly. The study area should extend as far as necessary to take all potential impacts into account, for the purpose of an assessment under Subsections 9.2.4 and 9.2.5 [of the FBA].	The upstream study area comprises the area between full supply level (FSL) and the Project PMF. This equates to an area of about 5,280 ha (and noting that a portion of this area is already potentially affected by flooding). The principal areas of interest in the study area for the assessment are the survey area and upstream impact area as defined below.
Field survey area	Not defined within the FBA. A field survey area was identified to allow focussed survey effort across a large study area. The field survey area was delineated with input from the former OEH and DoEE prior to surveys commencing (refer Section 1.5.5)	Area within a representative 1 in 100 chance in a year event (1% AEP) with the Project plus nine percent climate change (that is, a nine percent increase in rainfall under a climate change scenario). This equates to an area of about 3,740 ha.
Upstream impact area	Not defined within the FBA (refer Section 1.5.4)	The area between the likely inundation level with the Project (10.25 m above FSL, RL 126.97 mAHD) and the likely inundation level for the existing dam (2.78 m above FSL, RL 119.5 mAHD). The size of this area is about 1,400 ha.

1.5.3 Potential upstream impacts of the Project

The Project would have impacts beyond the immediate footprint of the raised dam (that is, the development site). For the upstream area, impacts on biodiversity values would be principally associated with the effects of temporary inundation from operation of the flood mitigation zone, the lower limit of which is the existing full supply level. The exact nature of the impacts on biodiversity values will be dependent on multiple factors, such as the timing and magnitude of the rainfall events, catchment conditions at the time of the rainfall event, the existing storage level, the

[3] The Environment portfolio within DoEE was transferred to the new Department of Agriculture, Water and the Environment (DAWE) which commenced operation on 1 February 2020.

depth and duration of inundation, and the tolerance of plant species to inundation. These and other factors contribute to uncertainty with regard to quantifying the impacts on biodiversity values. For the purposes of completing the FBA assessment and calculation of biodiversity offsets an upstream impact area has been identified where it has been precautionarily assumed there would be a 100 percent loss of biodiversity values within this area. The basis for defining the impact area is outlined in Section 1.5.4.

1.5.4 Upstream impact area

The upstream study area comprises the maximum extent of flood prone land estimated from the probable maximum precipitation and resultant inundation. The probabilistic nature of flooding in the upstream study area presents a challenge in identifying appropriate flood events to inform an assessment of potential impacts, and noting that for a specific flood event of a particular chance of occurrence, there is already an existing potential impact associated with that particular flood event.

For the upstream study area, potential impacts would be principally associated with the effects of temporary inundation from operation of the FMZ, the lower limit of which is the existing FSL. The exact nature of the impacts would be dependent on multiple factors such as:

- the timing and magnitude of the rainfall events
- catchment conditions at the time of the rainfall event
- the existing storage level
- the duration, depth and extent of inundation for an individual flood event
- the potential change in vegetation integrity as a result of the differing responses of individual plant species to different inundation regimes
- the type and condition of Aboriginal cultural heritage items and places.

These and other factors contribute to substantial uncertainty with regard to quantifying the potential impacts on World Heritage values, notably biodiversity values and Aboriginal cultural heritage.

In view of this, it was determined that a different approach to assessing potential impacts was required in order to provide relative greater certainty around potential impacts and importantly, to provide a more objective basis for identification and development of mitigation measures. The approach taken has been to identify an 'impact area' that takes account of the variability of flood events and their extent over time.

A review of the historical record identified at least one large flood above FSL would occur within a 20 year period. Building on previous hydrological modelling carried out for the Project, further modelling was undertaken to assess the likely level of inundation upstream of the dam. Around 20,000 Monte Carlo simulated events were used to generate a 200,000 year flood record. This included the full range of possible events based on the latest hydrology analyses. This was then analysed by selecting the maximum inundation level in 20 year periods to determine the 'average' or likely inundation level. This was also undertaken for the existing dam scenario so that a comparison of inundation extents could be made.

Since flood behaviour in the Hawkesbury Nepean Valley has distinct multi-decade wet and dry periods, the inundation assessment period outcomes considered:

- randomly selected periods
- half wet / half dry periods
- wet dominated periods
- dry dominated periods.

The results from all these hypothetical flood sequences were then analysed to determine what the average or likely inundation outcomes would be.

The average results for the flood/drought sequence were then used to define the upper and lower elevations for the impact area as these were considered to provide the most likely outcome on a statistical basis. These are:

- Lower extent: 2.78 metres above FSL (119.5 mAHD)
- Upper extent: 10.25 metres above FSL (126.97 mAHD).

The likely inundation level for the existing dam is also about the maximum recorded level since construction of Warragamba Dam. For the purposes of the Project, the area between these two levels has been adopted as the upstream impact area. The size of the upstream impact area is about 1400 hectares.

The upstream impact area has been used as a means to offset the potential impacts of the Project. For the purposes of offsetting the potential impacts of the Project, it has been assumed that there would be a complete loss of values in this area. In reality, this is unlikely as sensitive areas/sites would have differing risks of impact depending on their respective locations in terms of elevation. Areas/sites at lower elevations would have a greater risk of temporary inundation than areas/sites at higher elevations within the upstream study area.

The location of the upstream impact area is shown in Figure 1-8.

1.5.5 Consultation with regulatory authorities for development of assessment methodology

The SEARs require that the Proponent to assess biodiversity impacts in accordance with the current guidelines including the FBA, unless otherwise agreed by OEH. WaterNSW has met with representatives of the Department of Planning, Industry and Environment (DPIE) and DoEE/DAWE to resolve how the FBA can be applied to the upstream area that would be subject to temporary inundation from the proposal particularly as the impacts would be infrequent, cumulative and difficult to measure over time. The agencies agreed that the upstream impact area for the purpose of assessment and offsetting of impacts be the area identified in Section 1.5.4.

1.5.6 Approach to management of impacts

An offset strategy has been prepared to address the potential impacts of the Project resulting from upstream temporary inundation (See Appendix F6 (Biodiversity offset strategy)). The upstream impact area has been used as the basis for the offset calculation. The assessment has used the BioBanking Credit Calculator (BBCC) to generate a credit calculation, assuming that there would be 100 percent loss of ecosystem and species values within the upstream impact area.

Other impacts associated with temporary inundation would be managed in accordance with the Environmental Management Plan (EMP) required to be prepared under Part 5A of the *Water NSW Act 2014* (Water NSW Act).

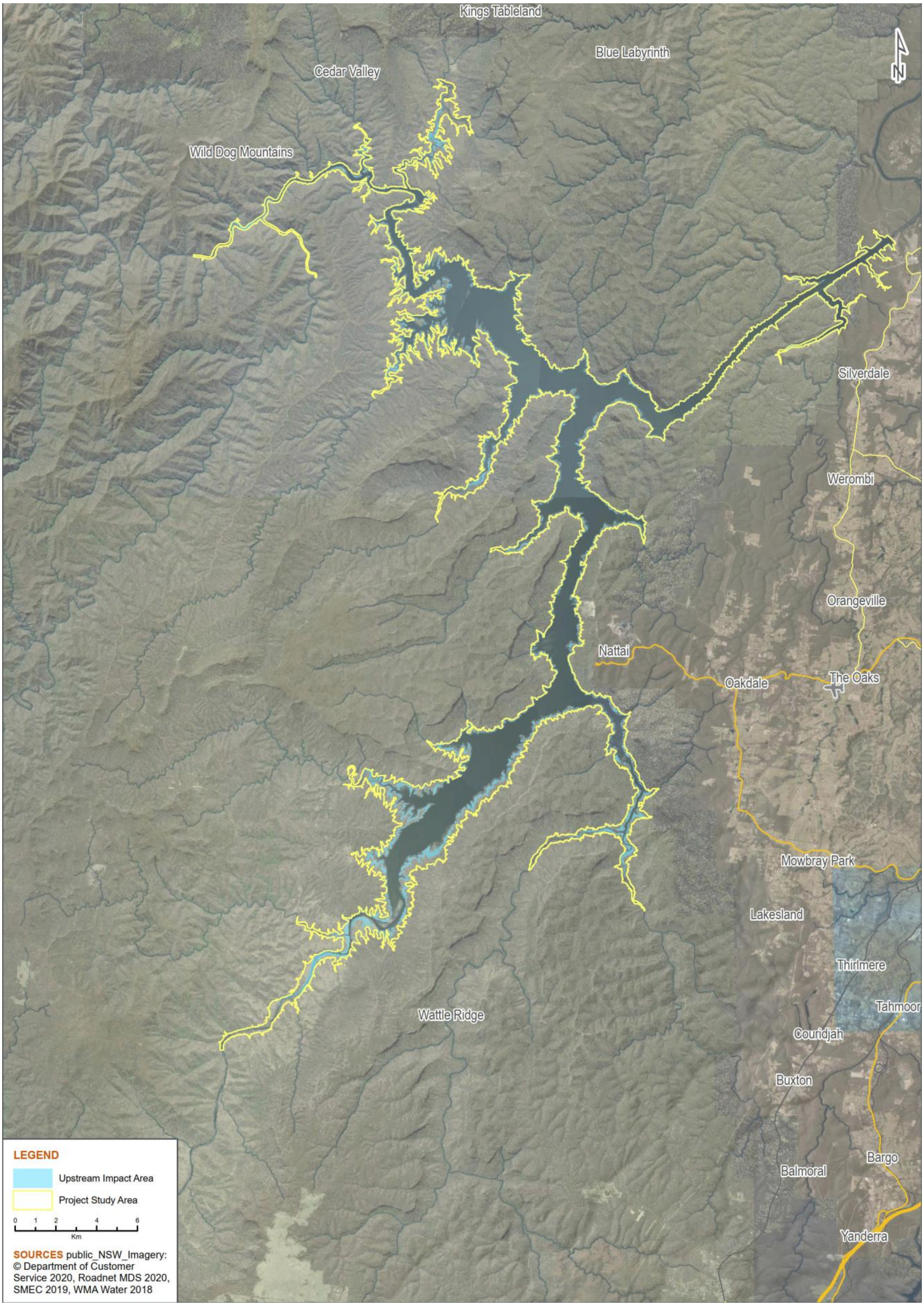
1.5.7 2019-2020 bushfire event

Following field surveys for this biodiversity assessment, New South Wales, including the catchment of Lake Burragorang, experienced severe bushfire between 2019 and 2020. These bushfires are described as unprecedented in their extent and intensity affecting at least 5.4 million hectares (seven percent of NSW) including 27 percent of national park estate, more than 81 percent of the World Heritage listed Greater Blue Mountains Area and 54 percent of the NSW components of the Gondwana Rainforests of Australia World Heritage property (DPIE 2020a). The most affected ecosystems were rainforests (37 percent of their state-wide extent), wet sclerophyll forests (50 percent) and heathlands (52 percent) (DPIE 2020a). The fires affecting the study area began in late October 2019 in remote bushland near Lake Burragorang, near Yerranderie, and in Kanangra-Boyd National Park. Due to the extreme isolation of the area and rugged inaccessible terrain, the fire spread and merged to eventually become the Green Wattle Creek Fire on 27 November 2019. This fire rapidly affected the study area where it burnt out of control for at least nine weeks. A total of 278,700 hectares in the Wollondilly area were affected by this fire until it was officially declared as ‘contained’ on 30 January 2020. The fire was declared as ‘extinguished’ by the NSW Rural Fire Service (RFS) on 10 February 2020 following a torrential rain event over the preceding week.

The NSW DPIE Remote Sensing and Landscape Science team has, in collaboration with other organisations, developed fire mapping and modelling of the 2019-2020 bushfire event in order to determine the extent, severity, and impact of the bushfires on native vegetation. There are two fire maps:

- Google Earth engine burnt area map (GEEBAM), which was developed in collaboration with University of NSW, was developed as a rapid mapping approach which detected how badly the tree canopy had burnt by measuring the change in colour in vegetation before and after fire (DPIE, 2020b). GEEBAM’s rapid assessment of vegetation post-fire made information quickly available on the likely impacts of the fire event on biodiversity, supporting important conservation and environmental management decisions (DPIE 2020b)

Figure 1-8. Upstream impact area



The NSW DPIE Remote Sensing and Landscape Science team has recommended that FESM be utilised over the rapid GEEBAM product for assessing the impacts of the fire event within the study area.

The FESM classifies the fire severity into five burn severity classes. A description of each class, and the approximate extent of each burn severity class within the upstream study area and upstream impact area are provided in Table 1-3. The extent of the fires and the burn severity is shown on Figure 1-9. The mapping provided by DPIE includes areas below FSL; the mapping has been modified to show only areas above FSL.

Table 1-3. FESM burn severity classes and approximate burn extent within the upstream study area and upstream impact area

Severity class	Description	Percent foliage fire affected	% of upstream study area	% of upstream impact area
Unburnt	Unburnt surface with green canopy	0% canopy and understory burnt	26.9%	30.2%
Low	Burnt understory with unburnt canopy	>10% burnt understory >90% green canopy	35.6%	35.4%
Moderate	Partial canopy scorch	20-90% canopy scorch	27.7%	25.4%
High	Complete canopy scorch (+/- partial canopy consumption)	>90% canopy scorched <50% canopy consumed	5.3%	4.6%
Extreme	Complete canopy consumption	>50% canopy biomass consumed	4.5%	4.4%

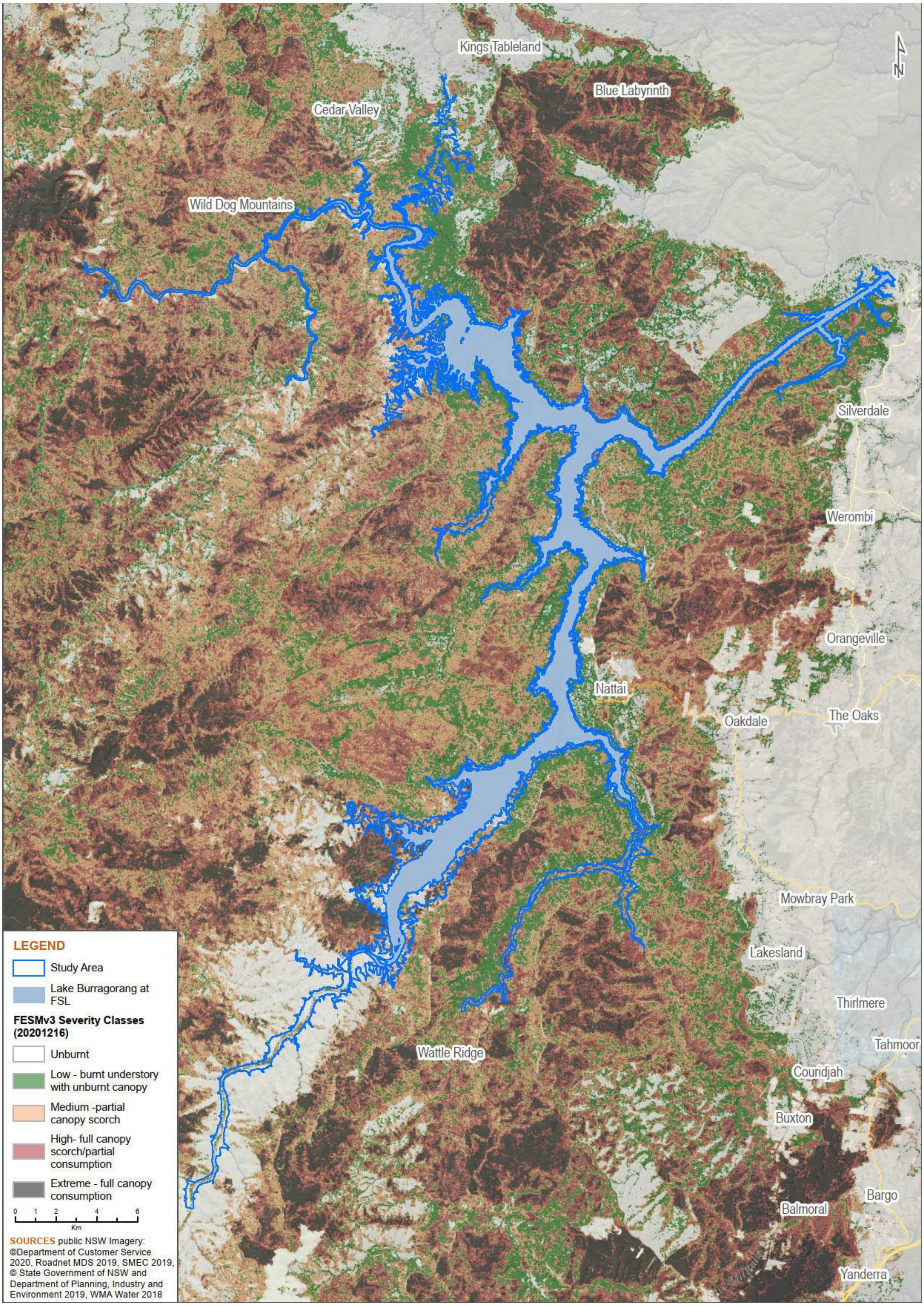
The 'NPWS Fire History – Wildfires and Prescribed Burns' is a mapping layer released by DPIE on the history of fire in national parks based on data captured by the RFS and Forestry Corporation NSW (DPIE 2020d). According to this mapping, the majority of the study area has been affected by wildfire historically and at least 30 percent of the extent has been subjected to a prescribed burn. Wildfires have affected the catchment variably since 1964-65 however none has been as extensive in size as the 2019-2020 fire. Historically, the catchment has experienced at least four major wildfire events: 1964-65, 1994-95, 1997-98 and 2001-02 (DPIE 2020d). The effects of the 2019-2020 bushfires on the environment, including the ecological consequences, are not yet fully understood. Though bushfires are not uncommon in Australia, they are usually of a lower scale and intensity that only affect small parts of the overall distribution of ecosystems and habitats (DPIE 2020e). Post-fire studies have found that a number of species (both threatened and not currently threatened) have had their entire global populations burnt in the 2019-2020 fires. This includes some species and ecological communities that are known to be sensitive to severe fire (DPIE 2020e).

The long-term fire regime including fire frequency, intensity and seasonality influence the ecosystem in various ways, including having both positive and negative effects. If fires are too frequent, plants may be killed before they have matured or before they have set sufficient seed to ensure population recovery. Alternatively, infrequent fires can impact negatively on plants that rely on fire to regenerate. If fire is too infrequent, these species can grow old and die, and their seeds rot in the soil before germinating. In this way, plant community species richness and composition can be shaped by the fire regime. Some plant species have no or limited natural fire tolerance and may be extirpated or significantly reduced in density over their affected ranges. Other ecological inputs following fire, particular widespread and intense fires, can have additional effects on post-fire ecology. These inputs may include recurrent fires, drought, intense rainfall, flood, erosion and predation.

Notwithstanding, a number of threatened ecological communities, threatened species, and non-threatened species are considered to have been disproportionately impacted by the 2019-2020 bushfires. Consequently, DoEE/DAWE has released an initial list of threatened and migratory species which have more than 10% of their known or predicted distribution in areas affected by bushfires in southern and eastern Australia from 1 August 2019 and 13 January 2020. Of this list, 58 species either recorded during current field surveys, or predicted to occur based on habitat preferences, within the study area, including:

- *Eucalyptus benthamii* (30 to <50 percent)
- *Hakea dohertyi* (≥ 80 percent)
- *Bossiaea oligosperma* (10 to <30 percent)

Figure 1-9. Extent of 2019/2020 bushfires



- *Pomaderris brunnea* (50 to <80 percent)
- *Eucalyptus glaucina* (10 to <30 percent)
- Regent Honeyeater (10 to <30 percent)
- Koala (10 to <30 percent)
- Brushtail Rock Wallaby (30 to <50 percent)
- Greater Glider (10 to <30 percent)
- Broad-headed Snake (50 to <80 percent)

In addition to the above, DoEE/DAWE has released an initial list of fauna species which require urgent management intervention (DoEE 2020). A total of three bird species, nine mammal species, and two frog species listed on DoEE/DAWE's initial list were either recorded during current field surveys, or predicted to occur based on habitat preferences, within the study area. These include, Regent Honeyeater, Lyrebird, Yellow-bellied Glider, Greater Glider, Koala, Grey-headed Flying-fox, and Giant Burrowing Frog.

Table 1-3 and Figure 1-9 suggest that the extent and severity of fire within the Project study area was less than the surrounding landscape. Intuitively this makes sense as the study area comprises primarily gorge and riparian landscapes likely to be less prone to fire than ridgelines. This suggests that the study area is likely to be an important refuge for fauna during major fire events.

In March 2020, DPIE released a set of guidelines relating to carrying out biodiversity assessments, specifically BAM assessments, at severely burnt sites. The guidelines aim to provide assessors with a reasonable, evidence-based and transparent process for identifying severely burnt native vegetation and provides a range of approaches for applying the BAM on land impacted by severe bushfire. Section 4.1.1 of the guidelines state that where the Stage 1 BAM assessment has been completed prior to severe bushfire, the assessor should use this information to prepare the impact assessment. Given that Stage 1 of the FBA is broadly consistent with the objectives and outcomes of Stage 1 of the BAM, it is reasonable to conclude that further assessment in line with the guidelines is not required for this assessment.

1.6 Information sources

1.6.1 Database analysis

The following information sources were used in the preparation of this report:

- Aerial maps, Project layers and environmental layers provided by WaterNSW and OEH
- Department of the Environment and Energy Species Profiles and Threats database (SPRAT) (DoEE n.d.b)
- Department of Environment, Climate Change and Water Mitchell Landscapes NSW OEH v3 Bioregional Assessment Source Dataset (DECCW 2010a)
- Department of the Environment and Energy Protected Matters Search Tool (DoEE 2015)
- Matters of National Environmental Significance Significant Impact Assessment Guidelines 1.1 (DoE 2013)
- NSW OEH's BioBanking credit calculator (OEH n.d.a)
- NSW Atlas of NSW Wildlife (OEH 2017b)
- OEH Threatened Species Profiles (OEH 2017g)
- Mitchell Landscapes with per cent cleared estimates (Eco Logical Australia 2007)
- Framework for Biodiversity Assessment: NSW (OEH 2018b)
- NSW Biodiversity Offsets Policy for Major Projects (OEH 2014)
- Vegetation Classification Database (OEH 2017c)
- Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems (BoM 2019)
- NSW Government's Biodiversity Values Map and Threshold Tool (OEH 2019a)
- Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge 2003)

1.6.2 Literature review

Several biodiversity investigations have been previously undertaken for previous dam-related projects. A review of ecological literature relevant to the site was undertaken as part of this assessment to evaluate the biodiversity values associated with the site.

The following reports were reviewed in preparation of this report:

- *Warragamba Dam EIS - Dam Site Environmental Studies, Fauna and Flora* (Mount King Ecological Surveys 1992)
- *Warragamba Dam Raising Preliminary Environmental Assessment* (BMT WBM Pty Ltd 2016)
- *Warragamba Dam Auxiliary Spillway Project – Construction Environmental Management Plan Framework* (Australian Water Technologies and SKM 2003)
- *Safeguarding Warragamba Dam: proposed auxiliary spillway* (Sydney Water 1996)
- *Eucalyptus benthamii* Inundation Experiment: Reporting on stand health and soil properties over a 12-month monitoring period (Bush *et al*. 2018)
- Glasshouse evaluation of inundation tolerance of Camden White Gum (*Eucalyptus benthamii*) (Marcar 1995)
- *The Native Vegetation of the Warragamba Special Area, Part A: Technical Report* (NPWS 2003a)
- *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region* (DECC 2007a, 2007b, 2007c)
- *Threatened and pest animals of Greater Southern Sydney* (DECC 2007d).
- *Literature and Field Assessment of Environmental Impacts of Temporary Inundation Upstream of Queensland Flood Mitigation Dams* (Hydrobiology 2020)

In addition to the literature review of previous biodiversity investigations listed above, the following sources of information were reviewed as part of the assessment:

- Soil Landscapes of the Penrith 1:100,000 Sheet map and report (Bannerman and Hazelton 1990)
- Soil Landscapes of the Katoomba 1:100,000 Sheet map and report (King, 1994)
- Descriptions for NSW (Mitchell) Landscapes, Version 2 (DECC, 2002)
- 'Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands' (Tozer *et al*. 2010)
- Matters of National Environmental Significance Significant Impact Guidelines (DoE 2013)
- Framework for Biodiversity Assessment (OEH 2018b)
- NSW Biodiversity Offsets Policy for Major Projects (OEH 2014)
- Aerial maps, Project layers and environmental layers provided by WaterNSW and OEH.

An extensive literature review was carried out for the impact assessment. This review is described in detail in Section 7.2.1.

1.6.3 Aerial photography

The aerial imagery used was taken from the SIXmaps imagery (Department of Finance and Services 2017), as well as Nearmap where appropriate, and original imagery supplied by WaterNSW.

The SIXmaps aerial details are in Table 1-4 below.

Table 1-4. SIXmaps specifications – 27 December 2018

Parameter	Details
BlockName	Penrith; Burragorang; Katoomba
BlockType	ADS40_SC
BlockStartDate	19 September 2013; 29 September 2013; 3 September 2013
BlockEndDate	N/A

2 Legislation and policies

2.1 Commonwealth legislation

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's principal piece of environmental legislation and is administered by the Commonwealth Department of the Environment and Energy (DoEE). It is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES), which include threatened species of flora and fauna, endangered ecological communities and migratory species, as well as other protected matters. Among other things, it defines the categories of threat for threatened flora and fauna, identifies key threatening processes and provides for the preparation of recovery plans for threatened flora, fauna and communities.

Matters of national environmental significance identified in the EPBC Act are that are relevant to the Project:

- World Heritage properties
- national heritage places
- nationally threatened species and communities.

The Protected Matters Search Tool (DoEE 2015) (search date: 26th April 2019) for the study area with a 10-kilometre buffer resulted in the following MNES that may occur in, or may relate to, this area:

- 1 World Heritage property
- 1 National Heritage place
- 12 threatened ecological communities
- 78 threatened species
- 16 migratory species.

The following MNES were recorded within the study area during surveys:

- Regent Honeyeater (*Anthochaera phrygia*) – Critically Endangered
- Few-seeded Bossiaea (*Bossiaea oligosperma*) - Vulnerable
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – Vulnerable
- Camden White Gum (*Eucalyptus benthamii*) – Vulnerable
- Slaty Red Gum (*Eucalyptus glaucina*) – Vulnerable
- Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*) – Vulnerable
- Kowmung Hakea (*Hakea dohertyi*) – Endangered
- Greater Glider (*Petauroides volans*) – Vulnerable
- Brown Pomaderris (*Pomaderris brunnea*) - Vulnerable
- Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland – Critically Endangered Ecological Community (CEEC).

The preliminary environmental assessment (BMT WBM Pty Ltd 2016) of the MNES present within the study area indicated that there are likely to be impacts on areas of White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland CEEC as well as individuals of Camden white gum (*Eucalyptus benthamii*), Kowmung Hakea (*Hakea dohertyi*) and Few-seeded Bossiaea (*Bossiaea oligosperma*). In addition, the Project may have additional impacts on suitable habitat for a number of other EPBC Act-listed species and as such, a referral to DoEE was required for further consideration.

The Project has been deemed a controlled action (ref 2017/7940) as it has the potential to significantly impact on MNES, and as such requires assessment under the EPBC Act. In accordance with the Bilateral Agreement reached between the NSW and Commonwealth Governments, an EIS under the EP&A Act for State Significant Infrastructure (SSI) can also be used for an EIS under the EPBC Act for a controlled action, where directed by the Commonwealth Minister. The direction was given for the Project to be assessed under the Bilateral Agreement on 17 July 2017. The Project will be assessed by relevant NSW departments in the first instance followed by assessment by the Commonwealth Minister for final approval.

2.2 New South Wales

2.2.1 Environmental Planning and Assessment Act 1979

The EP&A Act is the overarching planning legislation in NSW that provides for the creation of planning instruments that guide land use. The EP&A Act also provides for the protection of the environment, including the protection and conservation of native animals and plants. This includes threatened species, populations and ecological communities, and their habitats of biodiversity values, as listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and NSW *Fisheries Management Act 1994* (FM Act).

The protection of the environment is addressed in Part 5, Division 5.2, subdivision 2 of the EP&A Act – Environmental assessment and approvals of infrastructure for State Significant Infrastructure. Specifically, this section provides guidance on significant effect on species, populations or ecological communities or their habitats. It is noted that the *Biodiversity Conservation Act 2016* (BC Act) came into effect on 25 August 2017, repealing and replacing the TSC Act, but retaining the threatened species listings. Preliminary work on the EIS commenced prior to the date that the BC Act came into effect, triggering consultation with OEH for clarity on the appropriate planning pathway. Consequently, in accordance with Part 7, clause 29 of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*, WaterNSW is obliged to continue to apply the former planning provisions.

WaterNSW, as the Proponent and a determining authority for the Project within the meaning of Part 5 of the EP&A Act, has formed the view that the impact of the Project is likely to significantly affect the environment and, therefore, would require the preparation of an EIS. The Project is declared to be SSI under section 5.12(2) of the EP&A Act. The effect of the EP&A Act and the relevant SEPPs is that WaterNSW would have been the determining authority for the Project under Part 5 of the EP&A Act, were it not for the application of section 5.12(2) of the EP&A Act. In this instance, section 5.12(2) of the EP&A Act is triggered by reason of the operation of clause 14 and Schedule 3 of State Environmental Planning Policy (State and Regional Development) 2011 (State and Regional Development SEPP).

Accordingly, the Project is subject to assessment under Part 5, Division 5.2 of the EP&A Act and requires the approval of the NSW Minister for Planning and Public Spaces under section 5.14 of the EP&A Act. Further information on the assessment process is available on the DPIE website (www.planning.nsw.gov.au).

The SEARs for the Project were issued by the former NSW Department of Planning and Environment (DP&E) on 30 June 2017 and updated were issued on 13 March 2018. The provisions that are relevant to this BAR are reproduced in Table 1-1.

An assessment of the type and magnitude of impacts that would result from the Project on biodiversity values and measures to avoid and mitigate these impacts within the study area are presented within this BAR. A separate biodiversity offset strategy (BOS) has been prepared to address offset measures (refer Appendix F6).

2.2.2 Biodiversity Conservation (Savings and Transitional) Regulation 2017

The BC Act and its supporting regulations commenced on 25 August 2017. The BC Act repeals the TSC Act along with other natural resource management legislation, while retaining the TSC Act species list.

The BC Act sets out the environmental impact assessment framework for threatened species, threatened ecological communities and areas of outstanding biodiversity value (formerly critical habitat) for major projects (amongst other types of development).

However, the transitional provisions of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 apply to this Project as the application for the SEARs for the Project was made prior to the commencement of the BC Act. Consequently, the Project has been assessed in accordance with the provisions of the TSC Act.

When referring to the planning assessment provisions used for this assessment, the report uses the TSC Act. When referring to threatened species, populations, or ecological community listings, the report uses the BC Act.

2.2.3 Threatened Species Conservation Act 1995

The biodiversity assessment has been carried out in accordance with the relevant provisions of the TSC Act through the effect of the Biodiversity Conservation (Savings and Transitional) Regulation 2017. Consideration has also been given to relevant matters under the BC Act, particularly with regard to threatened species, populations and ecological communities that may have been listed, or existing listings that may have been amended subsequent to the BC Act coming into force.

The TSC Act was the key piece of legislation in NSW relating to the protection and management of biodiversity and threatened species. The TSC Act aimed to protect and encourage the recovery of threatened species, populations and ecological communities of plants and animals that are listed under the Act through threat abatement and species recovery programs.

The Schedules of the TSC Act identified endangered or vulnerable subjects and the processes likely to be affecting them. This was achieved through the declaration and mapping of habitats that are critical to the survival of the relevant species, populations and ecological communities (critical habitats). Further, the TSC Act also set out the methods of assessment, management and regulation of actions that may damage critical or other habitat or otherwise significantly affect threatened species, populations and ecological communities. Provision was made for the preparation of recovery plans to mitigate and manage key threatening processes.

2.2.4 Fisheries Management Act 1994

The objectives of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. More detailed objectives relevant to the Project are:

- to conserve fish stocks and key fish habitats
- to conserve threatened species, populations and ecological communities of fish and marine vegetation
- to promote ecologically sustainable development, including the conservation of biological diversity.

Certain separate approvals under the FM Act are not required if the Project is approved under Part 5, Division 5.2 of the EP&A Act. Other requirements of the FM Act would need to be considered including impacts on threatened fish and aquatic species and key fish habitat, as well as key threatening processes to aquatic ecosystems and species needs to be considered. A separate aquatic ecology impact assessment (Appendix F4 to the EIS) assesses these issues.

Section 218 of the FM Act requires projects involving alteration of a dam, weir or reservoir or involving blockage to fish passage to conduct an assessment to identify the potential impacts. The Project must also be referred to the Minister responsible for the FM Act and, if requested, involve inclusion of a suitable fishway or bypass.

2.2.5 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the protection of Aboriginal sites and designated conservation areas as well as the flora and fauna within conservation areas. Conservation areas declared under the NPW Act that are within the study area include:

- Warragamba Special Area (see Section 2.2.9 regarding the Water NSW Act)
- Kanangra-Boyd and Nattai wilderness areas (see Section 2.2.6 regarding the *Wilderness Act 1987*)
- Kowmung, Colo and Grose wild rivers
- Kanangra-Boyd, Blue Mountains and Nattai national parks
- Burragorang, Yerranderie and Nattai state conservation areas
- Yerranderie Regional Park.

The works for the Project would be undertaken only within the Warragamba Special Area. As WaterNSW jointly manages the Special Area with the National Parks and Wildlife Service (NPWS) it has authority under the Water NSW Act to undertake works associated with Warragamba Dam, subject to approval under the EP&A Act. Consequently, no permit or other approval is required in relation to any National Park, State Conservation Area or Regional Park as no works are planned within these areas.

While works associated with the Project would not occur directly in any conservation area declared under the NPW Act, conservation areas both upstream and downstream may be impacted by changes in temporary inundation and flooding. The impacts of any changes in inundation and flooding due to the Project on conservation areas are assessed in Chapter 20 (Protected and sensitive lands) and Chapter 21 (Socio-economic, land use and property) of the EIS.

Under section 153 of the NPW Act, the relevant Minister is prohibited from granting a lease, licence, easement or right of way for the purposes of inundation of any land which is protected under the NPW Act and is land to which the *Sydney Water Catchment Management Act 1998* applies. However, the Water NSW Act was amended in October 2018 to exclude the need for a lease, licence, easement or right of way under the NPW Act from the relevant Minister for temporary inundation of the Warragamba Dam catchment.

Impacts to Wild Rivers have been assessed in Chapter 15 (Flooding and hydrology) and Chapter 20 (Protected and sensitive lands) of the EIS. As part of preparation of the EIS, the Minister administering the NPW Act has been consulted in regard to potential impacts from all aspects of the Project, including changes of flow patterns in the Kowmung, Colo and Grose Rivers.

2.2.6 Wilderness Act 1987

The objectives of the *Wilderness Act 1987* (Wilderness Act) are:

- to provide for the permanent protection of wilderness areas
- to provide for the proper management of wilderness areas
- to promote the education of the public in the appreciation, protection, and management of wilderness.

Development cannot occur in a wilderness area subject to a wilderness protection agreement or conservation agreement unless subject to written consent under section 15 of the Wilderness Act from the Minister administering the Act. Development under the Wilderness Act is defined as 'the use of that area' – which temporary inundation could be defined as.

Some areas of the Lake Burragorang catchment are in the Kanangra-Boyd and Nattai wilderness areas, and would experience increased temporary inundation due to the operation of the Project. However, these areas are not subject to either a wilderness protection agreement or conservation agreement. Therefore, consent under section 15 of the Wilderness Act from the Minister administering the Act is not required.

2.2.7 Biosecurity Act 2015

The *Biosecurity Act 2015* replaced the *Noxious Weeds Act 1993* on 1 July 2017. The Biosecurity Act is a wide-ranging legislation that outlines the requirements of government, councils, private landholders and public authorities in the management of biosecurity matters. Priority weeds are regulated under the Biosecurity Act with a general biosecurity duty to prevent, eliminate or minimize any biosecurity risk they may pose. Some priority weeds have additional management obligations which may apply generally, or under specific circumstances. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised as is reasonably practicable.

2.2.8 NSW Biodiversity Offsets Policy for Major Projects

The *NSW Biodiversity Offsets Policy for Major Projects* was adopted in September 2014 and applies to SSI designated under the EP&A Act. The policy provides a standard method for assessing impacts of major projects on biodiversity and determining offsetting requirements (OEH 2014). The policy is underpinned by six principles which must be considered when assessing offsets for major projects. These principles are:

1. Before offsets are considered, the impacts must first be avoided, and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.
2. Offset requirements should be based on reliable and transparent assessment of losses and gains.
3. Offsets must be target by the biodiversity values being lost or to higher conservation priorities.
4. Offsets must be additional to other legal requirements.
5. Offsets must be enduring, enforceable and auditable.
6. Supplementary measures can be used in lieu of offsets.

The FBA has been developed in conjunction with the policy to provide a method for determining the cumulative magnitude of impacts. The FBA provides rules and software for calculating the number and type of credits that a development will require in order to offset its impacts and thus improve or maintain biodiversity values. 'Credits' are the currency used within the FBA and they are not specifically area measurements. Rather, they are a measure of the current quality of habitat. Where a proponent is proposing to establish an offset site as part of the BOS, the BioBanking Assessment Methodology (BBAM) must be used to assess the biodiversity values of the offset site and to identify the number and type of credits that may be created on the offset site (OEH 2014).

The FBA requires the preparation of the following documents:

- Biodiversity Assessment Report: To describe the biodiversity values present within the development site and the impact of the Project on these values.
- Biodiversity Offset Strategy: To outline how the proponent intends to offset the impacts of the Project.

These reports are required to be submitted as part of the EIS.

As the FBA applies predominantly to terrestrial biodiversity, the *NSW Offsets Policy for Major Projects* and FBA refers to the NSW Department of Primary Industries (DPI) *Policy and guidelines for fish habitat conservation and management* (Fairfull, 2013) for guidance on assessing and offsetting aquatic impacts. Offsets for identified key fish habitats are required once avoidance and mitigation measures have been implemented. Details regarding the *Policy and guidelines for fish habitat conservation and management* (Fairfull 2013) and aquatic offsets are provided in Appendix F4 of the EIS (Aquatic ecology assessment report).

2.2.9 Water NSW Act 2014

The Water NSW Act enabled WaterNSW to be established as a legal entity. Under the Act, the former State Water Corporation became WaterNSW and the functions from the previous Sydney Catchment Authority were transferred to WaterNSW. As a result, Water NSW is the responsible authority for and owner of Warragamba Dam. It should be noted that Water NSW is the official legal entity and WaterNSW is the trading name of the same entity.

Under the Water NSW Act, WaterNSW has the power to operate and modify works within its control (including Warragamba Dam) for the purposes of catchment management, subject to approval under the EP&A Act. The Water NSW Act also allows dams and their catchments to be declared as catchment areas, special areas and controlled areas. These declared areas are established to provide the appropriate water management authority, the Minister and/or NSW Parliament powers to control development, access, and ownership of land in and around water supply dams. The Warragamba Dam site and a large part of its catchment have been declared a special area under the provisions of the Act.

Under the NPW Act, the relevant Minister must not grant a lease, licence, easement, or right of way for the purposes of inundation of any land which is protected under the NPW Act and is land to which the *Sydney Water Catchment Management Act 1998* applies.

In October 2018, Part 5A of Water NSW Act was approved. Part 5A exempts the need for the Project to obtain a lease, licence, easement, or right of way for the temporary inundation of land protected under the NPW Act. However, before the temporary inundation of any land protected by the NPW Act can occur, WaterNSW must prepare an EMP to satisfaction of the Minister responsible for the NPW Act. The Minister responsible for the NPW Act, with the concurrence of the Minister responsible for Water NSW Act, also has powers to direct WaterNSW:

(a) to take specified action in relation to the temporary inundation of national park land resulting from the Project, including action relating to the monitoring of risks associated with the temporary inundation and relating to the rehabilitation or remediation of land,

(b) to prepare a draft amendment of an approved EMP, or a new draft EMP, for approval under this Part,

(c) to conduct a review of an approved EMP and report on the outcome of the review.

Before the Project commences operation, WaterNSW would be required to have an approved EMP in place.

2.2.10 State Environmental Planning Policy (Koala Habitat Protection) 2020

State Environmental Planning Policy (Koala Habitat Protection) 2020 (Koala Habitat Protection SEPP) commenced on 30 November 2020 replacing State Environmental Planning Policy (Koala Habitat Protection) 2019 which in turn had replaced State Environmental Planning Policy No 44—Koala Habitat Protection.

The SEPP aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline:

- by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and
- by encouraging the identification of areas of core koala habitat, and
- by encouraging the inclusion of areas of core koala habitat in environment protection zones.

The Project is being assessed under Part 5 of the EP&A Act and the provisions of the Koala Habitat Protection SEPP therefore do not apply to the Project.

3 Landscape features

3.1 General description of the study area

3.1.1 General environment

The study area surrounds Lake Burragorang and comprises timbered hills and ridges with broad open valleys located between 90 and 180 mAHD. The slope varies across the study area. South-west of the dam, immediately down the main arm of the lake, the study area is at its steepest with the almost vertical sandstone walls and benches of the East Warragamba and West Warragamba Walls. Surrounding the main lake area and its tributaries, along the Wollondilly River arm, and along the Nattai River Arm, the study area is bound by sandstone escarpments with their associated colluvial slopes. The majority of the study area falls within these colluvial sloping landscapes which vary in steepness from very steep to gently sloping. Towards the mouth of the Wollondilly River and along the river itself, the study area falls within a valley floor and valley sides, where the terrain consists of alluvial flats and rolling hills. In the north west of the development site along the Coxs River and Kowmung River, the study area falls within steep to very steep slopes with talus and scree slopes.

The study area is located within the following lands listed under the NPW Act:

- Blue Mountains National Park
- Burragorang State Conservation Area
- Nattai National Park
- Nattai State Conservation Area
- Yerranderie State Conservation Area.

Furthermore, the study area falls within parts of:

- NSW Declared Wilderness (Kanangra-Boyd and Nattai)
- Greater Blue Mountains World Heritage Area.

The mean rainfall for the general locality around the study area is:

- Warragamba: 541.5 millimetres per year (BoM 2018b)
- Oberon (Jenolan Caves): 970 millimetres per year (BoM 2018a)
- Oakdale (Cooyong Park): 875.9 millimetres per year (BoM 2018c)
- Wollondilly (River View): 863.2 millimetres per year (BoM 2018d).

The highest rainfall generally occurs in the warmer months, particularly during the month of February.

A number of underlying substrates occur within the study area including:

- Hawkesbury sandstone
- Narrabeen Group sandstones and other rock
- Illawarra Coal Measures (Permian shales, sandstones, conglomerates, chert, torbanite, and coal)
- Berry Siltstone
- Upper Devonian Bindook Porphyry
- Lachlan Fold Belt rocks (Upper Devonian quartzites, sandstones, siltstones and claystones of the Lambie Group).

The Soil Landscapes of the Penrith 1:100,000 soil landscape sheet (Bannerman and Hazelton 1990) and the Soil Landscapes of the Katoomba 1:100,000 soil landscape sheet (King 1994) have mapped 10 soil landscapes within the Site as outlined in Table 3-1. It should be noted that there is no soil landscape mapping within the study area south of Lacys Bay and Brimstone Bay down the Wollondilly River arm of Lake Burragorang.

Table 3-1. Soil landscape description

Soil landscape	Description
Hawkesbury	Rugged, rolling to very steep hills on Hawkesbury Sandstone. Local relief 40–200 m, slopes >25%. Rock outcrop >50%. Narrow crests and ridges, narrow incised valleys, steep sideslopes with rocky benches, broken scarps and boulders. Mostly uncleared Eucalypt open-woodland (dry sclerophyll forest) and tall open-forest (wet sclerophyll forest).
Faulconbridge	Level to gently undulating crests and ridges on plateau surfaces of the Hawkesbury Sandstone. Local relief <20 m, slopes <5%. Infrequent rock outcrop. Partially cleared Eucalypt woodland.
Warragamba	Narrow convex crests and ridges and steep colluvial sideslopes on Narrabeen Group sandstones with minor cliffs and scarps on steeper slopes. Local relief 80 – 130 m. Slopes >35%. Elevation mostly <700 m. Uncleared tall open-forest.
Cedar Valley	Rolling to steep hills, narrow valleys and narrow crests away from sandstone escarpments in the Kedumba Valley and Cedar Valley and in the vicinity of Lake Burragorang. Local relief 50 – 150 m. Elevation <600 m. Slope gradients 15 – 60%. Uncleared woodland.
Round Mount	Steep to very steep hills and mountains on Carboniferous granite in the Hartley Valley and Kanangra Gorge. Local relief <400 m. Slopes generally >35%. Elevation <150 – 1,200 m. Granite rock outcrop (tors) is commonplace. Occasional cliffs. Open-woodland.
Hassans Walls	Cliffs derived from Narrabeen Group sandstones and steep colluvial talus sideslopes developed over the Illawarra Coal Measures and the Shoalhaven Group. Local relief >100 – 500 m. Slopes mostly >40%. Elevation 200 – 1,100 m. Open-forest and open-woodland.
Kanangra Gorge	Steep to very steep deeply incised valleys beneath narrow convex crests on Devonian and Silurian metasediments in the Kanangra Gorge and Cedar Valley. Local relief is >300 m. Slopes >30%. Elevation generally 120 – 1,000 m. Uncleared woodland, open-forest and closed-forest
Kedumba	Undulating to rolling rises and broad valley flats on Shoalhaven Group sediments in the Kedumba Valley and on Scotts Main Range. Local relief <30 m. Slope gradients 5 – 15 %. Elevation 120 – 230 m. Open-woodland.
Gymea	Undulating to rolling rises and low hills on Hawkesbury Sandstone. Local relief 20–80 m, slopes 10–25%. Rock outcrop <25%. Broad convex crests, moderately inclined side slopes with wide benches, localised rock outcrop on low broken scarps. Extensively cleared open forest (dry sclerophyll forest) and eucalypt woodland.

3.1.2 Vegetation

Vegetation within the study area can be classified into 11 vegetation classes (Keith 2004). The vegetation classes comprise:

- Northern Warm Temperate Rainforests
- Central Gorge Dry Sclerophyll Forests
- Sydney Sand Flats Dry Sclerophyll Forests
- Dry Rainforests
- Coastal Floodplain Wetlands
- Sydney Hinterland Dry Sclerophyll Forests
- Sydney Coastal Dry Sclerophyll Forests
- Eastern Riverine Forests
- North Coast Wet Sclerophyll Forests
- Western Slopes Grassy Woodlands
- Northern Hinterland Wet Sclerophyll Forests.

Of the total vegetation cover within the study area, 98.5 percent is mapped as native vegetation with the remaining area mapped as Cleared-Modified land and exposed rock. A single map figure showing the broad scale vegetation mapping within the study area is down in Figure 3-1, and a detailed multipage figure is shown in Appendix L of this report.

3.1.3 Hydrology

The Project boundary occurs across the Hawksbury-Nepean catchment. Lake Burragorang is the dominant hydrological feature of the site. Created by damming the Warragamba River and flooding the Burragorang Valley, Lake Burragorang is four times the size of Sydney Harbour and is currently managed as Sydney's main water supply dam (WaterNSW 2015). Lake Burragorang is fed by the Wollondilly, Nattai and Little rivers from the south, Lacys, Green Wattle, and Butchers creeks to the west and the Coxs, Kowmung and Kedumba rivers to the north. Each of these rivers are in turn fed by a number of creek systems that originate in steep valleys that flow off the Great Dividing Range.

Wild Rivers are rivers that near-pristine condition and free from unnatural rates of siltation and bank erosion (OEH, 2018c). As a result, they are considered to be of high conservation value. A section of the Kowmung River, which occurs in the study area, was declared a Wild River in 2005.

A River Styles® assessment carried out by GHD (GHD 2013) found that of the rivers, creeks and tributaries feeding into Lake Burragorang, 57 percent of stream reaches within the wider catchment were either in good condition or in a protected area. All of the stream reaches within the study area are within a protected area. To be assessed as being in good condition, the following characteristics must be met:

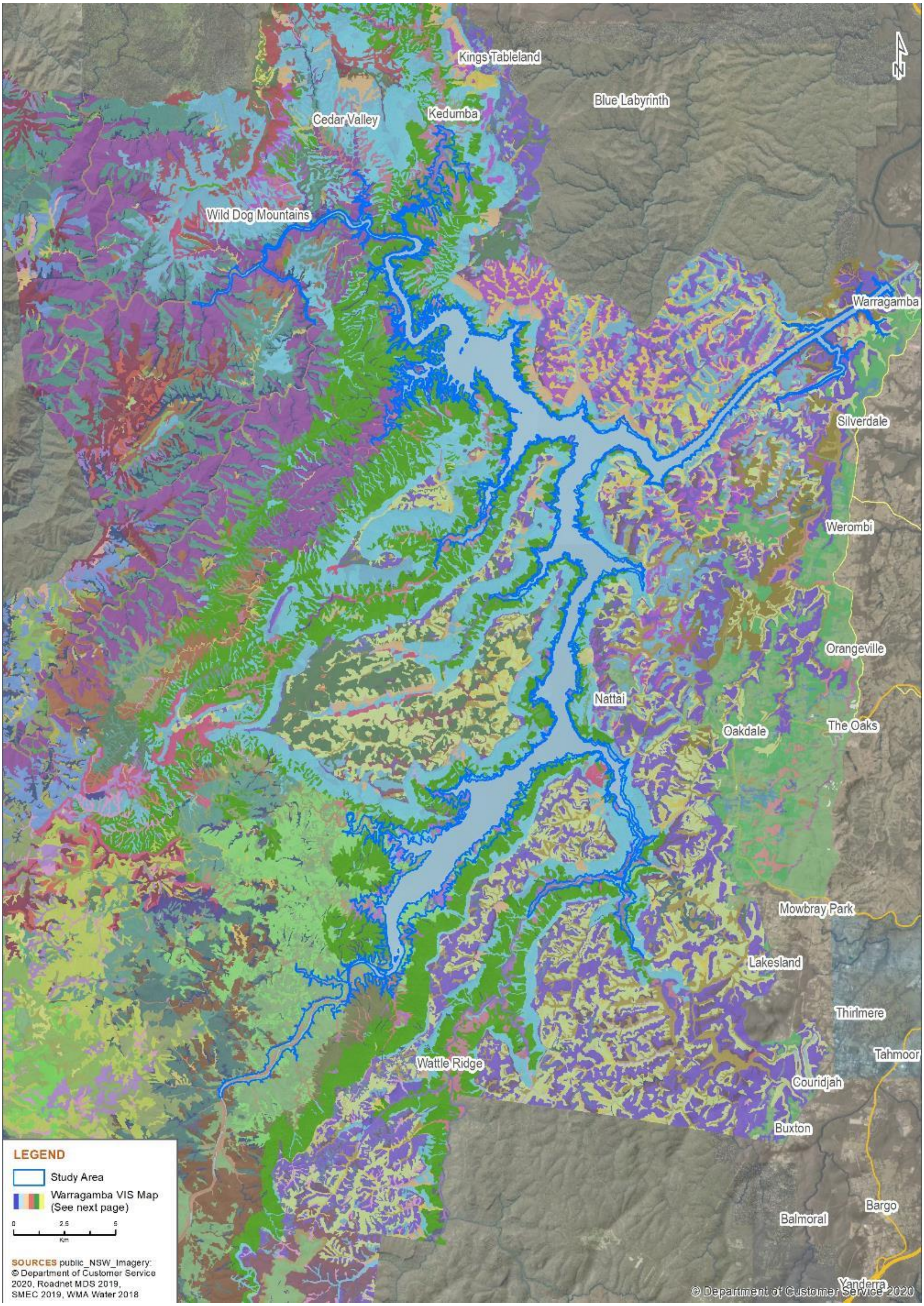
- river character and behaviour is similar to the pre-development state presenting a high potential for ecological diversity
- minimal alteration to catchment controls such as sediment supply and the hydrological regime allowing fast recovery from natural disturbance
- relatively intact and effective vegetation coverage dominated by native species, giving resistance to natural disturbance and accelerated erosion.

Given the size of the catchment, streams of all Strahler orders flow into Lake Burragorang. The major rivers are classified as follows:

- Wollondilly River: 8th order Strahler stream
- Nattai River: 7th order Strahler stream
- Little River: 6th order Strahler stream
- Coxs River: 8th order Strahler stream
- Kowmung River: 7th order Strahler stream
- Kedumba River: 6th order Strahler stream
- Warragamba River: 9th order Strahler stream.

Warragamba River is downstream of the dam. Water is discharged into Warragamba River when the dam spills. Water is also released into the Warragamba River (downstream of the Warragamba Weir) to provide a secure water supply to the population of North Richmond. The major upstream catchments within the study area are shown on Figure 3-2. A multipage figure is provided in Appendix L to this report.

Figure 3-1. Broadscale vegetation mapping (NPWS 2003)

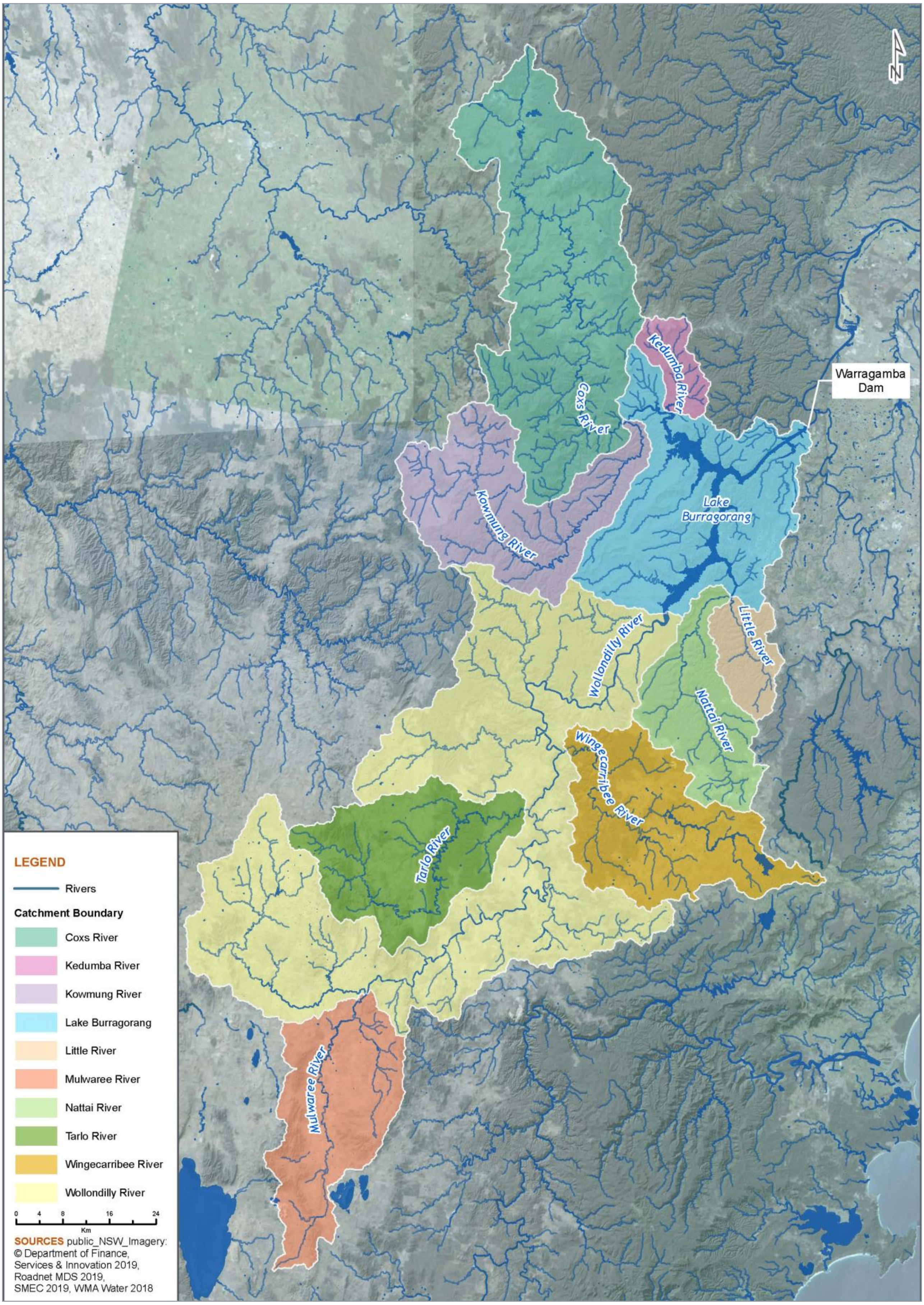


LEGEND

warragamba_VISmap_2380

- 1 Sandstone Warm Temperate Rainforest
- 10 Sheltered Sandstone Smooth-barked Apple Forest
- 11 Sheltered Sandstone Blue-leaved Stringybark Forest
- 12 Escarpment Mountain Grey Gum Forest
- 13 Sheltered Escarpment Blue Gum Forest
- 14 Escarpment Grey Gum Forest
- 15 Highlands Gorge River Peppermint Forest
- 16 Bindook Highlands Open Forest
- 17 Yerranderie White-topped Box Forest
- 18 Sheltered Porphyry Forest
- 2 Montane Cool - Warm Temperate Rainforest
- 20 Montane Sheltered Narrow-leaved Peppermint Forest
- 21 Kanangra Gorge Sheltered Grey Gum Forest
- 22 Oakdale Blackbutt Gully Forest
- 23 Burragorang River Flat Forest
- 24 Highlands Sandstone Dry Shrub Forest
- 25 Blue Mountains Sandstone Dry Shrub Forest
- 26 Nattai Sandstone Dry Shrub Forest
- 27 Burragorang Sandstone Dry Shrub Forest
- 28 Kowmung Sheltered Red Gum Forest
- 29 Exposed Devonian Grey Gum Forest
- 3 Grey Myrtle Dry Rainforest
- 31 Highlands Slopes Grey Gum - Stringybark Forest
- 32 Permian Footslopes Grassy Grey Box Forest
- 33 Tonalli Escarpment Dry Shrub Forest
- 34 Montane Sandstone Silvertop Ash Shrub Forest
- 35 Montane Exposed Silvertop Ash Forest
- 36 Montane Slopes Stringybark Forest
- 37 Montane Sandstone Dry Shrub Forest
- 38 Oakdale Alluvial Rough-barked Apple Forest
- 39 Tablelands River Oak Forest
- 4 Kowmung Dry Rainforest
- 40 Exposed Blue Mountains Sandstone Woodland
- 41 Exposed Burragorang Sandstone Shrub Woodland
- 42 Rocky Sandstone Heath Woodland
- 46 Kanangra Gorge Narrow-leaved Ironbark Woodland
- 47 Exposed Permian Sandstone Woodland
- 48 Escarpment Slopes Dry Ironbark Woodland
- 49 Dry Alluvial Paperbark Woodland
- 5 Highlands Basalt Acacia Scrub
- 50 Douglas Scarp Woodland
- 51 Devonian Red Gum - Yellow Box Woodland
- 52 Devonian Red Gum - Ironbark Woodland
- 53 Devonian Red Gum - Grey Box Woodland
- 55 Highlands Transitional Shale Woodland
- 56 Cumberland Plain Shale Sandstone Transition Forest (Low Sandstone Influence)
- 57 Cumberland Plain Shale Sandstone Transition Forest (High Sandstone Influence)
- 58 Cumberland Plain Alluvial Woodland
- 59 Cumberland Plain Shale Hills Woodland
- 6 Sandstone Riparian Scrub
- 60 Cumberland Plain Shale Plains Woodland
- 61 Rock Plate Heath-Mallee
- 62 Montane Heath-Mallee
- 64 Rosy Paperbark Heath
- 66 Kowmung Acacia Scrub
- 67 Regenerating Vegetation
- 68 Highlands Peat Swamp
- 69 Highlands Swamp Gum - Tea Tree Heath-Woodland
- 7 Montane Gully Brown Barrel Forest
- 70 Montane Sedgeland Heath
- 71 Upland Swamps Cyperoid Heath
- 72 Upland Swamps Tea Tree Thicket
- 73 Sandstone Brittle Gum Swamp Woodland
- 74 Thirlmere Sand Swamp Woodland
- 75 Lepironia Freshwater Wetland
- 76 Bindook Highlands Grassland
- 77 Exposed Rock
- 78 Cleared-Modified Land
- 79 Water Bodies
- 8 Sandstone Moist Blue Gum Forest
- 9 Sheltered Sandstone Intermediate Blue Gum Forest

Figure 3-2. Major upstream catchments



3.1.4 Land uses

The study area is located within Warragamba Dam catchment, with the dam itself located at the north-eastern extent of the study area. Lake Burragorang is Australia's largest urban water supply reservoir, which supplies water to greater Sydney and Blue Mountains area.

As detailed within Section 3.1.1, the land within the study area occurs within national parks estate, including two national parks and three state conservation areas. This land reserved for the purposes of environmental and cultural heritage conservation, and is managed by NPWS in accordance with relevant plans of management for the national parks estate. The study area also falls within water storage catchment 'special areas' which are areas of restricted or prohibited access to protect against pollutants entering the storage. Consequently, the public access across the majority of the study area is prohibited, with exception of a walking track between Katoomba and Mittagong which crosses the study area at the Coxs River, near Mount Cookem, and Wollondilly River at Murphy's Crossing.

3.2 Landscape features

3.2.1 IBRA[4] bioregions and IBRA subregions

Bioregions are large, geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features and plant and animal communities. All 89 Australian bioregions have some representation in the National Reserve System, with 61 bioregions having more than 10 percent protected and 28 bioregions currently at less than 10 percent. Some bioregions already have much of their total area protected, while other bioregions, such as those with large tracts of cleared land, have very little area protected.

The bioregions and subregions are the reporting unit for assessing the status of native ecosystems and their level of protection in the National Reserve System. In this way, IBRA is used as a dynamic tool for monitoring progress towards building a 'comprehensive, adequate and representative' (CAR) reserve system. Such information assists governments to decide how to best prioritise funding to meet national protection targets. IBRA is also used in the monitoring and evaluation of the Australian Government's natural resource management initiatives (DoEE n.d.a).The study area is located across two IBRA Bioregions: Sydney Basin and South Eastern Highlands, and there are four subregions which are relevant to the assessment. These are described in greater detail as follows.

Bioregions

The Sydney Basin Bioregion occupies approximately 3.6 million hectares (approximately 4.5 percent of NSW) and extends from just north of Batemans Bay to Nelson Bay on the central coast, and almost as far west as Mudgee (NPWS 2003a). The Sydney Basin Bioregion is one of the most species diverse in Australia, which is the result of the variety of rock types, topography and climates in the bioregion. The Sydney Basin Bioregion is one of two bioregions contained wholly within the state. It consists of a geological basin filled with near horizontal sandstones and shales of Permian to Triassic age that overlie older basement rocks of the Lachlan Fold Belt. The sedimentary rocks have been subject to uplift with gentle folding and minor faulting during the formation of the Great Dividing Range. Erosion by coastal streams has created a landscape of deep, cliffed gorges and remnant plateaus across which an east-west rainfall gradient and differences in soil control the vegetation of eucalypt forests, woodlands and heaths. The Sydney Basin Bioregion includes coastal landscapes of cliffs, beaches and estuaries (NPWS 2003a).

The frontal slope of the Blue Mountains (where the Site is located) is formed along the Lapstone monocline. A secondary flexure and similar escarpments occur at the coast forming the Hornsby Plateau and the Illawarra escarpment. These structural features combine with different rock types and strong trends in joint patterns to control drainage patterns and the distribution of gorges and swamps (OEH 2016d).

The South Eastern Highlands Bioregion lies just inland from the coastal bioregions of the South East Corner and the Sydney Basin, bounded by the Australian Alps and South Western Slopes bioregions to the south and west. The bioregion includes most of the ACT and extends south into Victoria. The South Eastern Highlands Bioregion has an area of 4,888,633 hectares in NSW. The bioregion occupies approximately 6.11 percent of the state (OEH 2016b; NPWS 2003b). The South Eastern Highlands Bioregion covers the dissected ranges and plateau of the Great Dividing Range that are topographically lower than the Australian Alps, which lie to the southwest. It extends to the Great Escarpment in the east and to the western slopes of the inland drainage basins. The bioregion continues into Victoria.

[4] Interim Biogeographic Regionalisation for Australia; see https://www.environment.gov.au/land/nrs/science/ibra

The South Eastern Highlands are part of the Lachlan fold belt that runs through the eastern states as a complex series of metamorphosed Ordovician to Devonian sandstones, shales and volcanic rocks intruded by numerous granite bodies and deformed by four episodes of folding, faulting and uplift. The general structural trend in this bioregion is north-south and the topography strongly reflects this. There are four centres of Tertiary basalt flows (OEH, 2016c). This bioregion is dominated by a temperate climate characterised by warm summers and no dry season. Significant areas in the north and south of the bioregion are at higher elevations in a montane climate zone, where summers are much milder.

Subregions

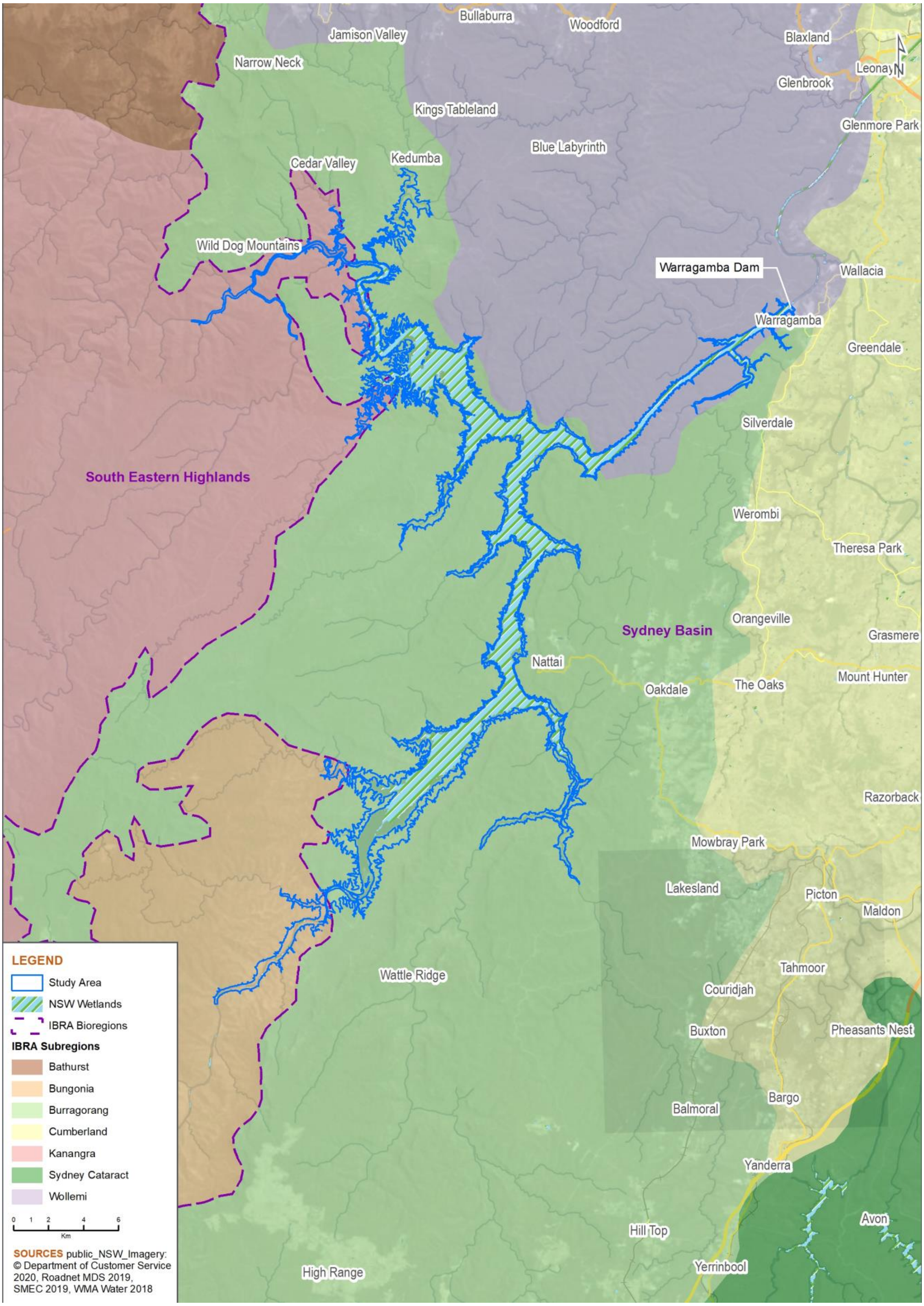
The study area is located across four IBRA subregions being Burragorang IBRA subregion, Wollemi IBRA subregion, Kanangra IBRA subregion, and Bungonia IBRA subregions (DoEE, 2018). Table 3-2 provides a description of each IBRA subregion.

The extent of the subregions within the Project boundary is shown on Figure 3-3.

Table 3-2. Description of the subregions

Subregion	Geology	Characteristic landforms	Typical Soils	Vegetation
Sydney Basin Bioregion				
Burragorang Part A	Permian and Triassic sandstones and shales on the western edge of the Basin. Limited basalt caps.	Rolling hills on a sandstone plateau with deep gorges and sandstone cliffs in Burragorang valley.	Rocky outcrops, texture contrast soils and uniform sands on sandstone. Bouldery debris with sandy clay matrix below cliffs. Rich loams in alluvium.	Heath, shrubland and woodland with black ash, hard-leaved scribbly gum, Sydney peppermint and red bloodwood on sandstone similar to other parts of the Basin. Deane's gum, turpentine, blue-leaved stringybark immediately below escarpment passing to grey gum, narrow-leaved ironbark and thin-leaved stringybark on bouldery slopes. River oak along main streams below the plateaus.
Wollemi	Hawkesbury Sandstone and equivalent quartz sandstones of Narrabeen Group, sub-horizontal bedding, strong vertical joint patterns. A few volcanic necks.	Highest part of the Blue Mountains. Sandstone plateau with benched rock outcrops. Creek directions controlled by jointing deep gorge of the Capertee and Wolgan Rivers.	Thin sands or deep yellow earths on plateau, thin texture contrast soils on shale benches. Organic sands in swamps and joint crevices, bouldery slope debris below cliffs, sandy alluvium in pockets along the streams. Red brown structured loams on basalts.	Red bloodwood, yellow bloodwood, rough-barked apple, smooth-barked apple, hard-leaved scribbly gum, and grey gum with diverse shrubs and heaths on plateau. Smooth-barked apple, Sydney peppermint, blue-leaved stringybark, and turpentine and gully rainforests in gullies and canyon heads. Ribbon gum and Blaxland's stringybark on basalt. River oak along main streams.
South Eastern Highlands Bioregion				
Kanangra	Devonian sandstones with small areas of granite and fine-grained Silurian and Ordovician sediments at the edge of the Sydney Basin.	Ridges and small plateaus to 1,200 m, deep valleys, swampy upper tributary floors, outcrops and tors on granite hills.	Red and yellow earths and structured loams. Well drained slopes, moderate fertility.	Grey gum, Blaxland's stringybark on lower areas, and brown barrel, mountain gum, narrow-leaved peppermint and ribbon gum on higher areas. Patches of snow gum. High diversity swamps on Boyd Plateau with carex and tea tree, sphagnum bogs in streams.
Bungonia	Primarily fine-grained Palaeozoic sedimentary and meta-sedimentary rocks, with minor areas of acid volcanics and limestone. Areas of Tertiary river terrestrial sediments and low sandsheets in the south with very limited basalt.	Distinct plateau with very steep, deep margins on the Great Escarpment dropping into the Shoalhaven River. Strong linear ridges on resistant sandstones and volcanics, wide valleys with some cold air drainage and inverted tree lines.	Mostly yellow texture contrast soils some with harsh clay subsoils. Shallow structured organic loams on limestone and basalt, deep siliceous sands and clayey sands on Tertiary sediments.	Mottled gum, broad-leaved peppermint, white gum, red stringybark and black ash forests and woodlands. Snow gum with and snow grass in cold pockets. Black she-oak common as understorey and in regeneration areas. Limited distribution of argyle apple.

Figure 3-3. IBRA subregions within the study area



3.2.2 NSW landscape regions (Mitchell Landscapes)

The study area occurs across 10 landscape regions:

- Boyd Plateau
- Burragorang Valley and Gorges
- Kurrajong Fault Scarp
- Lapstone Slopes
- Nattai Plateau
- Scotts Main Range
- Silverdale Slopes
- Sydney Basin Diatremes
- Sydney Basin Western Escarpment
- Wollondilly – Bindook Tablelands and Gorges.

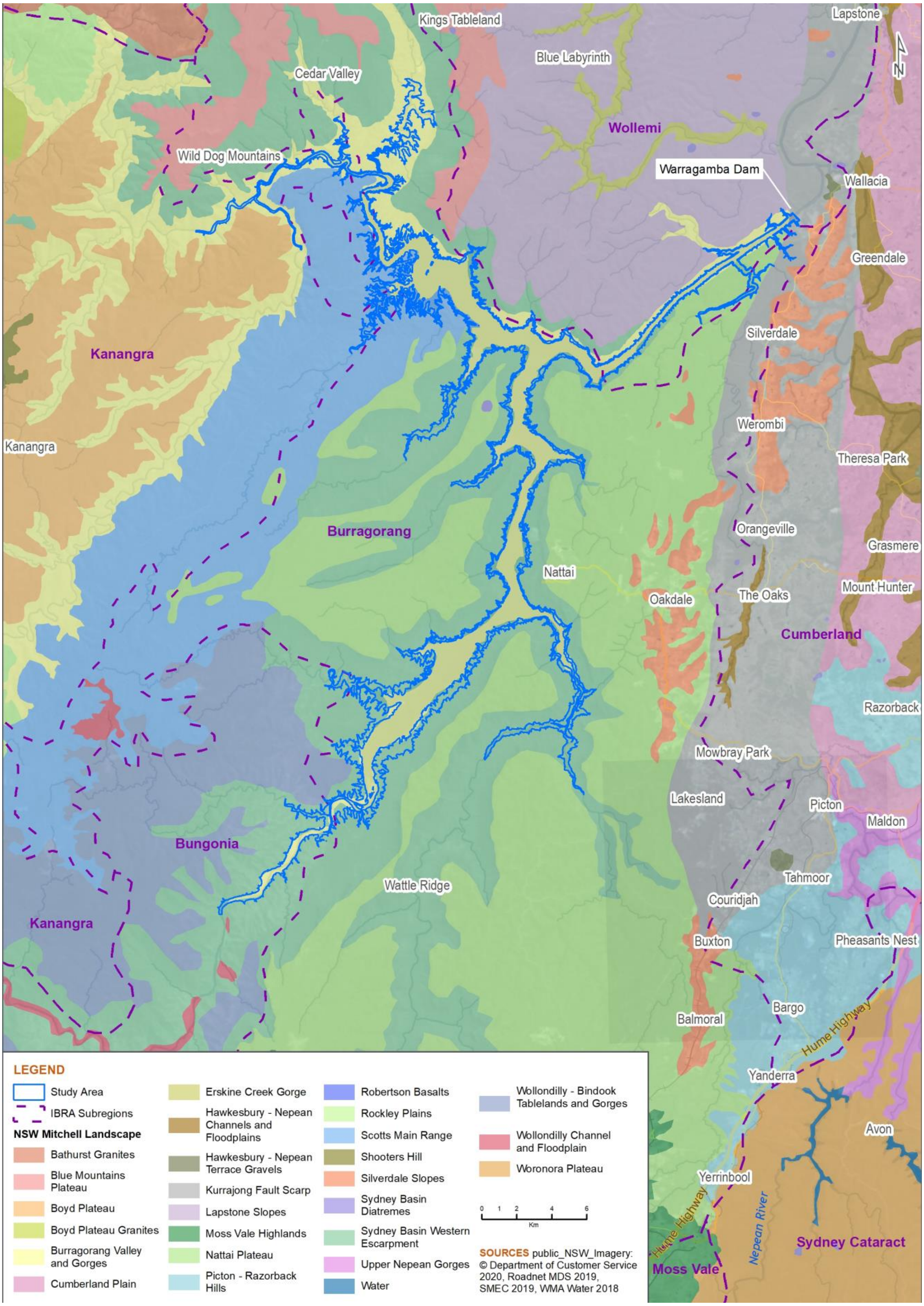
Burragorang Valley and Gorges occurs over the majority of the study area followed by Sydney Basin Western Escarpment, Scotts Main Range, and Nattai Plateau. The Mitchell Landscape descriptions (DECC 2002) are provided in Table 3-3.

Table 3-3. Description of the Mitchell Landscapes

Mitchell Landscape
Boyd Plateau
Plateau with extensive swamps, low hills and deeply dissected margin on Devonian sandstone, siltstone, shale and conglomerate. Small areas capped by horizontal Permian lithic sandstone, quartz sandstone, conglomerate and shale. General elevation 1,100 to 1,250 m, local relief < 80 m. Extensive rock outcrop, thin stony loams on Palaeozoic rocks, thin wet siliceous sands on sandstone and gleyed texture-contrast soils on shale benches. Heath and scrub of mountain mallee (Eucalyptus stricta), dwarf casuarina (*Allocasuarina nana*), heath banksia (*Banksia ericifolia*), finger hakea (*Hakea dactyloides*), tea-tree (*Leptospermum* sp.), scribbly gum (*Eucalyptus rossii*) and snow gum (*Eucalyptus pauciflora*).
Burragorang Valley and Gorges
Deep steep sided benched slopes and gorge of the Wollondilly and Coxs Rivers incised into mostly horizontal Triassic quartz sandstone conglomerate, siltstone, and shale, cliffs to 150 m high with waterfalls, general elevation 50 to 220, local relief 150 m. The gorge widens upstream and exposes underlying Permian chest, mudstones and conglomerate. Very extensive rock outcrop, thin yellow to yellow-brown silty sand and gravel with occasional white clay layers forming either shallow yellow earths or gleyed texture-contrast profiles. Red bloodwood (*Corymbia gummifera*), turpentine (*Syncarpia glomulifera*), and rainforest elements at the base of the gorge in sandstone. Steep debris slopes below cliff upstream with forest red gum (*Eucalyptus tereticornis*), red stringybark (*Eucalyptus macrorhyncha*), narrow leaved ironbark (*Eucalyptus crebra*), and brittle gum (*Eucalyptus mannifera*). Moist protected environments with Sydney blue gum (*Eucalyptus saligna*), mountain grey gum, (*Eucalyptus cypellocarpa*) yellow stringybark (*Eucalyptus muelleriana*) and gully gum (*Eucalyptus smithii*). Gallery forest of river oak (*Casuarina cunninghamiana*) with round-leaved gum (*Eucalyptus deanei*) and Camden white gum (*Eucalyptus benthamii*) along the main streams.
Kurrajong Fault Scarp
Dissected and broken slopes on Triassic Quartz sandstone and shale across the Lapstone monocline and Kurrajong fault scarp. Local dips on the sedimentary rocks up to 300, general elevation 100 to 250 m, local relief 100 m. Abundant rock outcrop with pockets of yellowbrown sand and occasional yellow texture-contrast soils. Open forest with a shrubby understorey of; blue-leaved stringybark (*Eucalyptus agglomerata*), turpentine (*Syncarpia glomulifera*), red bloodwood (*Corymbia gummifera*). Smooth-barked apple (*Angophora costata*), Sydney peppermint (*Eucalyptus piperita*), narrow-leaved peppermint (*Eucalyptus radiata*), grey gum (*Eucalyptus punctata*), blackbutt (*Eucalyptus pilularis*) and she-oaks (*Allocasuarina* sp.). Several streams have formed extensive reed swamps behind the fault block with deep organic sands and scattered forest red gum (*Eucalyptus tereticornis*), roughbarked apple (*Angophora floribunda*) and white stringybark (*Eucalyptus globoidea*) on the margins.
Lapstone Slopes
The frontal slope of the Blue Mountains formed by folding and faulting of Triassic quartz sandstone and shale with a veneer of Tertiary river gravels. A southern extension of the Kurrajong Fault Scarp landscape. Larger streams cut through the structural ridge in deep gorges, but smaller streams have accumulated organic sands in swamps and lagoons on the western side of the flexure. General elevation 50 to 300 m, local relief 180 m, steep dip slopes on the eastern face and benched faulted slopes on the west. Extensive rock outcrop, thin sandy soils with gravel and occasional white or yellow clay subsoils. Pockets of deep sand in some streams. Red bloodwood (*Corymbia gummifera*), yellow bloodwood (*Corymbia eximia*), grey gum (*Eucalyptus punctata*), forest oak (*Allocasuarina torulosa*), silvertop ash (*Eucalyptus sieberi*), narrow-leaved peppermint (*Eucalyptus radiata*) with diverse shrubby understorey.

Mitchell Landscape
Nattai Plateau
Steeply dissected plateau remnants on lower Triassic lithic sandstone, shale and tuff, abundant rock outcrop and cliffs, steep debris slopes, general elevation 600 to 700 m, local relief 80 m. Shallow sand and occasional yellow texture-contrast soils. Forests of thin-leaved stringybark (*Eucalyptus eugenioides*), broad-leaved ironbark (*Eucalyptus fibrosa ssp. fibrosa*), Port Jackson pine (*Callitris rhomboidea*), silvertop ash (*Eucalyptus sieberi*), Blaxland's stringybark (*Eucalyptus blaxlandii*), brown barrel (*Eucalyptus fastigata*) and manna gum (*Eucalyptus viminalis*).
Scotts Main Range
Linear ranges with small sandstone caps, string structural control of drainage by folded Devonian basement, prominent cliff lines in Triassic units with joint control. Triassic lithic sandstone, conglomerate and siltstone over Permian conglomerates and lithic sandstones unconformably on upper Devonian quartzose sandstone and shale. General elevation 400 to 850 m, local relief 250 m with a few peaks to 1,000 m. Shallow sand and occasional yellow texture-contrast soils. Woodland of; narrow-leaved ironbark (*Eucalyptus crebra*), grey gum (*Eucalyptus punctata*), thin-leaved stringybark (*Eucalyptus eugenioides*), scribbly gum (*Eucalyptus sclerophylla*), and narrow-leaved apple (*Angophora bakeri*).
Silverdale Slopes
Moderately undulating slopes descending to the east on gently dipping Triassic shales and sandstones. General elevation 230 to 630 m, local relief 200 m. Brown to yellow-brown texture-contrast soils. Woodland to forest with a shrubby understorey, common species; grey gum (*Eucalyptus punctata*), white box (*Eucalyptus albens*), grey ironbark (*Eucalyptus paniculata*), narrow-leaved ironbark (*Eucalyptus crebra*), broad-leaved ironbark *(Eucalyptus fibrosa ssp. fibrosa*), grey box (*Eucalyptus moluccana*), forest oak (*Allocasuarina torulosa*), thin-leaved stringybark (*Eucalyptus eugenioides*) and occasional turpentine (*Syncarpia glomulifera*).
Sydney Basin Diatremes
Widely distributed across the Sydney Basin and distinguished as a landscape because they always contain locally different landform, soil and vegetation. Diatremes are circular volcanic vents filled with layered, brecciated country rock cemented by a fine-grained basaltic matrix. Some contain a core of basalt. In sandstone country the volcanic breccia weathers and erodes more rapidly than the sandstone and the landform is a deep circular with the appearance of a crater. Soils in the crater are dominated by sandstone detritus from the surrounding slopes but the subsoil is a fertile well, structured clay derived from the breccia and these protected sites carry more mesic variants of the local vegetation. In shale country the breccia is more resistant than the shale and the diatremes form a low rounded hill with red-brown gradational profiles of clay loam and structured clay with moderate to high fertility. General elevation varies considerably across the basin, local relief of positive landforms up to 25 m, negative landforms ('craters') 180 m.
Sydney Basin Western Escarpment
Steep dissected slopes on the western margin of the Triassic rocks and descending into the Permian conglomerate, shale and sandstone. Cliffs and gorges to 100 m, general elevation 250 to 1,000 m, local relief 150 m. Brown loamy sands in rubbly soil on debris slopes, with deeper accumulations toward the valley floor. Dry aspects; open forest of Sydney peppermint (*Eucalyptus piperita*), smooth-barked apple (*Angophora costata*), grey gum (*Eucalyptus punctata*), broad-leaved ironbark (*Eucalyptus fibrosa ssp. fibrosa*) and rough-barked apple (*Angophora floribunda*). Moist aspects; tall open forest of round-leaved gum (*Eucalyptus deanei*), turpentine (*Syncarpia glomulifera*), Sydney blue gum (*Eucalyptus saligna*), blue leaved stringybark (*Eucalyptus agglomerata*), thin-leaved stringybark (*Eucalyptus eugenioides*) and narrow-leaved ironbark (*Eucalyptus crebra*). Coachwood (*Ceratopetalum apetalum*) and sassafras (*Doryphora sassafras*) in the gullies.
Wollondilly - Bindook Tablelands and Gorges
Dissected tablelands, marginal gorges and scree slopes on massive Devonian quartz porphyry and small areas of massive Devonian granite. General elevation 600 to 900 m, local relief 250 m. Thin gritty uniform profiles on steep slopes and around rock outcrops, grey and yellow texture-contrast profiles on flatter slopes. Woodland and open forest of; forest red gum (*Eucalyptus tereticornis*), yellow box (*Eucalyptus melliodora*), grey box (*Eucalyptus molucanna*), white box (*Eucalyptus albens*), black wattle (*Acacia mearnsii*), Parramatta wattle (*Acacia parramattensis*), black she-oak (*Casuarina litoralis*) with numerous shrubs, bracken (*Pteridium esculentum*) and grasses.

Figure 3-4. Mitchell Landscapes within the study area



3.2.3 Rivers and streams

The study area falls within the Warragamba catchment. Bordered on the west by the Great Dividing Range, the catchment stretches from north of Lithgow at the head of the Coxs River in the Blue Mountains, to the source of the Wollondilly River west of Crookwell, and south of Goulburn along the Mulwaree River (WaterNSW n.d.).

Lake Burragorang is fed by the Wollondilly, Nattai and Little Rivers from the south, Lacys, Green Wattle and Butchers Creeks to the west, and the Coxs, Kowmung and Kedumba Rivers to the north. Each of these are in turn fed by a number of creek systems that originate in steep valleys that flow off the Great Dividing Range. The study area includes all riparian areas of Lake Burragorang and associated tributaries. At the point of the dam wall, Lake Burragorang is considered to be a 9th order stream in accordance with the Strahler stream ordering method. The Project would potentially impact upon all of the riparian buffers within the study area.

3.2.4 Wetlands

One wetland (Lake Burragorang) has been mapped within the construction study area within the NSW Wetland shapefile (OEH 2010). No important or local wetlands occur within the study area. There are a number of smaller dams mapped to the east of the study area, while the Nepean River and Penrith Lakes have been mapped to the north. There are no mapped Ramsar wetlands within 10 kilometres of the study area.

3.2.5 Native vegetation extent

The extent of native vegetation within the study area is shown on Figure 3-1. This extent has been determined through aerial photograph interpretation and field surveys as described in Section 4.2. It is considered that there are no material differences between the mapped vegetation extent and the vegetation shown on the aerial imagery.

The study area is centred around Lake Burragorang and associated tributaries, which was created when Warragamba Dam was constructed and then opened in 1960. As such, the vegetation surrounding Lake Burragorang is not typical riparian or flood plain vegetation. Instead much of the study area is comprised of vegetation typical of ridgetops on skeletal soils and vegetation typical of valley slopes. The majority of the study area supports dry sclerophyll forest of shrubby sub-formation, as well as areas of wet sclerophyll forest, dry rainforest, warm temperate rainforest, grassy woodlands, and forested wetlands.

To the west of Warragamba Dam, to both the north and south of Lake Burragorang on the walls of what was Warragamba Gorge, the vegetation is dominated by species characteristic of ridgetop woodlands around the Sydney Basin, including *Angophora costata*, *Eucalyptus piperita*, *Eucalyptus eugenioides*, *Eucalyptus sieberi* and *Corymbia gummifera*. Pockets of Warm Temperate Rainforest are present in sheltered, south-facing gullies. Dry sclerophyll forest communities are present around of the majority of Lake Burragorang. The vegetation communities within this area is dominated by *Eucalyptus punctata*, *Eucalyptus tereticornis*, *Eucalyptus glaucina*, *Eucalyptus deanei*, *Eucalyptus fibrosa*, and *Eucalyptus crebra*. Within drainage lines feeding into Lake Burragorang from the surrounding escarpment, the vegetation consists of tall wet forest dominated by *Eucalyptus deanei* and dry rainforest dominated by *Backhousia myrtifolia* and *Melaleuca styphelioides*.

Near the mouth of the Wollondilly River and along the river itself, the vegetation is dominated by a grassy woodland consisting of *Eucalyptus melliodora*, *Eucalyptus tereticornis*, *Eucalyptus glaucina*, *Eucalyptus albens-moluccana* intergrade, and *Brachychiton populneus*. This vegetation conforms to White Box Yellow Box Blakely's Red Gum Woodland and Derived Native Grassland Critically Endangered Ecological Community (CEEC). Forested wetlands dominated by *Eucalyptus deanei*, *Eucalyptus elata*, *Eucalyptus benthamii*, and *Casuarina cunninghamiana* are present along Nattai River, Kedumba River, Coxs River, and many other smaller tributaries flowing into Lake Burragorang. Much of this vegetation conforms to River Flat Eucalypt Forest on Coastal Floodplains Endangered Ecological Community (EEC). Extensive areas of Dry Rainforest dominated by *Backhousia myrtifolia* are present along the Coxs River and Kowmung River. The dry sclerophyll forest within this area is dominated by *Eucalyptus crebra*, *Eucalyptus tereticornis*, *Eucalyptus punctata*, and various stringybark species.

About 207 hectares of native vegetation has been mapped occurring below the FSL, with most extents occurring within the tributaries flowing into Lake Burragorang. This includes the first and second order streams, as well as the major tributaries, such as Nattai, Wollondilly, and Coxs Rivers. This native vegetation mapped does not appear to be part of the regrowth that colonises the areas below FSL when the dam levels are low for an extended period of time, and there does not appear to be any evidence of disturbance from lacustral process on underlying substrate. Around much of the main storage, there is a clear delineation between the area below the FSL and remnant vegetation above. This was evidenced by a white mineral stain on the underlying substrate, observable erosion and depositional processes including well sorted soil particles, and where present, regrowth vegetation typically consisting of dense stands of *Casuarina cunninghamiana,* as show in Photograph 3-1 and Photograph 3-2. When the field surveys commenced, the dam level was at 86 percent capacity with limited regrowth around the edge of Lake Burragorang, but evidence of past regrowth in the form of dead *Casuarina cunninghamiana* and Eucalypts of a similar age class extending above the water level. As the water levels decreased, the area below FSL was colonised by a variety of native and some exotic species, dominated by sedges and graminoids species, but with some recruitment of Eucalypt species and *Casuarina cunninghamiana* in locations.

Given this vegetation occurs below the FSL, and therefore outside the study area, impacts from the Project on this vegetation have not been considered as part of this assessment.

Photograph 3-1. Clear delineation of remnant vegetation above FSL – taken in November 2017 when dam was at approximately 86% capacity (WaterNSW 2017).

Photograph 3-2. Colonised Casuarina cunninghamiana *with drowned specimens below the FSL – taken in November 2017 when dam was at approximately 86% capacity (WaterNSW 2017).*

The native vegetation occurring below the FSL was typically intact with little evidence of frequent and/or long-term disturbance regimes. The composition of the native vegetation varied depending on vegetation type, but a large proportion consisted of riparian vegetation on or within the streambanks of the major tributaries and included large canopy Eucalypt species such as *Eucalyptus deanei* and *Eucalyptus elata*. The area of native vegetation mapped occurring within the FSL increases as the distance from Lake Burragorang increases. Examples of the native vegetation mapped within the FSL are shown on the photos below.

Photograph 3-3. Native vegetation within the Little River below the FSL – taken March 2018 when dam capacity was approximately 76% (WaterNSW 2018)

Photograph 3-4. Native vegetation within the Wollondilly River below the FSL – taken at Murphy's Crossing, November 2017 when dam capacity was approximately 82% (WaterNSW 2017)

It is unclear why remnant native vegetation occurs within the FSL; however, it is hypothesised to be one or more of the following reasons:

- Diminishing influence of the dam: the influence and effects of the dam decrease, in relation to natural riparian influences, as the distance from the main storage increases. Consequently, the surrounding environment is driven primarily by riparian influences, not influences from the dam. This can be seen within the figures above which show natural inflows within the river bank (when the dam was below FSL), and little evidence of effects of damming on vegetation.
- Variability of the dam levels: the dam levels vary as a result of inflows and outflows, and as a result, the dam levels are not retained at the FSL for an extended period of time.
- Inaccuracies in the delineation of the FSL:
  - alternate FSL models have varying extents, both in terms of altitude and length up tributaries. The FSL utilised for the assessment is modelled at a lower attitude (116.8 metres above sea level, versus 118.0 metres above sea level), however, extends further up the tributaries than alternate model. The model selected better reflects the observable altitudinal location of the FSL, especially around Lake Burragorang, but the other model better reflects the observable extent of the FSL along the major tributaries.
  - the scale and precision of the digital elevation model (DEM) may not be fine enough to capture small variations (that is, smaller than one metre) in elevation as result of rock outcrops, boulders, and in-creek sediment banks. These features can be seen in Photograph 3-4 above, taken within the Little River.
- Tolerance of the native vegetation: as discussed in Section 7.1.2, some vegetation communities are likely to possess some level of tolerance to short-term inundation when occurring on rapidly draining, alluvial substrates, such as those found within the major tributaries of Lake Burragorang. The native vegetation occurring under the FSL grows in course sand particles, rocks, or on boulders.

3.2.6 State or regionally significant biodiversity links

State significant biodiversity links, regionally significant biodiversity links, very large area biodiversity links, large area biodiversity links or local area biodiversity links are defined in the FBA. To date, there are no approved biodiversity corridor plans.

Appendix 2 of the FBA outlines the riparian buffer widths required for each order of stream classified in accordance with the Strahler system. The Project would impact upon the 50-metre riparian buffer for a 9th order stream. Under the FBA, riparian buffers for 6th order streams or higher are considered to be a state significant biodiversity link. Consequently, the Project would be impacting upon a state significant biodiversity link.

3.2.7 Biodiversity values map

The Biodiversity Values (BV) map identifies land with high biodiversity value that is especially sensitive to impacts from development and clearing. Land types included on the BV map include:

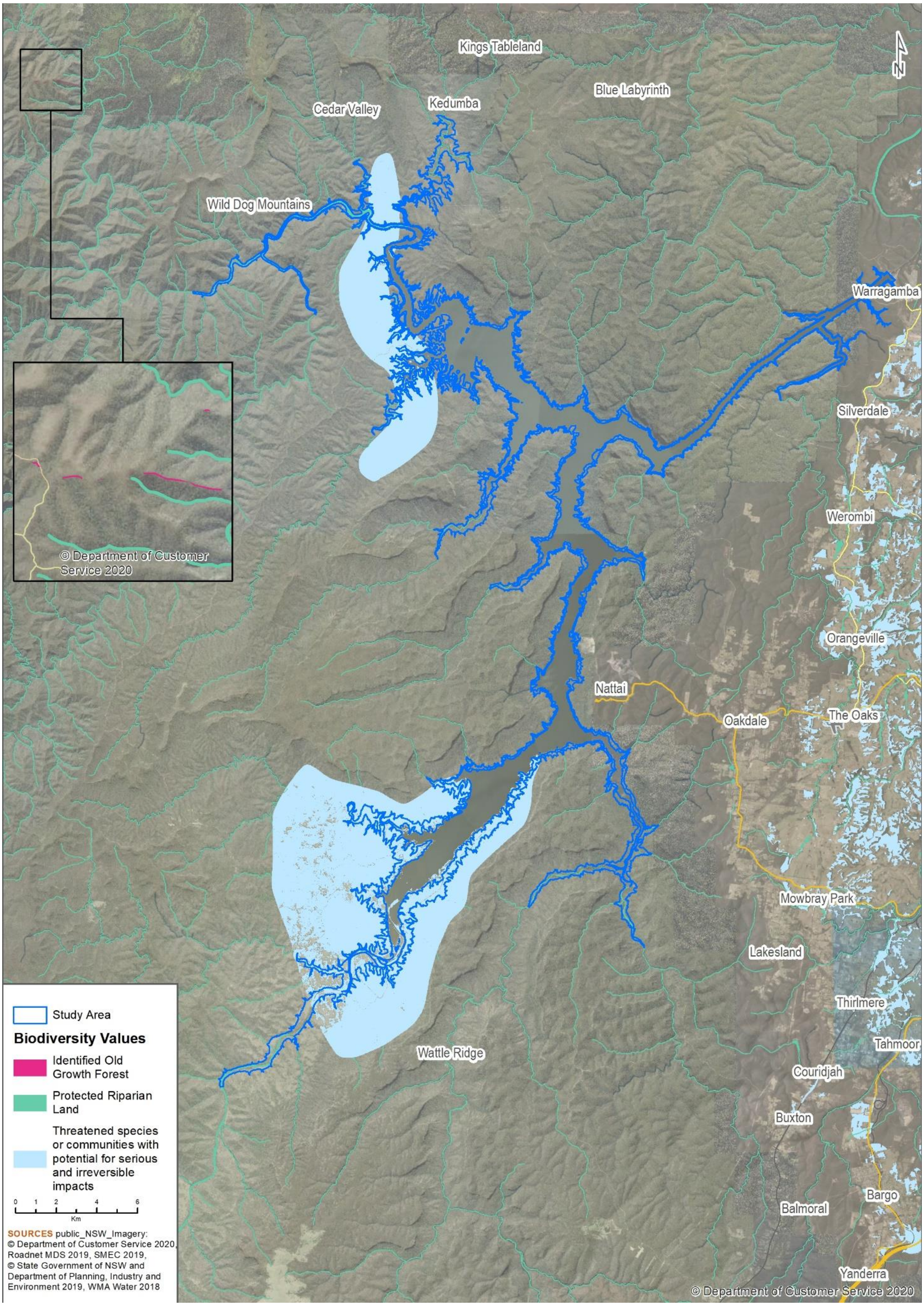
- Core koala habitat identified in a plan of management under the previous SEPP 44
- Declared Ramsar wetlands defined by the EPBC Act
- Land containing threatened species or threatened ecological communities identified as potential serious and irreversible impacts (SAII) under section 6.5 of the BC Act
- Protected riparian land
- High conservation value grasslands or groundcover
- Old growth forest identified in mapping developed under the National Forest Policy Statement (Commonwealth of Australia 1995) but excluding areas not meeting the criteria published jointly by the Minister of the Environment and the Minister for Primary Industries
- Rainforest identified in mapping developed under the National Forests Policy Statement but excluding areas not meeting the criteria published jointly by the Minister for the Environment and the Minister for Primary Industries
- Declared areas of outstanding biodiversity value (listed critical habitat)
- Council nominated areas with connectivity or threatened species habitat that the Minister for the Environment considers will conserve biodiversity at bioregional or state scale
- Any other land that in the opinion of the Environment Agency Head is of sufficient biodiversity value to be included.

Areas of the study area mapped on the BV map are shown on Figure 3-5. The majority of these areas mapped are riparian buffers around streams and rivers. However, two areas (around the mouth of Wollondilly River and in the west of the study area between Butchers Creek and Coxs River) have been mapped as land containing threatened species or threatened ecological communities identified as potential serious and irreversible impacts (SAII) under section 6.5 of the BC Act. As noted in Section 2.2.2, the Project is being assessed under the provisions of the TSC Act and therefore consideration of SAII under the BC Act is not required.

3.2.8 Other landscape features

No other landscape features within the study area requiring consideration were identified in the SEARs.

Figure 3-5. Areas mapped on biodiversity values map occurring within the study area



3.3 Landscape value score components

Due to the study area crossing multiple IBRA subregions, four BioBanking Credit Calculator (BCC) (V4.0) assessments were completed for the Project. The Project IDs for these assessments are detailed in Table 3-4.

Table 3-4. Project IDs for all assessments as part of the WDR Project

IBRA Subregion	Project ID	Version	Proposal name
Burragorang Part A	174/2019/5016MP	4	WDR_Burragorang V4
Bungonia	174/2018/4906MP	4	WDR_Bungonia V4
Kanangra	174/2018/4907MP	4	WDR_Kanangra V4
Wollemi	174/2018/4905MP	4	WDR_Wollemi V4

The assessment type was selected for each assessment was 'Major Project'. This section summarises the values entered into the Landscape values section of the BCC assessment.

3.3.1 Method applied

The assessment used the 'linear-based development' module within each of the four BCC assessments. As the study area covers a large spatial area of land, it crosses a number of boundaries of various spatial datasets. This linear FBA landscape assessment is conducted according to:

- Section 10 of the FBA Operational Manual (OEH 2018b)
- Appendix 5 of the FBA.

These two documents contradict each other in some instances. Where this is the case, it is noted which methodology was used.

3.3.2 Percent native vegetation cover in the landscape

To map the extent of native vegetation within the study area, the Warragamba_VISmap_2380 shapefile was overlain on a 2016 aerial image available through the Department of Lands SIXmaps application. The extent of native vegetation cover was confirmed and revised, where necessary, through surveys of the study area conducted by SMEC from December 2017 to January 2019. Amendments to the extent of native vegetation were made using a Geographic Information System (GIS), ArcGIS 10.6. Where feasible, the boundaries of native vegetation were reduced in areas that have been cleared since the previous vegetation mapping was prepared. Conversely, the boundaries of native vegetation were extended in areas where the previous vegetation mapping indicated the land was cleared but has subsequently been mapped or can be predicted to contain native vegetation using aerial imagery.

Native vegetation occurring within the 550-metre linear assessment buffer is shown on Figure 3-1. Native vegetation occupies 17,177.28 hectares of the 550-metre linear assessment buffer and is predominately large, intact patches of native forest of at least four vegetation formations. The remaining land is comprised of Lake Burragorang, parkland as well as recreational areas and infrastructure associated with tourism at Warragamba Dam and township. It is considered that the mapped vegetation extent and the vegetation indicated by the aerial imagery is broadly consistent.

The percent native vegetation cover within the 550-metre linear assessment buffer before and after development was calculated in accordance with Appendix 5 of the FBA. The calculation for percent native vegetation cover was based on the Warragamba_VISmap_2380 shapefile. In order to calculate the percent native vegetation cover, the following steps were carried out:

1. Warragamba_VISmap_2380 shapefile was clipped to the 550-metre linear assessment buffer
2. Polygons that do not contain native vegetation (that is, where 'MU_NAME' = 'Cleared-Modified Land', 'Exposed Rock' or 'Water Bodies') are deleted. This layer becomes the 'native vegetation before development'
3. Erase 20% AEP (1 in 5 chance in a year) event polygon from the 'native vegetation before development' layer and export as new layer. This becomes 'native vegetation after development'
4. Clip both 'native vegetation before development' layer and 'native vegetation after development' layer to each IBRA subregion. Calculate the area of each layer within each IBRA subregion.

5. Calculate the percent change in native vegetation cover as a proportion of the total area of the 550-metre linear assessment buffer within each IBRA subregion.

As described in Section 1.5, the impact area has been used to calculate the change in percent native vegetation cover in the landscape. The area of native vegetation within the impact area is around 1400 hectares. A summary of the current and future percentage of native vegetation cover in the linear assessment buffer area is provided in Table 3-5.

Table 3-5. Native vegetation cover and score per IBRA Subregion

IBRA Subregion	Native vegetation cover before (ha)*	Native vegetation cover after (ha)*	Native vegetation cover before (%)	Native vegetation cover after (%)	Native vegetation cover proportional change (%)	Native vegetation cover score
Burragorang Part A	14,947.51	13,847.20	69	64	5	0.00
Bungonia	701.28	622.59	55	49	6	0.50
Kanangra	2,828.23	2,691.01	86	82	4	0.00
Wollemi	2,967.13	2,891.08	79	77	2	0.00

* Note that the 550-metre buffers and native vegetation layers for the IBRA subregion assessments overlap. The sum of their areas is therefore larger than the areas for the overall area of 550-metre buffer. Areas are inclusive of Lake Burragorang.

3.3.3 Connectivity value

A 'State significant biodiversity link' has been identified as being impacted by the development. A state significant biodiversity link' is defined as either:

- an area identified by the assessor as being part of a state significant biodiversity link and in a plan approved by the Chief Executive, OEH or
- a riparian buffer of 50 metres either side of a 6th order stream or higher or
- a riparian buffer of 50 metres around an important wetland or an estuarine area.

The Project is anticipated to impact the riparian buffers of the Warragamba River and Lake Burragorang which are 6th order streams or greater, as such is the connecting link in accordance with Appendix 5, Table 17 of the FBA is determined to be a state significant biodiversity link. Table 3-6 describes the connectivity link and value within each IBRA Subregion.

Table 3-6. Connectivity link classification and score per IBRA Subregion

IBRA Subregion	Connectivity link	Connectivity score
Burragorang Part A	State Significant	12.50
Bungonia	State Significant	12.50
Kanangra	State Significant	12.50
Wollemi	State Significant	12.50

3.3.4 Area/perimeter ratio

Patch size has been determined in accordance with Appendix 5 of the FBA (Table 3-7). To calculate the area/perimeter ratio, the total sum of areas (in square metres) and the total length of perimeters (in metres) are calculated for all vegetation patches which have an area of greater than 1 hectare for the native vegetation layers as per Section 10.4 of the FBA operational manual. In order to calculate the area/perimeter ratio, the following steps were carried out:

1. Calculate area (square metre), area (hectare) and perimeter (metre) for the 'native vegetation before development' layer for each IBRA subregion
2. Sort by area (hectare) in descending order
3. Summarise perimeter (metre) and area (square metre) for all rows where area (hectare) is greater than one hectare

4. Repeat for 'native vegetation after development' layer for each IBRA subregion
5. Calculate ratio by dividing total area (square metre) by total perimeter (metre) for each IBRA subregion, that is, before/after development per IBRA subregion assessment.

Note that the FBA operational manual states to only include separate patches 'greater than 1 hectare (ha) in size' (Section 10.4 Step 1), while the methodology does not mention this restriction (Appendix 5, Section 5, Step 2).

Furthermore, the individual vegetation polygons were not merged into vegetation types but left as individual polygons as per vegetation map. It is not clear in the instructions whether this step is necessary, but it should not make much difference in the ratio change, since the method to calculate the before and after area/perimeter ratios are identical.

Table 3-7. Area/perimeter ratio and score per IBRA Subregion

IBRA subregion	Area/perimeter ratio before	Area/perimeter ratio after	Proportional change in the area/perimeter ratio (%)	Area/perimeter ratio score
Burragorang Part A	54	42	12.10	1.00
Bungonia	35	31	3.83	1.00
Kanangra	44	37	7.03	1.00
Wollemi	42	35	6.98	1.00

3.3.5 Patch size

As the Project is a linear shaped development, patch size has been determined in accordance with Appendix 5 of the FBA and Section 10.5 Step 1 of the FBA operational manual, the patch size used is the largest contiguous patch of native vegetation inside and outside of the buffer for each Mitchell Landscape. The study area occurs within nine Mitchell Landscapes.

The patch size for each Mitchell Landscape is calculated according to Section 10.5 of the FBA operational manual and Section 4 of Appendix 5 of the FBA. Calculation of the area/perimeter ratios comprised the following steps:

1. Highlight each Mitchell Landscapes layer within the linear assessment buffer for each of the IBRA subregion assessments
2. Export as 'patch size' layer for the relevant IBRA subregion assessment
3. Explode into separate polygons and calculate areas in hectares
4. Select the largest patch for each Mitchell landscape.

The native vegetation within the study area and linear assessment buffer is identified in Section 4.4.3.

Table 3-8. Mitchell Landscapes within linear assessment buffer

Mitchell landscapes	Area within buffer (ha)*	% within buffer	Patch size (ha)*
Boyd Plateau	49.89	0.20	27,898.53
Burragorang Valley and Gorges	10,320.20	40.34	27,172.12
Kurrajong Fault Scarp	363.69	1.42	33,921.76
Lapstone Slopes	386.21	1.51	51,017.86
Nattai Plateau	1,333.53	5.21	83,531.73
Scotts Main Range	2,217.61	8.67	30,314.34
Silverdale Slopes	0.16	0.00	1,115.17
Sydney Basin Western Escarpment	10,887.95	42.56	71,510.92
Wollondilly - Bindook Tablelands and Gorges	22.32	0.09	18,712.10

*Areas are inclusive of Lake Burragorang

Based on this assessment, the average patch size class for each IBRA Subregion is shown in Table 3-9.

Table 3-9. Average patch size and score per IBRA Subregion

IBRA Subregion	Average patch size	Patch size score
Burragorang Part A	Extra Large	11.6
Bungonia	Extra Large	12.50
Kanangra	Extra Large	12.50
Wollemi	Extra Large	12.50

3.3.6 Summary of landscape value score components

A summary of the landscape value score components for each IBRA Subregion is provided in Table 3-10, Table 3-11, Table 3-12, and Table 3-13.

Table 3-10. Summary of Burragorang part a landscape value score components

Components	Value	Score
Native vegetation cover before development	69%	0.5
Native vegetation cover after development	64%	
Connectivity value	State significant biodiversity link	12.50
Area/Perimeter ratio proportional change	22%	3
Patch Size (Mitchell Landscape)	Seven landscapes assessed above 1,000 ha	11.60
Landscape value score	**27.60**	

Table 3-11. Summary of Bungonia landscape value score components

Components	Value	Score
Native vegetation cover before development	55%	0.50
Native vegetation cover after development	49%	
Connectivity value	State significant biodiversity link	12.50
Area/Perimeter ratio proportional change	11%	2
Patch Size (Mitchell Landscape)	Three landscapes assessed above 1,000 ha	12.50
Landscape value score	**27.50**	

Table 3-12. Summary of Kanangra landscape value score components

Components	Value	Score
Native vegetation cover before development	86%	0.40
Native vegetation cover after development	82%	
Connectivity value	State significant biodiversity link	12.50
Area/Perimeter ratio proportional change	16%	2
Patch Size (Mitchell Landscape)	Four landscapes assessed above 1,000 ha	12.50
Landscape value score	**27.40**	

Table 3-13. Summary of Wollemi landscape value score components

Components	Value	Score
Native vegetation cover before development	79%	0.00
Native vegetation cover after development	77%	
Connectivity value	State significant biodiversity link	12.50
Area/Perimeter ratio proportional change	17%	2
Patch Size (Mitchell Landscape)	Six landscapes assessed above 1,000 ha	12.50
Landscape value score	**27.00**	

4 Native vegetation

4.1 Review of existing data

Prior to field surveys a review of existing vegetation data was undertaken. The following primary sources of information were consulted as part of a desktop assessment of the native vegetation within the upstream area:

- BioNet Vegetation Classification System (OEH 2017c)
- Spatial Information eXchange (Department of Finance and Services 2017)
- *The Native Vegetation of the Warragamba Special Area* (NPWS 2003a)
- Warragamba_VISmap_2380 (NPWS 2003a)
- The Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands Version 1.0 (Tozer *et al*. 2010).

The following secondary sources were reviewed:

- Preliminary Environmental Assessment – Warragamba Dam Raising (BMT WBM Pty Ltd 2016)
- Proposed Warragamba Flood Mitigation Dam – Environmental Impact Statement (ERM Mitchell McCotter 1995)
- Warragamba Dam EIS – Dam Site Environmental Studies Flora and Fauna Report (Mount King Ecological Surveys 1992).

Information obtained during the review of existing data was used in conjunction with field data collected by SMEC to assess native vegetation within the site.

4.2 Surveys

4.2.1 Overview

As discussed in Section 1.5.2, a field survey area was identified to allow focussed survey effort across a large study area. The field survey area was delineated with input from the former OEH and DoEE prior to surveys commencing (refer Section 1.5.5) was defined as the 1% AEP (1 in 100 chance in a year) event plus 9% climate change flood scenario. As a result, the majority of field surveys including vegetation mapping, plot and transect surveys, and threatened flora and fauna surveys were carried out within this area. However, a small number of plots and incidental observations of threatened species were recorded outside of this field survey area, within the study area and adjacent lands.

Prior to field surveys, the descriptions of the map units contained within Part B of *The Native Vegetation of the Warragamba Special Area* (NPWS 2003a) were analysed and compared with potential plant community type (PCT) generated from the 'Plant Community Identification' tool within the BioNet Vegetation Classification System. Potential PCTs were cross referenced with their referenced published mapping methodology, namely 'The Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0' (Tozer *et al.* 2010). PCTs were assigned to the map units mentioned above when the floristic and structural information contained within mapping methodology and PCT details within BioNet Vegetation Classification System were found to be consistent with the information contained within the descriptions of the above map units.

Surveys of the vegetation within the field survey area were conducted from 11 October 2017 over a period of about 39 non-consecutive weeks and concluded on 18 January 2019. The first round of survey was conducted to obtain an overview of the nature and extent of vegetation not just within the field survey area but also within adjacent lands. Another objective of the first round of surveys was to map the extent of vegetation communities within the field survey area and establish the number of floristic plots required for the assessment. Once the likely PCTs were identified, full floristic plots and plot and transect surveys were conducted to verify the PCTs and collect site value data from the identified vegetation zones.

Vegetation mapping, PCT identification as well as full floristic plots and plot transect surveys were undertaken concurrently, with periodic refinements during the survey period. As data was collected, full floristic plots and plot and transect surveys were conducted to verify the PCTs and collect site value data from the identified vegetation zones. Vegetation mapping was refined where necessary. For six of the PCTs, access was not feasible to all plot locations due to topographical constraints of the site. For these PCTs, the balance of plots has been met using surrogate plots using benchmark data.

Areas of native vegetation were assigned to PCTs onsite using a Samsung Galaxy Pen Global Positioning System (GPS) enabled tablets loaded with QGIS and aerial photograph interpretation.

An edited version of Warragamba_VISmap_2380 was loaded into QGIS. The edits included the addition of editable attribute fields including the following:

- SMEC assigned map unit
- SMEC assigned PCT
- SMEC assigned TSC Act listed EEC/CEEC
- SMEC assigned EPBC Act listed EEC/CEEC.

Mapped Warragamba_VISmap_2380 polygons were assigned to a NPWS Map Unit (NPWS 2003a), PCT, and EEC (endangered ecological community) where relevant. They were also assigned to an assessment method as follows:

- Ground truthed: polygon visited by SMEC and floristics directly compared to PCTs
- Rapid assessment: polygon either visited by SMEC but no formal floristic data collected, or polygon not visited by SMEC, but floristics assessed at distance via binoculars.

SMEC has assessed approximately 80 percent of the field survey area. For the purposes of this assessment, polygons that were not ground truthed or assessed via rapid assessment have been accepted as being correct by SMEC. Each map unit polygon has been assigned to its corresponding PCT. Figure 4-1 shows the areas of the field survey area which were ground truthed, assessed via rapid assessment, or PCT assumed as part of the current assessment on a single page map. A multipage figure is included in Appendix L of this report. Polygons within the NPWS mapping that were not assigned to map units were managed in the following way:

- Water bodies: retained unless ground truthing found the polygon to be otherwise
- Exposed rock: retained unless ground truthing found the polygon to be otherwise
- Regenerating vegetation: allocated to an adjacent PCT based on desktop interpretation of aerial imagery, aspect, elevation, and topography
- Cleared-Modified Land: allocated to an adjacent PCT based on desktop interpretation of aerial imagery, aspect, elevation, and topography.

The areas of vegetation that have been ground truthed, rapid assessed, and accepted as correct are shown on Figure 4-1, and the area of each assessment type is shown in Table 4-1.

Table 4-1. Area of each survey and assessment type

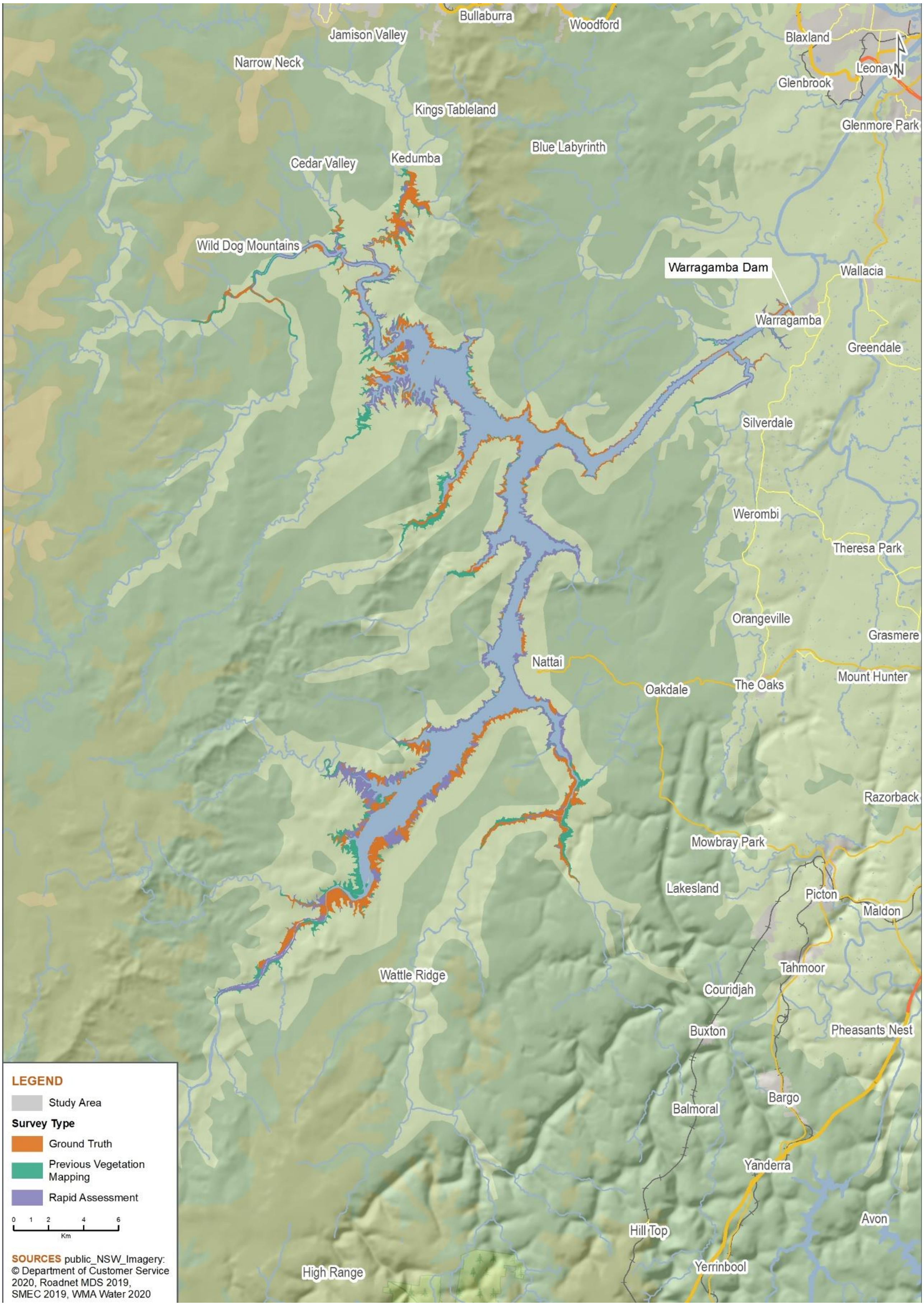
Survey type	Area (ha) within survey area	Percentage (%) of survey area	Area (ha) within impact area	Percentage (%) of impact area
Ground truth	1,511.85	40.45	611.25	43.62
Rapid assessment	1,362.34	46.45	564.32	40.28
NPWS (2003) accepted	863.49	23.10	119.64	8.54
Total	**3,737.68**	**100.00**	**1,295.21**	**92.44**

The distribution of PCTs between the field survey area and the boundary of the study area was extrapolated based on NPWS mapping, with PCTs assigned to polygons based on the equivalent NPWS map unit. There were no additional map units/PCTs occurring within the area between the field survey area and study area boundary. It should be noted that vegetation zones were delineated to the survey area only, not to the boundary of the study area.

For the purposes of assigning PCTs to native vegetation communities, plot based full floristic survey was undertaken in accordance with Table 1 of the FBA at 97 sites across the study area. However, the data collected within two of these plots was not considered reliable, therefore, these plots were removed from the assessment. Consequently, this assessment has included data from within 95 plots. The same sites were also used for plot and transect surveys of each vegetation zone.

The PCTs occurring within the field survey area were stratified into areas represented by the locally-defined vegetation communities. The majority of the PCTs within the field survey area are of the same broad condition type, thus are provided for within their own single vegetation zone. However, one PCT (HN527) occurs within the field

Figure 4-1. Areas that have been ground truthed and rapid assessed during field surveys



survey area as two condition classes. The field survey area has been stratified into 19 vegetation zones as shown in Appendix L of this report.

4.2.2 Plot-based full floristic survey

Ninety-five full floristic plots were surveyed within the field survey area and have been used in this assessment. The following information was collected at each of the 20 x 20 metre full floristic plots in accordance with Table 1 of the FBA:

- Stratum (and layer): stratum and layer in which each species occurs.
- Growth form: growth form for each recorded species.
- Species name: scientific name and common name.
- Cover: a measure or estimate of the appropriate cover measure for each recorded species; recorded from 1–5% and then to the nearest 5%. If the cover of a species is less than 1% and the species is considered important, then the estimated cover should be entered (for example, 0.4).
- Abundance rating: a relative measure of the number of individuals or shoots of a species within the plot. Use the following intervals; numbers above about 20 are estimates only: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, or 1,000, or specify a number greater than 1,000 if required.

The locations of these plots are shown on Figure 4-2.

4.2.3 Plot and transect surveys

Ninety-five plot and transect sites were surveyed within the field survey area and have been used in this assessment. The following information was collected at each of the 20 x 50-metre plot and transect sites in accordance with Section 5.3.2 of the FBA:

- native species richness recorded within each stratum of a 20-metre x 20-metre sub-plot
- native overstorey cover recorded at 10 points along a 50-metre transect
- native mid-storey cover recorded at 10 points along a 50-metre transect
- native ground cover recorded at 50 points along a 50-metre transect for three life forms (shrubs, grasses and other)
- exotic plant cover expressed as a total percent cover across all strata (each stratum measured using the same method for native overstorey, mid-storey and ground cover)
- number of trees with hollows visible from the ground within the 20-metre x 50-metre plot
- total length of fallen logs >10 cm in diameter within the 20-metre x 50-metre plot
- proportion of regenerating overstorey species within the vegetation zone.

The locations of the plot and transect sites are shown on Figure 4-2 (single-page figure) and in Appendix L (multipage figure). The minimum number of plots per vegetation zone is based on the requirements set out in Table 3 of the FBA and shown in Table 4-2 of this report. The locations of the plot and transect sites were determined by randomly marking a point within each observable PCT, where possible, within the field survey area. In areas where access was difficult, the plot and transect survey has been completed within, or immediately adjacent to, the field survey area. As discussed in Section 4.2.1, for six of the PCTs, access was not feasible to all plot locations due to topographical constraints of the site. For these PCTs, the balance of plots has been met using surrogate plots using benchmark data.

Table 4-2 summarises the plot and transect survey effort undertaken for the Project. For all vegetation zones assessed the minimum number of plot and transect surveys has been conducted. Data collected from all plot and transect sites were used to determine the site value score for each vegetation zone.

The locations of the full floristic plots were determined by randomly marking a point within each observable PCT within adjoining land to the field survey area that would enable an appropriate assessment of expected environmental variation. Areas considered not suitable for assessment include ecotones, vehicle tracks and their edges, and disturbed areas which are readily distinguishable from the broad condition state of the vegetation zone.

Where feasible, plots were carried out within the field survey area, however, a small proportion of plots were undertaken within vegetation contiguously within or adjacent to the study area in areas where access was limited. Note that the field survey area is a larger area than the impact area (refer to defintions in Section 1.5.2). The number of required plots is based on the greater area.

Figure 4-2. Plot-based floristic survey and plot and transect survey sites

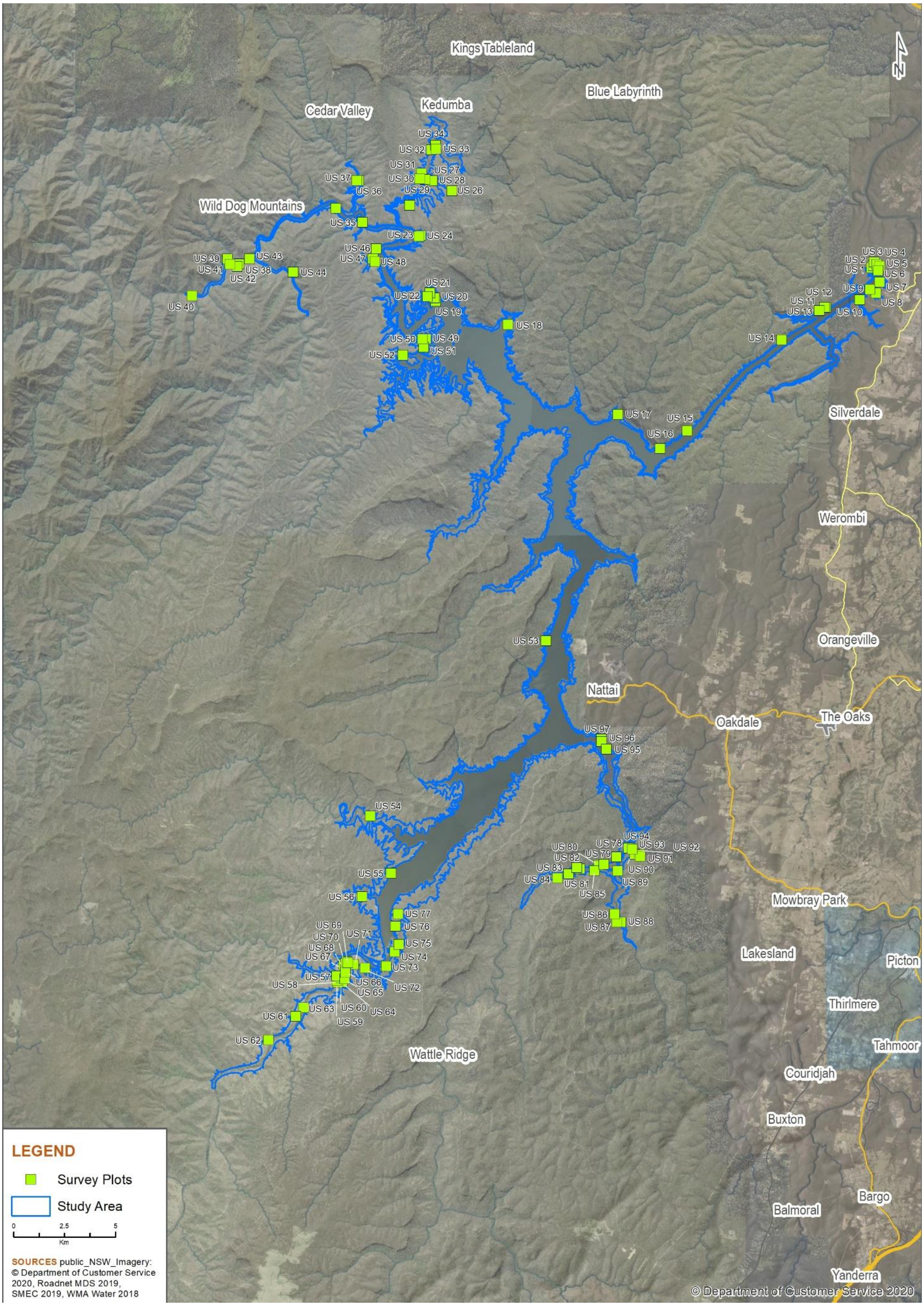


Table 4-2. Plot and transect survey effort

Vegetation zone	PCT code/BVT code	Condition*	Area within survey area (ha)	Min. plot and transects required for survey area	No. plot and transects sampled
1	1081/HN564	Moderate/good	5.12	3	4
2	1083/HN566	Moderate/good	18.28	3	4
3	1086/HN568	Moderate/good	67.71	5	1**
6	941/HN553	Moderate/good	362.81	7	7
7	877/HN538	Moderate/good	140.66	6	6
8	875/HN537	Moderate/good	12.77	3	1**
9	871/HN536	Moderate/good	506.48	7	9
10	870/HN535	Moderate/good	63.40	5	4**
11	862/HN533	Moderate/good	29.28	4	5
12	860/HN532	Moderate/good	543.48	7	7
13	840/HN527	Moderate/good	198.31	6	8
14	840/HN527	Moderate/good_DNG	139.76	6	5**
15	832/HN525	Moderate/good	354.14	7	7
16	769/HN517	Moderate/good	1.13	1	1
17	1401/HN557	Moderate/good	646.20	7	7
18	1292/HN607	Moderate/good	43.18	4	4
19	1284/HN606	Moderate/good	49.62	4	2**
20	1246/HN598	Moderate/good	20.92	4	3**
21	1105/HN574	Moderate/good	527.05	7	7

* Condition names reflect options available within the BioBanking Credit Calculator rather than on-ground condition.

** Surrogate plots utilised in BioBanking Calculations.

Note: Vegetation Zones 4 and 5 fall within the construction development site, not within the upstream study area

4.3 Identification of plant community types

Identification of the PCTs occurring within the study area was guided by the results of the review of existing data (see Section 4.1) and surveys of the field survey area (see Section 4.2). The data collected during surveys of the field survey area was analysed in conjunction with a review of the PCTs held within the VIS Classification Database. Consideration was given to the following:

- occurrence within the South Sydney Basin and South Eastern Bioregions and relevant subregions
- vegetation formation
- landscape position
- dominant upper, mid and ground strata species.

The analysis determined that the vegetation within the study area aligned with 18 PCTs held within the VIS Classification Database. Table 4-3 lists the PCTs that have been identified within the study area and the justification for their selection.

Table 4-3. Justification for selection of PCTs within the study area

PCT Code (PCT ID)	PCT Name	Evidence used for identification	Species relied upon for identification
HN517 (PCT ID 769)	Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Bungonia, Kanangra and Wollemi IBRA subregions **Vegetation formation**: Rainforests **Landscape position**: Occurs in moist gully heads and sheltered slopes below sandstone cliffs between 400 and 800 m altitude	**Upper stratum species**: *Ceratopetalum apetalum, Acmena smithii, Doryphora sassafras, Acacia elata* **Mid stratum species**: *Backhousia myrtifolia, Callicoma serratifolia, Cyathea australis, Gynochthodes jasminoides* **Ground stratum species**: *Blechnum cartilagineum*
HN525 (PCT ID 832)	Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang and Kanangra IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrub/grass sub-formation) **Landscape position**: Occurs on loams on intermediate slopes within rocky gorges of the Kowmung and Wollondilly Rivers between 100 and 750 m altitude	**Upper stratum species**: *Allocasuarina torulosa, Eucalyptus crebra, Eucalyptus tereticornis, Eucalyptus punctata, Brachychiton populneus subsp. populneus* **Mid stratum species**: *Acacia implexa, Breynia oblongifolia, Bursaria spinosa subsp. spinosa, Clematis glycinoides* **Ground stratum species**: *Adiantum aethiopicum, Cheilanthes sieberi subsp. sieberi, Cymbopogon refractus, Desmodium gunnii*
HN527 (PCT ID 840)	Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Bungonia and Kanangra IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrub/grass sub-formation) **Landscape position**: Occurs on shallow loams on dry slopes within rocky gorges between 150 and 700 m in the southern parts of the Sydney Basin. Known from the Wollondilly, Shoalhaven, Coxs and Jenolan Gorges	**Upper stratum species**: *Eucalyptus melliodora, Eucalyptus tereticornis, Eucalyptus moluccana, Brachychiton populneus subsp. populneus, Eucalyptus eugenioides* **Mid stratum species**: *Bursaria spinosa subsp. spinosa, Clematis aristata, Olearia viscidula* **Ground stratum species**: *Aristida ramosa, Cheilanthes distans, Cheilanthes sieberi subsp. sieberi, Desmodium brachypodum*
HN532 (PCT ID 860)	Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Bungonia, Kanangra and Wollemi IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrub/grass sub-formation) **Landscape position**: Occurs on dry hill slopes with loamy soils in gorges of the Blue Mountains, particularly the Burragorang Valley	**Upper stratum species**: *Eucalyptus punctata, Eucalyptus fibrosa, Eucalyptus eugenioides, Eucalyptus crebra* **Mid stratum species**: *Billardiera scandens, Hardenbergia violacea, Lissanthe strigosa, Notelaea longifolia* **Ground stratum species**: *Aristida vagans, Cheilanthes sieberi subsp. sieberi, Dianella revoluta var. revoluta, Entolasia stricta*

PCT Code (PCT ID)	PCT Name	Evidence used for identification	Species relied upon for identification
HN533 (PCT 862)	Grey Gum - Hard-leaved Scribbly Gum woodland of the Coxs River Valley, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Bungonia, Kanangra and Wollemi IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrubby sub-formation) **Landscape position**: Mainly occurs in the Kedumba and Megalong valleys on sandy loams derived from Permian sediments at altitudes up to 700 m	**Upper stratum species**: *Eucalyptus signata*, *Eucalyptus punctata, Eucalyptus fibrosa, Eucalyptus eugenioides, Eucalyptus crebra* **Mid stratum species**: *Banksia spinulosa, Leptospermum trinervium, Persoonia linearis, Phyllanthus hirtellus* **Ground stratum species**: *Cheilanthes sieberi subsp. sieberi, Cyathochaeta diandra, Dianella revoluta var. revoluta, Entolasia stricta*
HN535 (PCT ID 870)	Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Bungonia and Kanangra IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrub/grass sub-formation) **Landscape position**: Occurs on loams on dry slopes within rocky gorges of the Kowmung and Wollondilly Rivers between 100 and 750 m	**Upper stratum species**: *Eucalyptus punctata*, *Eucalyptus elata, Eucalyptus eugenioides, Eucalyptus tereticornis, Eucalyptus cypellocarpa* **Mid stratum species**: *Acacia falciformis, Clematis aristata, Olearia viscidula* **Ground stratum species**: *Cheilanthes sieberi subsp. sieberi, Desmodium gunnii, Dichondra repens, Echinopogon ovatus*
HN536 (PCT ID 871)	Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Bungonia, Kanangra and Wollemi IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrub/grass sub-formation) **Landscape position**: Occurs on sheltered hill slopes on loamy soils within rocky gorges of the Blue Mountains	**Upper stratum species**: *Eucalyptus punctata*, *Allocasuarina torulosa, Eucalyptus crebra, Eucalyptus deanei, Angophora floribunda* **Mid stratum species**: *Billardiera scandens, Breynia oblongifolia, Eustrephus latifolius, Geitonoplesium cymosum* **Ground stratum species**: *Adiantum aethiopicum, Desmodium gunnii, Dianella caerulea, Dichondra repens*
HN537 (PCT ID 875)	Grey Myrtle – Lilly Pilly dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Kanangra and Wollemi IBRA subregions **Vegetation formation**: Rainforest **Landscape position**: Occurs in dry shale gullies below 400 m mainly south of Nowra, with occasional occurrences on sandstone in the lower Blue Mountains to the north	**Upper stratum species**: *Backhousia myrtifolia, Acmena smithii* **Mid stratum species**: *Ficus coronata, Pittosporum undulatum, Breynia oblongifolia, Cissus hypoglauca* **Ground stratum species**: *Blechnum neohollandicum, Oplismenus imbecillis, Pseuderanthemum variabile*

PCT Code (PCT ID)	PCT Name	Evidence used for identification	Species relied upon for identification
HN538 (PCT ID 877)	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Bungonia, Kanangra and Wollemi IBRA subregions **Vegetation formation**: Rainforest **Landscape position**: Occurs on steep rocky slopes of dry gorges and gullies below about 500 m	**Upper stratum species**: *Backhousia myrtifolia* **Mid stratum species**: *Notelaea longifolia, Breynia oblongifolia, Melicytus dentatus, Sigesbeckia orientalis* **Ground stratum species**: *Adiantum aethiopicum, Asplenium flabellifolium, Pellaea falcata, Dichondra repens*
HN553 (PCT ID 941)	Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang IBRA subregion **Vegetation formation**: Forested wetlands **Landscape position**: Occurs on sheltered valley flats upstream of Lake Burragorang	**Upper stratum species**: *Eucalyptus deanei, Eucalyptus eugenioides, Angophora floribunda, Eucalyptus benthamii* **Mid stratum species**: *Rubus parvifolius, Leptospermum polygalifolium, Acacia spp., Breynia oblongifolia* **Ground stratum species**: *Lomandra longifolia, Pratia purpurascens, Pteridium esculentum, Adiantum aethiopicum*
HN557 (PCT ID 1401)	Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Bungonia and Kanangra IBRA subregions **Vegetation formation**: Grassy woodlands **Landscape position**: Occurs on dry rocky escarpment slopes with loamy soils at altitudes of 150-450 m in the lower Nattai and Wollondilly Valleys and near the upper reaches of Lake Burragorang	**Upper stratum species**: *Acacia binervia, Eucalyptus albens – moluccana intergrade, Eucalyptus crebra, Eucalyptus tereticornis, Callitris glaucophylla* **Mid stratum species**: *Acacia implexa, Lissanthe strigosa, Persoonia linearis, Olearia viscidula, Phyllanthus hirtellus* **Ground stratum species**: *Aristida ramosa, Aristida vagans, Austrostipa scabra subsp. scabra, Cheilanthes sieberi subsp. sieberi*
HN564 (PCT ID 1081)	Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang and Wollemi IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrubby sub-formation) **Landscape position**: Occurs on loamy soils on dry ridges below about 400 m in the rainshadow zone surrounding the Cumberland Plain	**Upper stratum species**: *Corymbia gummifera, Eucalyptus punctata, Angophora costata, Syncarpia glomulifera* **Mid stratum species**: *Phyllanthus hirtellus, Persoonia linearis, Leptospermum trinervium, Acacia ulicifolia* **Ground stratum species**: *Entolasia stricta, Lomandra obliqua, Pomax umbellata, Themeda australis*
HN566 (PCT ID 1083)	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang and Wollemi IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrubby sub-formation) **Landscape position**: Occurs on crests, ridges and exposed slopes on coastal sandstone plateaux	**Upper stratum species**: *Corymbia gummifera, Eucalyptus haemastoma, Eucalyptus racemosa, Eucalyptus oblonga* **Mid stratum species**: *Acacia suaveolens, Acacia ulicifolia, Angophora hispida, Banksia ericifolia* **Ground stratum species**: *Actinotus minor, Caustis flexuosa, Cyathochaeta diandra, Dampiera stricta*

PCT Code (PCT ID)	PCT Name	Evidence used for identification	Species relied upon for identification
HN568 (PCT ID 1086)	Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang, Kanangra and Wollemi IBRA subregions **Vegetation formation**: Dry sclerophyll (Shrubby sub-formation) **Landscape position**: Occurs on sandy loams on elevated sandstone slopes between 250 and 800 m, mainly in the Nattai-Wingecarribee area	**Upper stratum species**: *Eucalyptus globoidea, Corymbia gummifera, Eucalyptus punctata, Eucalyptus sieberi* **Mid stratum species**: *Banksia spinulosa, Leptospermum trinervium, Lomatia silaifolia, Persoonia levis* **Ground stratum species**: *Billardiera scandens, Dampiera purpurea, Dianella caerulea, Entolasia stricta*
HN574 (PCT ID 1105)	River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion	**IBRA Subregion**: Occurs within the Burragorang and Wollemi IBRA subregions **Vegetation formation**: Forested wetlands **Landscape position**: Occurs on river banks of major rivers or banks of swift flowing streams and rivers	**Upper stratum species**: *Casuarina cunninghamiana* **Mid stratum species**: *Acacia floribunda, Acacia mearnsii, Pandorea pandorana, Stephania japonica* **Ground stratum species**: *Dichondra repens, Lomandra longifolia, Microlaena stipoides var. stipoides, Oplismenus aemulus*
HN606 (PCT ID 1284)	Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang and Wollemi IBRA subregions **Vegetation formation**: Wet sclerophyll (Shrubby sub-formation) **Landscape position**: Occurs on sheltered sandstone slopes and in gullies up to an altitude of 700 m	**Upper stratum species**: *Syncarpia glomulifera, Angophora costata, Eucalyptus deanei, Eucalyptus piperita* **Mid stratum species**: *Cissus hypoglauca, Clematis aristata, Elaeocarpus reticulatus, Leucopogon lanceolatus* **Ground stratum species**: *Billardiera scandens, Blechnum cartilagineum, Calochlaena dubia, Dianella caerulea*
HN607 (PCT ID 1292)	Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion	**IBRA Subregion**: Occurs within the Burragorang and Wollemi IBRA subregions **Vegetation formation**: Forested wetlands **Landscape position**: Occurs on sandy banks and sandstone beds of streams draining sandstone plateaux below 450 m	**Upper stratum species**: *Tristaniopsis laurina, Ceratopetalum apetalum* **Mid stratum species**: *Lomatia myricoides, Tristania neriifolia, Leptospermum morrisonii* **Ground stratum species**: *Lomandra longifolia, Entolasia stricta, Schoenus melanostachys, Lomandra fluviatilis*
HN598 (PCT ID 1246)	Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion	**IBRA Subregion**: Occurs in the Kanangra, Burragorang, and Wollemi IBRA subregions **Vegetation formation**: Dry sclerophyll forests (Shrubby sub-formation) **Landscape position**: Occurs between Bell and the Tonalli Range in the western Blue Mountains	**Upper stratum species**: *Eucalyptus piperita, Eucalyptus punctata, Eucalyptus sclerophylla, Angophora costata* **Mid stratum species**: *Banksia spinulosa, Lomatia silaifolia, Phyllanthus hirtellus, Persoonia linearis* **Ground stratum species**: *Entolasia stricta, Goodenia hederacea, Lomandra obliqua, Lomandra multiflora*

4.4 Description of plant community types

4.4.1 Overview

Table 4-4 provides a summary of the PCTs occurring within the study area, including vegetation formation, percent cleared within Hawkesbury-Nepean catchment of each PCT. The distribution of these PCTs within the study area is shown in Appendix L of this report.

Table 4-4. Summary of PCTs occurring within the study area

BVT Code	PCT Name	Vegetation formation	Vegetation class	PCT % cleared within Hawkesbury-Nepean catchment	Area within study area (ha)	Area within upstream impact area (ha)
HN517 (PCT 769)	Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion	Rainforest	Northern Warm Temperate Rainforests	5	1.52	0.53
HN525 (PCT 832)	Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion	Dry Sclerophyll Forest (shrub/grass sub-formation)	Central Gorge Dry Sclerophyll Forests	5	544.90	143.14
HN527 (PCT 840)	Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands	Dry Sclerophyll Forest (shrub/grass sub-formation)	Central Gorge Dry Sclerophyll Forests	50	490.47	127.75
HN532 (PCT 860)	Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes on the Blue Mountains, Sydney Basin Bioregion	Dry Sclerophyll Forest (shrub/grassy sub-formation)	Central Gorge Dry Sclerophyll Forests	25	963.64	226.04
HN533 (PCT 862)	Grey Gum - Hard Leaved Scribbly Gum woodland of the Cox River Valley	Dry Sclerophyll Forest (shrubby sub-formation)	Sydney Sand Flats Dry Sclerophyll Forests	20	84.62	10.97
HN535 (PCT 870)	Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountain gorges, Sydney basin Bioregion	Dry Sclerophyll Forest (shrub/grassy sub-formation)	Central Gorge Dry Sclerophyll Forests	10	91.26	22.17
HN536 (PCT 871)	Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	Dry Sclerophyll Forest (shrub/grassy sub-formation)	Central Gorge Dry Sclerophyll Forests	5	800.41	212.92
HN537 (PCT 875)	Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion	Rainforest	Dry Rainforest	10	16.07	5.62

BVT Code	PCT Name	Vegetation formation	Vegetation class	PCT % cleared within Hawkesbury-Nepean catchment	Area within study area (ha)	Area within upstream impact area (ha)
HN538 (PCT 877)	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East corner Bioregion	Rainforest	Dry Rainforest	25	231.16	50.15
HN553 (PCT 941)	Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion	Forested Wetlands	Coastal Floodplain Wetlands	5	378.04	104.51
HN557 (PCT 1401)	Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion	Grassy Woodlands	Western Slopes Grassy Woodlands	55	957.26	302.81
HN564 (PCT 1081)	Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion	Dry Sclerophyll Forest (shrubby sub-formation)	Sydney Hinterland Dry Sclerophyll Forest	40	7.37	1.92
HN566 (PCT 1083)	Red bloodwood -scribbly gum heathy woodland on sandstone plateaux of the Sydney basin Bioregion	Dry Sclerophyll Forest (shrubby sub-formation)	Sydney Coastal Dry Sclerophyll Forest	17	25.14	6.57
HN568 (PCT 1086)	Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion	Dry Sclerophyll Forest (shrubby sub-formation)	Sydney Hinterland Dry Sclerophyll Forest	20	100.01	25.72
HN574 (PCT 1105)	River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion	Forested Wetlands	Eastern Riverine Forests	40	368.15	84.23
HN598 (PCT 1246)	Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion	Dry Sclerophyll Forest (shrubby sub-formation)	Sydney Hinterland Dry Sclerophyll Forest	10	33.10	9.71
HN606 (PCT 1284)	Turpentine - smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion	Wet Sclerophyll Forests (Shrubby sub-formation)	North Coast Wet Sclerophyll Forest	5	75.39	20.82
HN607 (PCT 1292)	Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion	Forested Wetlands	Eastern Riverine Forests	10	36.58	14.66

4.4.2 Threatened ecological communities

Based on the VIS Classification Database six PCTs identified within the study area have the potential to be a component of six different threatened ecological communities (TEC) listed under both the BC Act and EPBC Act as follows:

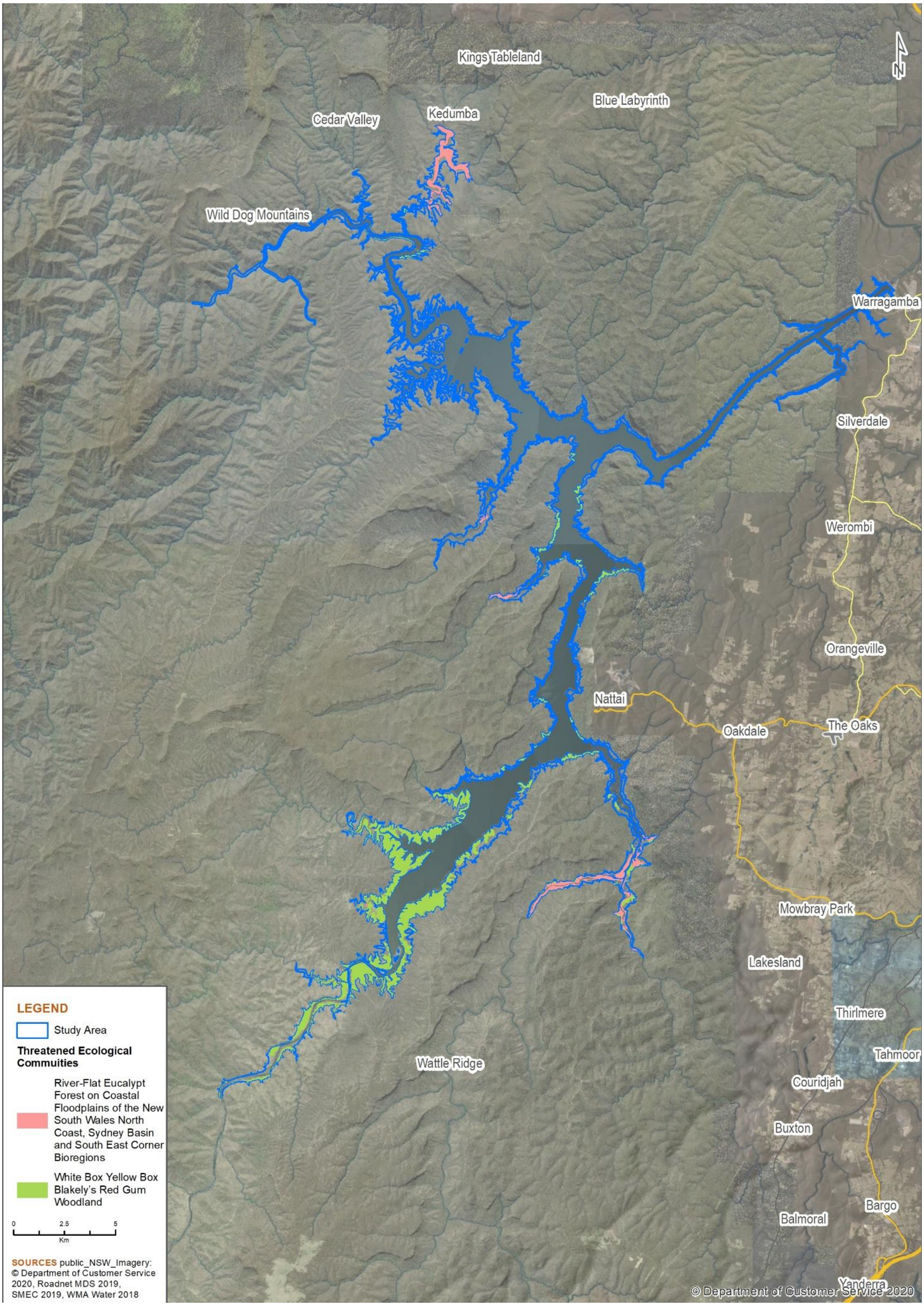
- White Box Yellow Box Blakely's Red Gum Woodland listed as Critically Endangered under the BC Act and Critically Endangered under the EPBC Act
- Western Sydney Dry Rainforest in the Sydney Basin Bioregion listed as Endangered under the BC Act and Critically Endangered under the EPBC Act
- River-Flat Eucalypt Forest on Coastal Floodplains listed as Endangered under the BC Act and Critically Endangered under the EPBC Act
- Sydney Turpentine Ironbark Forest listed as Critically Endangered under the BC Act and Critically Endangered under the EPBC Act
- Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion listed as Endangered under the BC Act and Critically Endangered under the EPBC Act.

The vegetation within the study area was compared against the assemblage of species, area of occupancy, and supplementary descriptors outlined within the NSW Scientific Committee's Scientific Determination under the BC Act for each of the TECs listed above. In addition, the vegetation within the study area was compared against the listing advice and/or conservation advice for each TEC under the EPBC Act, especially in relation to relevant size and condition thresholds pertinent to EPBC Act listings. The comparisons and assessment as to whether the PCT conforms to either the BC or EPBC listings of these six TECs are provided in Table 4-5. The location of TECs within the study area are shown on Figure 4-3 (single page figure) and in Appendix L (multipage figures).

Table 4-5. Comparisons and assessment as to whether PCT conforms to either the BC Act or EPBC Act TEC

BVT code	PCT name	TEC name	BC Act status	EPBC ACT status	Assessed as TEC
HN527	Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands	White Box Yellow Box Blakely's Red Gum Woodland	Critically Endangered	Critically Endangered	Yes (Both BC and EPBC Acts)
HN538	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	Western Sydney Dry Rainforest in the Sydney Basin Bioregion	Endangered	Critically Endangered	No
HN553	Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains	Endangered	Critically Endangered (gazetted 6 December 2020)	Yes
HN557	Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion	White Box Yellow Box Blakely's Red Gum Woodland	Critically Endangered	Critically Endangered	Yes (Both BC and EPBC Acts)
HN606	Turpentine - smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion	Blue Mountains Shale Cap Forest	Endangered	Critically Endangered	No
		Sydney Turpentine-Ironbark Forest	Critically Endangered	Critically Endangered	No

Figure 4-3. Distribution of TECs across the study area



4.4.2.1 White Box Yellow Box Blakely's Red Gum Woodland

The vegetation within the study area was compared against the assemblage of species, area of occupancy, and supplementary descriptors outlined within the NSW Scientific Committee's Scientific Final Determination under the BC Act for each of the BC Act TECs listed above. In addition, the vegetation within the study area was compared against the listing advice and/or conservation advice for each TEC under the EPBC Act, especially in relation to relevant size and condition thresholds pertinent to EPBC Act listings.

Note that acronyms for each threatened community in this section relate only to the particular legislation for it discussed within the subsection.

Two PCTs, HN527 and HN557, recorded within the study area are considered to be components of White Box Yellow Box Blakely's Red Gum Woodland.

White Box Yellow Box Blakely's Red Gum Woodland under the BC Act

Under the BC Act, an ecological community is defined as an assemblage of species occupying a particular area.

The NSW Scientific Committee Final Determination (NSW Scientific Committee, 2011d) lists characteristic species of this assemblage. The Final Determination also includes plant species that may be part of the assemblage but are atypical of its broader distribution, particularly on the margins of the community's distribution.

Thirteen 20 metre x 20 metre plots were carried out in HN527 within the study area. Of these, eight were carried out within woodland (HN527_Moderate/Good), and five were carried out within derived native grassland (DNG) (HN527_Moderate/Good_DNG). Within HN527_Moderate/Good, 33 species listed as characteristic species of White Box Yellow Box Blakely's Red Gum Woodland as per the NSW Scientific Committee's Final Determination were recorded within these eight plots. This represents 34 percent of the 97 species described as characteristic within the Final Determination for White Box Yellow Box Blakely's Red Gum Woodland. Within HN527_Moderate/Good_DNG, 15 species listed as characteristic species of White Box Yellow Box Blakely's Red Gum Woodland as per the NSW Scientific Committee's Final Determination were recorded within these five plots. This represents 15 percent of the 97 species described as characteristic within the Final Determination for White Box Yellow Box Blakely's Red Gum Woodland.

Seven 20 metre x 20 metre plots were carried out in HN557_Moderate/Good within the study area. Twenty-five species listed as characteristic species of White Box Yellow Box Blakely's Red Gum Woodland as per the NSW Scientific Committee's Final Determination were recorded within these eight plots. This represents approximately 26 percent of the 97 species described as characteristic within the Final Determination for White Box Yellow Box Blakely's Red Gum Woodland. Across all 20 plots carried out within both PCTs, 41 White Box Yellow Box Blakely's Red Gum Woodland characteristic species were recorded. This represents 42 percent of the 97 species described as characteristic within the Final Determination for White Box Yellow Box Blakely's Red Gum Woodland. Beyond the number of species found in each plot that are described as characteristic species of White Box Yellow Box Blakely's Red Gum Woodland, within the total mapped extent of this PCT visited, the dominant species in terms of abundance, cover and/or biomass are representative of the assemblage detailed in the Final Determination. This includes species such as *Eucalyptus melliodora, Eucalyptus albens-moluccana intergrade,* and *Eucalyptus tereticornis* which were co-dominant across the community, and consistent with the description of the EEC as described within the Final Determination.

As noted within Point 2 of the Final Determination, the characteristic species listed within the Final Determination for White Box Yellow Box Blakely's Red Gum Woodland comprises only a subset of the complete list of species recorded within known examples of the EEC because the species composition of the community will be influenced by the size of the patch, recent rainfall or drought conditions, the disturbance history, and geographic and topographic location.

Structurally, the extent of HN527 and HN557 occurs generally as a grassy woodland, with all vegetation layers generally present, although though the mid-storey and understorey is sparse to absent. In some areas of the study area, HN527 exists as a derived native woodland dominated by grasses, forbs, and graminoids with a sparse shrub layer in some areas. Regeneration of canopy species is present across the derived native grassland. An area of old growth White Box Yellow Box Blakely's Red Gum Woodland is present within the study area, near the homestead by Joorilands crossing. This area contains 20 large *Eucalyptus albens-moluccana* with a diameter at breast height (DBH) of over 1.5 metres.

The Final Determination notes that White Box Yellow Box Blakely's Red Gum Woodland occurs within the Sydney Basin Bioregion and South Eastern Highlands Bioregion, which is the 'particular area' as per Sect. 1.6 of the BC Act. The majority of the study area is within the Sydney Basin Bioregion, although it does extent into South Eastern Highlands Bioregion within the south-west and north-west along the Wollondilly River, Tonalli River, and Coxs River.

As per the definition of an ecological community in section 1.6 of the BC Act, this report finds the extent of HN527 and HN557 mapped in the study area conforms floristically to the assemblage of species outlined in the Final Determination for White Box Yellow Box Blakely's Red Gum Woodland, and that extent is within the Sydney Basin Bioregion and South Eastern Highlands Bioregion.

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland under the EPBC Act

Attachment A to the SEARs considers that White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (hereby known as Box-Gum Woodland) as listed under the EPBC Act is particularly likely to be significantly impacted by the Project.

The Approved Listing Advice for Box-Gum Woodland listed under the EPBC Act identifies key diagnostic characteristics; how these relate to HN527 and HN557 on site are detailed in Table 4-6.

Table 4-6. Key diagnostic characteristics of Box-Gum Woodland (EPBC Act)

Key diagnostic characteristics for Box-Gum Woodland (EPBC act) as per 1.5.1 of approved conservation advice (including listing advice)	Discussion of key diagnostic characteristics present in HN527 and HN557 within the study area
Box-Gum Woodland is characterised by a species rich understorey of native tussock grasses, herb and scattered shrubs, and the dominance of (or prior dominance of) *Eucalyptus albens, Eucalyptus melliodora*, and *Eucalyptus blakelyi*. The tree cover is generally discontinuous and consists of widely-spaced trees in which canopies are generally separated.	Both HN527 and HN557 possess a diverse understorey layer of tussock grasses, herbs, and shrubs including *Bothriochloa macra, Rytidosperma racemosum, Anthosachne scabra, Sida corrugata, Chrysocephalum apiculatum*, and *Wahlenbergia communis*. The canopy is dominated by *Eucalyptus albens-moluccana* intergrade, and *Eucalyptus melliodora*. The PCTs structurally exist as a grassy woodland where the tree canopies are generally discontinuous and widely-spaced.
Associated and occasionally co-dominant species include, but not limited to: *Eucalyptus microcarpa, Eucalyptus conica, Eucalyptus bridgesiana, Eucalyptus polyanthemos, Eucalyptus macrorhyncha, Callitris glaucophylla, Callitris endlicheri, Eucalyptus goniocalyx, Eucalyptus caliginosa, Eucalyptus mannifera, Eucalyptus rubida, Eucalyptus cinerea, Brachychiton populneus*, and *Allocasuarina verticillata*.	The following associated species were recorded within the PCTs: *Eucalyptus bridgesiana, Callitris endlicheri, Brachychiton populneus, and Allocasuarina verticillata.* The following species listed on the EPBC Box-Gum Woodland species list were also recorded within the PCTs: *Angophora floribunda, Allocasuarina littoralis, Eucalyptus moluccana, Eucalyptus sideroxylon.*
The CEEC occurs in areas where rainfall is between 400 millimetres and 1,200 millimetres per annum, and on moderate to highly fertile soils at altitudes between 170 metres and 1,200 metres.	The PCTs receive approximately 900 millimetres of rain per annum (NPWS 2003). The elevation of the study area is between 116 metres and 190 metres asl.
Shrub cover within Box-Gum Woodland is naturally patchy and shrubs may be dominant within a localised area. Patches within a significant layer of tussock grasses and where shrubs are sparse to patchy, is part of the CEEC. Patches with a continuous shrub layer which is has a cover greater than 30 percent, is considered to be shrubby woodland not part of the CEEC.	Shrub cover is generally low across both HN527 and HN557, with the much of PCT dominated by tussock grasses. Localised patches of shrub layer are present, especially, within HN557. It should be noted that shrub cover has not been quantified across the study area in line with the recommended 0.1 hectare minimum measure.
Box-Gum Woodland CEEC occurs in an arc along the western slopes and tablelands of the Great Diving Range from southern Queensland, though NSW, to Central Victoria. It occurs in the Brigalow Belt South, Nandewar, New England Tableland, South Eastern Queensland, Sydney Basin, NSW North Coast, South Eastern Highlands, South East Corner, NSW South Western Slopes, Victorian Midlands and Riverina Bioregions.	HN527 and HN557 occur within Sydney Basin and South Eastern Highlands Bioregions.
Patches of vegetation where both an overstorey and understorey are present are considered to be part of the CEEC where: ▪ It possesses a predominantly native understorey.	The understorey within HN527_Moderate/Good is predominantly dominated by tussock grasses such as *Bothriochloa macra, Rytidosperma racemosum, Anthosachne scabra*, and *Themeda tridandra*, as well as variety of native herbs, forbs, ferns, and graminoids. It contains over 70 native non-grass species, including 28 important species such as *Cheilanthes distans, Themeda triandra*,

Key diagnostic characteristics for Box-Gum Woodland (EPBC act) as per 1.5.1 of approved conservation advice (including listing advice)	Discussion of key diagnostic characteristics present in HN527 and HN557 within the study area
▪ Contains at least 12 native non-grass species (forbs, shrubs, ferns, sedges). ▪ Contain at least one 'important species' within the understorey. ▪ Be of at least two hectares in size. ▪ Possesses either natural regeneration of overstorey species or at least 20 mature trees per hectare.	and *Arthropodium milleflorum*. The patches of HN527 area over two hectares in size and contain natural regeneration of overstorey species or at least 20 mature trees per hectare. The understorey within HN557_Moderate/Good is predominantly dominated by tussock grasses such as *Austrostipa ramosissima, Rytidosperma racemosum* and *Microlaena stipoides*, however the shrub layer is much more abundance in this PCT. It possesses over 10 native non-grass species, including 28 important species such as *Brachyscome aculeata*, *Themeda triandra*, and *Calotis lappulacea*. The patches of HN527 area over two hectares in size and contain natural regeneration of overstorey species or at least 20 mature trees per hectare.
Patches of vegetation where the overstorey is absent are considered to be part of the CEEC where: ▪ It possesses a predominantly native understorey. ▪ Contains at least 12 native non-grass species (forbs, shrubs, ferns, sedges). ▪ Contain at least one 'important species' within the understorey. ▪ Be of at least 0.1 hectares in size.	The understorey within HN527_Moderate/Good_DNG *Bothriochloa macra, Rytidosperma racemosum, Anthosachne scabra*, and *Themeda tridandra*, as well as variety of native herbs, forbs, ferns, and graminoids. It contains over 70 native non-grass species, including 12 important species such as *Cheilanthes distans, Themeda triandra*, and *Arthropodium milleflorum*. The patches of HN527 area over 0.1 hectares in size.

The extent of HN527 and HN527 mapped by the current study has been found to conform to Box-Gum Woodland due to species abundance, cover and richness of characteristic species listed in the Conservation Advice for Box-Gum Woodland and associated lists, along with condition thresholds class thresholds being met. It should be noted that shrub cover has not been quantified across the study area in line with the recommended 0.1 hectare-minimum measure. As such, there may be areas within PCT527 where the cover of shrubs is greater 30 percent. As such, it has been assumed that all occurrences of this PCT within the study area conform to the EPBC listing of Box-Gum Woodland.

4.4.2.2 Western Sydney Dry Rainforest in the Sydney Basin Bioregion

The vegetation within the study area was compared against the assemblage of species, area of occupancy, and supplementary descriptors outlined within the NSW Scientific Committee's Scientific Final Determination under the BC Act for each of the BC Act TECs listed above. In addition, the vegetation within the study area was compared against the listing advice and/or conservation advice for each TEC under the EPBC Act, especially in relation to relevant size and condition thresholds pertinent to EPBC Act listings.

Note that acronyms for each threatened community in this section relate only to the particular legislation for it discussed within the subsection.

Western Sydney Dry Rainforest in the Sydney Basin Bioregion under the BC Act

Under the BC Act, an ecological community is defined as an assemblage of species occupying a particular area.

The NSW Scientific Committee Final Determination (NSW Scientific Committee, 2011c) lists characteristic species of this assemblage. The Final Determination also includes plant species that may be part of the assemblage but are atypical of its broader distribution, particularly on the margins of the community's distribution.

Six 20-metre x 20-metre plots were carried out within HN538 within the study area. Within HN538, 54 species listed as characteristic species of Western Sydney Dry Rainforest as per the NSW Scientific Committee's Final Determination were recorded within these six plots. This represents 33 percent of the 159 species described as characteristic species within the Final Determination.

Structurally, the extent of HN538 is generally a rainforest with a closed canopy of *Backhousia myrtifolia*, with *Melaleuca stypheloides* dominant or co-dominant in some areas. The mid-storey is generally open, while the understorey is variable in density. Often, emergent Eucalypts are present.

The Final Determination notes that Western Sydney Dry Rainforest occurs within the Sydney Basin Bioregion, which is the 'particular area' as per section 1.6 of the BC Act. The study area falls within the Sydney Basin and South Eastern Highlands Bioregions. The Final Determination also states that the EEC has been recorded within Camden, Fairfield, Wollondilly, Hawkesbury, and Baulkham Hills LGA. The study area occurs within Wollondilly, Blue Mountains, and Wingecarribee LGA.

eSPADE v2.0 (https://www.environment.nsw.gov.au/eSpade2WebApp, accessed 31/08/2019) maps a number of soil landscapes within the study area. As discussed in Section 3.1.1, there is no soil landscape mapping south of Lacys Bay and Brimstone Bay, down the Wollondilly River arm of Lake Burragorang. The soil landscapes within the study area consists of a mixture of sandstone derived colluvial landscapes, or soils derived from eroded metasediments, granite, or siltstones. Section 3.1.1 details the soil landscapes within the study area.

The Final Determination notes that Western Sydney Dry Rainforest's distribution is strongly correlated with soils derived from Wianamatta Shale on the Cumberland Plain. There are no soil landscapes derived from Wianamatta Shale occurring within the study area. Wianamatta Shale is strongly associated with the Cumberland Plain, although small areas of Wianamatta Shale overlay Hawkesbury Sandstone on the ridgetops in the Blue Mountains. Given the known distribution of Wianamatta Shale and topography of the study area, it is unlikely that Wianamatta Shale occurs within the study area.

As per the definition of an ecological community in section 1.6 of the BC Act, this report finds the extent of HN538 mapped in the study area conforms floristically to the assemblage of species outlined in the Final Determination for Western Sydney Dry Rainforest, and that extent is within the Sydney Basin Bioregion. However, the PCT onsite does not occur on Wianamatta Shale. As such, the PCT does not meet the Final Determination for the Western Sydney Dry Rainforest and the EEC does not occur within the study area.

Western Sydney Dry Rainforest and Moist Woodland on Shale under the EPBC Act

Attachment A of the SEARs considers that Western Sydney Dry Rainforest and Moist Woodland on Shale under the EPBC Act as listed under the EPBC Act may be impacted by the Project within the downstream operational area only.

The Approved Listing Advice for Western Sydney Dry Rainforest and Moist Woodland on Shale listed under the EPBC Act identifies key diagnostic characteristics, and how these relate to HN538 on site are detailed in Table 4-7 below.

Table 4-7. Key diagnostic characteristics of Western Sydney Dry Rainforest and Moist Woodland on Shale (EPBC Act)

Key diagnostic characteristics for Western Sydney Dry Rainforest and Moist Woodland on Shale (EPBC Act) as per 1.5.1 of approved conservation advice (including listing advice)	Discussion of key diagnostic characteristics present in HN538 within the study area
Distribution is in the Sydney Basin Bioregion. Most occurrences are in the Cumberland Sub-region, which covers a geographic area commonly known as the Cumberland Plain, a rain-shadow coastal valley in western Sydney. A few occurrences extend into the southern part of the Yengo Sub-region.	There are occurrences of HN538 within the Sydney Basin Bioregion, as well as within the South Eastern Highlands Bioregion. The study area falls within Burragorang, Wollemi, Kanangra, and Bungonia IBRA subregions.
Occurrences are typically on clay soils derived from Wianamatta Group shale geology.	There are no soil landscapes derived from Wianamatta Shale occurring within the study area. Wianamatta Shale is strongly associated with the Cumberland Plain, although small areas of Wianamatta Shale overlay Hawkesbury Sandstone on the ridgetops in the Blue Mountains. Given the known distribution of Wianamatta Shale and topography of the study area, it is unlikely that Wianamatta Shale occurs within the study area. Table 2 of the EPBC listing advice (SEWPaC 2013), states that that where the PCT occurs on different soils/geology (that is, where pre-Permian rocks underlying those of the Sydney Basin are exposed), it does not meet the determination for the CEEC.
It generally occurs in areas with a mean annual rainfall of 800 to 920 millimetres/year at higher elevations of the Cumberland Plain, up to 300 metres asl.	The PCT occurs within an area where the mean annual rainfall is approximately 900 millimetres and below 300 metres asl. However, the study area does not occur on, or on the margins of, the Cumberland Plain.

Key diagnostic characteristics for Western Sydney Dry Rainforest and Moist Woodland on Shale (EPBC Act) as per 1.5.1 of approved conservation advice (including listing advice)	Discussion of key diagnostic characteristics present in HN538 within the study area
It generally occurs in rugged terrain and other patches may occur on undulating terrain, with dry rainforest patches typically occupying steep lower slopes and gullies, and moist woodland patches typically occupying upper sections of the slope or where partial clearance or fire has disturbed the rainforest vegetation.	HN538 occurs within rugged terrain on steep lower slopes and gullies.
A tree canopy layer is present forming a simple, low closed forest (often with emergents) to a more open woodland, with a small tree layer forming a sub-canopy.	Structurally, the extent of HN538 is generally as rainforest with a closed canopy of *Backhousia myrtifolia*, with *Melaleuca styphelioides* dominant or co-dominant in some areas. Often emergent Eucalypts are present.
A shrub layer is usually present, though variable in density, and has good representation of mesic species.	The mid-storey is generally open but can be variable in density. Mesic species such as *Pittosporum revolutum*, *Melicytus dentatus*, and *Notelaea longifolia* are present within the PCT.
The ground layer is variable and generally sparse with a diverse mix of forbs, ferns and shade-tolerant grasses (the latter more typical of the moist woodland form).	The ground later is variable in species richness and density, containing species such as *Adiantum aethiopicum, Pellaea falcata, Dichondra repens, Pseuderanthemum variabile, Microlaena sipoides, Entolasia marginata*, and *Oplismenus* spp.
Vines and scramblers are typically present across the ecological community.	Fifteen species of vines and climbers were recorded across the HN538 including, *Aphanopetalum resinosum, Marsdenia flavescens, Parsonsia straminea, Eustrephus latifolius, Stephania japonica,* and *Cissus antarctica*.
Patches typically contain plant species presented at Appendix A and may contain fauna species presented at Appendix B of the listing advice (SewPAC 2013).	Fifty-four species listed within Appendix A of the listing advice were recorded within HN538 within the current surveys. This represents 33 percent of the 159 species described as characteristic species within the appendix.
The following groups/taxa often present in other rainforest/moist woodland types in New South Wales, are typically absent or uncommon in the ecological community: palms (family Arecaceae), figs (Ficus spp.), *Backhousia myrtifolia* (grey myrtle), vascular epiphytes and mosses	Of the 117 species recorded across the six plots within HN538, there were: ▪ No palm species recorded. ▪ One *Ficus* species (*Ficus cononata*) was recorded within three of the plots. It is relatively common within these plots. ▪ *Backhousia myrtifolia* was recorded within all but one plot, and is the dominant canopy species with a cover of 80 to 90 PFC. ▪ Four species of epiphytes were recorded at very low abundance recorded within the six plots.

The extent of HN538 mapped by the current study has been found not to conform to Western Sydney Dry Rainforest and Moist Woodland on Shale due to:

- the study area occurring outside of the Cumberland and Yengo IBRA subregions
- the soil within the study area is unlikely to contain Wianamatta Shale.

4.4.2.3 River-Flat Eucalypt Forest on Coastal Floodplains

The vegetation within the study area was compared against the assemblage of species, area of occupancy, and supplementary descriptors outlined within the NSW Scientific Committee’s Scientific Final Determination under the BC Act for each of the BC Act TECs listed above. In addition, the vegetation within the study area was compared against the listing advice and/or conservation advice for each TEC under the EPBC Act, especially in relation to relevant size and condition thresholds pertinent to EPBC Act listings.

Note that acronyms for each threatened community in this section relate only to the particular legislation for it discussed within the subsection.

River Flat Eucalypt Forest on Coastal Floodplains under the BC Act

Under the BC Act, an ecological community is defined as an assemblage of species occupying a particular area.

The NSW Scientific Committee Final Determination (NSW Scientific Committee, 2011b) lists characteristic species of this assemblage. The Final Determination also includes plant species that may be part of the assemblage but are atypical of its broader distribution, particularly on the margins of the community's distribution.

Seven 20-metre x 20-metre plots were carried out in HN553 within the study area. Within these three plots, species listed as characteristic species of River Flat Eucalypt Forest on Coastal Floodplains (RFEF) as per the NSW Scientific Committee's Final Determination are outlined in Table 4-8.

Table 4-8. Proportion of RFEF characteristic species within each plot

Plot number	Number of RFEF characteristic species recorded	Total number of species recorded	Percentage of characteristic species in plot
US27	10 species	23 species	43% characteristic species
US28	16 species	31 species	52% characteristic species
US31	13 species	24 species	54% characteristic species
US32	21 species	30 species	70% characteristic species
US34	16 species	28 species	57% characteristic species
US41	19 species	42 species	45% characteristic species
US90	19 species	40 species	47% characteristic species

Across all seven plots carried out within HN553, 37 RFEF characteristic species were recorded. This represents 42 percent of the 88 species described as characteristic within the Final Determination for RFEF. Beyond the number of species found in each plot that are described as characteristic species of RFEF, within the total mapped extent of this PCT visited, the dominant species in terms of abundance, cover and/or biomass are representative of the assemblage detailed in the Final Determination. This includes species such as *Eucalyptus elata* and *Eucalyptus benthamii* which were co-dominant across the community, and consistent with the description of the EEC of the Final Determination.

The characteristic species listed within the Final Determination for RFEF comprises only a subset of the complete list of species recorded within known examples of the EEC as the composition of RFEF is primarily determined by the frequency and duration of waterlogging, as well as the texture, nutrient, and moisture content of the soil (NSW Scientific Committee, 2011b).

Structurally, the extent of HN553 within the study area consists as a tall forest, with all vegetation layers generally present. The canopy is dominated by *Eucalyptus deanei*, *Eucalyptus elata*, and *Eucalyptus benthamii*, while the mid-storey and understorey contains a variety of local indigenous species such as *Melaleuca linariifolia, Acacia floribunda, Pteridium esculentum*, and *Microlaena stipoides*.

The Final Determination notes that RFEF occurs within the, NSW North Coast, Sydney Basin Bioregion, and South East Corner which is the 'particular area' as per section 1.6 of the BC Act. The study area is within the Sydney Basin and South Eastern Highlands Bioregion. Consequently, only patches of HN553 that occur within the Sydney Basin Bioregion meet Final Determination for the TEC.

The Final Determination notes that RFEF is associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The TEC generally occurs below 50 metres asl but is known to occur at elevations of up to 250 metres in some location within its distribution. Within the study area, HN553 occurs on alluvial soils between 116 metres and 160 metres asl, with major occurrences along the Nattai, Little and Kedumba Rivers.

As per the definition of an ecological community in section 1.6 of the BC Act, this report finds the extent of HN553 mapped in the study area conforms floristically to the assemblage of species outlined in the Final Determination for RFEF, however, only the extents that are within the Sydney Basin Bioregion meet the Final Determination with regard to the 'particular area' they occupy.

River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria undet the EPBC Act

This TEC was determined to be critically endangered under the EPBC Act in December 2020. Assessment of this community against the key diagnostic characteristics of the EPBC Act listed community has not been undertaken. It has been assumed that all areas identified as meeting the definition of this TEC under the BC Act would also meet the EPBC Act.

4.4.2.4 Sydney Turpentine-Ironbark Forest (STIF)

The vegetation within the study area was compared against the assemblage of species, area of occupancy, and supplementary descriptors outlined within the NSW Scientific Committee's Final Determination under the BC Act for each of the BC Act TECs listed above. In addition, the vegetation within the study area was compared against the listing advice and/or conservation advice for each TEC under the EPBC Act, especially in relation to relevant size and condition thresholds pertinent to EPBC Act listings.

Note that acronyms for each threatened community in this section relate only to the particular legislation for it discussed within the subsection.

Sydney Turpentine Ironbark Forest under the BC Act

Under the BC Act, an ecological community is defined as an assemblage of species occupying a particular area. The Final Determination (NSW Threatened Species Scientific Committee, 2019) notes that Sydney Turpentine-Ironbark Forest (STIF) occurs within the Sydney Basin Bioregion, which is the 'particular area' as per s 1.6 of the BC Act. The mapped extents of HN606 within study area occur wholly within the Sydney Basin Bioregion.

Two 20-metre x 20-metre plots were carried out in HN606 within the study area. Within these three plots, species listed as characteristic species of STIF as per the NSW Scientific Committee's Final Determination are outlined in Table 4-9.

Table 4-9. Proportion of STIF characteristic species within each plot

Plot number	Number of RFEF characteristic species recorded	Total number of species recorded	Percentage of characteristic species in plot
US14	17 species	33 species	52% characteristic species
US15	13 species	37 species	35% characteristic species

Across all three plots carried out within HN606, 24 STIF characteristic species were recorded. This represents 21 percent of the 112 species described as characteristic within the Final Determination for STIF.

Structurally, the extent of HN606 is generally as intact forest, with all vegetation layers generally present. This is consistent with the description within the Final Determination, although the determination also notes that STIF can also exist as woodland or groups of remnant trees as a result of past disturbance.

The nearest extent of STIF is mapped (OEH 2013) approximately five kilometres to the north east and south west.

eSPADE v2.0 (https://www.environment.nsw.gov.au/eSpade2WebApp, accessed 30/08/2019), maps the areas of HN606 within the study area as occurring on Warragamba soil landscapes. The Warragamba soil landscape is a colluvial landscape, which is derived from Narrabeen Group Sandstone consisting of fine-grained lithic quartz sandstone, occasionally interbedded with this shale lenses. According to the eSPADE soil landscape report, Warragamba soil landscape can support soil materials of loamy sand, clayey sand and pedal clay. It is presumed that the clay component is most likely to be autochthonous to the parent geology here, including the matrix of the sandstone and any shale lenses within the Hawkesbury sandstone, and unlikely derived from Wianamatta Shale.

The Final Determination for STIF states that the EEC typically occurs on low rolling hills characteristic of the Cumberland Plain and on broad shale-capped ridges of the surrounding plateau, within areas of clay soil derived from Wianamatta shale or shale layers within Hawkesbury Sandstone. The topography of the study area, including presence of sandstone steep rock outcropping within HN606 are not consistent with deep Wianamatta Shale soils. While there are extents of the Blacktown soil landscape in the locality, they are separated from HN606 in the study area by the Warragamba River to the south-east and the Nepean River to the north-east.

In considering the definition of STIF in line with the Final Determination, the assessment has found that the extent of HN606 within the study area does not meet the Final Determination for the TEC as the extent of the PCT on study area does not occur shale capped ridges as described within the Final Determination. It is noted that HN606 does possess strong floristic and structural similarities to STIF.

Sydney Turpentine Ironbark Forest under the EPBC Act

The Approved Conservation Advice (including listing advice) for Turpentine-Ironbark Forest in the Sydney Basin Bioregion listed under the EPBC Act identifies key diagnostic characteristics, and how these relate to HN606 on site are detailed in Table 4-10.

It should be noted that the EPBC listing includes the following TEC listed under the BC Act:

- STIF
- Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion.

Table 4-10. Key Diagnostic Characteristics of Turpentine-Ironbark (EPBC Act)

Key diagnostic characteristics for Shale Sandstone Transition Forest of the Sydney Basin Bioregion (EPBC Act) as per approved conservation advice (including listing advice)	Discussion of key diagnostic characteristics present in HN604 of study area
Limited to the Sydney Basin Bioregion (IBRA v7).	The mapped extent of HN606 in the study area is within the Sydney Basin.
Occurs primarily on clay soils derived from Wianamatta shale, including clay lenses of Wianamatta shale within Hawkesbury sandstone. The ecological community less commonly occurs on transitional areas between soils derived from the Wianamatta shale and Hawkesbury sandstone, or on soils derived from Holocene alluvium, or the Mittagong formation.	Occurs Warragamba Soil landscape, derived from Narrabeen Sandstone, and containing soil materials of loamy sand, clayey sand and pedal clay. It is presumed that the clay component is most likely to be autochthonous to the parent geology here, including the matrix of the sandstone and any shale lenses within the Hawkesbury sandstone, and unlikely derived from Wianamatta Shale.
Occurs as forest or woodland, and may have a primarily shrubby or primarily grassy understorey	Occurs as a forest to woodland.
Tree canopy: Turpentine (*Syncarpia glomulifera*) and Ironbarks (*Eucalyptus* spp) are dominant. Turpentine occurs throughout the ecological community, but the associated tree species varies with local abiotic conditions.	*Syncarpia glomulifera* and *Eucalyptus deanei* are dominant within the PCT.
Midstorey: A stratum of small trees may occur, including *Pittosporum undulatum*, *Trema aspera*, and *Acacia parramattensis*. Where present, a shrub layer may include *Polyscias sambucifolia*, *Notelaea longifolia*, *Leucopogon juniperinus*, *Pittosporum revolutum*, *Breynia oblongifolia*, *Maytenus silvestris* and *Ozothamnus diosmifolius*.	*Pittosporum revolutum* and *Trema tomentosa* were recorded within one of the two the plots. *Notelaea longifolia* was also recorded within one plot. The other species listed within the listing description were not recorded.
Ground layer: Where present in its natural state, the ground layer may include *Oplismenus aemulus*, *Pseuderanthemum variabile*, *Echinopogon ovatus Microlaena stipoides* and *Themeda triandra*.	One only species on the key diagnostics list, *Pseuderanthemum variabile,* was recorded within the PCT.

Two 20-metre x 20-metre plots were carried out in HN606 within the study area, with a third plot carried out just outside the study area in the same contiguous polygon of this PCT. Within these three plots, species listed as characteristic species of Turpentine-Ironbark Forest as per the Listing Advice are outlined in Table 4-11.

Table 4-11. Proportion of STIF (EPBC Act) characteristic species within each plot

Plot number	Number of RFEF characteristic species recorded	Total number of species recorded	Percentage of characteristic species in plot
US14	4 species	33 species	12% characteristic species
US15	4 species	37 species	10% characteristic species

It should be noted that the species list contained within both the EPBC listing and conservation advice is brief, and the conformity of the floristics present within HN606 to Turpentine-Ironbark Forest is likely to be greater.

The extent of HN606 occurring within the study area has been found not to conform to Turpentine-Ironbark Forest as the extent of the PCT on study area does not occur shale capped ridges as described within the Listing Advice.

4.4.2.5 Blue Mountains Shale Cap Forest

The vegetation within the study area was compared against the assemblage of species, area of occupancy, and supplementary descriptors outlined within the NSW Scientific Committee's Scientific Final Determination under the BC Act for each of the BC Act TECs listed above. In addition, the vegetation within the study area was compared against the listing advice and/or conservation advice for each TEC under the EPBC Act, especially in relation to relevant size and condition thresholds pertinent to EPBC Act listings.

Note that acronyms for each threatened community in this section relate only to the particular legislation for it discussed within the subsection.

Blue Mountains Shale Cap Forest under the BC Act

Two 20-metre x 20-metre plots were carried out in HN606 within the study area. Within these three plots, species listed as characteristic species of Blue Mountains Shale Cap Forest as per the NSW Scientific Committee's Final Determination (NSW Scientific Committee, 2011a) are outlined in Table 4-12.

Table 4-12. Proportion of Blue Mountains Shale Cap Forest (EPBC Act) characteristic species within each plot

Plot number	Number of RFEF characteristic species recorded	Total number of species recorded	Percentage of characteristic species in plot
US14	18 species	33 species	55% characteristic species
US15	14 species	37 species	37% characteristic species

Across all two plots carried out within HN606, 22 Blue Mountains Shale Cap Forest characteristic species were recorded. This represents 29 percent of the 75 species described as characteristic within the Final Determination for Blue Mountains Shale Cap Forest.

Structurally, the extent of HN606 is generally as intact forest, with all vegetation layers generally present. This is consistent with the description within the Final Determination, although the determination also notes that Blue Mountains Shale Cap Forest can also exist as woodland or groups of remnant trees as a result of past disturbance.

The Final Determination notes that Blue Mountains Shale Cap Forest occurs within the Sydney Basin Bioregion, which is the 'particular area' as per section 1.6 of the BC Act. The mapped extents of HN606 within study area occur wholly within the Sydney Basin Bioregion.

eSPADE v2.0 (https://www.environment.nsw.gov.au/eSpade2WebApp, accessed 30/08/2019), maps the areas of HN606 within the study area as occurring on Warragamba soil landscapes. The Warragamba soil landscape is a colluvial landscape, which is derived from Narrabeen Group Sandstone consisting of fine-grained lithic quartz sandstone, occasionally interbedded with this shale lenses. According to the eSPADE soil landscape report, Warragamba soil landscape can support soil materials of loamy sand, clayey sand and pedal clay. As discussed in Section 4.4.2.4, it is presumed that the clay component is most likely to be autochthonous to the parent geology within HN606, including the matrix of the sandstone and any shale lenses within the Narrabeen sandstone, and unlikely derived from Wianamatta Shale.

The Final Determination for Blue Mountains Shale Cap Forest notes that the EEC is found on deep fertile Wianamatta Shale soils. The soils present within the study area were identified as having both sand and clay components. The topography of the study area, including presence of sandstone steep rock outcropping within HN606 are not consistent with deep Wianamatta Shale soils. While there are extents of the Blacktown soil landscape in the locality, they are separated from HN606 in the study area by the Warragamba River to the south-east and the Nepean River to the north-east.

In considering the definition of Blue Mountains Shale Cap Forest in line with the Final Determination, the assessment has found that the extent of HN606 within the study area does not meet the Final Determination for the TEC as the study area does not possess deep Wianamatta Shale as described within the Final Determination. It is noted that HN606 does possess strong floristic and structural similarities to Blue Mountains Shale Cap Forest.

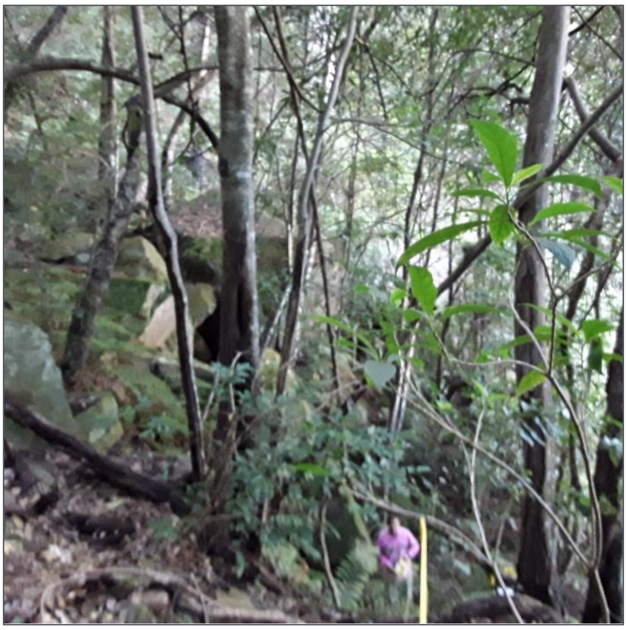
4.4.3 Description of plant community types within the study area

4.4.3.1 HN517: Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion

HN517: Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion was recorded within deeply incised gorges and steep south facing slopes along the west Warragamba Wall. The vegetation community is comprised of a closed canopy dominated by *Acmena smithii, Ceratopetalum apetalum*, and *Doryphora sassafras* although emergent *Eucalyptus deanei* are occasionally present. The mid-storey was generally open, containing species such as *Stenocarpus salignus, Guioa semiglauca*, and *Melicope micrococca* at low densities. Ferns including *Blechnum cartilagineum, Blechnum patersonii, Microsorum scandens,* and *Cyathea australis* occur in isolated pockets within sandstone crevices. In some locations, the community is dominated by climbers such as *Cissus hypoglauca, Gynochthodes jasminoides and Smilax australis*.

Much of this community within the study area was mapped as 'Cleared-Modified' (NPWS, 2003b) despite being generally being relatively undisturbed and weed free. This PCT is broadly equivalent to 'MU1 Sandstone Warm Temperate Rainforest' (NPWS 2003a) and 'RF p114: Sandstone Scarp Warm Temperate Rainforest' (Tozer *et al*. 2010).

Photograph 4-1. Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion Plot US13



Photograph 4-2. Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion Plot US13

4.4.3.2 HN525: Forest Red Gum - Narrow-Leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion

HN525: Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion was recorded on both relatively exposed and sheltered, dry slopes along the Coxs River, Cedar Creek, Kedumba River, Kowmung River, and around the main Lake Burragorang area, primarily north-west of Green Wattle Creek, usually on soils derived from Devonian quartzites.

The community is an open forest showing a variation of species dominance. In more exposed aspects, or where the soil is shallower and rockier, the structure of the community is a low, dry open woodland with a scattered shrub layer and a mixed ground cover dominated mostly by grasses. In areas with more protection, this community may be taller, with a more developed shrub layer and more forbs in the groundcover stratum.

The more exposed extents of this community have a canopy typically dominated by *Eucalyptus crebra*, *Eucalyptus tereticornis* and *Eucalyptus glaucina*, with subdominants being *Eucalyptus punctata*, *Angophora floribunda*, *Eucalyptus melliodora*, *Eucalyptus sparsifolia*, *Eucalyptus eugenioides*, and rarely *Eucalyptus fibrosa* and *Eucalyptus sideroxylon*. A sub-canopy of small trees typically includes species such as *Allocasuarina torulosa*, *Acacia binervia* and *Allocasuarina littoralis*. Shrubs such as *Bursaria longisepala*, *Lissanthe strigosa* and *Exocarpos strictus* typically form a sparse shrub layer. A ground layer of forbs and graminoids commonly includes *Cymbopogon refractus*, *Dianella revoluta*, *Cheilanthes* spp, *Lomandra* spp, *Aristida* spp, *Desmodium varians* and *Rytidosperma* spp.

More protected extents of this community are typically dominated by *Eucalyptus tereticornis*, with minor associates of *Eucalyptus crebra*, *Angophora floribunda*, *Eucalyptus punctata* and *Eucalyptus moluccana*. A small tree layer is often present, dominated by *Brachychiton populneus*, *Backhousia myrtifolia* and *Allocasuarina torulosa*. A moderately dense shrub layer is dominated by *Acacia clunies-rossiae*, *Olearia viscidula*, *Melicytus dentatus*, *Bursaria spinosa*, *Dodonaea viscosa* and *Notelaea longifolia*. In these more protected extents of the community, soft leaved ground covers such as *Dichondra repens*, *Pratia purpurascens*, *Plectranthus parviflorus*, *Adiantum aethiopicum*, *Oplismenus* spp, *Microlaena stipoides* var. *stipoides*, and *Glycine clandestina*. Climbers are relatively abundant and commonly include *Aphanopetalum resinosum*, *Geitonoplesium cymosum*, *Pandorea pandorana*, *Clematis spp* and *Stephania japonica*.

This PCT is almost entirely weed free and occurs within the study area as one condition class (Moderate/Good). This PCT is broadly equivalent to 'MU46 Kanangra Gorge Narrow-leaved Ironbark Woodland' and 'MU28 Kowmung Sheltered Red Gum Forest' (NPWS 2003b) and 'DSF p36: Kowmung - Wollondilly Gorge Woodland' (Tozer *et al*. 2010).

Photograph 4-3. Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion Plot US40

Photograph 4-4. Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion Plot US52

4.4.3.3 HN527: Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion

HN527: Forest Red Gum – Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands was recorded in the south of the study area, south of Higgins Bay along the shores of Lake Burragorang and through the Lower Wollondilly River Valley and Joorilands. This PCT typically occurs on soils derived from fertile Porphyry sediments on undulating foothills as well as on erodible slopes with an abundance of surface rock and rock outcrops.

HN527: Forest Red Gum – Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands meets the Final Determination for White Box Yellow Box Blakey's Red Gum Woodland under the BC Act, and White Box-Yellow Box-Blakey's Red Gum Grassy Woodland and Derived native Grassland under the EPBC Act. A detailed discussion of how the PCT meets the requirements of the TEC under both Acts is provided in Section 4.4.2.1.

HN527 consists of an open grassy eucalypt woodland with a variable understory of shrubs, grasses, forbs and graminoids. In areas where there has been historical agricultural land usage, it occurs as a derived native grassland. On the rolling hills and lowlands, the canopy is dominated by a mosaic of *Eucalyptus tereticornis*, *Eucalyptus glaucina*, *Eucalyptus melliodora*, and *Eucalyptus albens-moluccana* intergrade with occasional *Eucalyptus crebra*, *Eucalyptus punctata*, *Angophora floribunda*, and *Brachychiton populneus*. The shrub layer is almost non-existent within these areas but where present it consists of *Acacia floribunda*, *Acacia implexa*, *Lissanthe strigosa*, *Breynia oblongifolia, Dodonaea viscosa*, *Persoonia linearis*, and *Hibbertia* sp. The ground cover within these areas are a diverse mix of grasses, forbs, and graminoids including *Cymbopogon refractus*, *Aristida* sp., *Bothriochloa macra*, *Austrostipa* sp., *Rytidosperma* sp., *Desmodium* sp., *Lomandra* sp., *Wahlenbergia* sp., *Vittadinia* sp., *Calotis lappulacea*, and *Zornia dyctiocarpa*.

On steeper slopes, the canopy is dominated by *Eucalyptus tereticornis* and *Eucalyptus albens-moluccana* intergrade with *Brachychiton populneus* and *Ficus rubiginosa* occasionally present as a small tree. The understory is much shrubbier within these areas, and consists of *Olearia viscidula*, *Cassinia* sp., *Bursaria spinosa*, and *Breynia oblongifolia*. The ground cover contains similar species to those found in lower lying and less steep areas. In sheltered sites, *Backhousia myrtifolia* and *Melaleuca stypheloides* comprise a significant component of the mid-storey.

An area of old growth vegetation is present within the study area, near the homestead by Joorilands crossing. This area contains an over 20 very large *Eucalyptus albens-moluccana* with DBH of over 1.5 metres.

As a result of past land use practices, exotic weed species are present primarily through the groundcover stratum of this PCT. Exotic species present within the PCT include *Bidens* sp., *Echium plantaginuem*, *Senecio madgascariensis*, *Verbeena* sp., and *Sida rhomifolia*. Notwithstanding, the PCT was found to be in moderate to good condition and consists as two condition classes: Moderate/Good and Moderate/Good_derived native grassland.

This PCT is broadly equivalent to three map units described within NPWS (2003b):

- MU53 Devonian Red Gum-Grey Box Woodland.
- MU51 Devonian Red Gum-Yellow Box Woodland.
- Components of MU52 Devonian Red Gum-Ironbark Woodland.

It is also broadly equivalent to 'DSF p35: Wollondilly-Cox-Shoalhaven Gorge Woodland' (Tozer *et al*. 2010). It should be noted that of the map units above, only Devonian Red Gum-Ironbark Woodland and Devonian Red Gum-Grey Gum Woodland were recorded within the current assessment. Devonian Red Gum-Yellow Box Woodland was mapped by NPWS within areas of the study area not visited by SMEC during the assessment. For the purposes of this assessment is has been assumed that this map unit is present within the areas within which it was mapped.

Photograph 4-5. Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion Plot US55	*Photograph 4-6. Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion Plot US71*
	

4.4.3.4 HN532: Grey Gum - Broad-Leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion

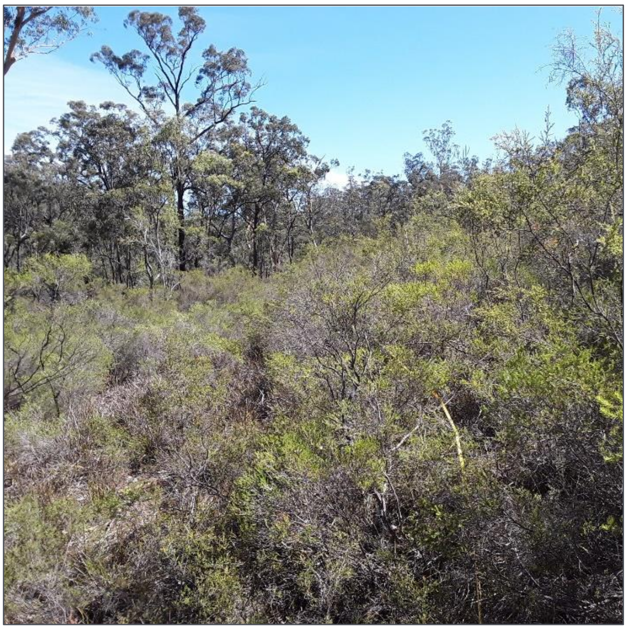
HN532: Grey Gum – Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion occurs extensively throughout study area, primarily occurring on the escarpment slopes surrounding Lake Burragorang, and along the main river tributaries such as the Nattai River, Little River, Green Wattle Creek, and Kedumba River. This community occurs as a dry, open forest or woodland on exposed slopes containing shallow, infertile soils. These soils are predominantly colluvial in nature comprising a mix of eroded Triassic Sandstone material and Permian sediments from the underlying strata. This PCT often occurs adjacent to the other two dominant communities; HN536: Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, and HN557: Narrow-leaved Ironbark – Forest Red Gum on rocky slopes of the Lower Burragorang Gorge, Sydney Basin Bioregion.

Compared to many of the other Eucalyptus-dominated communities in the Warragamba Special Area, this community has a relatively sparse and low canopy. This canopy is dominated by *Eucalyptus fibrosa*, *Eucalyptus punctata* and *Eucalyptus eugenioides*. While not as common as *Eucalyptus fibrosa*, *Eucalyptus crebra* was also recorded occurring in this community. *Allocasuarina littoralis*, *Angophora bakeri* and *Brachychiton populneus* make up a sparse sub-canopy. An open shrub layer occurs in this community, consisting of species such as *Persoonia linearis*, *Notelaea longifolia*, *Bursaria spinosa*, *Bursaria longisepala* and *Leptospermum polygalifolium*. A diverse ground-cover was recorded throughout this community. Component species include *Aristida vagrans*, *Lomandra multiflora* subsp. *multiflora*, *Lomandra glauca*, *Pomax umbellata*, *Gahnia aspera* and *Dianella revoluta*. *Cheilanthes sieberi* and *Glycine clandestina* being the most common fern and vine taxa recorded. The lower recorded fern and vine species richness may have been a result of an extended dry period prior to and during surveys.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'MU48 Escarpment Slopes Dry Ironbark Woodland' within NPWS (2003b) and 'DSF p5: Burragorang Hillslope Forest' within Tozer *et al* (2010).

Photograph 4-7. Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion Plot US25



Photograph 4-8. Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion Plot US84

4.4.3.5 HN533: Grey Gum - Hard Leaved Scribbly Gum woodland of the Cox River Valley

HN533: Grey Gum – Hard Leaved Scribbly Gum woodland of the Cox River Valley was recorded from the edge of Lake Burragorang near the Coxs River, Green Wattle Creek, and from the Kedumba Valley. All locations are exposed and supported low-nutrient skeletal soils.

This community is a low, dry woodland that is not dominated by any one canopy species, rather *Eucalyptus signata*, *Eucalyptus crebra*, *Eucalyptus eugenioides* and *Angophora bakeri* have all been recorded as canopy species. The sub-canopy is sparse with the most common species being *Acacia binervia*. A diverse shrub layer exists comprising species such as *Lissanthe strigosa*, *Grevillea arenaria*, *Persoonia linearis*, *Banksia spinulosa* and the threatened wattle *Acacia clunies-rossiae*. Few fern taxa were recorded occurring in this PCT with *Cheilanthes sieberi* being the most common. A number of climbers and vines were found to occur with species such as *Hardenbergia violacea*, *Glycine clandestina* and *Parsonsia straminea* occurring commonly. Species such as *Xanthorrhoea media*, *Dianella revoluta*, *Cyathochaeta diandra* and *Lomandra obliqua* occurred frequently throughout the understory.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'MU47 Exposed Permian Sandstone Woodland' (NPWS 2003a) and 'DSF p5: Burragorang Hillslope Forest' (Tozer *et al.* 2010).

Photograph 4-9. Grey Gum - Hard Leaved Scribbly Gum woodland of the Coxs River Valley Plot US18

Photograph 4-10. Grey Gum - Hard Leaved Scribbly Gum woodland of the Coxs River Valley Plot US33

4.4.3.6 HN535: Grey Gum - Thin-Leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion

HN535: Grey Gum-Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion was recorded within the north of the study area, along the Coxs River, Kedumba River, and around the edge of Lake Burragorang north from Butcher's Creek.

The community is a tall open forest, characterised by an open shrubby understorey with a ground cover of grasses, forbs and moisture loving herbs. It occurs on rocky, sandy clay loam soils and the sheltered aspect of slopes. The dominant canopy species is *Eucalyptus punctata*, however other species such *as Eucalyptus eugenioides*, *Eucalyptus crebra* and *Eucalyptus tereticornis* also occur. The small tree layer is primarily made up of *Allocasuarina torulosa*. The open shrub layer is generally consistent between locations, comprising *Breynia oblongifolia*, *Indigofera australis*, *Olearia viscidula* and *Bursaria spinosa*. The ground layer consists of *Pratia purpurascens*, *Dichondra repens*, *Echinopogon ovatus* and *Microlaena stipoides*.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'MU21 Kanangra Gorge Sheltered Grey Gum Forest' (NPWS 2003a) and 'DSF p37: Kowmung-Wollondilly Grassy Gorge Forest' (Tozer *et al.* 2010).

Photograph 4-11. Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion Plot US35

Photograph 4-12. Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion Plot US46

4.4.3.7 HN536: Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion

HN536: Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion is another PCT which occurs extensively through the study area, from the Kedumba River in the north to the Nattai and Little rivers in the south and surrounding the edge of Lake Burragorang. The community occurs on the colluvial slopes beneath the escarpment cliffs and walls, on typically infertile soils derived from a mixture of eroded sandstone from the surrounding walls and Permian sediments from the Shoalhaven Group parent geology.

On protected sites and within sheltered aspects, generally immediately beneath the escarpment walls, the PCT is dominated by *Eucalyptus deanei*, with *Syncarpia glomulifera* subsp. *glomulifera*, *Eucalyptus punctata*, *Eucalyptus eugenioides* and *Angophora floribunda* also present at lower densities. The shrubby mid-storey consists of *Allocasuarina torulosa*, *Pittosporum undulatum, Acacia decurrens* and *Melaleuca stypheloides*. The understory predominantly contains ferns, grasses, graminoids, and an abundance of vines and climbers. Species within this stratum include *Pellaea falcata*, *Doodia aspera*, *Adiantum aethiopicum*, *Cissus hypoglauca*, *Stephania japonica*, *Tylophora barbata*, *Marsdenia suaveolens*, and *Gynochthodes jasminoides*.

In less protected and sheltered areas, the PCT is slightly drier and as such *Eucalyptus deanei* occurs less frequently. Within these areas, the canopy is dominated by *Eucalyptus punctata* and *Eucalyptus eugenioides*, with *Eucalyptus tereticornis*, *Syncarpia glomulifera* subsp. *glomulifera*, and *Angophora floribunda* occurring less frequently. The understorey consists of a relatively sparse shrub layer of *Breynia oblongifolia*, *Persoonia linearis*, and *Olearia viscidula*, while the ground cover species consist of *Microlaena stipoides*, *Oplismenus aemulus*, *Dichondra repens*, and *Hibbertia sp*.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'MU13 Sheltered Escarpment Blue Gum Forest' and 'MU14 Escarpment Grey Gum Forest' (NPWS 2003a) and 'DSF p88: Burragorang Escarpment Forest' (Tozer *et al.* 2010).

Photograph 4-13. Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion Plot US95

Photograph 4-14. Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion Plot US21

4.4.3.8 HN537: Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion

HN537: Grey Myrtle – Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion was recorded within one location along Cedar Creek which feeds into the Coxs River. At the time, Cedar Creek contained water and was running through a dry, sheltered gorge.

HN537 occurred as a closed forest with a larger number of species compared to the similar HN538: Grey Myrtle dry rainforest of the Sydney basin Bioregion and South East corner Bioregion. The canopy was comprised of species such as *Acmena smithii*, *Ceratopetalum apetalum* and *Backhousia myrtifolia*. A sub-canopy including *Glochidion ferdinandi* var. *ferdinandi*, *Melaleuca styphelioides* and *Acacia implexa* was also prevalent throughout this community. Due to its location along Cedar Creek a number of riparian species such as *Casuarina cunninghamiana*, *Tristaniopsis laurina* and *Stenocarpus salignus* were recorded. The observed shrub-layer was relatively sparse with the most common species being *Pittosporum undulatum*, *Melicytus dentatus* and *Alectryon subcinereus*. Like most rainforests, a diverse assemblage of climbers and vines was present in this community. Recorded species include *Pandorea pandorana*, *Gynochthodes jasminoides*, *Smilax australis*, *Cissus antarctica* and *Sarcopetalum harveyanum.* A diverse groundcover with an assemblage of species comprising immigrants from the surrounding dry gorge slopes and riparian zone was recorded. Such species include *Dichondra repens*, *Viola sp*., *Pellaea falcata*, *Lomandra longifolia*, *Entolasia marginata* and *Hydrocotyle sp*.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'RF p40: Temperate Dry Rainforest' (Tozer *et al*. 2010). An equivalent vegetation community is not mapped within the NPWS mapping.

Photograph 4-15. Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion Plot US36

Photograph 4-16. Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion Plot US36

4.4.3.9 HN538: Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion

HN538: Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion was the most common rainforest community recorded in the Warragamba Special Area. It was recorded occurring on a variety of different soil types and adjacent to most other communities. Grey myrtle dry rainforest occurred in any form of sheltered terrain where moisture could accumulate, from the steep slopes of the Coxs River Valley to the thin, incised creek lines that ran into the Nattai River. From analysis of The Native Vegetation of the Warragamba Special Area (NPWS, 2003a) and on-the-ground surveys it appears that this community is replaced by other rainforest communities such as PCT 769: Coachwood - Lilly Pilly warm temperature rainforest in moist sandstone gullies, Sydney Basin Bioregion, only when terrain becomes very steep and a semi-permanent water source is present.

This PCT is broadly equivalent to two maps units described by NPWS, ‘MU3 Grey Myrtle Dry Rainforest’ and ‘MU49 Dry Alluvial Paperbark Woodland’. Both of these map units were recorded by SMEC within the survey area during the current survey. Of these, there is better correlation between the descriptions of MU3 and HN538 in terms of species composition and landscape position. MU48 is similar in structure to MU3, especially within narrow gullies, the dominant floristics are substantially different with MU3 being dominated by *Backhousia myrtifolia* and MU48 by *Melaleuca stypheloides*. MU48 has been included as part of this PCT because SMEC was unable to find a PCT which more accurately described the floristics and structure of MU48 mapped vegetation. While HN538 is a ‘best fit’ PCT for the vegetation observed, it does not fit the vegetation description particularly well.

HN538 is broadly equivalent to ‘RF p38 Grey Myrtle Dry Rainforest’ (Tozer *et al.* 2010).

A closed canopy dominated by *Backhousia myrtifolia* and *Melaleuca styphelioides* occurs throughout the community. In some areas the species is dominated by only one of the species, and within some areas there is a mixture of both species. Emergent trees such as *Casuarina cunninghamiana*, *Angophora floribunda* and *Eucalyptus punctata* can occur on the edges of this community. A sparse sub-canopy was recorded that includes species such as *Ficus coronata*, *Pittosporum undulatum* and *Alphitonia excelsa*. A diverse assemblage of ferns was recorded including *Adiantum aethiopicum*, *Pellaea falcata*, *Pyrrosia rupestris*, *Doodia aspera* and *Pteris tremula*. A number of vine species were also recorded; however, this observed assemblage of species did not differ greatly from those found in other wet communities such as PCT 941: Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion. Such species include *Cissus antarctica*, *Cissus hypoglauca*, *Stephania japonica* and *Eustrephus latifolius*.

The shrub and ground-cover layers are sparse due to the intermittent light reaching the forest floor. Recorded shrub species include *Notelaea longifolia*, *Melicytus dentatus* and *Pittosporum revolutum*. Ground-cover species common throughout the special area were also discovered throughout this community such as *Lomandra longifolia*, *Dichondra repens*, *Microleana stipoides*, and *Stellaria flaccida*. Epiphytic species such as *Plectorrhiza tridentata* also occurred in this community. This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

Photograph 4-17. Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion Plot US44

Photograph 4-18. Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion Plot US24

4.4.3.10 HN553: Mountain Blue Gum - Thin-Leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion

HN553: Mountain Blue Gum – Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion was recorded in four areas of the study area; the Kedumba Valley, Nattai River Valley, Little River Valley, and Green Wattle Creek. These locations are within the river's riparian area and as such are supported by sandy alluvial soils. Variation between the three occurrences of this community was recorded, with the greatest difference being the presence of the threatened species *Eucalyptus benthamii* in the Kedumba Valley.

The Mountain Blue Gum – Thin-leaved Stringybark open forest community occurs as a forest that can reach heights greater than 35 metres. The characteristic tall canopy is dominated by *Eucalyptus deanei*, however in the Kedumba Valley *Eucalyptus benthamii* may be the dominant species. Other common canopy species include *Eucalyptus eugenioides*, *Casuarina cunninghamiana* and *Angophora floribunda*. The tall semi-open canopy allows for the development of a shrub-layer that can include species such as *Bursaria spinosa*, *Podocarpus spinulosus*, *Breynia oblongifolia* and *Elaeocarpus reticulatus*. Climbers and vines are common in this community, in some locations even being the dominant component of the ground-layer. Common species include *Cissus hypoglauca*, *Parsonsia straminea*, *Stephania japonica* and *Tylophora barbata*. Other common ground cover species include *Pratia purpurascens*, *Commelina cyanea*, *Microlaena stipoides*, *Entolasia marginata* and *Oplismenus imbecillis*.

This PCT supports low levels of exotic species within areas and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'MU23: Burragorang River Flat Forest' (NPWS 2003a), and 'RF p40: Temperate Dry Rainforest' (Tozer *et al*. 2010).

Photograph 4-19. Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion Plot US41

Photograph 4-20. Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion Plot US27

4.4.3.11 HN564: Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion

HN564 was recorded occurring on both sides of the Warragamba Gorge where it was found on moderately exposed, sloping sandstone terrain. This community was confirmed within the study area as occurring on sandy-clay soils. This PCT is equivalent to 'MU27 Burragorang Sandstone Dry Shrub Forest' (NPWS 2003a) and 'DSF p146: Sydney Hinterland Transition Woodland' within (Tozer *et al*. 2010).

This community is a dry sclerophyll woodland with a shrubby, open understorey. The canopy has been described in the NPWS mapping as consisting of *Eucalyptus punctata, Angophora costata, Syncarpia glomulifera* subsp. *glomulifera* and *Corymbia gummifera*, growing to a mean height of 20 metres. SMEC surveys found these species as occurring within the study area, as well as *Corymbia eximia* and *Eucalyptus pilularis*. The recorded shrub layer was comprised of *Persoonia linearis, Grevillea mucronulata, Acacia linifolia, Dodonaea triquetra, Leptospermum trinervium* and *Banksia spinulosa* var. *spinulosa*. A diverse ground cover occurs throughout the surveyed areas of this community including *Pomax umbellata, Entolasia stricta, Lepidosperma laterale, Xanthorrhoea media, Lomandra longifolia* and *Cyathochaeta diandra*.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

Photograph 4-21. Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion Plot US37

Photograph 4-22. Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion Plot US11

4.4.3.12 HN566: Red Bloodwood - Scribbly Gum heathy woodland on sandstone plateaux of the Sydney basin Bioregion

HN566 occurs on ridgetops and upper valley slopes. The community consists of a low eucalypt forest characterised by a sclerophyll shrub layer and a sparse groundcover of sedges. The composition of the PCT throughout its range may vary between sites depending on the level of exposure, elevation, and parent geology. This PCT is broadly equivalent to 'MU41 Exposed Burragorang Sandstone Shrub Woodland' and 'MU42 Rocky Sandstone Heath Woodland' (NPWS 2003a) and 'DSF p131 Coastal Sandstone Ridgetop Woodland' (Tozer *et al*. 2010).

The extent of this community across the study area includes ridgetops on skeletal soils, primarily within the north and south west of the study area. The canopy within the study area is made up of *Corymbia gummifera, Eucalyptus piperita, Corymbia eximia, Angophora costata,* and *Eucalyptus eugenioides*. The mid-storey consisted of a diverse range of species including *Allocasuarina littoralis*, *Leptospermum trinervium*, *Banksia serrata*, *Banksia spinulosa*, and *Xylomelum pyriforme*. The groundcover extent and diversity within the study area is variable across the area, dependent upon seral stage and fire frequency. The stratum is comprised of a mixture of sclerophyllous shrubs, grasses, forbs, and graminoids including *Xanthorrhoea arborea*, *Xanthosia pilosa*, *Dillwynia retorta*, *Caustis flexuosa*, *Dianella caerulea*, *Entolasia stricta*, and various *Lomandra* species.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

Photograph 4-23. Red Bloodwood - Scribbly Gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion Plot US10

Photograph 4-24. Red Bloodwood - Scribbly Gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion Plot US10

4.4.3.13 HN568: Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion

HN568 has been mapped by SMEC as occurring primarily on the southern side of the Warragamba Gorge within the study area, although small areas were mapped occurring on the northern side of the gorge also. HN568 occurs as an open forest on sandy loams that have accumulated adjacent to sandstone ridges and outcrops. This PCT is broadly equivalent to 'MU25 Blue Mountains Sandstone Dry Shrub Forest' and 'MU26 Nattai Sandstone Dry Shrub Forest' (NPWS 2003a), and 'DSF p144: Wingecarribee-Burragorang Sandstone Forest' (Tozer *et al*. 2010).

Within the study area, the canopy of this community is open and between 15 and 25 metres tall, consisting of species such as *Corymbia gummifera*, *Corymbia eximia*, *Angophora costata* and *Syncarpia glomulifera* subsp. *glomulifera* and stringybark species like *Eucalyptus eugenioides*. The shrub layer contained species such as *Persoonia linearis*, *Banksia spinulosa*, *Boronia ledifolia*, *Lomatia silaifolia* and *Lambertia formosa*. A patchy yet diverse ground cover occurs throughout the community comprising species such as *Lomandra obliqua*, *Lomandra multiflora*, *Xanthorrhoea media*, *Cyathochaeta diandra* and *Patersonia glabrata*.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

Photograph 4-25. Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion Plot US9

4.4.3.14 HN574: River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion

HN574: River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion was recorded bordering major watercourses and creek lines such as the Wollondilly River, Nattai River, Kowmung River and Coxs River. Vegetation grows in alluvial sediments that have settled amongst the boulders and pebbles of these rivers and creeks. The soils in this community are dominated by sands which begin to intergrade with a clay loam as they extend away from the water's edge.

The canopy is dominated by *Casuarina cunninghamiana* subsp. *cunninghamiana* with *Angophora floribunda* occurring less frequently. In areas where this community occurred adjacent to HN533, *Eucalyptus deanei* could also occur infrequently. Of note was the presence of *Grevillea robusta*, a rainforest species native to Northern NSW and Queensland, in a section of River Oak open forest along Sheehys Creek. In this circumstance, the recorded *Grevillea robusta* had most likely naturalised from planted individuals in Western Sydney. A variable sub-canopy was recorded throughout the extent of this community in the study area. In areas adjacent to dry rainforest, *Backhousia myrtifolia* occurred as a sub-canopy species while in areas adjacent to HN533, *Pittosporum undulatum* and *Acacia decurrens* where present. *Melaleuca styphelioides* and *Brachychiton populneus* occurred sporadically in this community.

The species recorded in the lower stories varied across the study area. While the shrub layer was generally sparse, commonly recorded species include *Bursaria spinosa, Melicytus dentatus* and *Phyllanthus gunnii*. Species such as *Breynia oblongifolia*, *Trema aspera* and *Clerodendrum tomentosum* were common in some areas but did not consistently occur in this community across the Special Area. Common native climbers include *Stephania japonica* and *Cissus hypoglauca*, while the exotic climber *Araujia sericifera* was prevalent. The native ground-cover species include *Cheilanthes sieberi, Pellaea falcata, Geranium homeanum* and *Microlaena stipoides* which would often be present in large swathes.

Weed and exotic species where uncommon in this community most likely through the transport of seeds and other plant material through the adjacent watercourses. The most common exotic species were *Bidens pilosa, Sida rhombifolia* and *Tradescantia fluminensis*.

This PCT supports low levels of exotic species within areas and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'MU39: Tablelands River Oak Forest' (NPWS 2003a) and 'FoW p32: Riverbank Forest' (Tozer *et al*. 2010).

Photograph 4-26. River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion Plot US89

Photograph 4-27. River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion Plot US64

4.4.3.15 HN589: Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion

HN589: Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion was recorded in two locations within the study area, along the footslopes of the Tonalli Range between Irish Bay and Lacys Creek, and along the Nattai River close to where the Nattai River joins the Wollondilly River. This PCT occurs on colluvial soils derived from Hawkesbury Sandstone.

Dominant canopy species within this PCT include *Eucalyptus punctata* and *Eucalyptus agglomerata*, with occasional presence of *Eucalyptus piperita*, and a typical canopy height of 25 metres. The sandy soils observed in this community support *Leptospermum polygalifolium* subsp. *polygalifolium, Banksia spinulosa* var. *spinulosa* and *Hakea sericea* throughout the sclerophyll shrub layer. The ground cover commonly consists of *Dianella caerulea, Entolasia stricta, Gonocarpus tetragynus* and *Lomatia silaifolia*.

This PCT is almost entirely weed free and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'MU: Tonalli Escarpment Dry Shrub Forest' (NPWS 2003a), and 'DSF p244: Megalong-Tonalli Sandstone Forest' (Tozer *et al*. 2010).

Photograph 4-28. Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion Plot US97

Photograph 4-29. Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion Plot US53

4.4.3.16 HN606: Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion

HN606: Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion is composed of two communities that were mapped and identified in *The Native Vegetation of the Warragamba Special Area* (NPWS 2003a): MU08 Sandstone Moist Blue Gum Forest and MU09 Sheltered Sandstone Intermediate Blue Gum Forest. This PCT was recorded from within Warragamba Gorge where it occurred on both sides of the gorge walls in relatively sheltered positions. In areas that were more exposed, the PCT community graded into HN564 and HN556. When conditions became wetter and more protected, this community was occasionally found adjacent to HN517.

The community is a tall to very tall (≥50 metres) eucalypt forest with a variable canopy that depends on the protection and aspect each particular site receives. Less exposed sites of this community are characterised by the canopy reaching heights over 50 metres. *Eucalyptus deanei* and *Syncarpia glomulifera* subsp. *glomulifera* are the dominant canopy species under these conditions. As this community occupied more exposed locations two species of *Angophora* were recorded: *Angophora costata* and *Angophora floribunda*. A diverse assemblage of sub-canopy species was recorded by SMEC including, *Allocasuarina torulosa, Pittosporum undulatum, Acmena smithii* and *Glochidion ferdinandi* var. *ferdinandi*.

Due to the dense canopy cover, the ground cover was primarily made up of ferns and vines. Recorded fern species include *Adiantum aethiopicum*, *Blechnum cartilagineum* and *Blechnum parrisiae*. The recorded vine assemblage was highly diverse compared to other communities in the catchment, comprising species such as *Cissus hypoglauca*, *Gynochthodes jasminoides, Eustrephus latifolius, Stephania japonica* and *Smilax australis*.

Areas of this community which were more exposed typically had a less dense canopy but a more divers shrub layer and sub-canopy. Species that would occur in these exposed areas include *Clerodendrum tomentosum, Notelaea longifolia* and *Astrotricha latifolia*.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

Photograph 4-30. Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion Plot US14

Photograph 4-31. Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion Plot US14

4.4.3.17 HN607: Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion

HN607: Water gum – Coachwood riparian scrub along sandstone stream, Sydney Basin Bioregion was recorded in the predominantly dry sections of river bed in the Nattai and Little Rivers. Large sandstone boulders and course alluvial sands are interrupted by sections of river that still contain water and sections of beach marking where the river would flow after times of heavy precipitation. The community that SMEC has surveyed and mapped is different to what has been described in *The Native Vegetation of the Warragamba Special Area* (NPWS, 2003a) as it occurs in flatter, wider and sandier river beds compared to the incised, rocky gullies provided in the aforementioned mapping methodology.

This community occurs as a distinct low scrub or low forest less than five metres tall. Emergent species such as *Casuarina cunninghamiana* subsp. *cunninghamiana* and *Eucalyptus deanei* are rare and reflect the dominant canopy species of the surrounding communities. The canopy is comprised of small trees or tall shrubs such as *Tristaniopsis laurina*, *Melaleuca linariifolia* and *Stenocarpus salignus*. A diverse assemblage of smaller shrubs was observed in the community, composed of species such as *Correa reflexa, Grevillea arenaria, Dodonaea triquetra* and *Persoonia linearis*. The ground-cover only occurs in small sections that are slightly elevated from the river's high-water mark or where small patches of higher nutrient soil have collected. Ground-cover species that were recorded in this community include *Lomandra longifolia*, *Pimelea linifolia*, *Adiantum aethiopicum* and *Oplismenus imbecillis.*

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good).

This PCT is broadly equivalent to 'MU6: Sandstone Riparian Scrub' (NPWS 2003a) and 'FoW p58: Sandstone Riparian Scrub' (Tozer *et al*. 2010).

Photograph 4-32. Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion Plot

Photograph 4-33. Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion Plot US80

4.4.3.18 HN557: Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion

HN557: Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion is a highly variable PCT that was recorded across the study area from the Lower Wollondilly River Valley and along the Nattai and Little River, northwards to the confluence of the Kedumba River and Coxs River. This PCT typically occurs on loamy soils derived from a combination of fertile Porphyry sediments and Permian geology.

HN557: Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion meets the Final Determination for White Box Yellow Box Blakey's Red Gum Woodland under the BC Act, and White Box-Yellow Box-Blakey's Red Gum Grassy Woodland and Derived native Grassland under the EPBC Act. A detailed discussion of how the PCT meets the requirements of the TEC under both Acts is PROVIDED in Section 4.4.2.1.

HN557 consists of an open grassy eucalypt woodland with a variable understory of shrubs, grasses, forbs and graminoids. There are three variants within this PCT which are broadly equivalent to three map units described within the NPWS mapping:

- Components of MU52 Devonian Red Gum-Ironbark Woodland
- MU50 Douglas Scarp Woodland
- MU32 Permian Footslopes Grassy Grey Box Forest.

The most common variant of the PCT is the one which is broadly equivalent to components of MU52 Devonian Red Gum-Ironbark Woodland. This variant mostly occurs around Lake Burragorang, especially towards the mouth of the Wollondilly River. This variant of the community is dominated by *Eucalyptus tereticornis*, *Eucalyptus glaucina*, *Eucalyptus albens-moluccana* intergrade, and occasional *Eucalyptus crebra* and *Eucalyptus melliodora* within the canopy. The mid-storey is often open, containing *Acacia implexa*, *Bursaria spinosa*, and *Exocarpos strictus*. The understorey contains a variety of shrubs, grasses, and forbs including *Astroloma humifusum*, *Lissanthe strigosa*, *Cheilanthes sieberi*, *Cymbopogon refractus*, *Aristida vagans*, and *Wahlenbergia gracilis*.

Another variation of the PCT is common near the mouth of the Wollondilly River, and small patches also occur along the Coxs River. This variant is broadly equivalent to MU50 Douglas Scarp Woodland. This variant is distinctive in the dominance *Eucalyptus crebra* and *Callitris endlicheri* in the canopy, with *Eucalyptus tereticornis*, *Eucalyptus punctata*, and *Eucalyptus moluccana* occurring as minor associates. The mid-storey is dominated by *Acacia binervia*. The understorey consists of *Persoonia linearis*, *Lissanthe strigosa*, *Astroloma humifusum*, *Cheilanthes sieberi*, and *Cymbopogon refractus*.

The third variant of HN557 is broadly equivalent to MU32 Permian Footslopes Grassy Grey Box Forest and is found widely around Lake Burragorang and along within the Nattai River valley. This variant is dominated by *Eucalyptus moluccana*, with *Eucalyptus tereticornis*, *Eucalyptus fibrosa* and *Eucalyptus crebra* occurring occasionally. The mid-storey is open, consisting of *Acacia falcata* and *Exocarpos cupressiformis*, while the understorey contains a variety of shrubs and grasses including *Lissanthe strigosa*, *Bossiaea buxifolia*, *Cymbopogon refractus*, and *Aristida vagans*.

This PCT is almost entirely weed-free and occurs within the study area as one condition class (Moderate/Good). Much of the grassy understory of this PCT had dried off as a result of the lack of rain prior to and during field surveys.

This PCT is broadly equivalent to 'DSF p202: Burragorang Rocky Slopes Woodland' (Tozer *et al*. 2010).

Photograph 4-34. Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion Plot US65

Photograph 4-35. Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion Plot US77

4.5 Vegetation zones

All of the PCTs identified within the study area were assessed as being in Moderate/Good condition in line with the broad condition definitions outlined in the FBA. Seventeen of the 18 PCTs were assessed as being within one broad condition state and consisted of largely homogenous tracts of vegetation. The other PCT consisted of two varying condition classes, and thus split into two vegetation zones. Hence, a total of 19 vegetation zones were identified within the study area. A summary of the vegetation zones within the study area is provided in Table 4-13 and their distribution is shown on a multipage figure in Appendix L of this report. As discussed in Section 4.2.1, vegetation zones were mapped and delineated to the survey area only, not to the boundary of the study area.

Each vegetation zone was assessed using plot and transect surveys to determine the site value score. Plot and transect data collected from the vegetation zones are provided in Appendix A of this report. The calculated site value score for each of the vegetation zones identified within the study area is shown in Table 4-13. All vegetation zones within the study area have a site value score of ≥17 and therefore must be assessed further.

Note that Vegetation Zone 4 and Vegetation Zone 5 fall wholly within the development site, and therefore impacts to these vegetation zones are not assessed within this report.

Table 4-13. Vegetation zones within the survey area

Vegetation zone	PCT Name	Condition*	Site value score	Patch size (ha)
1	HN564: Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good	60.63	1,001+
2	HN566: Red Bloodwood – scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Moderate/Good	77.08	1,001+
3	HN568: Red Bloodwood – Sydney Peppermint – Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion	Moderate/Good	91.06	1,001+
6	HN553: Mountain Blue Gum – Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion	Moderate/Good	68.12	1,001+
7	HN538: Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East corner Bioregion	Moderate/Good	84.44	1,001+
8	HN537: Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion	Moderate/Good	100.00	1,001+
9	HN536: Grey Gum shrubby open forest on gorge slopes of the Blue Mountains Sydney Basin Bioregion	Moderate/Good	86.28	1,001+
10	HN535: Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountain gorges Sydney Basin Bioregion	Moderate/Good	100.00	1,001+
11	HN533: Grey Gum - Hard Leaved Scribbly Gum woodland of the Cox River Valley	Moderate/Good	75.36	1,001+
12	HN532: Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes on the Blue Mountains Sydney Basin Bioregion	Moderate/Good	59.42	1,001+
13	HN527: Forest Red Gum - Yellow Box woodland of dry gorge slopes southern Sydney Basin Bioregion and South Eastern Highlands Bioregion	Moderate/Good	72.22	1,001+
14	HN527: Forest Red Gum – Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion	Moderate/Good_DNG	53.38	1,001+
15	HN525: Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges Sydney Basin Bioregion	Moderate/Good	67.15	1,001+
16	HN517: Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies Sydney Basin Bioregion	Moderate/Good	78.26	1,001+
17	HN557: Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge Sydney Basin Bioregion	Moderate/Good	73.44	1,001+

Vegetation zone	PCT Name	Condition*	Site value score	Patch size (ha)
18	HN607: Water Gum - Coachwood riparian scrub along sandstone streams Sydney Basin Bioregion	Moderate/Good	64.98	1,001+
19	HN606: Turpentine - smooth-barked Apple moist shrubby forest of the lower Blue Mountains Sydney Basin Bioregion	Moderate/Good	85.99	1,001+
20	HN598: Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains Sydney Basin Bioregion	Moderate/Good	83.51	1,001+
21	HN574: River Oak open forest of major streams Sydney Basin Bioregion and South East Corner Bioregion	Moderate/Good	74.64	1,001+

* Condition names reflect options available within the BioBanking Credit Calculator rather than on-ground condition

4.6 Groundwater dependent ecosystems

Ecosystems which depend on groundwater for some or all of their water source/s are classified as Groundwater dependent ecosystems (GDEs).These were initially identified by reviewing the Groundwater Dependent Ecosystem Atlas (BoM 2019) for the study area. Each GDE is classified as having a high, moderate or low potential of interaction with groundwater. Nineteen GDEs were identified within the study area as follows:

- Blue Mountains Heath.
- Burragorang Escarpment Forest.
- Burragorang Hillslope Forest.
- Burragorang River Flat Forest.
- Burragorang Rocky Slopes Woodland.
- Burragorang-Nepean Hinterland Woodland.
- Coastal Sandstone Ridgetop Woodland.
- Grey Myrtle Dry Rainforest.
- Hinterland Sandstone Gully Forest.
- Kowmung Dry Shrub/Herb Forest – *Eucalyptus punctata*.
- Kowmung-Wollondilly Gorge Forest.
- Lower Blue Mountains Wet Forest.
- Megalong-Tonalli Sandstone Forest.
- Riparian Acacia Shrub/Grass/Herb Forest – *Casuarina cunninghamiana*.
- Riverbank Forest.
- Sandstone Riparian Scrub.
- Sandstone Scarp Warm Temperate Rainforest.
- Sydney Hinterland Transition Woodland.
- Wollondilly-Cox-Shoalhaven Gorge Woodland

Geoscience Australia (n.d.) and the Bureau of Meteorology (2020) state that GDEs are 'Natural ecosystems that require access to groundwater to me*et al*l or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services.'

Table 4-14 describes the potential GDEs that can be found within the study area, including the following community attributes:

- vegetation type
  - describes the broad characteristics of the ecological community
- landscape
  - describes the topography of the area, which has an effect on the flow of water (Argent, 2016)
- IBRA Bioregion
  - the IBRA Bioregion the area belongs to
- land use
  - The main land use in the area, which has an effect on ecological processes (DPIE, n.d.)
- groundwater management area
  - The administrative management area to which the GDE belongs
- inflow dependent ecosystem (IDE) likelihood
  - IDEs are ecosystems that are 'likely to be using another source of water in addition to rainfall' (BOM 2020), which includes GDEs. The BOM GDE Atlas uses values from 1 (low) to 10 (high) to represent the likelihood that this GDE is an IDE
- GDE classification
  - this is the likelihood that this particular ecosystem is a GDE, which is determined to either have a low, moderate or high potential.

A figure showing the location of all GDEs identified within the study area is shown on a multipage figure in Appendix L of this report. The impacts to the PCTs that are identified as GDEs within the study area are assessed in Chapter 7.

Table 4-14. Groundwater dependent ecosystems within the study area

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Blue Mountains Heath	Slope	Burragorang	Minimal use	Nepean Sandstone	6	Low potential GDE
Burragorang Escarpment Forest	Low Lying	Bungonia	Minimal use	Nepean Sandstone	10	Moderate potential GDE
		Burragorang	Livestock grazing	Blue Mountains Sandstone	7	Low potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
				Nepean Sandstone	3	Low potential GDE
					5	Moderate potential GDE
					6	Low potential GDE
					7	Low potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
			Minimal use	Coxs River Fractured Rock	6	Low potential GDE
					8	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
				Blue Mountains Sandstone	8	Low potential GDE
						Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Escarpment Forest	Low Lying	Burragorang	Minimal use	Nepean Sandstone	6	Low potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Low potential GDE
						Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
			Other protected areas including Indigenous uses	Nepean Sandstone	8	Moderate potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	8	Moderate potential GDE
					10	Moderate potential GDE
				Blue Mountains Sandstone	7	Low potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
		Wollemi	Livestock grazing	Blue Mountains Sandstone	10	Moderate potential GDE
			Minimal use	Blue Mountains Sandstone	10	Moderate potential GDE
	Plateau	Burragorang	Minimal use	Coxs River Fractured Rock	6	Low potential GDE
					8	Moderate potential GDE
					9	Low potential GDE
						Moderate potential GDE
				Blue Mountains Sandstone	7	Low potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
				Nepean Sandstone	10	Moderate potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	9	Moderate potential GDE
				Blue Mountains Sandstone	8	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Escarpment Forest	Plateau	Kanangra	Minimal use	Nepean Sandstone	8	Moderate potential GDE
	Slope	Burragorang	Livestock grazing	Coxs River Fractured Rock	9	Moderate potential GDE
					10	Moderate potential GDE
				Blue Mountains Sandstone	10	Moderate potential GDE
				Nepean Sandstone	6	Low potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
			Minimal use	Coxs River Fractured Rock	5	Moderate potential GDE
					6	Low potential GDE
					7	Low potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
				Blue Mountains Sandstone	6	Low potential GDE
					7	Low potential GDE
					8	Moderate potential GDE
					9	Low potential GDE
						Moderate potential GDE
					10	Moderate potential GDE
				Nepean Sandstone	5	Low potential GDE
					6	Low potential GDE
					7	Low potential GDE
						Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Escarpment Forest	Slope	Burragorang	Minimal use	Nepean Sandstone	8	Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
			Other protected areas including Indigenous uses	Nepean Sandstone	8	Moderate potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	9	Moderate potential GDE
				Blue Mountains Sandstone	9	Moderate potential GDE
				Nepean Sandstone	6	Low potential GDE
					8	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Hillslope Forest	Low Lying	Burragorang	Livestock grazing	Blue Mountains Sandstone	7	Low potential GDE
					8	Moderate potential GDE
					9	Low potential GDE
						Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
				Nepean Sandstone	6	Low potential GDE
						Moderate potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Hillslope Forest	Low Lying	Burragorang	Minimal use	Coxs River Fractured Rock	8	Moderate potential GDE
					10	Moderate potential GDE
				Blue Mountains Sandstone	5	Low potential GDE
					6	Low potential GDE
						Moderate potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Low potential GDE
						Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
				Nepean Sandstone	3	Low potential GDE
					4	Low potential GDE
						Moderate potential GDE
					5	Low potential GDE
					6	Low potential GDE
						Moderate potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Low potential GDE
						Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Hillslope Forest	Low Lying	Burragorang	Other protected areas including Indigenous uses	Nepean Sandstone	7	Low potential GDE
					8	Moderate potential GDE
					10	Moderate potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	8	Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
		Wollemi	Livestock grazing	Blue Mountains Sandstone	9	Moderate potential GDE
					10	Moderate potential GDE
				Nepean Sandstone	9	Moderate potential GDE
			Minimal use	Blue Mountains Sandstone	10	Low potential GDE
						Moderate potential GDE
	Plateau	Burragorang	Livestock grazing	Blue Mountains Sandstone	10	Low potential GDE
						Moderate potential GDE
			Minimal use	Coxs River Fractured Rock	5	Low potential GDE
				Blue Mountains Sandstone	6	Low potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
				Nepean Sandstone	9	Moderate potential GDE
					10	Moderate potential GDE
		Kanangra	Minimal use	Blue Mountains Sandstone	8	Moderate potential GDE
	Slope	Bungonia	Minimal use	Nepean Sandstone	10	Moderate potential GDE
		Burragorang	Livestock grazing	Coxs River Fractured Rock	9	Moderate potential GDE
				Blue Mountains Sandstone	9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Hillslope Forest	Slope	Burragorang	Livestock grazing	Nepean Sandstone	6	Low potential GDE
						Moderate potential GDE
					7	Low potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
			Minimal use	Coxs River Fractured Rock	9	Moderate potential GDE
					10	Moderate potential GDE
				Goulburn Fractured Rock	10	Moderate potential GDE
				Blue Mountains Sandstone	5	Moderate potential GDE
					6	Low potential GDE
						High potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
				Nepean Sandstone	1	Moderate potential GDE
					6	Low potential GDE
						Moderate potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Low potential GDE
						Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Hillslope Forest	Slope	Burragorang	Other protected areas including Indigenous uses	Nepean Sandstone	8	Low potential GDE
						Moderate potential GDE
		Kanangra	Minimal use	Blue Mountains Sandstone	8	Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
				Nepean Sandstone	10	Low potential GDE
		Wollemi	Livestock grazing	Nepean Sandstone	9	Low potential GDE
						Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang River Flat Forest	Low Lying	Bungonia	Minimal use	Nepean Sandstone	9	High potential GDE
		Burragorang	Livestock grazing	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	7	High potential GDE
					10	High potential GDE
			Minimal use	Blue Mountains Sandstone	6	High potential GDE
					7	High potential GDE
					8	High potential GDE
					10	High potential GDE
				Nepean Sandstone	6	Low potential GDE
						High potential GDE
					7	High potential GDE
					9	High potential GDE
					10	Moderate potential GDE
						High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang River Flat Forest	Low Lying	Kanangra	Minimal use	Coxs River Fractured Rock	8	High potential GDE
					9	High potential GDE
					10	Moderate potential GDE
						High potential GDE
				Blue Mountains Sandstone	9	High potential GDE
				Nepean Sandstone	10	Moderate potential GDE
						High potential GDE
	Plateau	Burragorang	Minimal use	Nepean Sandstone	8	High potential GDE
	Slope	Burragorang	Livestock grazing	Nepean Sandstone	8	High potential GDE
					9	High potential GDE
			Minimal use	Nepean Sandstone	6	High potential GDE
					7	High potential GDE
					8	Moderate potential GDE
						High potential GDE
					9	High potential GDE
					10	High potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	8	Moderate potential GDE
						High potential GDE
					9	High potential GDE
					10	High potential GDE
				Blue Mountains Sandstone	9	High potential GDE
				Nepean Sandstone	8	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang Rocky Slopes Woodland	Low Lying	Burragorang	Livestock grazing	Nepean Sandstone	7	Low potential GDE
					8	Low potential GDE
						Moderate potential GDE
					10	Moderate potential GDE
			Minimal use	Blue Mountains Sandstone	10	Moderate potential GDE
				Nepean Sandstone	6	Low potential GDE
					7	Low potential GDE
					8	Low potential GDE
						Moderate potential GDE
					9	Low potential GDE
						Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
	Plateau	Burragorang	Livestock grazing	Nepean Sandstone	8	Moderate potential GDE
	Slope	Bungonia	Minimal use	Nepean Sandstone	8	Moderate potential GDE
					10	Moderate potential GDE
		Burragorang	Livestock grazing	Nepean Sandstone	8	Low potential GDE
						Moderate potential GDE
			Minimal use	Nepean Sandstone	6	Low potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Moderate potential GDE
					9	Low potential GDE
						Moderate potential GDE
					10	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Burragorang-Nepean Hinterland Woodland	Low Lying	Burragorang	Minimal use	Blue Mountains Sandstone	8	Moderate potential GDE
					10	Moderate potential GDE
	Slope	Burragorang	Minimal use	Blue Mountains Sandstone	7	Low potential GDE
					8	Moderate potential GDE
					10	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Coastal Sandstone Ridgetop Woodland	Low Lying	Burragorang	Livestock grazing	Blue Mountains Sandstone	10	Moderate potential GDE
			Minimal use	Nepean Sandstone	9	Moderate potential GDE
					10	Moderate potential GDE
		Wollemi	Forestry	Blue Mountains Sandstone	10	Moderate potential GDE
			Livestock grazing	Blue Mountains Sandstone	10	Moderate potential GDE
				Nepean Sandstone	6	Low potential GDE
			Minimal use	N/A	9	Moderate potential GDE
					10	Moderate potential GDE
				Blue Mountains Sandstone	10	Moderate potential GDE
				Nepean Sandstone	8	Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
	Plateau	Burragorang	Minimal use	Nepean Sandstone	9	Moderate potential GDE
		Wollemi	Minimal use	Blue Mountains Sandstone	10	Moderate potential GDE
				Nepean Sandstone	9	Moderate potential GDE
					10	Moderate potential GDE
	Slope	Burragorang	Livestock grazing	Nepean Sandstone	10	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Coastal Sandstone Ridgetop Woodland	Slope	Burragorang	Minimal use	Nepean Sandstone	9	Moderate potential GDE
					10	Moderate potential GDE
		Wollemi	Forestry	Nepean Sandstone	9	Moderate potential GDE
			Livestock grazing	Nepean Sandstone	10	Moderate potential GDE
			Minimal use	Blue Mountains Sandstone	10	Moderate potential GDE
				Nepean Sandstone	9	Moderate potential GDE
					10	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Grey Myrtle Dry Rainforest	Low Lying	Bungonia	Minimal use	Goulburn Fractured Rock	9	Low potential GDE
						High potential GDE
					10	Low potential GDE
						High potential GDE
		Burragorang	Livestock grazing	Nepean Sandstone	6	Moderate potential GDE
					8	High potential GDE
			Minimal use	N/A	10	High potential GDE
				Coxs River Fractured Rock	6	Low potential GDE
						Moderate potential GDE
					8	Low potential GDE
						High potential GDE
					10	High potential GDE
				Goulburn Fractured Rock	10	High potential GDE
				Blue Mountains Sandstone	6	Moderate potential GDE
						High potential GDE
					8	High potential GDE
					10	Low potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Grey Myrtle Dry Rainforest	Low Lying					High potential GDE
				Nepean Sandstone	10	High potential GDE
		Kanangra	Minimal use	N/A	8	High potential GDE
					9	High potential GDE
					10	High potential GDE
				Coxs River Fractured Rock	6	Moderate potential GDE
						High potential GDE
					7	Moderate potential GDE
						High potential GDE
					8	Low potential GDE
						High potential GDE
					9	Low potential GDE
						High potential GDE
					10	Low potential GDE
						High potential GDE
				Blue Mountains Sandstone	9	High potential GDE
					10	High potential GDE
	Plateau	Burragorang	Minimal use	Coxs River Fractured Rock	9	High potential GDE
				Blue Mountains Sandstone	8	High potential GDE
					9	High potential GDE
					10	High potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	9	High potential GDE
				Blue Mountains Sandstone	9	High potential GDE
					10	High potential GDE
				Nepean Sandstone	8	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Grey Myrtle Dry Rainforest	Slope	Bungonia	Minimal use	Nepean Sandstone	6	Moderate potential GDE
			Other protected areas including Indigenous uses	Goulburn Fractured Rock	8	High potential GDE
		Burragorang	Livestock grazing	Nepean Sandstone	9	High potential GDE
			Minimal use	Coxs River Fractured Rock	9	Low potential GDE
						High potential GDE
					10	High potential GDE
				Blue Mountains Sandstone	6	Moderate potential GDE
						High potential GDE
					7	Moderate potential GDE
					8	High potential GDE
					9	High potential GDE
					10	High potential GDE
				Nepean Sandstone	6	High potential GDE
					7	Moderate potential GDE
						High potential GDE
					8	High potential GDE
					9	High potential GDE
					10	High potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	8	High potential GDE
					9	High potential GDE
					10	High potential GDE
				Blue Mountains Sandstone	9	High potential GDE
					8	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Hinterland Sandstone Gully Forest	Low Lying	Burragorang	Livestock grazing	Blue Mountains Sandstone	8	High potential GDE
					10	High potential GDE
			Minimal use	Nepean Sandstone	8	High potential GDE
					9	Low potential GDE
						High potential GDE
					10	Low potential GDE
						High potential GDE
		Wollemi	Forestry	Blue Mountains Sandstone	8	Low potential GDE
					9	High potential GDE
					10	Low potential GDE
						High potential GDE
				Nepean Sandstone	9	Low potential GDE
						High potential GDE
					10	High potential GDE
			Livestock grazing	Blue Mountains Sandstone	10	Low potential GDE
						High potential GDE
				Nepean Sandstone	6	High potential GDE
					8	High potential GDE
					10	Low potential GDE
						High potential GDE
			Minimal use	N/A	8	Low potential GDE
						High potential GDE
					9	Low potential GDE
						High potential GDE
					10	Low potential GDE
						High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Hinterland Sandstone Gully Forest	Low Lying	Burragorang		Blue Mountains Sandstone	8	High potential GDE
					9	High potential GDE
					10	Low potential GDE
						High potential GDE
				Nepean Sandstone	7	Moderate potential GDE
					8	Low potential GDE
						High potential GDE
					9	Low potential GDE
						High potential GDE
					10	Low potential GDE
						High potential GDE
	Plateau	Burragorang	Minimal use	Nepean Sandstone	9	High potential GDE
					10	High potential GDE
		Wollemi	Forestry	Nepean Sandstone	10	High potential GDE
			Minimal use	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	9	High potential GDE
					10	High potential GDE
	Slope	Burragorang	Minimal use	Nepean Sandstone	9	Low potential GDE
						High potential GDE
					10	High potential GDE
		Wollemi	Forestry	Nepean Sandstone	2	Low potential GDE
					9	High potential GDE
			Livestock grazing	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	10	High potential GDE
			Minimal use	N/A	10	High potential GDE
				Blue Mountains Sandstone	9	Low potential GDE
						High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Hinterland Sandstone Gully Forest	Slope	Wollemi	Minimal use	Blue Mountains Sandstone	10	Low potential GDE
						High potential GDE
				Nepean Sandstone	9	High potential GDE
					10	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Kowmung Dry Shrub/Herb Forest – E. punctata	Slope	Kanangra	Minimal use	Coxs River Fractured Rock	6	Low potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Kowmung-Wollondilly Gorge Forest	Low Lying	Burragorang	Minimal use	Coxs River Fractured Rock	6	Low potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Low potential GDE
						Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE
				Blue Mountains Sandstone	2	Low potential GDE
					6	Low potential GDE
						Moderate potential GDE
					7	Low potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Kowmung-Wollondilly Gorge Forest	Low Lying	Burragorang	Minimal use	Nepean Sandstone	8	Moderate potential GDE
		Kanangra	Minimal use	N/A	10	Moderate potential GDE
				Coxs River Fractured Rock	5	High potential GDE
					6	High potential GDE
					8	Moderate potential GDE
						High potential GDE
					9	Moderate potential GDE
						High potential GDE
					10	Low potential GDE
						Moderate potential GDE
						High potential GDE
				Blue Mountains Sandstone	9	Moderate potential GDE
					10	Moderate potential GDE
				Nepean Sandstone	10	Low potential GDE
						Moderate potential GDE
	Plateau	Burragorang	Minimal use	Blue Mountains Sandstone	10	Moderate potential GDE
		Kanangra	Minimal use	Blue Mountains Sandstone	10	Moderate potential GDE
	Slope	Burragorang	Minimal use	Coxs River Fractured Rock	7	Low potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
				Blue Mountains Sandstone	8	Moderate potential GDE
				Nepean Sandstone	8	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	8	Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Kowmung-Wollondilly Gorge Forest	Slope	Kanangra	Minimal use	Blue Mountains Sandstone	8	Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
				Nepean Sandstone	8	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Lower Blue Mountains Wet Forest	Low Lying	Wollemi	Livestock grazing	Nepean Sandstone	8	High potential GDE
			Minimal use	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	9	High potential GDE
					10	High potential GDE
	Slope	Wollemi	Livestock grazing	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	10	High potential GDE
			Minimal use	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	10	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Megalong-Tonalli Sandstone Forest	Low Lying	Burragorang	Livestock grazing	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	7	Moderate potential GDE
					9	High potential GDE
			Minimal use	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	6	Moderate potential GDE
					8	High potential GDE
					9	High potential GDE
					10	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Megalong-Tonalli Sandstone Forest	Low Lying	Wollemi	Minimal use	Blue Mountains Sandstone	10	High potential GDE
	Plateau	Burragorang	Livestock grazing	Blue Mountains Sandstone	10	High potential GDE
			Minimal use	Nepean Sandstone	9	High potential GDE
	Slope	Burragorang	Livestock grazing	Blue Mountains Sandstone	9	High potential GDE
					10	High potential GDE
				Nepean Sandstone	9	High potential GDE
			Minimal use	Blue Mountains Sandstone	10	High potential GDE
				Nepean Sandstone	8	High potential GDE
					9	High potential GDE
					10	High potential GDE
		Wollemi	Livestock grazing	Blue Mountains Sandstone	9	High potential GDE
			Minimal use	Blue Mountains Sandstone	9	High potential GDE
					10	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Riparian Acacia Shrub/Grass/Herb Forest – Casuarina cunninghamiana	Low Lying	Kanangra	Minimal use	Coxs River Fractured Rock	6	High potential GDE
					8	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Riverbank Forest	Low Lying	Bungonia	Forestry	Goulburn Fractured Rock	10	High potential GDE
			Minimal use	Goulburn Fractured Rock	7	Low potential GDE
						High potential GDE
					8	Moderate potential GDE
						High potential GDE
					9	Moderate potential GDE
						High potential GDE
					10	Moderate potential GDE
						High potential GDE
				Nepean Sandstone	7	Low potential GDE
					8	High potential GDE
					10	Moderate potential GDE
						High potential GDE
			Other protected areas including Indigenous uses	Goulburn Fractured Rock	9	High potential GDE
					10	Moderate potential GDE
						High potential GDE
		Burragorang	Livestock grazing	Nepean Sandstone	9	High potential GDE
					10	High potential GDE
			Minimal use	Coxs River Fractured Rock	10	Moderate potential GDE
						High potential GDE
				Goulburn Fractured Rock	9	High potential GDE
					10	High potential GDE
				Nepean Sandstone	5	Moderate potential GDE
					6	High potential GDE
					8	Moderate potential GDE
						High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Riverbank Forest	Low Lying	Burragorang			9	High potential GDE
					10	Moderate potential GDE
						High potential GDE
		Kanangra	Minimal use	N/A	9	High potential GDE
					10	High potential GDE
				Coxs River Fractured Rock	5	High potential GDE
					6	High potential GDE
					7	Low potential GDE
					8	Moderate potential GDE
						High potential GDE
					9	Moderate potential GDE
						High potential GDE
					10	Moderate potential GDE
						High potential GDE
	Plateau	Bungonia	Minimal use	Goulburn Fractured Rock	8	High potential GDE
	Slope	Bungonia	Minimal use	Goulburn Fractured Rock	8	Moderate potential GDE
						High potential GDE
					9	Moderate potential GDE
						High potential GDE
					10	Moderate potential GDE
						High potential GDE
				Nepean Sandstone	8	High potential GDE
					9	High potential GDE
					10	High potential GDE
			Other protected areas including Indigenous uses	Goulburn Fractured Rock	8	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Riverbank Forest	Slope	Burragorang	Minimal use	Goulburn Fractured Rock	8	High potential GDE
				Nepean Sandstone	8	High potential GDE
					10	High potential GDE
		Kanangra	Minimal use	Coxs River Fractured Rock	9	Moderate potential GDE
					10	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Sandstone Riparian Scrub	Low Lying	Wollemi	Minimal use	Nepean Sandstone	10	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Sandstone Scarp Warm Temperate Rainforest	Low Lying	Burragorang	Minimal use	Blue Mountains Sandstone	10	High potential GDE
	Slope	Burragorang	Minimal use	Nepean Sandstone	7	Moderate potential GDE
					8	High potential GDE
			Other protected areas including Indigenous uses	Nepean Sandstone	8	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Sydney Hinterland Transition Woodland	Plateau	Burragorang	Minimal use	Nepean Sandstone	10	High potential GDE
	Slope	Wollemi	Forestry	Blue Mountains Sandstone	10	High potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Wollondilly-Cox-Shoalhaven Gorge Woodland	Low Lying	Bungonia	Minimal use	Goulburn Fractured Rock	7	Low potential GDE
						Moderate potential GDE
					8	Low potential GDE
						Moderate potential GDE
					9	Low potential GDE
						Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
				Nepean Sandstone	10	Moderate potential GDE
			Other protected areas including Indigenous uses	Goulburn Fractured Rock	10	Moderate potential GDE
		Burragorang	Livestock grazing	Nepean Sandstone	8	Low potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
			Minimal use	Goulburn Fractured Rock	10	Moderate potential GDE
				Nepean Sandstone	6	Low potential GDE
					7	Low potential GDE
						Moderate potential GDE
					8	Low potential GDE
						Moderate potential GDE
					9	Low potential GDE
						Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Wollondilly-Cox-Shoalhaven Gorge Woodland	Low Lying	Kanangra	Minimal use	Coxs River Fractured Rock	6	High potential GDE
					7	Low potential GDE
						High potential GDE
					8	Moderate potential GDE
						High potential GDE
					9	Low potential GDE
						Moderate potential GDE
						High potential GDE
					10	Moderate potential GDE
						High potential GDE
	Plateau	Bungonia	Minimal use	Goulburn Fractured Rock	8	Moderate potential GDE
					9	Moderate potential GDE
	Slope	Bungonia	Minimal use	Goulburn Fractured Rock	8	Low potential GDE
						Moderate potential GDE
					9	Low potential GDE
						Moderate potential GDE
				Nepean Sandstone	6	Low potential GDE
					8	Moderate potential GDE
					9	Moderate potential GDE
					10	Low potential GDE
						Moderate potential GDE
		Burragorang	Minimal use	Goulburn Fractured Rock	10	Moderate potential GDE
				Nepean Sandstone	8	Low potential GDE
						Moderate potential GDE
					9	Moderate potential GDE
					10	Moderate potential GDE

Vegetation type	Landscape	IBRA Bioregion	Land use	Groundwater Management Area	IDE Likelihood	GDE Classification
Wollondilly-Cox-Shoalhaven Gorge Woodland	Slope	Kanangra	Minimal use	Coxs River Fractured Rock	8	High potential GDE
					9	Moderate potential GDE
						High potential GDE

5 Threatened species and populations

This section discusses the type and occurrence of threatened species and communities that would be potentially impacted by the operation of the Project.

5.1 Review of existing data

The following primary sources of information were consulted as part of a desktop assessment of potentially occurring threatened species and populations within the study area:

- BioBanking Credit Calculator (OEH n.d.a)
- Atlas of NSW Wildlife Database (OEH 2017b)
- Atlas of Living Australia (CSIRO n.d.)
- The Australian Virtual Herbarium (Council of Heads of Australasian Herbaria n.d.)
- Protected Matters Search Tool (DoEE 2015)
- Species Profiles and Threats database (SPRAT) (DoEE n.d.b)
- he Native Vegetation of the Warragamba Special Area VIS_ID 2380 (NPWS 2003a)
- The Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0 (Tozer *et al*. 2010)
- Warragamba Dam Raising Preliminary Ecological Assessment (BMT WBM Pty Ltd, 2016)

Information obtained during the review of existing data was utilised in determining candidate ecosystem credit species and species credit species.

5.2 Ecosystem credit species

5.2.1 Predicted ecosystem credit species

The BBCC generates a list of predicted ecosystem credit species from numerous inputs. Table 5-1 shows the ecosystem credit species have the highest TS offset multiplier in each vegetation zone. The TS multiplier is the inverse of the Tg value. The Tg value is defined within the FBA as the ability of a species to respond to improvement in site value or other habitat improvement at a biobanking site with management actions, and it is based on an assessment of effectiveness of management actions, life history characteristics, naturally rare species, and poorly known species.

Table 5-1. Ecosystem credit species with the highest TS offset multiplier in each vegetation zone

Vegetation zone	Scientific name	Common name	TS offset multiplier
1	*Tyto novaehollandiae*	Masked Owl	3.0
2	*Dasyurus maculatus*	Spotted-tailed Quoll	2.6
3	*Tyto novaehollandiae*	Masked Owl	3.0
6	*Ninox connivens*	Barking Owl	3.0
7	*Tyto tenebricosa*	Sooty Owl	3.0
8	*Ninox strenua*	Powerful Owl	3.0
9	*Ninox connivens*	Barking Owl	3.0
10	*Ninox connivens*	Barking Owl	3.0
11	*Tyto novaehollandiae*	Masked Owl	3.0
12	*Ninox connivens*	Barking Owl	3.0
13	*Tyto novaehollandiae*	Masked Owl	3.0
14	*Ninox connivens*	Barking Owl	3.0
15	*Ninox connivens*	Barking Owl	3.0
16	*Tyto tenebricosa*	Sooty Owl	3.0
17	*Tyto novaehollandiae*	Masked Owl	3.0

Vegetation zone	Scientific name	Common name	TS offset multiplier
18	*Tyto novaehollandiae*	Masked Owl	3.0
19	*Ninox strenua*	Powerful Owl	3.0
20	*Tyto novaehollandiae*	Masked Owl	3.0
21	*Ninox connivens*	Barking Owl	3.0

The ecosystem credit species' applicable to this Project (Table 5-3 and Table 5-4) have been predicted using the BBCC based on the criteria outlined in Table 5-2.

Table 5-2. Criteria used to predict ecosystem credit species within the study area

	IBRA subregion			
	Burragorang	**Bungonia**	**Kanangra**	**Wollemi**
Associated PCTs	HN536; HN525; HN553; HN538; HN532; HN535; HN557; HN566; HN568; HN533; HN517; HN598; HN607; HN527; HN574; HN606; HN537	HN574; HN527; HN538; HN557; HN553	HN574; HN536; HN525; HN535; HN538; HN557; HN532; HN553; HN537	HN568; HN536; HN566; HN532; HN533; HN606; HN517; HN564; HN607
Percent native vegetation in the linear assessment buffer	64%	51%	85%	78%
Condition of vegetation	Moderate to good (all vegetation zones)	Moderate to good (all vegetation zones)	Moderate to good (all vegetation zones)	Moderate to good (all vegetation zones)
Patch size (ha)	1001+	1001+	1001+	1001+
Credit type	Ecosystem	Ecosystem	Ecosystem	Ecosystem

Table 5-3. Predicted ecosystem credit species –Zones 1-11

Scientific name	Common name	TS offset multiplier	IBRA subregion	Zone 1	Zone 2	Zone 3	Zone 4	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11
Callocephalon fimbriatum	Gang-gang Cockatoo	2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Calyptorhynchus lathami	Glossy Black-Cockatoo	1.8	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	-	✓	✓	✓	✓
Chthonicola sagittata	Speckled Warbler	2.6	Burragorang, Bungonia, Kanangra, Wollemi	-	-	-	✓	-	-	-	-	✓	
Circus assimilis	Spotted Harrier	1.4	Burragorang, Wollemi	-	-	-	-	-	-	-	-	-	-
Climacteris picumnus subsp. victoriae	Brown Treecreeper (eastern subspecies)	2	Burragorang, Bungonia, Kanangra, Wollemi	✓	-	✓	-	✓	-	-	✓	✓	✓
Daphoenositta chrysoptera	Varied Sittella	1.3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dasyurus maculatus	Spotted-tailed Quoll	2.6	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Falsistrellus tasmaniensis	Eastern False Pipistrelle	2.2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Glossopsitta pusilla	Little Lorikeet	1.8	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	-	✓	✓	✓	✓
Grantiella picta	Painted Honeyeater	1.3	Bungonia	✓	-	-	✓	✓	-	-	-	-	-
Hieraaetus morphnoides	Little Eagle	1.4	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lathamus discolor	Swift Parrot	1.3	Burragorang, Bungonia, Wollemi	✓	✓	✓	✓	✓	✓	-	✓	✓	✓
Lophoictinia isura	Square-tailed Kite	1.4	Wollemi	✓	✓	✓	✓	✓	-	-	✓	✓	✓
Melanodryas cucullata subsp. cucullata	Hooded Robin	1.7	Burragorang, Bungonia, Wollemi	-	-	✓	-	-	-	-	-	-	-
Melithreptus gularis subsp. gularis	Black-chinned Honeyeater (eastern subspecies)	1.3	Burragorang, Bungonia, Wollemi	✓	-	-	✓	✓	-	-	✓	✓	✓
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	2.2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Neophema pulchella	Turquoise Parrot	1.8	Burragorang, Bungonia, Wollemi	✓	-	✓	✓	✓	-	✓	✓	✓	✓

Scientific name	Common name	TS offset multiplier	IBRA subregion	Zone 1	Zone 2	Zone 3	Zone 4	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11
Ninox connivens	Barking Owl	3	Burragorang, Bungonia, Kanangra, Wollemi	✓	-	✓	✓	✓	-	✓	✓	✓	✓
Ninox strenua	Powerful Owl	3	Burragorang, Bungonia, Kanangra, Wollemi	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Petaurus australis	Yellow-bellied Glider	2.3	Burragorang, Bungonia, Kanangra, Wollemi	-	-	✓	-	✓	-	-	✓	✓	✓
Petroica boodang	Scarlet Robin	1.3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	-	✓	✓	✓
Petroica phoenicea	Flame Robin	1.3	Burragorang, Bungonia, Kanangra, Wollemi	-	-	-	✓	✓	-	-	✓	✓	✓
Pomatostomus temporalis subsp. *temporalis*	Grey-crowned Babbler (eastern subspecies)	1.3	Wollemi	-	-	-	-	-	-	-	-	-	-
Pseudomys novaehollandiae	New Holland Mouse	2.6	Burragorang, Kanangra, Wollemi	✓	✓	✓	✓	-	-	-	-	-	-
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	2.2	Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Scoteanax rueppellii	Greater Broad-nosed Bat	2.2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stagonopleura guttata	Diamond Firetail	1.3	Burragorang, Bungonia, Wollemi	✓	-	✓	-	✓	✓	-	✓	✓	✓
Tyto novaehollandiae	Masked Owl	3	Burragorang, Bungonia, Kanangra, Wollemi	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Tyto tenebricosa	Sooty Owl	3	Burragorang, Kanangra, Wollemi	-	-	✓	✓	✓	✓	✓	✓	✓	-

Table 5-4. Predicted ecosystem credit species –Zones 12-21

Scientific name	Common name	TS offset multiplier	IBRA subregion	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17	Zone 18	Zone 19	Zone 20	Zone 21
Callocephalon fimbriatum	Gang-gang Cockatoo	2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Calyptorhynchus lathami	Glossy Black-Cockatoo	1.8	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
Chthonicola sagittata	Speckled Warbler	2.6	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	-	✓	-	✓	-	-	✓	✓
Circus assimilis	Spotted Harrier	1.4	Burragorang, Wollemi	-	-	✓	-	-	-	-	-	-	✓
Climacteris picumnus subsp. victoriae	Brown Treecreeper (eastern subspecies)	2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	-	✓	-	-	✓	✓
Daphoenositta chrysoptera	Varied Sittella	1.3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dasyurus maculatus	Spotted-tailed Quoll	2.6	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Falsistrellus tasmaniensis	Eastern False Pipistrelle	2.2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Glossopsitta pusilla	Little Lorikeet	1.8	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Grantiella picta	Painted Honeyeater	1.3	Bungonia	✓	✓	✓	✓	-	✓	-	-	-	✓
Hieraaetus morphnoides	Little Eagle	1.4	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lathamus discolor	Swift Parrot	1.3	Burragorang, Bungonia, Wollemi	✓	✓	✓	✓	-	✓	-	✓	-	✓
Lophoictinia isura	Square-tailed Kite	1.4	Wollemi	✓	✓	✓	✓	-	✓	✓	✓	✓	✓
Melanodryas cucullata subsp. cucullata	Hooded Robin (south-eastern form)	1.7	Burragorang, Bungonia, Wollemi	-	✓	✓	✓	-	✓	-	-	-	✓
Melithreptus gularis subsp. gularis	Black-chinned Honeyeater (eastern subspecies)	1.3	Burragorang, Bungonia, Wollemi	✓	✓	✓	✓	-	✓	-	-	✓	✓
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	2.2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Neophema pulchella	Turquoise Parrot	1.8	Burragorang, Bungonia, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Scientific name	Common name	TS offset multiplier	IBRA subregion	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17	Zone 18	Zone 19	Zone 20	Zone 21
Ninox connivens	Barking Owl	3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ninox strenua	Powerful Owl	3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Petaurus australis	Yellow-bellied Glider	2.3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	-	✓	✓	✓	✓	-
Petroica boodang	Scarlet Robin	1.3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	-	✓	✓	✓	✓	✓
Petroica phoenicea	Flame Robin	1.3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	-	✓	-	-	✓	✓
Pomatostomus temporalis subsp. temporalis	Grey-crowned Babbler (eastern subspecies)	1.3	Wollemi	-	-	-	-	-	-	-	-	-	✓
Pseudomys novaehollandiae	New Holland Mouse	2.6	Burragorang, Kanangra, Wollemi	-	-	-	-	-	-	-	-	✓	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	2.2	Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Scoteanax rueppellii	Greater Broad-nosed Bat	2.2	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stagonopleura guttata	Diamond Firetail	1.3	Burragorang, Bungonia, Wollemi	✓	✓	✓	✓	-	✓	-	-	-	✓
Tyto novaehollandiae	Masked Owl	3	Burragorang, Bungonia, Kanangra, Wollemi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tyto tenebricosa	Sooty Owl	3	Burragorang, Kanangra, Wollemi	✓	-	-	✓	✓	-	-	✓	✓	✓

5.3 Species credit species

5.3.1 Candidate species credit species

The BBCC generates a list of candidate species credit species from numerous inputs including classification of the species as a species credit species, the distribution of the species within the same IBRA subregion as the study area and the presence of habitat features or components associated with the species. The habitat features that have been assessed as present within the study area are as follows:

- land within 40 metres of heath, woodland or forest with sandy or friable soils
- land within 250 metres of termite mounds or rock outcrops
- rainforest or tall open wet forest with understory and/or leaf litter and within 100 metres of streams
- swamps, swamp margins or creek edges
- land within 100 metres of emergent aquatic or riparian vegetation
- land containing bark or leaf litter accumulation
- heath or eucalypt forest on sandstone with a build-up of litter or other debris and containing, or within 40 metres of, ephemeral or intermittent drainage lines
- rainforest or tall open wet forest with understory and/or leaf litter and within 100 metres of streams
- land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels
- land within 500 metres of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges and sandstone outcropping
- moist wet forest and rainforest gullies
- land within 100 metres of stream or creek banks
- land within 1 km of rock outcrops or cliff lines
- land below 1,000 metres altitude and within 40 metres of rainforest or eucalypt forest with deep litter.

Species credit species that have been generated by the BBCC as candidate species for this assessment are listed in Table 5-5. This includes 88 flora species or populations and thirty-five fauna species. In addition to these, species credit species have also been included within the list of candidate species if they:

- have been recorded within 10-kilometre radius of the study area on *Atlas of NSW Wildlife* database
- are known or predicted to occur within the IBRA subregions within which the study area is located
- have been confirmed as occurring within the study area as a result of previous surveys.

The list of candidate species was assessed against the criteria outlined in Section 6.5.1.3 of the FBA in order to determine if the species required further assessment. Species were not considered to require further assessment where:

- a habitat assessment has determined that habitat components required by the species as determined by the Threatened Species Profile Database (TSPD) or OEH Threatened Species Profile do not occur, or have been substantially degraded such that the species is unlikely to occur, on the study area
- an expert report has stated that the species is unlikely to occur
- the species is a vagrant species and unlikely to occur within the study area.

In addition, three species, *Callistemon linearifolius, Eucalyptus glaucina* and *Grammitis stenophylla*, not predicted within the BBCC or recorded in the database searches were observed by SMEC in the study area so have been added to the number of Species Credit Species requiring consideration.

Table 5-5. Assessment of potential presence of species credit species

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Flora						
Acacia baueri subsp. *aspera*	*Acacia baueri* subsp. *aspera*	NSW Atlas BBCC (Wollemi)	HN566	N/A	This species occurs in low heathlands, often on exposed rocky outcrops over a wide range of climatic and topographical conditions. Appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development; and many of the observations of this species have been made following fire, suggesting the species prefers early successional habitats. Site contains some suitable habitat present as floristic and structural associations, edaphic and landscape features.	Yes
Acacia bynoeana	Bynoe's Wattle	NSW Atlas SEARs PMST BBCC (Wollemi, Burragorang)	HN564; HN566; HN568; HN604	N/A	Suitable dry sclerophyll habitat, including floristic and structural associations, occurring on sandy soils is present within the study area. Known from only 30 populations the closest of which is in the Blue Mountains near Hazelbrook. This species could occur in the study area.	Yes
Acacia clunies-rossiae	Kanangra Wattle	NSW Atlas BBCC (Burragorang, Kanangra)	HN525; HN527; HN532; HN535; HN536; HN537; HN538; HN557; HN574; HN598	N/A	Recorded by SMEC in the study area.	Yes
Acacia flocktoniae	Flockton Wattle	SEARs BBCC (Wollemi, Burragorang, Kanangra, Bungonia)	HN525; HN527; HN533; HN535; HN536; HN564; HN568; HN598	N/A	Habitat includes dry sclerophyll forest on sandstone which does occur in the study area. The nearest records of this species are west of Lake Burragorang near Yerranderie. The study area contains some suitable habitat present as floristic and structural associations, edaphic and landscape features. This species has the potential to occur in the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Acacia gordonii	*Acacia gordonii*	SEARs BBCC (Wollemi)	HN564; HN566	N/A	Rock platforms habitat within dry sclerophyll forest occurs in the study area. The closest recorded individual is near Springwood. Site contains some suitable habitat present as floristic and structural associations, edaphic and landscape features.	Yes
Acacia pubescens	Downy Wattle	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang)	HN564; HN566; HN568; HN604	N/A	Suitable habitat includes shales, alluviums and the intergrades between shales and sandstone. The closest recorded populations are near Kemps Creek on the Cumberland Plain and near Oakdale. The study area contains some suitable habitat present as floristic and structural associations, edaphic and landscape features.	Yes
Acrophyllum australe	*Acrophyllum australe*	NSW Atlas PMST SEARs BBCC (Wollemi)	HN517; HN566; HN606	Land containing sheltered gullies beneath waterfalls or drip zones of rock overhangs/cliff faces.	Suitable habitat for this species includes sheltered gullied beneath waterfalls and drip zones of rock overhangs and cliff faces, typically where there is a constant source of water. It is generally associated with *Callicoma serratifolia*, *Dracophyllum secundum*, *Todea barbata*, *Alania endlicheri* and *Blechnum ambiguum*. The study area does not contain suitable edaphic or landscape features, or floristic associations for this species.	Yes
Allocasuarina glareicola	*Allocasuarina glareicola*	SEARs PMST	HN564	N/A	The species is found in open woodland, typically growing with *Eucalyptus parramattensis*, *Eucalyptus fibrosa*, *Angophora bakeri*, *Eucalyptus sclerophylla* and *Melaleuca decora* on lateritic soils. The study area does not contain suitable edaphic or landscape features, or floristic associations for this species.	No
Ancistrachne maidenii	*Ancistrachne maidenii*	NSW Atlas SEARs BBCC (Wollemi)	HN564; HN566; HN606	N/A	Species known from St Albans - Mt White - Maroota - Berowra areas on transitional soils, and from a recent record along Erskine Creek near the study area. The study area contains associated PCTs and transitional soils, consistent with suitable habitat for the species.	Yes
Asterolasia buxifolia	*Asterolasia buxifolia*	NSW Atlas BBCC (Burragorang)	HN574	N/A	Known only from a single site associated with granite occurring along the Lett River. Unlikely to occur in the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Asterolasia elegans	*Asterolasia elegans*	SEARs	HN564; HN566; HN606	N/A	Species occurs on Hawkesbury Sandstone in sheltered forests on mid- to lower slopes and valleys, for example, in or adjacent to gullies which support sheltered forest. The canopy at known sites includes *Syncarpia glomulifera* subsp. *glomulifera*), *Angophora costata*, *Eucalyptus piperita*, *Allocasuarina torulosa* and *Ceratopetalum gummiferum*. Ecological knowledge about this species is very limited. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Astrotricha crassifolia	Thick-leaf Star-hair	BBCC (Wollemi)	HN566; HN607	N/A	Suitable habitat in the form of dry sclerophyll forest on sandstone occurs in the study area. The nearest record is from the Royal National Park however other records have been made from parts of the Sydney Basin that have not been cleared. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Baloskion longipes	Dense Cord-rush	PMST BBCC (Burragorang, Kanangra)	HN574	N/A	Small populations have been recorded in the Blue Mountains and Kanangra-Boyd National Parks. Occurs in swamps or depressions supported by a sandy alluvium. Such habitat may occur in the study area however no one was recorded during the recent surveys.	Yes
Boronia deanei	Deane's Boronia	NSW Atlas PMST	N/A	Heath with adjoining swamps or streams	Grows in wet heath, often at the margins of open forest adjoining swamps or along streams. Associated plant community types or edaphics not present within the study area.	No
Bossiaea oligosperma	Few-seeded Bossiaea	NSW Atlas PMST SEARs BBCC (Burragorang, Bungonia)	HN525; HN532; HN574	N/A	Recorded by SMEC in the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Caesia parviflora var. *minor*	Small Pale Grass-lily	BBCC (Wollemi)	HN564; HN566	N/A	Suitable habitat in the form of damp places occurring on sandstone that supports open forest (habitat) occur in the study area. This species could potentially occur in the study area.	Yes
Caladenia tessellata	Thick Lip Spider Orchid	PMST	HN525; HN527; HN532; HN535; HN536; HN553; HN557; HN564; HN566; HN568	N/A	The Thick Lip Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil. While the study area contains PCTs associated with the species, it is not known from any of the IBRA subregions within which the study area occurs.	No
Callistemon linearifolius	*Callistemon linearifolius* -	Recorded on site	N/A	N/A	Recorded on site during the recent SMEC surveys.	Yes
Callistemon megalongensis	Megalong Valley Bottlebrush	PMST SEARs BBCC (Wollemi, Burragorang)	HN533	N/A	Species occurs in shrubby swamp habitat and swamp woodland. Associated species include *Callistemon citrinus*, *Leptospermum morrisonii*, *Leptospermum juniperinum, Leptospermum polygalifolium*, *Leptospermum obovatum*, *Empodisma minus* and *Grevillea asplenifolia*.	Yes
Callistemon purpurascens	*Callistemon purpurascens*	PMST	N/A	N/A	Swampy, moist riparian shrubland, swamp woodland and swamp forest with *Melaleuca linariifolia, Melaleuca styphelioides* and *Eucalyptus camphora*. Suitable swampy habitat is not present within the study area.	No
Calomnion complanatum	*Calomnion complanatum*	BBCC (Wollemi)	HN517	N/A	An easily over-looked species of moss that grows on the trunks of tree-ferns (*Dicksonia* and *Cyathea* species). Has only been recorded in three locations within NSW; Cambewarra Mountain (near Nowra), Rocky Creek Canyon (Newnes Plateau), and two sites at Mount Wilson.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Commersonia prostrata	Dwarf Kerrawang	NSW Atlas PMST	N/A	N/A	Occurs on sandy, sometimes peaty soils in a wide variety of habitats, for example, Snow Gum Woodland and Brittle Gum Low Open Woodland. Appears to respond positively to some forms of disturbance. Associated PCT and edaphics not present within the study area.	No
Cryptostylis hunteriana	Leafless Tongue-orchid	PMST	HN566	N/A	The species has an extensive distribution and poorly defined habitat preferences. Larger populations typically occur in woodland dominated by *Eucalyptus sclerophylla*, *Corymbia gummifera*, *Eucalyptus sieberi*, and *Allocasuarina littoralis*. These vegetation associations occur within the study area.	Yes
Cynanchum elegans	White-flowered Wax Plant	PMST SEARs	HN537; HN538	N/A	The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; *Leptospermum laevigatum – Banksia integrifolia subsp. integrifolia* coastal scrub; *Eucalyptus tereticornis* aligned open forest and woodland; *Corymbia maculata* aligned open forest and woodland; and *Melaleuca armillaris* scrub to open scrub.	Yes
Darwinia biflora	*Darwinia biflora*	SEARs	HN564; HN566	N/A	The species occurs on the edges of weathered shale-capped ridges over Hawkesbury sandstone, and is associated with *Eucalyptus haemastoma*, *Corymbia gummifera*, and *Eucalyptus squamosa.* The species primarily occurs within northern and north-west Sydney, although recent records have been recorded within the lower Blue Mountains The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Darwinia peduncularis	*Darwinia peduncularis*	BBCC (Wollemi)	HN536; HN566; HN607; HN598	N/A	Habitat is comprised of rocky outcrops supporting patches of well-drained sandy soil over sandstone. The nearest record in AVH is approximately 19 km to the west near McMahons Point. The study area contains some suitable habitat present as floristic and structural associations, edaphic and landscape features.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Dillwynia tenuifolia	*Dillwynia tenuifolia*	NSW Atlas SEARs BBCC (Wollemi)	HN564	N/A	Known to be locally abundant within Shale Gravel Transition Forest on laterised clays. The nearest records are from near Glenbrook and Luddenham on the Cumberland Plain. Soil associations include Faulconbridge, Gymea and Hawkesbury soil landscapes. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Diuris aequalis	Buttercup Doubletail	PMST	N/A	N/A	The species favours montane eucalypt forest, open low woodland with a grassy-heathy understory, and secondary grassland on gently sloping gravelly clay-loam. The study area does not contain PCTs, specific species associations, and soil type/edaphics associated with this species.	No
Epacris hamiltonii	*Epacris hamiltonii*	PMST BBCC (Wollemi)	HN517; HN607	Sandstone cliffs and footslopes.	Only known from the Grose Valley in the Blue Mountains. Occurs near sandstone cliffs (Narrabeen formation), along perennial cliffs often below hanging swamps. The study area is not located within the Grose Valley or support creeks located below hanging swamps on Narrabeen sandstone.	Yes
Epacris purpurascens var. *purpurascens*	*Epacris purpurascens* var. *purpurascens*	NSW Atlas SEARs	HN564; HN566; HN604; HN607	N/A	Found in a range of habitat types, most of which have a strong shale soil influence. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Epacris sparsa	Sparse Heath	SEARs BBCC (Wollemi)	HN607	N/A	Grows in riparian sandstone scrub, where it can be found on the base of cliffs or rock faces, on rock ledges or among rocks in the riparian flood zone. Grows in pockets of damp clay soil, chiefly on south-west facing slopes. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Eucalyptus aggregata	Black Gum	PMST	N/A	N/A	Grows in the lowest part of the landscape. Grows on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. Often grows in association with other cold-adapted eucalypts such as Snow Gum (*Eucalyptus pauciflora*), Manna or Ribbon Gum (*Eucalyptus viminalis*), Candlebark (*Eucalyptus rubida*), Black Sallee (*Eucalyptus stellulata*) and Swamp Gum (*Eucalyptus ovata*). The study area does not contain PCTs, specific species associations, and soil type/edaphics associated with this species.	No
Eucalyptus benthamii	Camden White Gum	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang)	HN532; HN553; HN574	Alluvial soils.	Occurs on the alluvial flats of the Kedumba and Nepean Rivers and their tributaries. Requires a combination of deep alluvial sands and a flooding regime that permits seedling establishment. SMEC recorded this species within the study area.	Yes
Eucalyptus copulans	*Eucalyptus copulans*	NSW Atlas PMST	N/A	N/A	Species occurs within once Council reserve along Jamison Creek at Wentworth Falls but through to have been associated with the swampy areas surrounding the creek. The study area does not contain any of the PCTs or soil types associated with this species.	No
Eucalyptus glaucina	Slaty Red Gum	Recorded on site.	N/A	N/A	Recorded by SMEC during surveys.	Yes
Eucalyptus macarthurii	Paddys River Box	NSW Atlas PMST	N/A	N/A	Occurs on grassy woodland on relatively fertile soils on broad cold flats within the Southern Highlands. The study area does not contain any of the PCTs or soil types associated with this species.	No
Eucalyptus pulverulenta	Silver-leafed Gum	BBCC (Wollemi)	HN533	N/A	Known only from two areas; between Lithgow and Bathurst, and the Monaro area between Bredbo and Bombala. Grows in shallow soils as an understory species of open woodlands. Unlikely to occur in the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Euphrasia arguta	*Euphrasia arguta*	PMST	N/A	N/A	Known from a few records from Sydney to Bathurst, most recently from Barrington Tops in 2012. Historic records state the habitat as *'in the open forest country around Bathurst in sub humid places', 'on the grassy country near Bathurst', and 'in meadows near rivers'*. The species is not known or predicted in any of the associated IBRA subregions or PCTs within the study area.	No
Euphrasia bowdeniae	*Euphrasia bowdeniae*	NSW Atlas BBCC (Wollemi)	HN517	Wet or damp cliff tops and rock faces on sandstone cliff lines.	Endemic to the upper Blue Mountains where it is confirmed to damp vertical sandstone rock faces on major south or eastern facing cliff lines. Associated PCTs and damp sandstone rock faces associated with major cliff-lines occur in the study area.	Yes
Genoplesium baueri	Bauer's Midge Orchid	SEARs; BBCC (Burragorang)	HN566	N/A	Occurs in coastal areas. Habitats include heathland, open forest, shrubby forest, heathy forest and woodland with sandy/sandy loam and well-draining soils. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Genoplesium superbum	Superb Midge Orchid	BBCC (Wollemi)	HN533	N/A	Known from two locations near Nerriga, one location north of Wallerawang and another in Morton National Park. Grows in wet heathland on shallow soils above sandstone. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Gentiana wingecarribiensis	Wingecarribee Gentian	SEARs	N/A	Land containing peat bogs and margins on either Sphagnum Moss humps or sedge communities.	Wingecarribee Gentian grows in bogs, in Sphagnum Moss humps and in sedge communities. Suitable habitat does not occur on the study area.	No
Grammitis stenophylla	Narrow-leaf Finger Fern	BBCC (Wollemi)	HN517; HN538; HN606; HN607	N/A	High moisture habitat in which this species occurs, such as streams and rainforest gullies, occurs in the study area. This species has been recorded in the Warragamba Gorge immediately outside the study area during the recent surveys.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Grevillea evansiana	Evans Grevillea	BBCC (Wollemi)	HN566	N/A	This species occurs in dry sclerophyll forest or woodland over Hawkesbury sandstone. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Grevillea juniperina subsp. *juniperina*	Juniper-leaved Grevillea	NSW Atlas	N/A	N/A	Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium (often with shale influence), typically containing lateritic gravels. Recorded from Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest.	No
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	BBCC (Wollemi, Burragorang)	HN564, HN566, HN604	N/A	This taxon was recorded in the study area.	Yes
Gyrostemon thesioides	*Gyrostemon thesioides*	SEARs; BBCC (Burragorang)	HN532; HN535; HN536; HN553; HN557; HN564; HN574; HN604; HN607; HN598	N/A	Grows on hillsides and riverbanks and may be restricted by fine sandy soils. A fire-opportunist, with recruitment occurring from a soil stored seed bank following fire. Associated PCTs occur within the study area.	Yes
Hakea dohertyi	Kowmung Hakea	SEARs; BBCC (Burragorang, Kanangra, Bungonia)	HN525; HN535; HN536; HN557	N/A	Confined to a small area in the Kowmung Valley of the Kanangra Boyd National Park along with smaller populations at Lake Burragorang, Tonalli Cove and the Bindook area. Grows in dry sclerophyll forest, usually dominated by grey gum or silvertop ash, with a sparse groundcover and mid-storey.	Yes
Haloragis exalata subsp. *exalata*	Square Raspwort	SEARs	HN538; HN574; HN607	N/A	Square Raspwort occurs in four widely scattered localities in eastern NSW. It is disjunctly distributed in the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW. Appears to require protected and shaded damp situations in riparian habitats. Whilst the study area contains suitable vegetation associations and habitat preferences, the species is not known or predicted from any of the IBRA subregions impacted by the Project.	No

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Haloragodendron lucasii	Hal	PMST SEARs BBCC (Wollemi)	HN566; HN607	N/A	Suitable habitat (gentle slopes below cliff lines in dry sclerophyll forest) could occur, however the species is only known from the North Shore of Sydney and so the study area is out of the known range.	Yes
Hibbertia puberula	*Hibbertia puberula*	SEARs BBCC (, Burragorang, Wollemi)	HN564; HN566; HN568; HN604	N/A	Suitable dry sclerophyll habitat occurs in the study area. The nearest recorded sightings are from the Penrith/Lapstone area, an area with similar geology and in places topography. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Hibbertia superans	*Hibbertia superans*	SEARs	HN564; HN566	Ridgetops.	Occurs from Baulkham Hills to South Maroota in northern Sydney. Also known from one locality at Mount Boss, just inland of Kempsey. Grows in heath and open woodland occurring on top of ridges. The species distribution does not overlap with the Project area however open woodland associated with ridges was observed.	No
Hygrocybe anomala var. *iathinomarginata*	*Hygrocybe anomala* var. *iathinomarginata*	BBCC (Wollemi, Burragorang, Kanangra)	HN517; HN536; HN566; HN606; HN607; HN598	N/A	The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Hygrocybe aurantipes	*Hygrocybe aurantipes*	BBCC (Wollemi)	HN517; HN536; HN566; HN606; HN598	Gallery warm temperate forests on sandy soils.	The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Hygrocybe reesiae	*Hygrocybe reesiae*	BBCC (Wollemi)	HN517; HN536; HN566; HN606; HN598	Gallery warm temperate forests on sandy soils.	The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Isopogon fletcheri	Fletcher's Drumsticks	BBCC (Wollemi)	HN536	N/A	Distribution is restricted to a small area near Blackheath in the Blue Mountains. Habitat includes moist sheltered cliffs within the spray zone of waterfalls. Associated with dry sclerophyll forests and heaths occurring in these sheltered positions. PCTs, specific species associations, and soil type/edaphics associated with this species occur within small areas of the study area.	Yes
Keraudrenia corollata var. *denticulata* in the Hawkesbury local government area	*Keraudrenia corollata* var. *denticulata* in the Hawkesbury local government area	SEARs	HN538; HN566; HN606	Tall open forest on sandy soils on sandstone banks and edge of floodplains, or Sydney Coastal River-Flat Forest (EEC).	This population is defined as only occurring in the Hawkesbury Council LGA – the Project area does not occur in this LGA. This population by definition cannot occur in the Project area.	No
Kunzea cambagei	Cambage Kunzea	SEARs	N/A	N/A	*Kunzea cambagei* mainly occurs in the western and southern parts of the Blue Mountains, NSW, mainly the Yerranderie/Mt Werong area, with four main populations with 20 to 150 individuals. Populations are also located west of Berrima, along the Wingecarribee River; Loombah Plateau east of Mount Werong; the Oberon-Colong Stock Route within Kanangra-Boyd National Park (NP); and Wanganderry Plateau within the Nattai NP.	No
Kunzea rupestris	*Kunzea rupestris*	SEARs	HN564; HN566	Sandstone rock outcrops.	Occurs in shallow, sandy, low nutrient soil in depressions on sandstone rock platforms. It is typically found in short to tall shrubland or heathland at altitudes of 50–300 metres. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Lastreopsis hispida	Bristly Shield Fern	BBCC (Wollemi)	HN517; HN606; HN607	Moist wet forest and rainforest gullies.	Suitable wet forest and rainforest gully habitat occurs in the study area. A record of this species has been made beneath the Kedumba Walls in the north of the Warragamba Special Area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Leionema lachnaeoides	*Leionema lachnaeoides*	NSW Atlas PMST BBCC (Wollemi, Burragorang)	HN517; HN598	Land within 200 m of sandstone cliffs, pagodas, platforms, shelves and/or terraces.	Occurs on exposed sandstone cliff-tops and terraces between 900–1,000 m in altitude. Known from 10 sites in the upper Blue Mountains between Katoomba and Blackheath.	Yes
Lepidosperma evansianum	Evans Sedge	BBCC (Wollemi)	HN517	Sandstone cliffs, pagodas, ledges, shelves, gullies and/or footslopes.	Known from three locations at Blackheath and Wentworth Falls. Grows on wet sandstone cliff faces. Such habitat is limited in the Project site.	Yes
Leucochrysum albicans var. *tricolor*	*Leucochrysum albicans* var. *tricolor*	PMST	N/A	N/A	Endemic to south -east Australia where it is known from three distinct areas in Tasmania, Victoria, and NSW. Within NSW, the species is known from the Southern Tablelands bounded by Albury, Bega, and Goulburn. The species is not listed under the BC Act.	No
Leucopogon exolasius	Woronora Beard-heath	BBCC (Wollemi, Burragorang)	HN564; HN566; HN568; HN607	N/A	Suitable habitat for the species, woodland on sandstone habitat occurs in the study area. The closest occurrence is within 25 km of the study area, along the northern extent of the Nattai River. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Leucopogon fletcheri subsp. *fletcheri*	*Leucopogon fletcheri* subsp. *fletcheri*	BBCC (Wollemi)	HN564; HN566	N/A	This species occurs in dry eucalypt woodland on clayey lateritic soils on gently sloping terrain along ridges. The closest reliable record of this taxon comes from 20 kilometres to the north at Springwood. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Marsdenia viridiflora subsp. *viridiflora* – endangered population	*Marsdenia viridiflora* subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs	SEARs	HN538	N/A	The study area does not occur in the population's associated LGAs.	No
Melaleuca biconvexa	Biconvex Paperbark	SEARs	N/A	Swamps, swamp margins or creek edges.	Known from the Gosford-Wyong and Jervis Bay areas where it occurs on low-lying areas. Habitat is supported by alluvial soils often associated with coastal floodplains. Habitat was not recorded in the study area nor were any associated PCTs mapped.	No
Melaleuca deanei	Deane's Paperbark	SEARs BBCC (Wollemi)	HN564; HN566	N/A	Ridgetop woodland occurs in the study area; however, this species is predominantly known from the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. Isolated observations have been recorded from the Springwood area. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species. SMEC recorded this species within the Warragamba Special Area but outside the study area.	Yes
Melaleuca groveana	Grove's Paperbark	BBCC (Wollemi)	HN566	N/A	The species grows in heath and shrubland on a variety of substrates including sandstone on rocky outcrops and cliffs. The known southern extent of this species distribution is around the southern edge of the Hunter Valley. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Micromyrtus blakelyi	*Micromyrtus blakelyi*	SEARs	HN564; HN566	N/A	The species is typically associated with heathlands on shallow sandy soils in cracks and depressions of sandstone rock platforms. Its current known extent is restricted to areas north of Sydney, near the Hawkesbury River. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Micromyrtus minutiflora	*Micromyrtus minutiflora*	SEARs	N/A	N/A	The species habitat includes Castlereagh Scribbly Gum Woodland, Ironbark Forest and Shale/Gravel Transition Forest on tertiary alluvium and consolidated river sediments. Vegetation and soil types associated with this species are not present within the study area.	No
Olearia cordata	-	SEARs BBCC (Wollemi)	HN564; HN566	N/A	The species grows on dry open sclerophyll forest habitat on sandstone ridges. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Pelargonium sp. striatellum	Omeo Storks-bill	SEARs	N/A	N/A	The species has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities. Vegetation and soil types associated with this species are not present within the study area.	No
Persicaria elatior	Tall Knotweed	NSW Atlas PMST	-	-	Species grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	Yes
Persoonia acerosa	Needle Geebung	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang)	HN566; HN568	N/A	Dry open forest occurring on low nutrient soil occurs in the study area. The only records within 30 km of the study area are from atop the Blue Mountains escarpment. The escarpment habitat supporting the nearest population does not occur in the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Persoonia bargoensis	Bargo Geebung	PMST BBCC (Burragorang)	HN564; HN566; HN568; HN606; HN607	N/A	Restricted to a small area on the western edge of the Woronora Plateau. Occurs in woodland and open forest supported by heavy, well-drained gravel soils derived from the Wianamatta Shale as well as on sandstone. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Persoonia glaucescens	Mittagong Geebung	NSW Atlas PMST BBCC (Burragorang)	HN564; HN566; HN568	N/A	Distribution extends from Buxton in the north and Berrima in the south. Grows in clay and lateritic soils. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Persoonia hirsuta	Hairy Geebung	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang)	HN564; HN566; HN568; HN604	N/A	This species has a large distribution (though scattered) occurring in dry sclerophyll forests on sandstone. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Persoonia nutans	Nodding Geebung	PMST SEARs	N/A	N/A	Restricted to the Cumberland Plain where it grows on alluvial and aeolian sediments, tertiary alluvium and shale/sandstone transitional soils. This species restricted distribution makes it unlikely to occur in the study area.	No
Pherosphaera fitzgeraldii	Dwarf Mountain Pine	BBCC (Wollemi)	HN517	Land within 40 metres of sandstone cliffs, ledges or footslopes.	All known populations occur between Katoomba and Wentworth Falls. Found within the spray zones and drip lines associated with seepage areas of waterfalls. Small areas of suitable habitat occur within the study area.	Yes
Phyllota humifusa	Dwarf Phyllota	NSW Atlas PMST BBCC (Burragorang)	HN568	Deep sandy soils.	Known from the southern Blue Mountains, specifically the Bimlow Tableland. Dry sclerophyll forest habitat is sported by deep sandy and gravelly soils. This species may occur in riparian areas towards the south of the study area along the Wollondilly, Nattai and Little Rivers.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Pilularia novae-hollandiae	Austral Pillwort	SEARs	N/A	Periodically waterlogged sites (including table drains and farm dams).	Most records have been made from the Albury-Urana area however outlier observations have been made in suburban Sydney. Habitat includes shallow swamps and waterways where it occurs among grasses and sedges.	No
Pimelea curviflora var. *curviflora*	*Pimelea curviflora* var. *curviflora*	PMST SEARs	HN564; HN566; HN604	N/A	The species occurs on shale/sandstone soils on ridgetops and upper slopes within woodland. It has a cryptic habitat and can persist as a tuberous root without foliage for an extended period of time after fire. Confined to the coastal area of the Sydney and Illawarra regions.	Yes
Pimelea spicata	Spiked Rice-flower	PMST SEARs	N/A	N/A	Within both known populations, the species is associated with well-structured clay soils. On Cumberland Plain, the species is associated with Grey Box communities. The study area does not contain the known associated PCTs or soil type.	No
Pomaderris brunnea	Brown Pomaderris	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang)	HN532; HN564; HN574; HN607	N/A	This species was recorded around the edge of Lake Burragorang with the exception of the Warragamba Gorge. The species is associated with moist woodland or forest or clay, and on alluvial soils on floodplains and creek lines. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Pomaderris cotoneaster	Cotoneaster Pomaderris	NSW Atlas PMST	-	N/A	Has been recorded in predominantly forested habitats. In forests it can be found growing in deep, friable soils, amongst rocks beside a creek, on rocky slopes and in steep gullies between sandstone cliffs. Little is known about the ecology or habitat preferences of the species. While the study area occurs within the associated IBRA subregion, no associated PCTs occur within the study area.	No
Pomaderris pallida	Pale Pomaderris	PMST	HN574	N/A	The species typically occurs in shrub communities with *Eucalyptus mannifera, Eucalyptus macrorhyncha*, or *Callitris sp*. While an associated PCT occurs within the study area, the study area does not occur within the IBRA subregions associated with the species.	No

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Prasophyllum fascum	Slaty Leek Orchid	NSW Atlas PMST	HN556; HN564	Moist heath	Species occurs in moist heath along drainage lines. The known population occurs in sandy soils on sandstone. Moist heath habitat constraint was not recorded in the study area.	No
Pterostylis chaetophora	*Pterostylis chaetophora*	NSW Atlas	-	-	The preferred habitat is seasonally moist, dry sclerophyll forest with a grass and shrub understory. Plants are deciduous and die back to the large, underground tubers after seed release. The study area does occur within the associated IBRA subregions, or associated PCTs.	No
Pterostylis saxicola	Sydney Plains Greenhood	NSW Atlas PMST SEARs	HN535; HN564; HN566	Typically, in shallow/skeletal soils on rock shelves and platforms.	The species is described as occurring within sclerophyll forest or woodland on a variety of soil types. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Pultenaea elusa	Elusive Bush-pea	SEARs	N/A	N/A	This species has been recorded twice in 1938 as occurring in swamp. The study area does not contain the known associated PCTs or soil type.	No
Pultenaea glabra	Smooth Bush-pea	NSW Atlas PMST SEARs BBCC (Burragorang, Wollemi)	HN566; HN568	N/A	Suitable riparian sandstone habitat occurs in the study area. The nearest records have been made in the higher Blue Mountains in the Katoomba-Hazelbrook areas. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Pultenaea parviflora	*Pultenaea parviflora*	NSW Atlas PMST SEARs	HN566	N/A	Species is endemic to the Cumberland Plain occurring in Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. Associated species include, *Eucalyptus fibrosa*, *Eucalyptus globoidea*, *Eucalyptus longifolia*, *Eucalyptus parramattensis*, *Eucalyptus sclerophylla*. *Eucalyptus sideroxylon* may also be present or co-dominant, with *Melaleuca decora* frequently forming a secondary canopy layer.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Pultenaea sp. Olinda	*Pultenaea sp. Olinda*	BBCC (Wollemi)	HN566; HN598	N/A	Has only been recorded in a limited area of pagoda rock formation east of Rylstone. These records were taken over 50 km from the study area. The study area contains PCTs associated with the species.	Yes
Pultenaea villifera – endangered population	*Pultenaea villifera* population in the Blue Mountains Local Government Area	BBCC (Wollemi)	HN564; HN566	N/A	This population is located specifically in the Blue Mountains and Hawkesbury LGAs. A small proportion of the study area occurs within Blue Mountains LGA. The study area contains PCTs associated with the species.	Yes
Rhizanthella slateri	Eastern Australian Underground Orchid	PMST SEARs BBCC (Wollemi)	HN517; HN606; HN607	N/A	The habitat requirements of this species area poorly understood making the occurrence of this species in the study area possible. The study area contains PCTs associated with the species.	Yes
Rhodamnia rubescens	Scrub Turpentine	NSW Atlas	HN517 HN537 HN538 HN606	N/A	Shrub or small tree that occurs within littoral, warm temperate, and subtropical rainforest, and wet sclerophyll forest. The study area contains PCTs associated with the species.	Yes
Seringia denticulata – endangered population	*Seringia denticulata* in the Hawkesbury local government area	SEARs	-	-	Endangered population restricted to Hawkesbury LGA. The study area does not occur within Hawkesbury LGA	No
Solanum armourense	*Solanum armourense*	NSW Atlas SEARs BBCC (Burragorang, Kanangra, Bungonia)	HN525; HN527; HN532; HN535; HN536; HN538; HN557; HN568	N/A	Recorded in the study area during the recent SMEC surveys.	Yes
Syzygium paniculatum	Magenta Lilly Pilly	PMST	-	-	Generally recorded rainforest close to the coast, however the distribution and ecology of the species is not well understood. The study area does not contain PCTs associated with this species.	No

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Tetratheca glandulosa	*Tetratheca glandulosa*	NSW Atlas SEARs BBCC (Wollemi, Burragorang)	HN517; HN564; HN566; HN568; HN604; HN606; HN607; HN598	N/A	Shale-sandstone transition habitat occurs in the study area as do associated species such as *Corymbia gummifera, Corymbia eximia* and *Eucalyptus punctata*. This species has the potential to occur in the study area.	Yes
Tetratheca juncea	Black-eyed Susan	SEARs	N/A	N/A	The species occurs in low open forest or woodland on the Awaba soil landscape. The study area does not contain the known associated PCTs or soil type.	No
Thelymitra kangaloonica	Kangaloon Sun Orchid	PMST	-	-	Known from three swamps above Kangaloon aquifer. The study area does not contain PCTs associated with this species.	No
Thesium australe	Austral Toadflax	SEARs	N/A	N/A	Grows in grasslands on coastal headlands, or on grassland and grassy woodland away from the coast. It often grows with *Themeda triandra.* The study area does not contain the known associated PCTs.	No
Trachymene scapigera	Mountain Trachymene	BBCC (Kanangra)	HN553; HN557; HN574	Riparian zones.	Known from Kanangra-Boyd National Park. Occurs in a variety of habitats from riparian zones to frost hollows and open woodlands. The study area contains associated PCTs and microhabitats.	Yes
Velleia perfoliata	*Velleia perfoliata*	BBCC (Wollemi)	HN532; HN536; HN564; HN566; HN598	Shallow sandy soil over sandstone.	Occurs in heath and forest on Hawkesbury sandstone shelves, on rocky hill sides, under cliffs or on rocky/sandy soils along tracks and trails. The species is associated with *Angophora bakeri*, *Corymbia eximia*, *Backhousia myrtifolia*, *Eucalyptus sparsifolia*, *Eucalyptus crebra*, *Eucalyptus notabilis*, *Allocasuarina torulosa* and *Leptospermum trinervium*. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.	Yes
Xanthosia scopulicola	*Xanthosia scopulicola*	BBCC (Wollemi)	HN606; HN598	N/A	Known only from scattered locations between Kings Tableland and Boars Head Rock in the Blue Mountains. Grows in cracks and crevices along sandstone cliff faces or on rocky outcrops above these cliffs. Marginal habitat occurs in the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Xerochrysum palustre	Swamp Everlasting	PMST	-	-	The species occurs in wetlands including sedge-swamps and shallow freshwater marshes, often on heavy black clay soils. The study area does not contain the PCTs associated with this species.	No – listed under the EPBC Act only.
Zieria covenyi	Coveny's Zieria	NSW Atlas PMST BBCC (Burragorang)	HN566; HN598	N/A	Only recorded from one location – Narrow Neck Peninsula south-west of Katoomba in the Blue Mountains. Two populations occur at this location. Habitat includes open sclerophyll forest on gentle slopes and ridges.	Yes
Zieria involucrata	*Zieria involucrata*	SEARs BBCC (Wollemi)	HN606	N/A	Occurs within sheltered forests on mid-lower slopes and valleys on Hawkesbury sandstone. It is typically associated with *Syncarpia glomulifera*, *Angophora costata*, *Eucalyptus agglomerata*, and *Allocasuarina torulosa,* however current ecological knowledge is limited. The study area specific species associations, and soil type/edaphics associated with this species.	Yes
Zieria murphyi	Velvet Zieria	BBCC (Wollemi)	HN566; HN598	N/A	Suitable sheltered gully habitat supporting eucalypt forest occurs in the study area. The study area contains PCTs and soil type/edaphics associated with this species.	Yes
Fauna						
Anthochaera phrygia	Regent Honeyeater	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang, Kanangra, Bungonia)	HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN538; HN553; HN557; HN564; HN566; HN568; HN574; HN604; HN606; HN607; HN598	N/A	Dry and open forest habitat with a large number of mature trees occurs in the study area. Additionally, this species was recently recorded on the western side of Lake Burragorang near Tonalli Point.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Aprasia parapulchella	Pink-tailed Worm-lizard	PMST SEARs	N/A	Land containing surface rocks (embedded or loose).	The species inhabits sloping, open woodland areas with predominantly native grassy ground layers, particularly those dominated by *Themeda triandra*. It is typically found beneath small, partially-embedded rocks and appear to spend considerable time in burrows below these rocks. These habitat features are not found on the study area.	No
Cercartetus nanus	Eastern Pygmy-possum	BBCC (Wollemi, Burragorang, Kanangra, Bungonia)	HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN553; HN557; HN564; HN566; HN568; HN604; HN606; HN607; HN598	N/A	This species has been found in a variety of habits from rainforest through to dry sclerophyll forest. Suitable habitat occurs in the study area. It is possible that this species occurs in the study area.	Yes
Chalinolobus dwyeri	Large-eared Pied Bat	NSW Atlas PMST SEARs; BBCC (Wollemi, Burragorang, Kanangra, Bungonia)	HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN538; HN553; HN557; HN564; HN566; HN568; HN574; HN604; HN606; HN607; HN598	Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels.	This taxon was recorded in the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Dasyornis brachypterus	Eastern Bristlebird	SEARs	HN566	Dense (>80% projected cover) heath. (Burnt heath will not be able to be fully utilised until three years after burning.) Absence of Bristlebirds can only be confirmed by surveys undertaken more than three years after a burn.	Habitat includes low vegetation such as heath and woodland with a heathy understory. The closest known population is centred around the Woronora Plateau. A shy species that is difficult to observe. While the study area contains an associated PCT, the species is not known from the IBRA subregion.	No
Heleioporus australiacus	Giant Burrowing Frog	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang, Kanangra)	HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN553; HN557; HN564; HN566; HN568; HN604; HN606; HN607; HN598	Land within 40 metres of heath, woodland or forest.	Woodland and dry sclerophyll forest supported by a sandstone geology occurs in the study area.	Yes
Hoplocephalus bungaroides	Broad-headed Snake	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang, Kanangra)	HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN553; HN564; HN566; HN568; HN574; HN604: HN606; HN607; HN598	Land within 500 metres of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges and sandstone outcropping.	Sandstone terrain essential for this species occurs in the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang, Kanangra)	HN525; HN527; HN532; HN533; HN535; HN536; HN553; HN557; HN566	N/A	Marginal habitat occurs in the study area. Open woodland occurs, but its understory is not dominated by heath species.	Yes
Ixobrychus flavicollis	Black Bittern	NSW Atlas BBCC (Wollemi)	HN553; HN574; HN607	Land within 40 metres of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation.	Habitat includes terrestrial and estuarine wetlands – areas of permanent water with dense vegetation.	Yes
Litoria aurea	Green and Golden Bell Frog	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang)	HN553; HN574; HN604; HN607	Land within 100 metres of emergent aquatic or riparian vegetation.	Habitat includes marshes, small dams and stream-sides supporting bull-rushes and spike-rushes. Grassy areas surrounding this habitat is preferable. No habitat was observed within the study area.	No
Litoria booroolongensis	Booroolong Frog	PMST	HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN553; HN557; HN564; HN566; HN568; HN574; HN607; HN598	Land within 100 metres of stream or creek banks.	The species lives along permanent streams with some fringing vegetation. Suitable habitat occurs in the form of the Warragamba River downstream of the Dam Wall. This species is currently only known from western flowing creeks and rivers and so the study area is not considered to be suitable habitat as it is east flowing (Dr. F. Lemckert personal communication). Consequently, the habit constraint required for the species is not present within the study area.	No

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Litoria littlejohni	Littlejohn's Tree Frog	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang)	HN517; HN566; HN606; HN607	Land within 100 metres of permanent rocky streams with thick fringing vegetation.	Non-breeding habitat in the form of woodland with low vegetation and leaf litter occurs in the study area. Suitable rocky breeding streams are present.	Yes
Macropus parma	Parma Wallaby	BBCC (Wollemi)	HN607	Forests with thick, shrubby understorey associated with grassy patches.	Once occurred from north-east NSW down to Bega. Current distribution begins in the Gosford district and extends up to the QLD border. Recorded in a range of habitat types including moist eucalypt forests, rainforest margins, grassy areas and occasionally dry eucalypt forest. Potential habitat occurs in the study area.	Yes
Meridolum corneovirens	Cumberland Plain Land Snail	NSW Atlas	-	Land containing bark or leaf litter accumulation.	Is known to occur in Shale Gravel Transition Forest where it will live under bark, leaves, logs and within soil and grassy clump. Such habitat occurs within the study area. The survey area does not contain associated PCTs for this species.	No
Mixophyes balbus	Stuttering Frog	PMST SEARs BBCC (Wollemi, Burragorang, Kanangra, Bungonia)	HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN538; HN553; HN557; HN564; HN568; HN574; HN606; HN607; HN598	Rainforest or tall open wet forest with understorey and/or leaf litter and within 100 metres of streams.	Suitable wet, tall forest on the eastern escarpments and foothills of the Great Dividing Range occur in the study area. However, this species distribution has contracted significantly and is now considered unlikely to occur (Dr. F. Lemckert personal communication).	No

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Mixophyes iteratus	Giant Barred Frog	BBCC (Wollemi)	HN517; HN533; HN537; HN538; HN553; HN557; HN574; HN606; HN607; HN598	Permanent freshwater coastal streams with pools and riffles and about 20 metres of adjacent forest. Generally moist riparian vegetation (for example, rainforest or wet sclerophyll), although sometimes drier forest or degraded riparian remnants.	Suitable freshwater streams and deep leaf litter occurs in the study area. The species southern extent is listed as Warrimoo, but the species is considered extinct in the Blue Mountains and no records have been obtained there since the 1970s (Dr. F. Lemckert personal communication).	No
Myotis macropus	Southern Myotis	NSW Atlas BBCC (Burragorang, Bungonia, Wollemi, Kanangra)	HN517; HN525; HN527; HN532; HN533; HN535; HN537; HN538; HN553; HN564; HN568; HN574; HN598; HN606; HN607	Hollow-bearing trees, bridges, caves or artificial structures within 200 metres of riparian zone	Suitable foraging habitat present over Lake Burragorang and inflowing tributaries. Suitable breeding habitat present in the form of cliff-lines and rocky overhangs with small cave-like structures.	Yes
Petauroides volans	Greater Glider	SEARs	N/A	N/A	This species was recorded during current surveys; however, it is listed under the EPBC Act only.	No
Petaurus norfolcensis	Squirrel Glider	BBCC (Wollemi, Kanangra, Burragorang, Bungonia)	HN525; HN527; HN532; HN533; HN535; HN536; HN553; HN557; HN566; HN568; HN604; HN606; HN598	N/A	Suitable Bloodwood-Blackbutt forest with feed trees and hollows occurs in close proximity to the study area.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Petrogale penicillata	Brush-tailed Rock-wallaby	NSW Atlas PMST SEARs; BBCC (Wollemi, Burragorang, Kanangra, Bungonia)	HN517; HN525; HN527; HN533; HN535; HN536; HN537; HN538; HN557; HN566; HN568; HN606; HN598	Land within 1 kilometre of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines.	Suitable rocky outcrop and cliff habitat occurs in the study area.	Yes
Phascogale tapoatafa	Brush-tailed Phascogale	BBCC (Wollemi)	HN532; HN533; HN564; HN566; HN604; HN606	N/A	Dry sclerophyll forest habitat suitable for this species occurs in the study area. The habitat looks to be marginal, but the species is potentially present.	Yes
Phascolarctos cinereus	Koala	NSW Atlas PMST SEARs BBCC (Wollemi, Burragorang, Kanangra, Bungonia)	HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN538; HN553; HN557; HN564; HN566; HN568; HN574; HN604; HN606; HN607; HN598	N/A	Records have been made downstream of the study area near the confluence of the Warragamba and Nepean Rivers. This species has the potential to occur in the study area.	Yes
Pseudophryne australis	Red-crowned Toadlet	NSW Atlas BBCC (Wollemi, Burragorang, Kanangra)	HN517; HN532; HN533; HN536; HN564; HN566; HN568; HN606; HN607; HN598	Heath or eucalypt forest on sandstone with a build-up of litter or other debris and containing, or within 40 m of, ephemeral or intermittent drainage lines.	This species was recorded in the study area and extensive areas of suitable sandstone drainage line is present.	Yes

Scientific name	Common name	Source	Associated PCTs within site	Required habitat component	Assessment of habitat within the site	Requires further assessment
Varanus rosenbergi	Rosenberg's Goanna	NSW Atlas BBCC (Wollemi, Burragorang, Kanangra, Bungonia)	HN525; HN527; HN533; HN535; HN536; HN553; HN557; HN564; HN566; HN568; HN574; HN604; HN606; HN607; HN598	Land within 250 m of termite mounds or rock outcrops.	Open forest on sandstone and with termite mounds occurs in the study area, providing suitable breeding and shelter habitat.	Yes

5.4 Impacts on biodiversity requiring further consideration

5.4.1 Impacts on threatened species

The threatened species in Table 5-6 was listed as requiring further consideration beyond the FBA Assessment based on Attachment C of OEH's submission as part of the reissued SEARs.

Table 5-6. Threatened species requiring further consideration

Scientific name	Common name	Associated IBRA subregion	Assessment of habitat within the study area	Requires further assessment
Epthianura albifrons	White-fronted Chat	Wollemi, Burragorang, Cumberland	Suitable damp, moist, swampy or marshy habitat was not identified within the study area. There are also no records in the locality according to BioNet Atlas of NSW Wildlife Database. Hence it has been determined that the species is unlikely to be occur in the study area.	No

5.4.2 Impacts on endangered populations

The endangered population in Table 5-7 was listed in Attachment C of OEH's submission (as part of the reissued SEARs) as requiring further consideration beyond the FBA Assessment.

Table 5-7. Endangered populations requiring further consideration

Scientific name	Common name	Assessment of habitat within the study area	Requires further assessment
Marsdenia R. Br. viridiflora subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool, and Penrith local government areas	Marsdenia R. Br. viridiflora subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool, and Penrith local government areas	The study area is within the Wollondilly LGA which is outside the local government areas of Bankstown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith that this population occurs. Therefore, it is not considered to be present in the study area.	No

5.4.3 Impacts on threatened ecological communities

No TECs were listed in Attachment C to the March 2019 SEARs and so no additional TECs require further consideration beyond those determined through the FBA assessment process.

5.4.4 Matters excluded from further consideration

The species, communities and populations in Table 5-8 were specifically excluded from further consideration in the SEARs and do njot require further aqssessment.

Table 5-8. Matters which have been specifically excluded further consideration

Scientific name	Associated IBRA subregion within sears	Assessment of habitat within the study area	Requires further assessment
Callistemon megalongensis	Wollemi, Burragorang	Species occurs in shrubby swamp habitat and swamp woodland. Associated species include *Callistemon citrinus, Leptospermum morrisonii, Leptospermum juniperinum, Leptospermum polygalifolium, Leptospermum obovatum, Empodisma minus* and *Grevillea asplenifolia*. Associated PCTs occur within the study area.	No
Gentiana wingecarribiensis	Burragorang	Wingecarribee Gentian grows in bogs, in Sphagnum Moss humps and in sedge communities. Suitable habitat does not occur on the study area.	No

Scientific name	Associated IBRA subregion within sears	Assessment of habitat within the study area	Requires further assessment
Pultenaea elusa	Burragorang	This species has been recorded twice in 1938 as occurring in swamp. The study area does not contain the known associated PCTs or soil type	No
Sun Valley Cabbage Gum Forest in the Sydney Basin Bioregion CEEC	Wollemi	This CEEC is dominated by *Eucalyptus amplifolia* with *Eucalyptus eugenioides* as an associated tree. Native understorey species include *Acacia parramattensis*, *Imperata cylindrica*, *Lomandra longifolia* and *Pteridium esculentum*. Approximately 15 ha of CEEC remains within Blue Mountains LGA. Floristic associations in the study area do not generally conform to this community.	No
Cumberland Plain Woodland in the Sydney Basin Bioregion CEEC	Burragorang	A woodland community dominated by *Eucalyptus moluccana* and *Eucalyptus tereticornis*, with *Eucalyptus. crebra*, *Corymbia maculata* and *Eucalyptus eugenioides* occurring less frequently. The shrub layer is dominated by Blackthorn *Bursaria spinosa*, with *Themeda australis Microlaena stipoides* var. *stipoides* abundant in the understorey. Floristic associations and soil types in the study area do not generally conform to this community.	No
Robertson Basalt Tall Open-forest in the Sydney Basin and South Eastern Highlands Bioregions CEEC	Burragorang	A tall forest or woodland with a sparse to moderately dense understorey, and dense herbaceous ground layer. The community is dominated by *Eucalyptus fastigata*, *Eucalyptus viminalis*, *Eucalyptus radiata* and *Eucalyptus cypellocarpa*. *Acacia melanoxylon* is a common small tree species in this community. Common shrubs include *Coprosma quadrifida* and *Senecio linearifolius*. Floristic associations and soil types in the study area do not generally conform to this community.	No

5.5 Field surveys

5.5.1 Habitat assessment

Fauna habitat assessments were undertaken within the study area and adjoining land between October 2017 and April 2018. Fauna habitat assessments included consideration of important indicators of habitat condition and complexity including the occurrence of microhabitats such as tree hollows, fallen logs, bush rock and wetland areas such as creeks and soaks, and the presence of mistletoe and flowering trees for nectivorous bird species. Hollows were used as a general indication of habitat quality for arboreal fauna and for hollow dependent birds and bats.

5.5.2 Targeted threatened species surveys

5.5.2.1 Flora

Targeted threatened flora surveys have been undertaken for 10 subject flora species as outlined in Table 5-9. The field survey technique as outlined within NSW *Guide to Survey Threatened Plants* (OEH 2016a) has been applied to the targeted surveys. Candidate species were selected for surveys based on records within the study area. The survey effort presented in Table 5-9 outlines the effort completed by SMEC (in kilometres and hours). Of importance to note in this instance is Section 4.4 (OEH 2016a) which states:

The survey approach defined in this guideline may be impractical for larger areas of potential habitat where the time taken to search vegetation for small threatened species is high (for example, grasslands, uninterrupted but narrow riparian habitat, semi-arid and arid shrublands and woodlands, or open woodland grading into disturbed or derived native grasslands). Options to reduce survey effort in these areas include dividing the proposed site into stages; refining the areas of potential habitat through site survey and an expert report; and reducing the survey area by realigning the boundaries or footprint of the proposed development, thereby reducing the area of impact.

For further advice the plant surveyor should consult with OEH Regional Operations staff located in the region where the development is proposed.

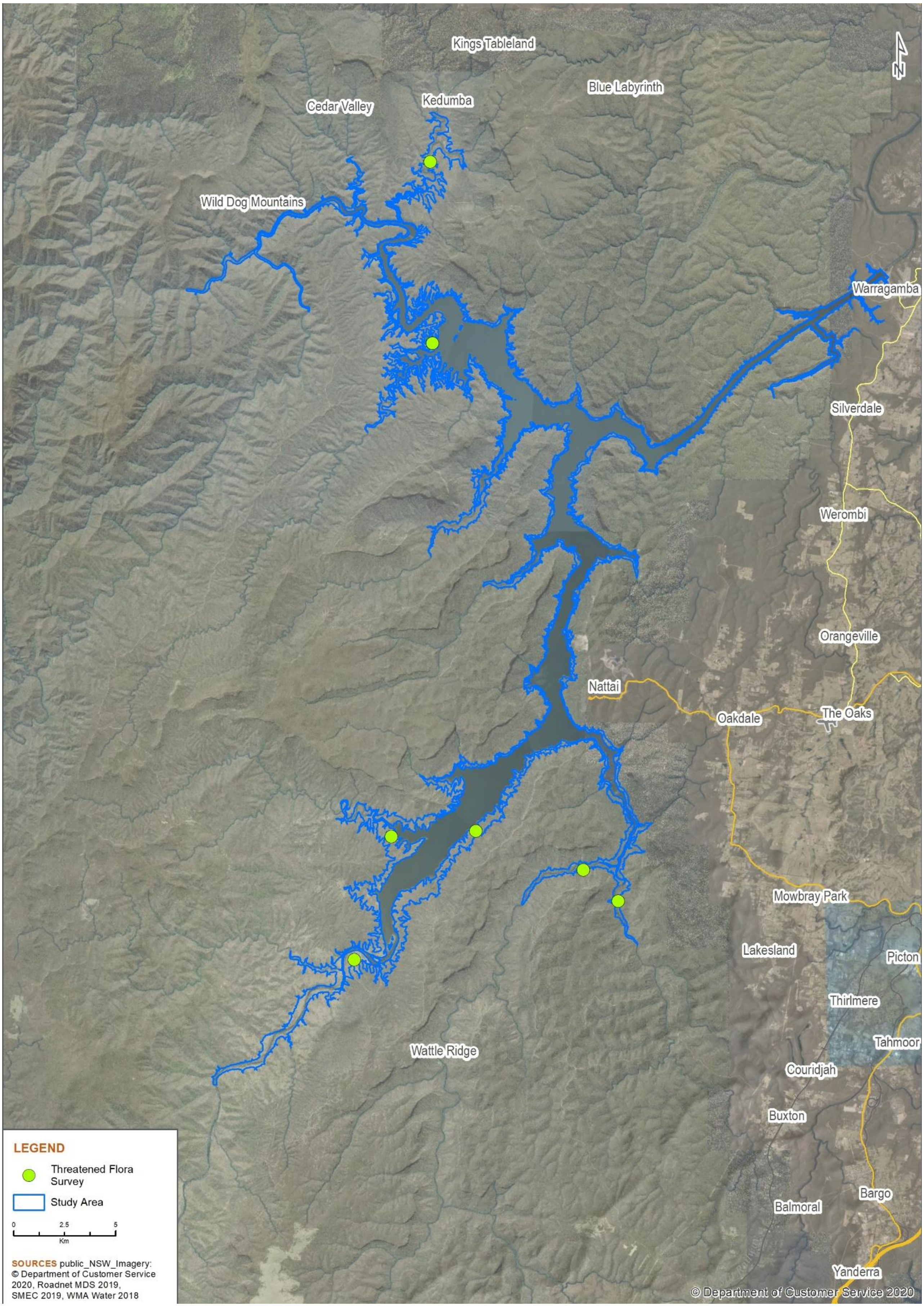
Of the options above, it was not possible to reduce the survey effort by realigning boundaries of the study area, and SMEC has commissioned an expert report for *Pterostylis saxicola*. Expert reports were sought for additional flora species but no experts were available. In the case of other threatened flora species such as *Gyrostemon thesioides,* personal communications with former Royal Botanic Garden Sydney (RBGS) staff suggest that the species is cryptic and spends most of its time in the soil seed bank and thus targeted surveys would have yielded an inconclusive result in this circumstance (Bob Makinson email to Lachlan Laurie, 2019). The remaining candidate flora species requiring assessment (Table 5-9) have been assumed as present within the upstream inundation study area as the survey effort was less than required by the guidelines. This is in accordance with Section 6.5.1.9 of the FBA.

Table 5-9. Threatened flora surveys completed for the study area

Scientific name	Common name	Survey type	Recorded	SMEC effort (km/hr)
Acacia clunies-rossiae	Kanangra Wattle	Parallel field traverse, Incidental	Yes	20/40
Bossiaea oligosperma	Few-seeded Bossiaea	Parallel field traverse, Incidental	Yes	20/40
Callistemon linearifolius	Netted Bottle Brush	Parallel field traverse, Incidental	Yes	10/20
Eucalyptus benthamii	Camden White Gum	Parallel field traverse, Incidental	Yes	48/96
Eucalyptus glaucina	Slaty Red Gum	Incidental	Yes	5/10
Grammitis stenophylla	-	Incidental	Yes	0.25/1
Grevillea parviflora subsp. parviflora	Small-Flower Grevillea	Parallel field traverse, Incidental	Yes	5/10
Hakea dohertyi	Kowmung Hakea	Parallel field traverse, Incidental	Yes	10/20
Pomaderris brunnea	Brown Pomaderris	Parallel field traverse, Incidental	Yes	20/40
Solanum amourense	-	Parallel field traverse, Incidental	Yes	15/30

The location of surveys targeting threatened flora area is shown on Figure 5-1. A detailed multipage figure is provided in Appendix L of this report.

Figure 5-1. Threatened flora survey locations



5.5.2.2 Fauna

General fauna surveys, including nocturnal searches, were conducted within the study area on various dates between October 2017 and April 2018. Fauna field surveys considered survey effort recommendations of *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC 2004), and relevant Commonwealth survey guidelines, with particular reference to the size of the survey sites, broad scale vegetation communities and major sampling stratification units.

The locations of threatened fauna surveys are shown on Figure 5-2. A detailed multipage figure is contained in Appendix L of this report. Fauna survey methods, dates and survey effort are summarised in Table 5-10. Methods are described in detail following Figure 5-2.

The remaining candidate fauna species requiring assessment (Table 5-10) have been assumed as present within the upstream study area as the survey effort was less than required by the guidelines. This is in accordance with Section 6.5.1.9 of the FBA.

Table 5-10. Summary of fauna survey effort for the study area

Method	Target species	Dates	Survey effort
Spotlighting and call playback	Koala, Greater Glider, Squirrel Glider	2 Nov – 7 Dec 2017	15 hours
Arboreal hair tubes	Squirrel Glider, Brush-tailed Phascogale	17 Oct 2017 – 31 Jan 2018	1,820 trap nights
Ground hair tubes	Southern Brown Bandicoot, Spotted-tail Quoll	24 Oct 2017 – 30 Jan 2018	1,400 trap nights
Arboreal cage traps	Squirrel Glider, Brush-tailed Phascogale	13 Nov – 8 Dec 2017	330 trap nights
Amphibian surveys	Giant Burrowing Frog, Red-crowned Toadlet, Stuttering Frog	15-16 Nov 2017	40 mins
Diurnal bird surveys	Regent Honeyeater	2 Nov – 13 Dec 2017	24 hours 40 mins
Ultrasonic call detection	Large-eared Pied Bat	23 Oct – 13 Dec 2017	78 trap nights
Remote sensing cameras	Southern Brown Bandicoot, Spotted-tail Quoll		1,083 nights
	Brush-tailed Rock-wallaby	13 Dec 2017 – 15 Mar 2018	184 nights
	Rosenberg's Goanna	14 Nov – 18 Dec 2017	157 nights
KSAT	Koala	9 Nov – 7 Dec 2017	3 hours 40 mins
Nest boxes	Eastern Pygmy-possum	9 Nov 2017 – 4 April 2018	1,220 trap nights

Amphibian habitat searches

Amphibian searches were undertaken in suitable habitat during optimal weather conditions. Searches involved two observers investigating potential areas of habitat by searching amongst leaf litter and under small rocks while listening for distinctive calls.

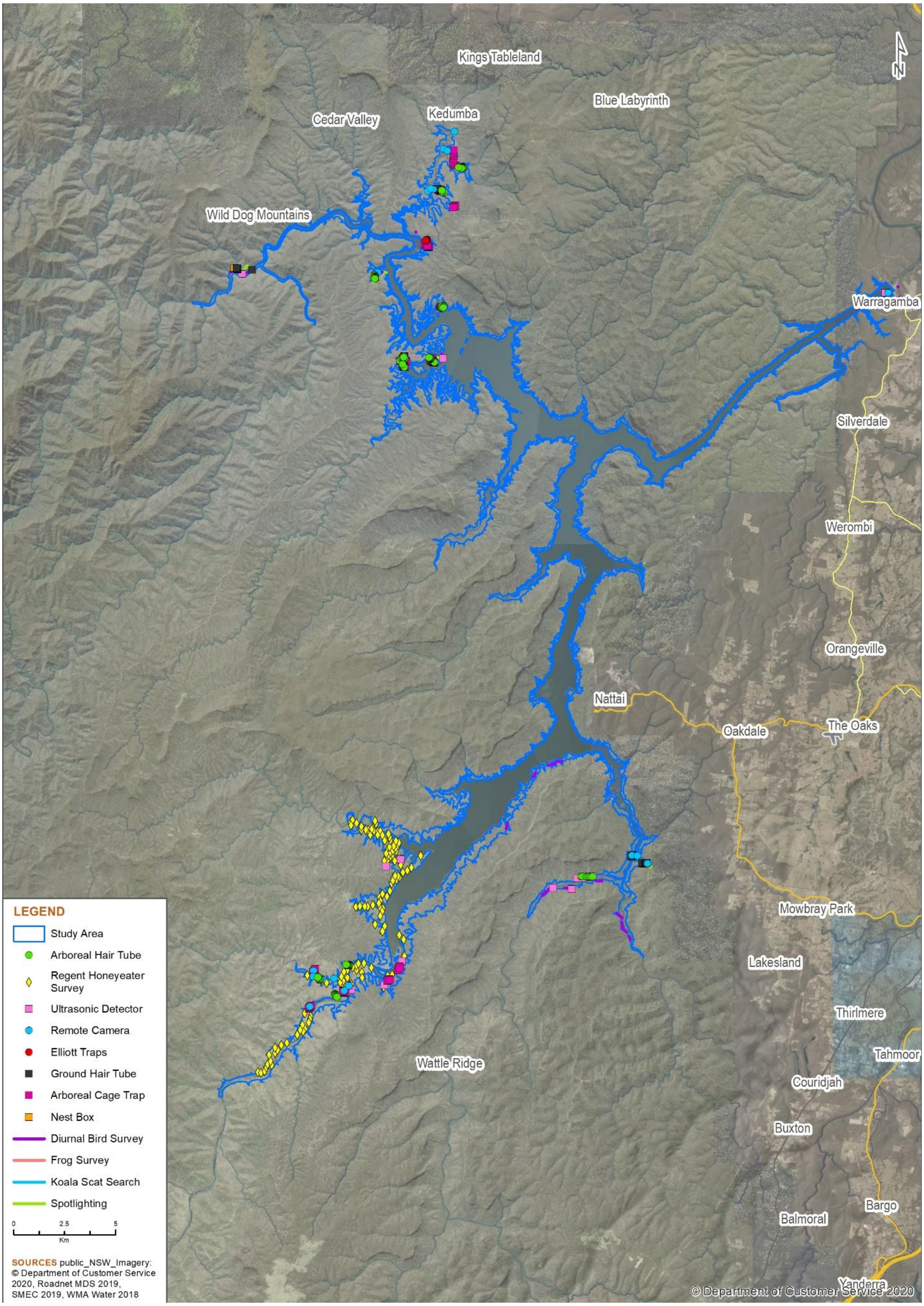
Spotlighting

Nocturnal spotlighting was conducted on foot for arboreal mammals. Using a hand-held spotlight, two observers traversed areas of suitable habitat for the target arboreal mammals. Observers were also listening for audible calls made by any nocturnal fauna.

Ultrasonic call detection

Ultrasonic call detectors (Song Meter SM4BAT ZC/FS, Wildlife Acoustics, USA) were deployed all night (minimum eight hours) for at least two nights per site. Locations were chosen as having suitable flyways to maximise the potential for bat detection. Recorded calls were converted to zero crossing using Kaleidoscope (Version 4.1.0a, Wildlife Acoustics, USA), sorted, and sent to Brad Law (NSW Primary Industries), a recognised expert in this field, for analysis.

Figure 5-2. Threatened fauna survey locations



Arboreal hair tubes

A total of 130 hair tubes were placed on trees within suitable habitat for Brush-tailed Phascogale (refer Figure 5-2). The hair tubes were placed in groups of 10, approximately 50 to 80 metres apart. Each hair tube was baited with balls of oats, peanut butter and honey.

Traps were left in position for at least 19 days, however it is expected that the bait is not acting as an attractant once 14 days have lapsed. Once hair tubes were collected, any samples of hair left on the wafers were sent to Barbara Triggs (a recognised expert) for identification.

Ground hair tubes

One-hundred hair tubes were placed on the ground within suitable habitat for the Southern Brown Bandicoot and Spotted-tail Quoll. The hair tubes were placed in groups of 10, approximately 10 metres apart. Each hair tube was baited with balls of oats, peanut butter and truffle oil.

Traps were left in position for at least 19 days, however it is expected that the bait is not acting as an attractant once 14 days have lapsed. Once hair tubes were collected, any samples of hair left on the wafers were sent to Barbara Triggs (a recognised expert) for identification.

Arboreal cage traps

Wire cage traps (210 x 165 x 490 millimetres) were attached to the trunk of large trees, at a height of three to five metres. A plastic bag was secured around the trap to cover approximately 75 percent of the trap, but leaving the entrance clear, to provide protection from wind and rain for any trapped animals. Coconut fibre insulation material was also placed inside the trap. Traps were baited with a mixture of oats, honey and peanut butter. A trail of honey/water mixture was sprayed on the trees to approximately three metres above the traps. Traps were set at dusk and checked at dawn for a total of 330 trap nights.

Remote sensing cameras

Ground-dwelling mammals were targeted using infrared motion and heat activated cameras (PC900 Hyperfire, Reconyx, USA). Cameras targeting the Southern Brown Bandicoot and Spotted-tail Quoll were placed one metre from a bait stations that consisted of a perforated PVC pipe containing oats and peanut butter. Brush-tailed Rock-wallaby and Rosenberg's Goanna cameras were placed in locations with habitat features required by these species, being sandstone caves/overhangs and termite mounds, respectively.

Diurnal bird surveys

Visual observation and call identification of diurnal birds was carried out within study area. Six 30-minute diurnal bird census points were surveyed between two ecologists equating to a total of 60 minutes' survey effort at each diurnal bird census survey point. Diurnal birds were also identified and recorded as they were encountered throughout the study area during all other surveys.

In addition, targeted breeding population surveys were conducted following Australian National University (ANU) survey methodology. Each survey consists of one minute of Regent Honeyeater call playback projected from a portable speaker followed by four minutes of listening and scanning the survey site for Regent Honeyeater.

All other bird species present within 50 metres of the centroid are recorded.

The following habitat data is recorded following each survey:

- eucalypt species presence
- presence and abundance of flowering within eucalypts
- presence of box or needle-leaved mistletoe (key foraging/nesting resources).

Should Regent Honeyeaters be detected during a survey, their breeding status is then investigated. This includes careful observation from a distance of >20 metres of the flight patterns of the birds to determine the precise location of nests or fledglings.

This survey approach is used by researchers at the ANU to monitor Regent Honeyeater throughout the Capertee Valley, Hunter Valley and Northern Tablelands in NSW. It is particularly effective at determining Regent Honeyeater presence/absence at the large scale (such as the Warragamba study area).

Koala scat searches

The Koala Spot Assessment Technique (KSAT) is a point-based tree sampling method that uses the presence/absence of koala faecal pellets around the base of trees to derive a measure of koala activity. The method is capable of detecting koala even at low activity sites. In order to establish a meaningful level of confidence for koala activity, 30 trees were sampled at each KSAT site. The following methods (Phillips and Callaghan 2011) were adopted:

1. *Locate and mark with flagging tape one tree (the focal tree) that meets one or more of the following selection criteria:*
   (a) A tree of any species, beneath which, one or more koala faecal pellets has been observed;
   (b) A tree in which a koala has been observed; and/or
   (c) Any other tree known to be potentially important for the koala (for example, recognised koala food trees).
2. *Identify and uniquely mark the 29 nearest koala habitat trees to this tree;*
3. *Undertake a search for koala faecal pellets beneath each of the 30 marked trees, based on a cursory inspection of the undisturbed ground surface within a distance of 100 centimetres around the base of each tree, followed (if no faecal pellets are initially detected) by a more thorough inspection involving disturbance of the leaf litter and ground cover within the prescribed search area.*

Only trees greater than 10 centimetres DBH or four metres in height were selected. As no previous koala records are known, or evidence of scats observed upon commencement of the survey, 1c. above was utilised as the focal tree.

A maximum of two person-minutes per tree was dedicated to the faecal pellet search. The search concluded either once a faecal pellet was found or when the two person-minutes were expired, whichever came first. A brief search of each tree was also made to determine the presence or absence of koalas. Any scats collected were sent to Barbara Triggs, a recognised expert in this field, for identification.

Nest boxes

Twelve nest boxes were installed across the study area, targeting suitable vegetation types, and left in situ for a minimum of two months. The nest boxes were constructed from hollow logs with an internal diameter of approximately 10 centimetres, a metal lid and an approximately 2.5-centimetre entry hole on the side. After two months the nest boxes were checked for signs of being inhabited (presence of possum, scats or hair, or nest) and removed.

Incidental observations

Any incidental vertebrate fauna species that was observed, heard calling, or otherwise detected on the basis of tracks or signs were recorded and listed in the total species list for the study area.

5.5.3 Weather conditions

Weather conditions during flora and fauna surveys were generally appropriate for detection of a wide variety of flora and fauna.

The weather conditions at the time of the flora surveys were generally favourable for plant growth and production of features required for identification of most species.

Conditions during the fauna survey were hot sunny days with clear, cool nights. Spring/summer daytime maximums were generally between 20 – 32°C, with still evenings dropping to as low as 2.0°C. Conditions were deemed suitable for amphibians with recent rain prior to and during survey.

A summary of the weather conditions during the survey effort is shown on Figure 5-3. , Figure 5-4, and Figure 5-5.

Figure 5-3. Weather conditions at Camden during survey period

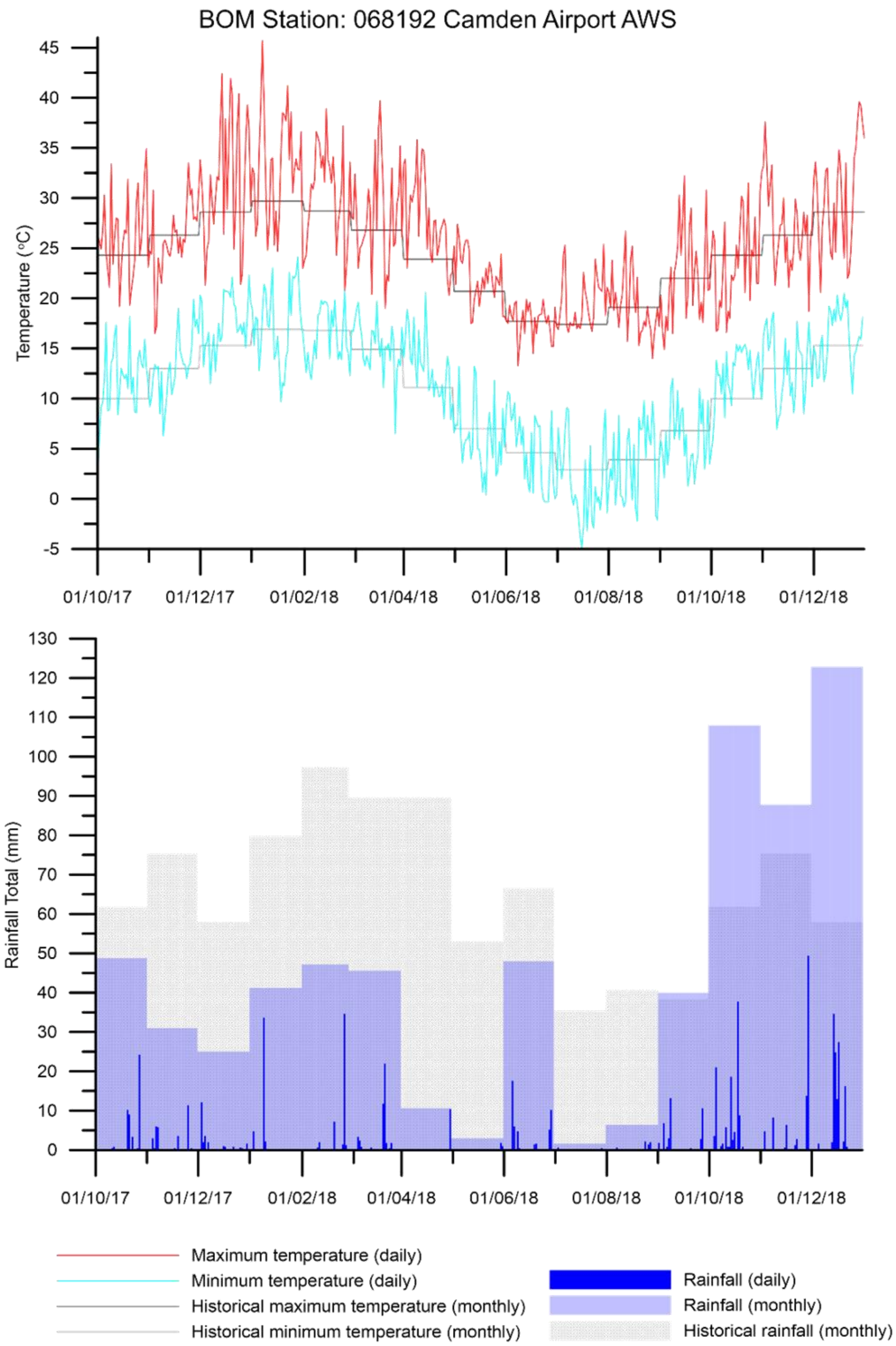


Figure 5-4. Weather conditions at Katoomba during survey period

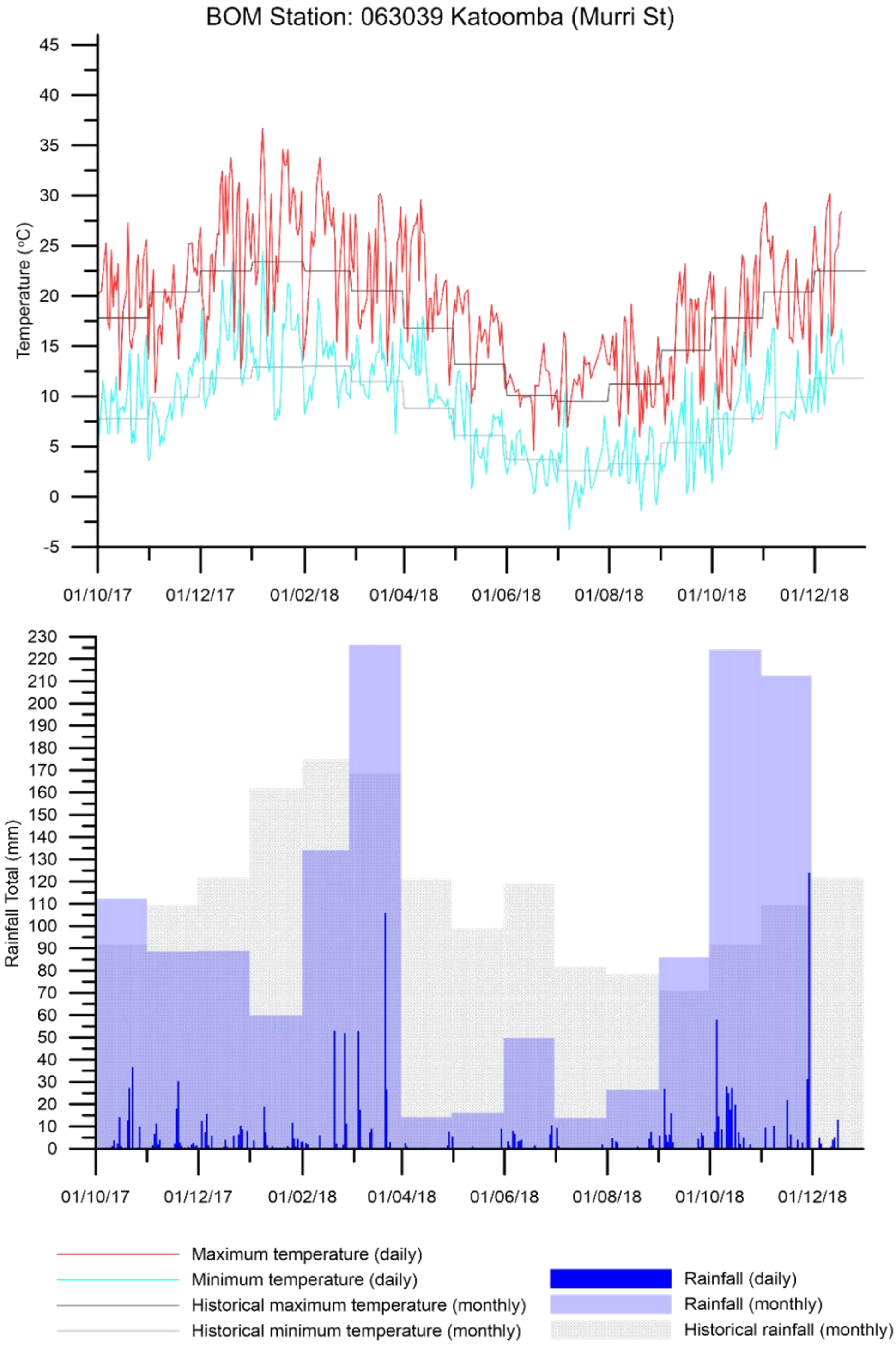
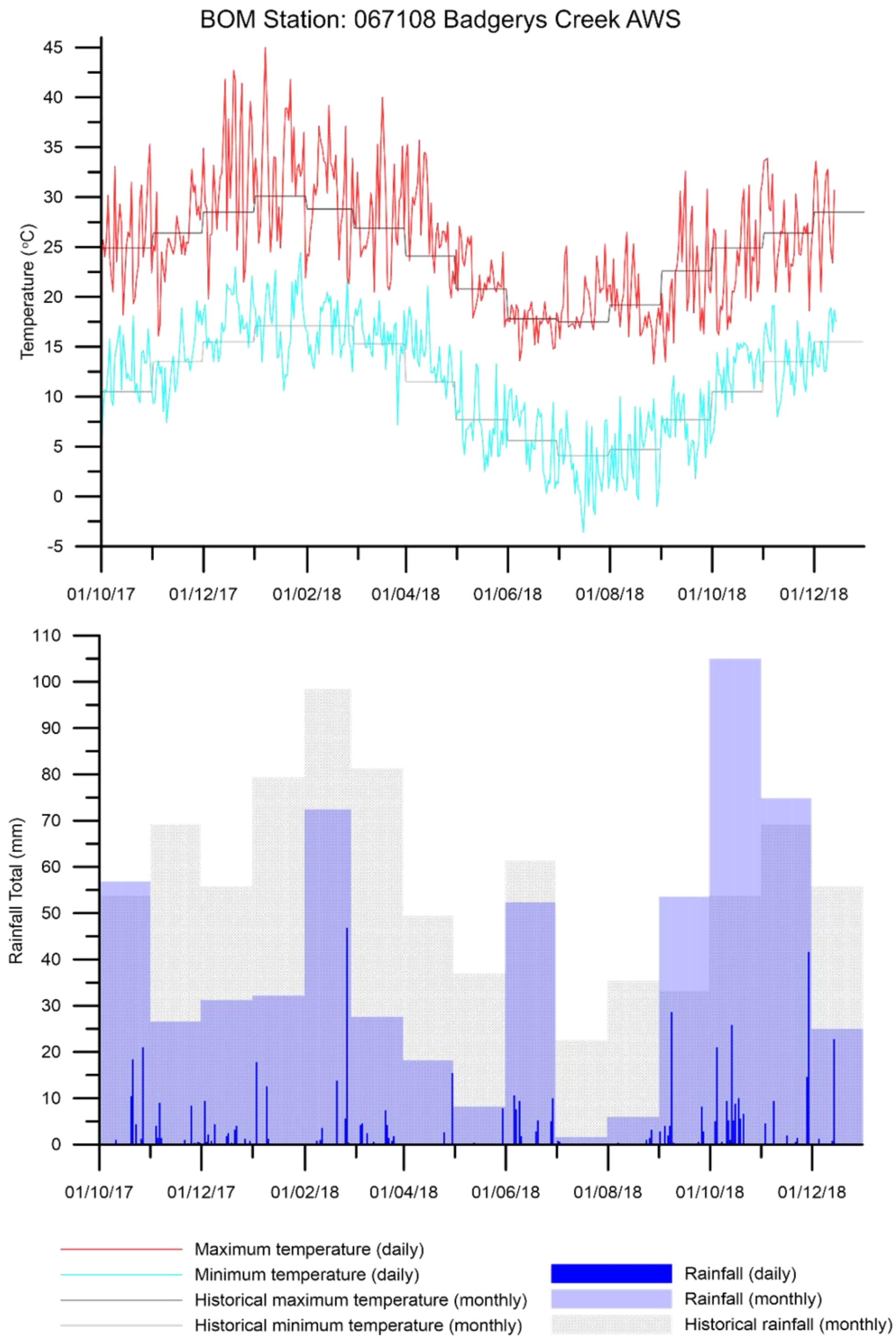


Figure 5-5. Weather conditions at Badgerys Creek during survey period



5.5.4 Survey limitations

Field surveys were conducted over 94 days and 93 nights in summer 2017-2018, two days in winter 2018 and 55 days in spring 2018 - summer 2019. In addition to the surveys undertaken, the full spectrum of flora and fauna species and ecological processes likely to occur on the site were considered by identifying potential habitats for such species and assessing the potential for these species to occur on the site based on previous records, the type and condition of habitats present, the land use of the site and its landscape context.

As stated by the Department of Environment and Conservation (DEC 2004)

> *The absence of a species from survey data does not necessarily mean it does not inhabit the survey area. It may simply mean that the species was not detected at that time with the survey method adopted and the prevailing seasonal or climatic conditions.*

Accordingly, the relative brevity of the survey and its timing mean that the full spectrum of flora and fauna species, as well as ecological processes, likely to occur on the subject site cannot be fully quantified or described in this report.

The following limitations specifically relate to the current assessment:

5.5.4.1 Flora

The data produced by the surveys is intended only to be indicative of the types of species that could occur and not an absolute census of all flora species of the study area. Although many species were detected during field surveys, additional species are likely to be present that have not been observed. Factors such as seasonality, population density and cryptic life histories can all affect the ability to detect species on ground.

To address the above limitations, surveys were conducted to best account for flowering schedules and other variations that may affect detectability. In addition to this, a precautionary approach was used to assess threatened species impacts. Presence of suitable habitat was considered when assessing the potential occurrence of a given threatened species; where potential habitat was present, and the species was known to occur at other locations in the locality, it was assumed that the species had potential to occur and were thus assessed accordingly.

5.5.4.2 Fauna

Fauna surveys relied on literature review, database analysis, fauna habitat assessment and on site fauna surveys. In common with the flora surveys, the fauna surveys were undertaken in a short period of time and therefore the fauna species recorded are a "snapshot" only, of species that were active at the time. Although many species were detected during field surveys, additional species are likely to be present that have not been observed.

5.6 Habitats within the site

Across the broader landscape of the study area, different habitats provide specific features and resources that are key elements required by native fauna for the maintenance of life cycles, including breeding, sheltering and foraging. Seven broad fauna habitat types were identified within the study area. Of these, the study area is dominated by dry sclerophyll forest habitat, with this habitat type covering approximately 48 percent of the study area. This is followed by grassy box woodland and alluvial woodland habitat types, with these habitat types covering approximately 26 percent and 20 percent of the study area respectively. Aquatic habitats, namely Lake Burragorang and its tributaries, also comprise a large proportion of the study area. Table 5-11 provides a breakdown of the proportion of fauna habitat types within the study area. Each of the fauna habitats identified in the current survey are summarised in the subsections below.

Table 5-11. Proportion of fauna habitat types within the study area

Habitat type	Proportion of the study area (%)
Alluvial Woodland	15.04
Grassy box woodland	27.81
Dry sclerophyll forest	50.92
Wet sclerophyll forest	1.45
Rainforest	0.03
Dry rainforest	4.75

5.6.1 Alluvial woodland

The structure of the alluvial woodland consists of a tall canopy, dense mid-story and often sparse understory. Predominant canopy species are *Eucalyptus deanei*, *Eucalyptus elata*, *Eucalyptus benthamii, Angophora floribunda,* and *Casuarina cunninghamiana*. Common mid-story shrubs are *Leptospermum* and *Acacia* species and Coffee Bush (*Breynia oblongifolia*). The groundcover is dominated by species such as *Lomandra* species, *Pratia purpurascens* and *Pteridium esculentum*.

Alluvial woodland occurs on the banks of the major rivers in the study area, the Wollondilly, Nattai, Kowmung, Coxs and Kedumba. The river banks are often steep with numerous rock outcrops. Other key habitat features present in the woodland areas include fallen timber, fragmented rock and hollow bearing trees. Sap feed trees for the Yellow-bellied Glider have been identified in this habitat.

Alluvial woodland has been identified as a priority animal habitat within the Warragamba Special Area (DECC 2007d). It provides important foraging habitat for a number of threatened species including the Large-eared Pied Bat, which was recorded in vegetation along the Nattai River.

Photograph 5-1. Alluvial woodland - vegetation along the Nattai River

5.6.2 Grassy box woodland

This habitat occurs on flat or undulating topography – predominantly in the south of the study area around Jooriland, on the banks of the Wollondilly River. Only a small area of this habitat occurs in the study area. There is a low distribution of canopy trees, predominately Grey Box (*Eucalyptus moluccana – albens intergrade*) and Forest Red Gum (*Eucalyptus tereticornis*). The understory consists of perennial grasses; shrubs are rare. Low rock outcrops are common amongst the groundcover.

Land previously cleared for agricultural purposes is beginning to regenerate but is still subject to continuous grazing pressure from large populations of native and introduced herbivores (for example Eastern Grey Kangaroos, deer and goats).

Grassy Box Woodland has been identified in a study of the fauna of the Warragamba Special Area (DECC 2007a) as the highest priority fauna habitat as it supports a number of threatened species that do not persist elsewhere in the region due to extensive clearing of similar habitat for the expansion of metropolitan Sydney. Species for which the Grassy Box Woodland of the Burragorang Valley is important include the critically endangered Regent Honeyeater and Swift Parrot (DECC 2007d).

Photograph 5-2. Grassy box woodland

5.6.3 Dry sclerophyll forest

The canopy of the dry sclerophyll forest is typically up to 20 metres and is dominated by Red Bloodwood (*Corymbia gumifera*), Scribbly Gums (*Eucalyptus haemastoma* and *E. racemosa*), Narrow-leaved Stringybark (*E. oblonga*) and Grey Gum (*E. punctata*). The mid-storey includes *Acacia*, *Banksia*, *Persoonia* and *Leptospermum* species.

The flooding of the Burragorang Valley has resulted in habitat that would usually occur only on ridgetops, occurring close to the surface level of the lake. Dry sclerophyll forest is the most common habitat within the study area. It occurs throughout the study area, close to the lake edges and adjacent to areas of alluvial woodland along the major rivers.

Fallen logs and leaf litter are common. Rocks are abundant throughout this habitat, providing sheltering habitat for small mammals and reptiles. Overhangs and cliffs also provide habitat for microbats. Hollow-bearing trees are present, although likely to occur at a lower abundance due to historical logging. Threatened woodland birds are likely to use this habitat for foraging, nesting and roosting. Suitable foraging habitat for microbats occurs.

Photograph 5-3. Dry sclerophyll forest

5.6.4 Wet sclerophyll forest

This tall, open forest occurs in patches across the study area, particularly around Brereton Head. The canopy is dominated by Turpentine (*Syncarpia glomulifera*), Grey Gum (*Eucalyptus punctata*), Blackbutt (*E. pilularis*) and Smooth-barked Apple (*Angophora costata*). The mid-storey is open, comprising shrubs and small trees including *Pittosporum*, *Acacia*, *Allocasuarina* and *Leucopogon* species. The understorey is formed by a diverse array of shrubs, grasses and graminoids.

Within this habitat, fallen logs, leaf litter and rocks are common. As is the case with other habitats in the study area, hollow-bearing trees are present, although likely to occur at a lower abundance due to historical logging. This vegetation provides suitable nesting, roosting and foraging habitat for threatened woodland birds and forging habitat for microchiropteran bats.

Photograph 5-4. Wet sclerophyll forest

5.6.5 Dry rainforest

The dry rainforest habitat found around Lake Burragorang has a moderately tall canopy (10 to 15 metres) dominated by Grey Myrtle (*Backhousia myrtifolia*), Lilly Pilly (*Acmena smithii*), Coachwood (*Ceratopetalum apetalum*) and Sassafras (*Doryphora sassafras*). Beneath the canopy, a sparse understory of scattered ferns, small shrubs and herbs occurs including Gristle Fern (*Blechnum cartilagineum*), Rough Treefern (*Cyathea australis*) and Necklace Fern (*Asplenium flabellifolium*). There is an abundance of leaf litter, fallen logs, rock outcrops and dry creek beds are often rocky.

This habitat generally occurs in small patches in sandstone gullies where the sides are steep with a southerly aspect. Suitable locations generally occur on small tributaries of the Kowmung and Coxs rivers.

Dry rainforest provides suitable sheltering, breeding and foraging habitat for the threatened Eastern Pygmy-possum (*Cercartetus nanus*) and Brush-tailed Rock-wallaby (*Petrogale pencilliata*). While neither species was recorded during the current surveys, Brush-tail Rock-wallabies have previously been recorded within the study area, and Eastern Pygmy-possums have been recorded within the locality. Both species are assumed to be present within the study area.

Photograph 5-5. Dry rainforest

5.6.6 Aquatic habitat

Aquatic habitat was assessed in an aquatic ecology report prepared by BMT in 2018. This report describes the upstream environment of the Warragamba catchment. Riverine (for example, Wollondilly River) and lacustrine (Lake Burragorang) wetlands comprise the largest areas in the catchment. There are no Ramsar or nationally significant wetlands in the study area. Despite being an artificial environment, WaterNSW reports that Lake Burragorang supports an abundance of aquatic flora and fauna. Minimal aquatic vegetation occurs within the creeks flowing into Lake Burragorang as a result of shading, instability of substrates and high velocity flows.

Platypus were observed foraging within the Wollondilly, Kedumba, Coxs and Nattai Rivers during the current surveys. The species was generally observed in relatively deep pools with overhanging vegetation, between shallow riffle systems.

All of the waterways within the study area are mapped as Key Fish Habitat under the FM Act. No detailed fish surveys were conducted for the aquatic ecology report, however the report noted one threatened fish species (the Macquarie Perch *Macquaria australasica*) has been detected in the study area. Tributary streams feeding into Lake Burragorang provide suitable habitat for two semi-aquatic invertebrate species: Adam's Emerald Dragonfly (*Archaeophya adamsi*) and Sydney Hawk Dragonfly (*Austrocordulia leonardi*) (DPI 2007, referenced in the report).

Photograph 5-6. Aquatic habitat

5.7 Fauna habitat connectivity

The study area lies within a large area of native vegetation maintained for water supply. Most of the area has been relatively undisturbed since the construction of Warragamba Dam in 1960 and the establishment of a three-kilometre exclusion zone to protect Lake Burragorang. Parts of the study area are located in the Blue Mountains National Park, Kanangra-Boyd National Park, Nattai National Park and the Burragorang, Nattai and Yerranderie state conservation areas.

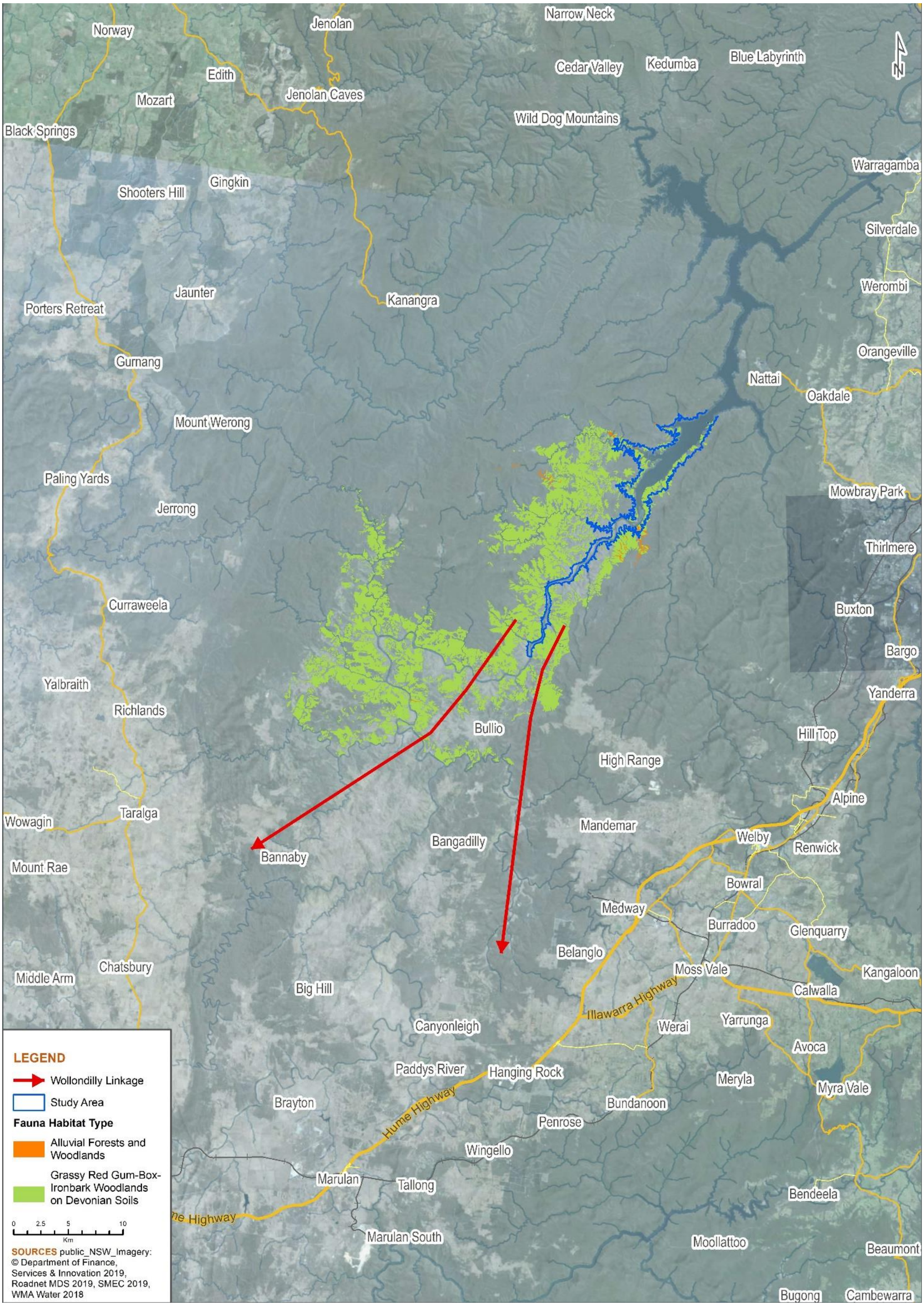
The area of vegetation location in which the study area lies is greater than 200,000 hectares. The lack of disturbance means there is extensive connectivity between habitat in the study area and neighbouring areas over the length of the approximately 600-kilometre study area boundary. Physical barriers are formed by naturally occurring landscape features such as escarpments and gorges, and man-made trails for vehicle and pedestrian access. Lake Burragorang and major rivers also act as a barrier to the majority of terrestrial species, as at many points the lake is over one kilometre wide.

Animals often use landscape features to guide their dispersal. Riparian vegetation is used by some species, such as the Spotted-tailed Quoll, to move through the landscape. These areas are particularly important given the presence of escarpments and cliffs that most ground-dwelling species would be incapable of negotiating.

The Wollondilly Linkage forms an important corridor connecting Grassy Box Woodland environments, which only occupy a small portion of the study area. This link extends from Jooriland, south along the Wollondilly River to Bullio (DECC 2007a). The northern end of this link falls within the study area as shown on Figure 5-6. The Wollondilly Linkage is of high conservation significance as it retains close to the full suite of grassy woodland bird species. Many of these species are of the highest priority fauna species in the Greater Southern Sydney Region due to significant declines across NSW and other part of their range.

A small, high gradient rocky stream connects Warragamba River to Lake Burragorang. This stream is important fish habitat, providing the only upstream movement corridor around the dam wall for juvenile eels into Lake Burragorang.

Figure 5-6. Fauna corridors - Wollondilly Linkage



5.8 Presence of threatened species

5.8.1 Predicted ecosystem credit species

The following ecosystem credit species outlined in Table 5-12 were recorded within the study area during the field surveys. The locations of ecosystem credit species recorded during the field surveys are shown on Figure 5-7 and Figure 5-8.

Table 5-12. Ecosystem credit species recorded within the study area

Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-
Calyptorhynchus lathami	Glossy Black-cockatoo	V	-
Chthonicola sagittata	Speckled Warbler	V	-
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-
Daphoenositta chrysoptera	Varied Sittella	V	-
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-
Glossopsitta pusilla	Little Lorikeet	V	-
Haliaeetus leucogaster	White-bellied Sea-eagle	V	-
Hieraaetus morphnoides	Little Eagle	V	-
Lophoictinia isura	Square-tailed Kite	V	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-
Miniopterus australis	Little Bent-winged Bat	V	-
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	V	-
Neophema pulchella	Turquoise Parrot	V	-
Ninox connivens	Barking Owl	V	-
Ninox strenua	Powerful Owl	V	-
Petauroides volans	Greater Glider	-	V
Petaurus australis	Yellow-bellied Glider	V	-
Pteropus poliocephalus	Grey-headed Flying-fox	V	V
Saccolaimus flaviventris	Yellow-Bellied Sheathtail-Bat	V	-
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-
Tyto novaehollandiae	Masked Owl	V	-
Tyto tenebricosa	Sooty Owl	V	-

[1] BC Act status: CE Critically Endangered; E1 – Endangered; V – Vulnerable.

[2] EPBC Act status: CE – Critically Endangered; E – Endangered; V – Vulnerable.

5.8.2 Candidate species credit species

Ten flora species credit species and four fauna species credit species were identified in the study area (Table 5-13). Locations of these records from recent surveys are provided on Figure 5-7 and Figure 5-8.

Table 5-13. Species credit species recorded within the study area

Genus	Common name	BC Act status[1]	EPBC Act status[2]
Flora			
Acacia clunies-rossiae	Kanangra Wattle	V	-
Bossiaea oligosperma	Few-seeded Bossiaea	V	V
Callistemon linearifolius	Netted Bottle Brush	V	-
Eucalyptus benthamii	Camden White Gum	V	V
Eucalyptus glaucina	Slaty Red Gum	V	V
Grammitis stenophylla	Narrow-leaf Finger Fern	V	-
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V
Hakea dohertyi	Kowmung Hakea	E	E
Pomaderris brunnea	Brown Pomaderris	E	V
Solanum amourense	-	E	-
Fauna			
Anthochaera phrygia	Regent Honeyeater	CE	CE
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Pseudophryne australis	Red-crowned Toadlet	V	-
Varanus rosenbergi	Rosenberg's Goanna	V	-

[1] BC Act status: CE Critically Endangered; E1 – Endangered; V – Vulnerable.

[2] EPBC Act status: CE – Critically Endangered; E – Endangered; V – Vulnerable.

Species assumed to being present in the study area are listed in Table 5-14.

Table 5-14. Species credit species to be assumed present within the study area

Species name	Common name	BC Act status[1]	EPBC Act status[2]
Flora			
Acacia baueri subsp. *aspera*	*Acacia baueri* subsp. *aspera*	V	-
Acacia bynoeana	Bynoe's Wattle	E	V
Acacia flocktoniae	Flockton's Wattle	V	V
Acacia gordonii	*Acacia gordonii*	E	E
Acacia pubescens	Downy Wattle	V	V
Acrophyllum australe	*Acrophyllum australe*	V	V
Ancistrachne maidenii	*Ancistrachne maidenii*	V	-
Asterolasia buxifolia	*Asterolasia buxifolia*	E	-
Asterolasia elegans	*Asterolasia elegans*	E	E
Astrotricha crassifolia	Thick-leaf Star-hair	V	V
Baloskion longipes	Dense Cord-rush	V	V
Caesia parviflora subsp. *parviflora*	Small Pale Grass-lily	E	-
Callistemon megalongensis	Megalong Valley Bottlebrush	CE	CE
Calomnion complanatum	*Calomnion complanatum*	E	-
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V

Species name	Common name	BC Act status[1]	EPBC Act status[2]
Cynanchum elegans	White-flowered Wax Plant	E	E
Darwinia biflora	*Darwinia biflora*	V	V
Darwinia peduncularis	*Darwinia peduncularis*	V	-
Dillwynia tenuifolia	*Dillwynia tenuifolia*	V	-
Epacris hamiltonii	*Epacris hamiltonii*	E	E
Epacris purpurascens var. *purpurascens*	*Epacris purpurascens* var. *purpurascens*	V	-
Epacris sparsa	Sparse Heath	V	V
Eucalyptus pulverulenta	Silver-leafed Gum	V	V
Euphrasia bowdeniae	*Euphrasia bowdeniae*	V	V
Genoplesium baueri	Bauer's Midge Orchid	E	E
Genoplesium superbum	Superb Midge Orchid	E	-
Grevillea evansiana	Evan's Grevillea	V	V
Gyrostemon thesioides	*Gyrostemon thesioides*	E	-
Haloragodendron lucasii	Hal	V	V
Hibbertia puberula	*Hibbertia puberula*	E	-
Hygrocybe anomala subsp. *ianthinomarginata*	*Hygrocybe anomala* subsp. *ianthinomarginata*	V	-
Hygrocybe aurantipes	*Hygrocybe aurantipes*	V	-
Hygrocybe reesiae	*Hygrocybe reesiae*	V	-
Isopogon fletcheri	Fletcher's Drumsticks	V	V
Kunzea rupestris	*Kunzea rupestris*	V	V
Lastreopsis hispida	Bristly Shield Fern	E	-
Leionema lachnaeoides	*Leionema lachnaeoides*	E	E
Lepidosperma evansianum	Evans Sedge	V	E
Leucopogon exolasius	Woronora Beard-heath	V	V
Leucopogon fletcheri subsp. *fletcheri*	*Leucopogon fletcheri* subsp. *fletcheri*	E	-
Melaleuca deanei	Deane's Paperbark	V	V
Melaleuca groveana	Grove's Paperbark	V	-
Micromyrtus blakelyi	*Micromyrtus blakelyi*	V	V
Olearia cordata	*Olearia cordata*	V	V
Persicaria elatior	Tall Knotweed	V	V
Persoonia acerosa	Needle Geebung	V	V
Persoonia bargoensis	Bargo Geebung	E	V
Persoonia glaucescens	Mittagong Geebung	E	V
Persoonia hirsuta	Hairy Geebung	E	E
Pherosphaera fitzgeraldii	Dwarf Mountain Pine	E	E
Phyllota humifusa	Dwarf Phyllota	V	V
Pimelea curviflora var. *curviflora*	*Pimelea curviflora* var. *curviflora*	V	V

Species name	Common name	BC Act status[1]	EPBC Act status[2]
Pterostylis saxicola	Sydney Plains Greenhood	E	E
Pultenaea glabra	Smooth Bush-Pea	V	V
Pultenaea parviflora	*Pultenaea parviflora*	E	V
Pultenaea sp. Olinda	*Pultenaea* sp. Olinda	E	-
Pultenaea villifera – endangered population	*Pultenaea villifera* population in the Blue Mountains Local Government Area	EP	-
Rhizanthella slateri	Eastern Australian Underground Orchid	V	E
Rhodamnia rubescens	Scrub Turpentine	CE	-
Tetratheca glandulosa	*Tetratheca glandulosa*		
Trachymene scapigera	Mountain Trachymene	E	E
Velleia perfoliata	*Velleia perfoliata*	V	V
Xanthosia scopulicola	*Xanthosia scopulicola*	V	-
Zieria covenyi	Coveny's Zieria	E	E
Zieria involucrata	*Zieria involucrata*	E	E
Zieria murphyi	Velvet Zieria	E	V
Fauna			
Cercartetus nanus	Eastern Pygmy-possum	V	-
Heleioporus australiacus	Giant Burrowing Frog	V	V
Hoplocephalus bungaroides	Broad-headed Snake	E	V
Isoodon obesulus subsp. *obesulus*	Southern Brown Bandicoot (eastern)	E	E
Ixobrychus flavicollis	Black Bittern	V	-
Litoria littlejohni	Littlejohn's Tree Frog	V	V
Macropus parma	Parma Wallaby	V	-
Myotis macropus	Southern Myotis	V	-
Petaurus norfolcensis	Squirrel Glider	V	-
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V
Phascogale tapoatafa	Brush-tailed Phascogale	V	-
Phascolarctos cinereus	Koala	V	V

[1] BC Act status: CE Critically Endangered; E1 – Endangered; V – Vulnerable.

[2] EPBC Act status: CE – Critically Endangered; E – Endangered; V – Vulnerable.

Figure 5-7. Threatened flora species records

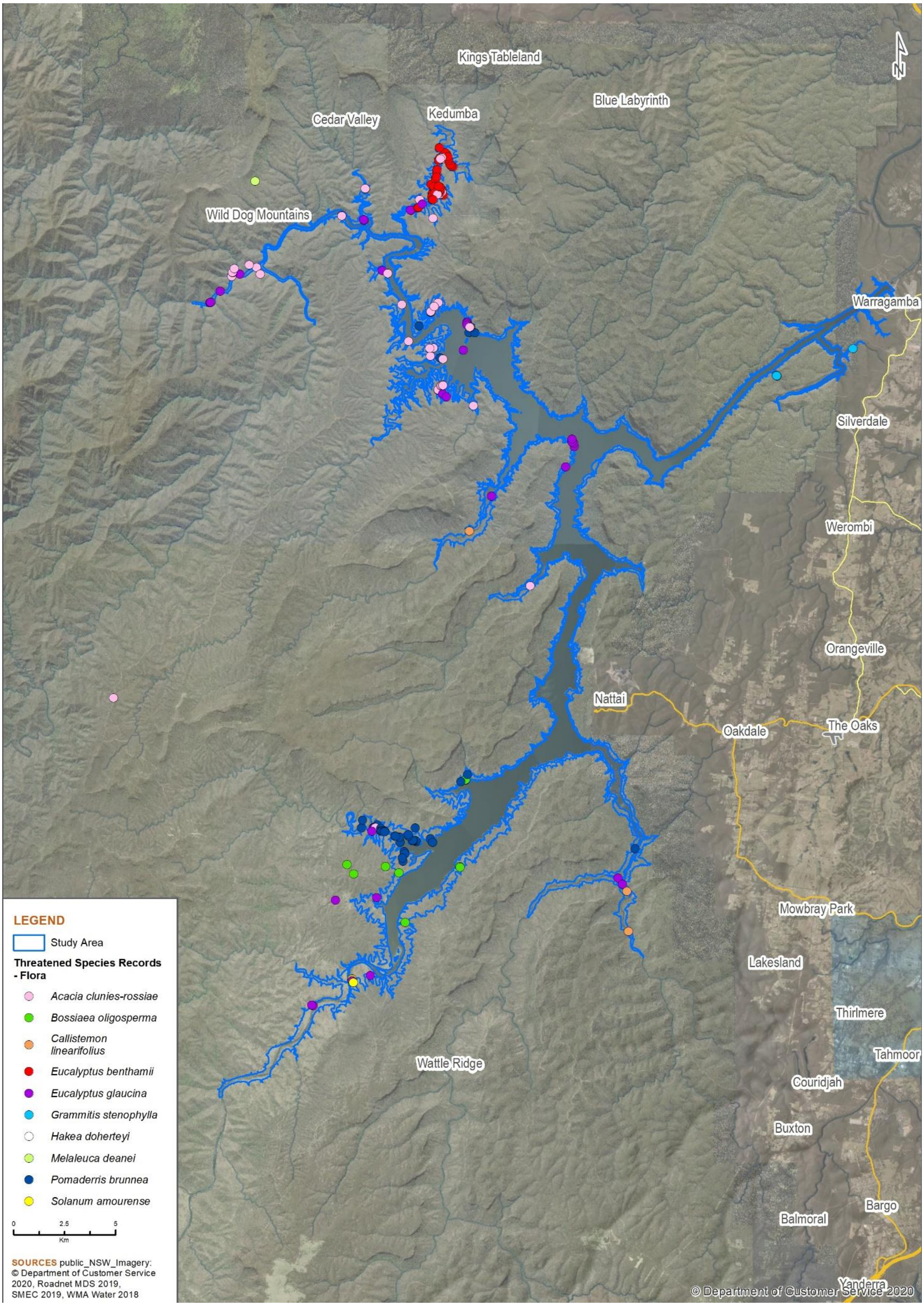
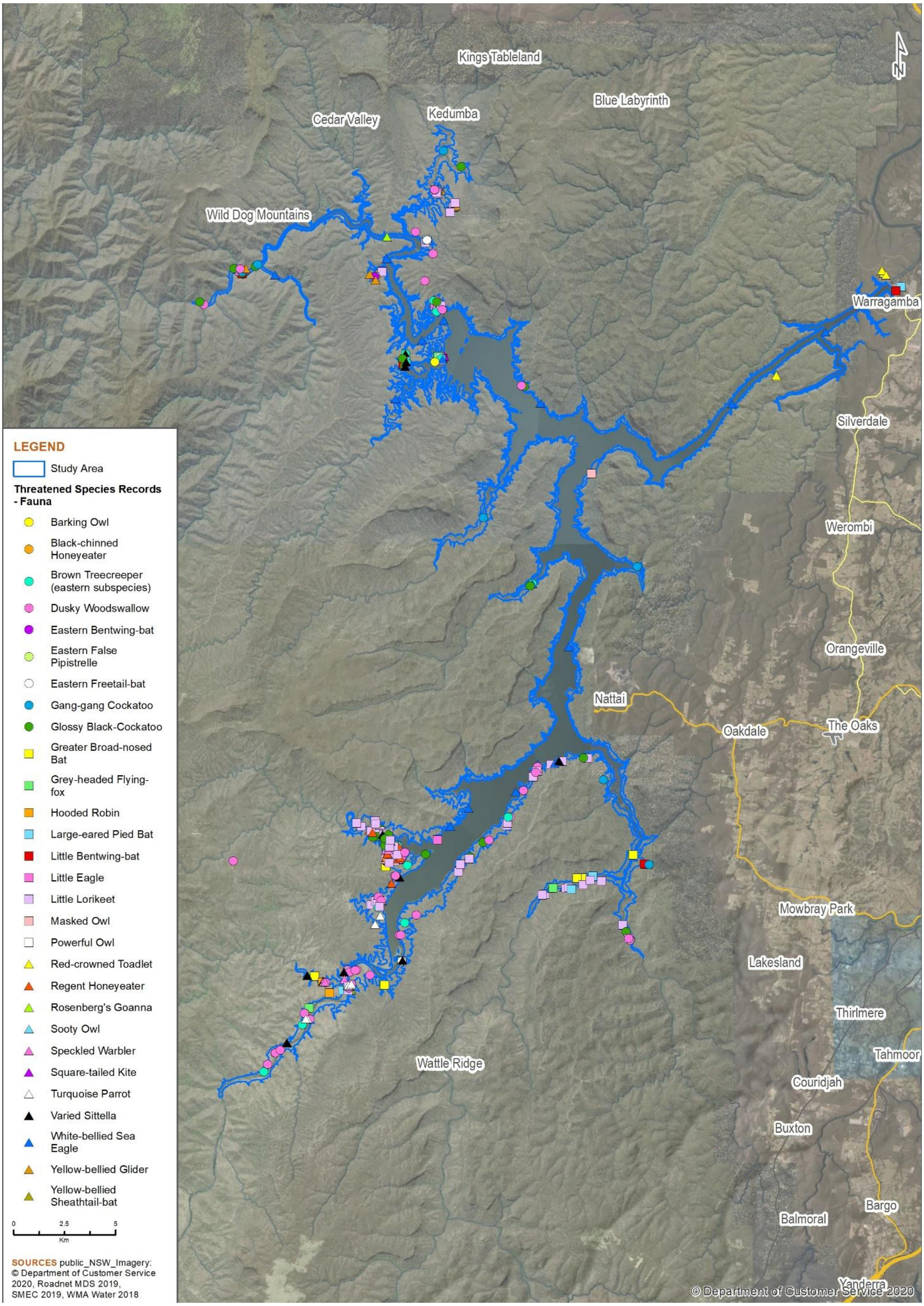


Figure 5-8. Threatened fauna species records



5.9 Biodiversity requiring further consideration

The following biodiversity requiring further consideration were outlined within Attachment C to the SEARs or were recorded within the study area during the field surveys.

Table 5-15 outlines the species included within the SEARs, applicable IBRA subregion, whether it was recorded within the current surveys, and justification for inclusion as a matter for further consideration.

Table 5-15. Biodiversity requiring further consideration recorded within the study area

Genus species	Species, population, or EEC	TSC Act status [1]	EPBC Act status [2]	Included within Attachment C of SEARs (Y/N)?	Applicable IBRA Subregion (SEARs)	Recorded during current surveys (Y/N)?	Justification for inclusion as matter of further consideration
White Box Yellow Box Blakely's Gum Woodland	EEC	CE	CE	N	N/A	Yes – recorded within the Burragorang, Bungonia, and Kanangra IBRA subregion	Species is listed as Critically Endangered thus meets the requirements for inclusion as per Section 9.2.4.1 of the FBA.
Ancistrachne maidenii	Species	V	-	Y	Wollemi	Assumed present	Threatened species has been specifically nominated in Attachment C of the SEARs.
Anthochaera phrygia	Species	CE	CE	N	N/A	Yes – recorded within Bungonia and Burragorang IBRA subregions	Species is listed as Critically Endangered thus meets the requirements for inclusion as per Section 9.2.5.1 of the FBA.
Bossiaea oligosperma	Species	V	V	Y	Bungonia, Burragorang	Yes – recorded within Bungonia and Burragorang IBRA subregions	Threatened species has been specifically nominated in Attachment C of the SEARs.
Callistemon linearifolius	Species	V	-	N	N/A	Yes – recorded within the Burragorang IBRA subregion	Species has not been previously recorded within the Burragorang subregion.
Dillwynia tenuifolia	Species	V	-	Y	Wollemi	Yes	Threatened species has been specifically nominated in Attachment C the SEARs.
Epacris purpurascens	Species	V	-	Y	Wollemi, Burragorang	Yes	Threatened species has been specifically nominated in Attachment C of the SEARs.

Genus species	Species, population, or EEC	TSC Act status [1]	EPBC Act status [2]	Included within Attachment C of SEARs (Y/N)?	Applicable IBRA Subregion (SEARs)	Recorded during current surveys (Y/N)?	Justification for inclusion as matter of further consideration
var. purpurascens							
Epacris sparsa	Species	V	V	Y	Wollemi	Yes	Threatened species has been specifically nominated in Attachment C of the SEARs
Eucalyptus benthamii	Species	V	V	Y	Burragorang, Kanangra,	Yes – recorded within Burragorang and Kanangra IBRA subregions	Threatened species has been specifically nominated in Attachment C of the SEARs.
Eucalyptus glaucina	Species	V	V	N	N/A	Y	Species has not been previously recorded within the Bungonia, Burragorang, and Kanangra IBRA subregions.
Genoplesium baueri	Species	E	E	Y	Burragorang	Assumed present	Threatened species has been specifically nominated in Attachment C of the SEARs.
Gyrostemon thesioides	Species	E	-	Y	Burragorang	Assumed present	Threatened species has been specifically nominated in Attachment C of the SEARs.
Hakea dohertyi	Species	E	E	Y	Burragorang	Yes – recorded within Burragorang IBRA subregion	Threatened species has been specifically nominated in Attachment C of the SEARs.
Hibbertia puberula	Species	E	-	Y	Wollemi, Burragorang	Assumed present	Threatened species has been specifically nominated in Attachment C of the SEARs.
Melaleuca deanei	Species	V	V	Y	Wollemi	Assumed present	Threatened species has been specifically nominated in Attachment C of the SEARs.
Pomaderris brunnea	Species	E	V	Y	Yengo	Yes – recorded within Bungonia and Burragorang IBRA subregions	Species has not been previously recorded within the Bungonia and Burragorang IBRA subregions.
Solanum armourense	Species	E	-	Y	Bungonia	Yes – recorded within Bungonia and	Threatened species has been specifically nominated in Attachment C of the SEARs.

Genus species	Species, population, or EEC	TSC Act status [1]	EPBC Act status [2]	Included within Attachment C of SEARs (Y/N)?	Applicable IBRA Subregion (SEARs)	Recorded during current surveys (Y/N)?	Justification for inclusion as matter of further consideration
						Burragorang IBRA subregions	
Tetratheca glandulosa	Species	V	-	Y	Burragorang	Assumed present	Threatened species has been specifically nominated in Attachment C of the SEARs.

[1] TSC Act Status: CE Critically Endangered (Schedule 1A); E1 – Endangered (Schedule 1); V – Vulnerable (Schedule 2).

[2] EPBC Act Status: CE – Critically Endangered; E – Endangered; V – Vulnerable.

6 Avoid and minimise impact

This chapter outlines the actions that have been undertaken to demonstrate that reasonable measures have been taken to avoid and minimise the potential impacts of the Project on biodiversity values.

6.1 Measures to avoid

Chapter 4 of the EIS discusses the proposed alternatives that were considered for flood mitigation in the Hawkesbury-Nepean Valley, including:

- infrastructure upgrades to enhance drainage or protect downstream communities
- new flood mitigation dams, including new dams built and operated only for flood mitigation
- operational alternatives using existing infrastructure
- evacuation road upgrades
- non-infrastructure alternatives, such as changes to planning controls, improved flood monitoring and response and better coordination between agencies
- strategies combining two or more of the above alternatives.

6.1.1 Avoidance of impacts

Under the FBA, a proponent must seek to avoid the impacts of a Major Project on all biodiversity values at the study area, including impacts on:

- EECs and CEECs
- PCTs that contain threatened species habitat
- areas that contain habitat for vulnerable, endangered or critically endangered threatened species or populations
- an area of land that the Minister for Environment has declared as critical habitat in accordance with section 47 of the TSC Act
- the riparian areas of 4th order or higher streams and rivers, important wetlands and estuaries
- State Significant biodiversity links.

Demonstration of these avoidance measures is summarised in Table 6-1.

Table 6-1. Avoidance of impacts on biodiversity values

Impacts	Avoidance mechanism proposed
Impacts to EECs and CEECs	The Project allows for the provision of a 14 metre dam raising, which provides an optimum balance between effective downstream flood mitigation and minimising, as much as possible, impacts associated with upstream temporary inundation. The scale and nature of the Project means that options to avoid impacts to EECs and CEECs are limited.
Impacts to PCTs that contain threatened species habitat	The Project allows for the provision of a14 metre dam raising, which provides an optimum balance between effective downstream flood mitigation and minimising, as much as possible, impacts associated with upstream temporary inundation. The scale and nature of the Project means that options to avoid impacts to PCTs that contain threatened species habitat are limited
Impacts to areas that contain habitat for vulnerable, endangered or critically endangered threatened species or populations	The Project allows for the provision of a 14 metre dam raising, which provides an optimum balance between effective downstream flood mitigation and minimising, as much as possible, impacts associated with upstream temporary inundation. The scale and nature of the development type means that options to avoid impacts to areas which contain habitat for vulnerable, endangered or critically endangered threatened species or populations are limited.
Impacts to an area of land that the Minister for Environment has declared as critical habitat in accordance with section 47 of the TSC Act	There are no areas of critical habitat within the study area.

Impacts	Avoidance mechanism proposed
Impacts to the riparian areas of 4th order or higher streams and rivers, important wetlands and estuaries	The Project is situated at Warragamba Dam with operational impacts occurring on land surrounding Lake Burragorang, which is a 9th order stream at points along its extent. As such, any impacts to the riparian buffers of a 4th order stream or higher cannot be avoided.
Impacts to state significant biodiversity links	The Project is situated at Warragamba Dam with operational impacts occurring on land surrounding Lake Burragorang, which is a 9th order stream at points along its extent. As such, any impacts to the riparian buffers of a 4th order stream or higher cannot be avoided.

6.1.2 Site selection

The Project proposes to raise the wall of Warragamba Dam to create an FMZ. As such, this site is fixed and there are no options for an alternative site. The selection of suitable flood mitigation options was informed though the consideration of various factors including social and environmental impacts and economic considerations. A discussion of Project siting is included within Chapter 10 of the EIS (Biodiversity – construction area). A summary of considerations during site selection in accordance with Section 8.3.2.2 of the FBA is shown in Table 6-2.

6.1.3 Incorporating principles of avoidance and minimising impacts to biodiversity during planning phase

Once a suitable study area was selected, further analysis of the biodiversity constraints of the proposed study area was used to inform concept planning, siting and design.

A summary of considerations during site planning in accordance with Sections 8.3.2.7 and 8.3.2.8 of the FBA is shown in Table 6-2.

Table 6-2. Considerations of the proposed development during site selection

FBA section	FBA criteria	Considerations of the FBA guidelines at the site
8.3.2.8 (a)	The Major Project should be located in areas where the native vegetation or threatened species habitat is in the poorest condition, or which avoid an EEC or CEEC	Due to the location, scale and nature of the development, operational impacts to White Box Yellow Box Blakey's Red Gum Woodland CEEC and River Flat Eucalypt Forest on Coastal Floodplains cannot be avoided.
8.3.2.8 (b)	The Major Project and associated construction infrastructure should be located in areas that do not have native vegetation, or in areas that require the least amount of vegetation to be cleared, and/or in areas where other impacts to biodiversity will be lowest.	Due to the location, scale and nature of the development, operational impacts to White Box Yellow Box Blakey's Red Gum Woodland CEEC and River Flat Eucalypt Forest on Coastal Floodplains cannot be avoided. The wall height has been amended several times to maximise flood mitigation outcomes and minimise impacts on biodiversity including a reduction of the dam raising from 20 metres down to 14 metres.
8.3.2.8 (c)	Major Projects can impact on the connectivity and movement of species through areas of adjacent habitat. Minimisation measures may include providing structures that allow movement of species across barriers or hostile gaps.	The operational impacts of the Project would occur around Lake Burragorang and its tributaries. The vegetation within and surrounding the study area is intact with very high levels of connectivity. The operational impacts of the Project would not prevent movement of individuals through the landscape.
8.3.2.8 (d)	Any other constraints that the assessor has considered in determining the siting and layout of the Major Project.	No additional constraints have been considered. A discussion of Project siting is included within Chapter 4 of the EIS.

6.2 Measures to minimise impacts

The Proponent will implement reasonable measures to avoid and minimise any impacts that may occur during the construction and operational phases of the Project that are additional to the impacts which occurred during the site selection and planning phases.

In 2018, an amendment to the WaterNSW Act was enacted which related specifically to the Project and the potential impacts of temporary inundation on national parks and state conservation areas in the Warragamba Dam catchment.

Under previous legislation, inundation of national park land was not permitted, however, the amendment of the WaterNSW Act provided a special provision to allow the temporary inundation of national park and state conservation area land in the Warragamba Dam catchment.

To ensure the mitigation of any impacts from temporary inundation, the special provisions also require:

- WaterNSW to prepare an EMP in consultation with the Chief Executive of the OEH[5] and NPWS if approval for the Project is given
- The NPW Minister to determine the matters that are to be addressed by an EMP
- The NPW Minister with the concurrence of the Minister for Water approve an acceptable EMP.
- The NPW Minister with the concurrence of the Minister for Water require an approved EMP to be updated or reviewed.
- The NPW Minister with the concurrence of the Minister for Water may direct Water NSW to take specified actions in relation to the temporary inundation of national park land resulting from the Warragamba Dam Project, including action relating to the monitoring of risks associated with the temporary inundation and relating to the rehabilitation or remediation of land.
- WaterNSW to implement and monitor the EMPs.
- Water NSW to notify the Chief Executive of the OEH if it is of the opinion that a flood event that may affect national park land in the vicinity of Warragamba Dam is likely to occur.

While the exact content of the EMP has yet to be determined, it would address issues such as:

- rehabilitation and habitat restoration
- sediment and erosion control
- weed and feral animal management
- ecological monitoring.
- responsibility for these actions (which would be negotiated between Water NSW and NPWS as part of development of the EMP).

It should be noted that the EMP will be separate to any other mitigation measures identified in this environmental assessment but would would complement and support these measures.

6.2.1 Minimising impacts during construction phase

Measures to minimise impacts related to the construction of the raised dam wall are outlined within the Chapter 10 of the EIS (Biodiversity – construction area).

6.2.2 Minimising impacts during operational phase

The following matters should be considered to avoid and minimise impacts on biodiversity values during the operational phase of the Project as described in Table 6-3.

Table 6-3. Considerations to minimise impacts of the proposed development during operation

FBA section	FBA criteria	Considerations of the FBA guidelines at the site
8.3.2.12a	Seasonal impacts – whether there are likely to be any impacts that occur during specific seasons. Minimisation measures may include amending operational times to minimise impacts on biodiversity during periods when seasonal events such as breeding, or species migration occur.	The timing and flood mitigation operations of these events will be dependent on dam levels, flow and upstream precipitation.
8.3.2.12b	Artificial habitats – using 'artificial habitats' for fauna where they may be effective in minimising impacts on such fauna. These include nest boxes, glider-crossings or habitat bridges.	Given the large extent of available habitat within the wider locality, no artificial habitats are proposed within the study area.
8.4.2.4f	Impacts during the operational phase – measures to avoid or minimise the indirect impacts on threatened species and	The EMP required under the Water NSW Act would contain mitigation

[5] Wording as per Part 5A of the *Water NSW Act 2014*; this function now sits within DPIE.

FBA section	FBA criteria	Considerations of the FBA guidelines at the site
	threatened species habitat on land adjoining the study area, migratory species or flight pathways as a result of the operation of the development. Such measures may include those adopted to avoid and minimise: (i) trampling of threatened flora species (ii) rubbish dumping (iii) noise (iv) light spill (v) weed encroachment (vi) nutrient run-off (vii) increased risk of fire, and (viii) pest animals.	measures for the operation of the Project. The EMP would provide for regular review and revision as required to ensure the ongoing efficacy of operational protocols and management measures.

6.3 Summary of measures

Although the Project would seek to avoid and minimise impacts, not all biodiversity impacts can be avoided for many aspects of the Project as have been detailed above. The measure described in Table 6-4 would be implemented to effectively manage and mitigate impacts during operation. Note that offsetting requirements are discussed in Section 8 of this report.

Table 6-4. Summary of measures to minimise impacts of the proposed development during operational phase

Impact	Mitigation measure	Outcome	Timing	Responsibility
General flora and fauna impacts	Offset strategy to mitigate potential impacts on biodiversity together (see Appendix F6 - Offset Strategy - Biodiversity)	Offset strategy	Operation	WaterNSW

6.4 Identification of final Project footprint

The layout for the Project has been refined through the consideration of a number of alternatives which have reduced the potential for adverse impacts to the environment, including specific impacts on threatened ecological communities.

7 Impact assessment

7.1 Introduction

The Project's operational impact would result in increased temporary inundation from mitigating large rainfall events in the study area. These impacts would involve changes to current temporary inundation extents, depths and durations, and rates of rising and receding flows. It is important to appreciate that the upstream area is already potentially affected by flooding associated with the existing dam. It is also important to appreciate that the PMF is primarily used to inform design development and, given the size of the Warragamba catchment, is highly unlikely to actually ever occur in nature.

7.1.1 Potential flooding with the Project

Changes to upstream flooding and hydrology and the associated potential impacts of the Project are addressed in detail in Chapter 15 (Flooding and hydrology). The following sections provide a summary of key aspects of the approach to the flood modelling and the results of the analysis of the modelling results.

7.1.1.1 Approach to flood modelling

The hydrological modelling for the Project used a Monte Carlo approach which takes into account the variability in multiple factors such as rainfall intensity and frequency, the spatial pattern of rainfall over the catchment, the amount of rainfall that infiltrates into ground and doesn't run off, etc. The Monte Carlo approach recognises that any design flood characteristic (e.g. peak flow) could result from a variety of combinations of flood-producing factors, rather than from a single combination. The approach mimics natural events in that the influence of all probability distributed inputs are explicitly considered, thereby providing a more realistic representation of the flood generation processes. The model outputs for a particular flood event with a specific chance of occurrence in any given year are therefore represented by an 'envelope' of events, which cover a wide range of flood durations and affected areas.

The Monte Carlo analysis used 20,000 model runs to generate an 'envelope' of flood events along the flood frequency curve. These were then used as inputs to a MIKE11 model to extract rating curves (flow-height relationships) under different dam raising scenarios. These rating curves were then used to derive hydrographs from flow inputs (from the RORB model) at all cross-sections for the 20,000 Monte Carlo runs of the existing dam and the Project. Representative hydrographs were then used to assess changes to flood levels and duration, flood frequencies, and flood extents between the existing dam and the Project.

The Monte Carlo methodology was also used to define the upstream impact area (refer Section 1.5.4).

Further details regarding the hydrological modelling are provided in Chapter 15, Section 15.2, of the EIS.

7.1.1.2 Changes to upstream flooding and hydrology

The following is a summary of the changes to flooding and hydrology in the catchment upstream of Warragamba Dam. It is stressed that these should not be considered in isolation and it is necessary to consider them holistically when assessing potential impacts of the Project.

It should also be noted that the PMF event is used principally as an input to design and, given the scale of the catchment of Lake Burragorang, is highly unlikely to occur in nature. Accordingly, more weight should be given to the flood events with a relatively greater chance of occurrence.

Depth and duration of temporary inundation

For upstream locations above the limit of the Project 1 in 100 year chance event:

- Increases in depth with the Project for all events would be half a metre or less
- Increases in duration of temporary inundation for all events for all locations would be less than half a day.

For locations approximating the limit of the Project 1 in 100 chance in a year event, increases in the depth of temporary inundation with the Project for all events up to the 1 in 100 chance in a year event would be half a metre or less.

Increases in the duration of temporary inundation for all events up to the 1 in 100 chance in a year event would be less than half a day on top of the existing duration of temporary inundation which for all four main rivers is around 5-7 days.

There is an increasing influence of the Project moving downstream with the increase in temporary depth and duration of temporary inundation, with locations within Lake Burragorang generally reflecting the pattern of changes in depth and duration of temporary inundation for the same flood events at the dam wall. This also holds generally for the upstream impact area.

Flood frequencies

- The Project would result in a shift in the flood frequency curves resulting in events of a specified depth occurring more frequently than currently occurs; this is most pronounced at the dam wall and in Lake Burragorang, and decreases moving up the tributaries
- Changes in flood frequencies for the upstream impact area are generally similar to Lake Burragorang
- There is no material difference in the existing and Project flood frequency curves at upstream locations that approximate the extent of the Project PMF (as would be expected).

Flood extents

- While the Project would increase the extent of any inundation with the use of the flood mitigation zone (FMZ) it is incremental to what already occurs. Based on modelling the likely incremental net increase in inundation area is around 1400 hectares.

7.1.2 Effects of temporary inundation

The impacts of alteration of natural flow regimes are wide-ranging. They are also difficult to predict and quantify. This section discusses the potential impacts temporary inundation may have on vegetation communities and habitat.

7.1.2.1 Flood stress

Flooding is considered to be a compound stress comprised of interacting changes within the plant cells induced by the flood water around the plant (Perata *et al*. 2011). Most terrestrial plant species cannot survive prolonged submergence or soil waterlogging and that these stresses are collectively termed flood stress (Jackson and Colmer 2005) (Loreti *et al*. 2016) (Kozlowski 1997). Generally, plants are either intolerant to flooding and therefore excluded from flood-prone habitats, or they are tolerant to flooding (Perata *et al.* 2011).

Once affected by flood stress, plants may be more susceptible to secondary biotic and abiotic impacts from the surrounding environment. When stressed or recovering from flood stress, plants may be less resilient to disease and pathogens, for example *Phytophthora cinnamomi* and Myrtle Rust, as well as to herbivory and parasitism. These supplementary biotic impacts may compound the flood stress, further reducing the vigour and health of the already stressed plant.

Flooding results in the inundation of part or all of the above ground structures, while waterlogging is restricted to the soils and rhizosphere (Colmer and Pedersen 2008) (Parolin and Wittmann 2010). Flood-tolerant plants, such as riparian or wetland species, typically possess traits that allow complex interactions of morphological, anatomical, and physiological adaptations to survive the physical and chemical effects of flooding (Catford and Jansson 2014) (Kozlowski, 1997). Such adaptions include, but are not limited to, the production of hypertrophied lenticels, aerenchyma tissue, and adventitious roots (Kozlowski 1997). However, even within these flood-tolerant plants, tolerance levels are not universal with different species highly adapted and specialised for a narrow and restricted set of environmental conditions, thus changes to baseline conditions can trigger stress responses ((Parolin and Wittmann 2010, Catford and Jansson 2014, Voesenek and Bailey-Serres 2015). Notably, even mortality in *Casuarina cunninghamiana* has been observed on the Hawkesbury-Nepean River as a result of extended inundation and waterlogging (Howell and Benson 2000), and has been demonstrated to be sensitive to oxygen depletion in its root zone (Woolfrey and Ladd 2001). Terrestrial plant species typically lack the suite of adaptations that enable tolerance to inundation, thus making them particularly susceptible to flood stress. The presence of adaptations may vary between species. Some species of eucalypt, such as *Eucalyptus camaldulensis*, possess the ability to form adventitious roots in waterlogged soils, while other species, such as *Eucalyptus globulus* do not (Bush and England 2019). Bush and England (2019) found that *Eucalyptus benthamii* may be tolerant to temporary inundation for up to six weeks duration to a depth of 30 centimetres, suggesting that the species may also possess similar morphological adaptions to enable some level of tolerance to flood stress.

During periods of inundation, the concentration of oxygen, carbon dioxide, reactive oxygen species, and ethylene are altered within the plant's cells. Whilst the exact changes and combinations are dependent upon the flood duration, depth, and predominant environmental conditions at the time (Perata *et al*. 2011), the overall affect is a change to plant metabolism which can detrimentally impact upon plant vigour and heath. During a flood event, plants are likely to experience a reduction in respiration as gaseous exchange is considerably slower underwater, and photosynthesis and transport of carbohydrates is inhibited by a reduction in light availability which can lead to a deficit of energy (Kozlowski 1997, Catford and Jansson 2014). Changes to soil structure and chemistry such as depletion of oxygen, accumulation of carbon dioxide and reactive oxygen species, and changes in pH can also affect hormonal balance and metabolism typically by increasing the proportion of ethylene present within the cells (Kozlowski 1997).

These changes to plant hormonal processes and metabolism can induce changes to plant morphology and anatomy. Inundation and waterlogging causes death and decay of plant roots (Kozlowski 1997, Catford and Jansson 2014). Post-flood, root formation and branching, as well as existing root growth and formation of mycorrhizae association are inhibited (Kozlowski 1997). This in turn reduces absorption of macronutrients and ability to uptake water from the environment (Kozlowski 1997). Inundation and waterlogging can result in impacts upon plant growth by causing early leaf-drop, senescence and shoot dieback, as well as suppressing the formation and expansion of new leaves and stem (Kozlowski 1997).

Inundation and water logging may also result in disruptions to life-history processes such as flowering, fruit production and fruit set (Kozlowski 1997). These processes may be withheld (that is, not occur at all), or proceed with reduced vigour and quality (Kozlowski 1997).

In addition, flood stressed plants may also less resilient to abiotic impacts such as storms and intense wind, or bushfire. Stressed plants with damaged roots may suffer from windthrow and tree fall, especially after flooding where the substrate has been altered through erosional processes and changes in soil strength associated with saturation. Furthermore, fire response adaptations may be compromised in flood stressed plants as a result of the reduced energy levels and altered hormonal processes.

Flood stress may also impact susceptible soil-stored seeds. Inundation may trigger germination for some species. This germination response would vary depending upon the current susceptibility of the soil stored seed to coupled triggers, of which inundation may be only one input. For seed that is not triggered into germination, other impacts may affect seed’s viability, predator interaction, physical arrangement within the soil, movement away from suitable habitat and metabolic stress. These impacts relate to the indirect impact of degradation and changes to terrestrial habitats.

Flood tolerance varies greatly among plant species, genotypes and environmentally induced development, and is influenced by plant age, time of year, duration, depth and frequency of flooding, condition of the floodwater, and current or historical environmental characteristics of site. Therefore, the actual flood stress response to inundation and waterlogging may vary between each flood event (Howell and Benson 2000).

7.1.2.2 Changes to vegetation structure, composition, and condition

Species composition within the study area has the potential to change within riparian, floodplain, and wetland communities, as well as for communities which are not strongly associated with fluvial, lacustrine or wetland processes. However, the potential magnitude of change across the study area would vary depending on the depth, duration, and frequency of inundation.

Structure, species composition and overall condition are related, but changes to ecological inputs, including impacts, may see a variable response to these three physical aspects of ecological communities. As discussed in Section 7.1.2.1, generally, vascular plants are either tolerant to inundation and waterlogging and are therefore present within flood-prone habitats, or they are intolerant to inundation and waterlogging and therefore excluded from these habitats (Catford and Jansson 2014). Notwithstanding, some species may be tolerant to inundation resulting from a stochastic or temporary event, depending on the specific environmental characteristics of that one-off event. Where the inundation results in waterlogging of soils, the distribution of many vascular plant species may be impacted through plant mortality, inhibited seed germination and growth, , and altered plant anatomy (Kozlowski 1997). Consequently, there is generally a negative correlation between tolerance to inundation and waterlogging, and distance from rivers and riparian areas, wetlands, and waterbodies (Catford and Jansson 2014).

Except for forested wetland communities occurring along the major tributaries, much of the vegetation surrounding Lake Burragorang is dry sclerophyll forest comprising species that are generally not adapted to inundation or waterlogging (Keith 2004). These dry sclerophyll forest communities typically occur on infertile soils on steep terrain away from the fertile valleys and plains (Keith 2004). Temporary inundation events across the study area at differing frequencies may result in the loss of species with few adaptions to tolerate temporary inundation or waterlogging, although the actual response may vary depending on the depth and duration of temporary inundation. Even with the riparian vegetation communities, such as forested wetlands, community composition is shaped by adaptations to inundation, flood disturbance, and dispersal mechanisms of the component plant species, thus resulting in an assemblage determined by the dispersal, environmental and biotic constraints (Catford and Jansson 2014). Thus, alterations or modifications to these inputs may alter community composition in response.

Areas disturbed by temporary inundation may be susceptible to weed invasion post-flood event as a result of germination triggers such as an increase in solar access, changes to soil nutrient levels, physical disturbance to soil, and deposition of weed propagules. Exotic species tend to have high propagule availability and greater dispersal capacity. Furthermore, as exotic plants tend to be generalist in their habitat requirements, and possess life history strategies suited to frequent disturbance, they would likely be able to out compete native species poorly adapted to new environmental conditions (Catford and Jansson 2014). Modification to existing soil structure and a reduction in native community resilience would also favour the establishment of exotic species. The extent of impact may also depend on proximity to sources of weed propagules.

Overall, the vegetation in the study area typically has intact vegetation structure, with high species diversity and in a high-quality condition for all plant communities. Some areas of PCT HN527, equivalent to White Box Yellow Box Blakely's Red Gum Woodland EEC, have been modified by previous grazing and clearing. These modified areas of White Box Yellow Box Blakely's Red Gum Woodland EEC are still in good condition, even though they include areas of derived native grassland and have some structural change. All vegetation in the study area, including these areas of derived native grasslands, have been assessed as the highest of the broad FBA condition class classification as 'moderate to good', with no areas identified as being in 'low' condition.

Impacts to vegetation structure and composition may see a change in vegetation condition or site value, depending on the depth and duration of temporary inundation.

7.1.2.3 Physical damage to vegetation and habitat

The Project would result in changes in temporary inundation in the main reservoir area, specifically it would result in increased extent, duration and frequency of temporary inundation. Because the Project does not impact the volume and velocity of inflows, there would only be marginal changes to velocity profiles under the Project scenarios.

While the likelihood of impact from the temporary inundation is low some physical damage upon the vegetation may occur in some areas. Inundation can cause physical damage to plants, namely, scarring, bending, and uprooting (Kozlowski 1997, Lind *et al*. 2014). Riparian plant species typically possess resistance strategies such as stem, leaf, and root flexibility, brittle twigs to enable self-thinning, and widespread root systems to assist in surviving inundation (Catford and Jansson 2014). These adaptations may not be present within the terrestrial plant species occurring within the study area. A plant's morphology is in part driven by its phenotypic characteristics, but also by the environmental conditions. As such, it is unlikely that the vegetation within the study area possesses adaptive or acclimatised growth to withstand the physical forces of inundation. Consequently, the vegetation within the study area may be susceptible to physical damage from the increased temporary inundation associated with the Project.

Physical damage to plants would produce edge effects, both biotic (as weed establishment, native vegetation change and disturbance succession) and abiotic (changes to light, humidity and edaphic conditions), which may persist for periods of time, particularly with ongoing effects of recurring changed flood regimes.

7.1.2.4 Erosion and sedimentation

An erosion hot spot model was developed which was used to assess potential changes in erosion potential due to the Project. The erosion hot spot model used the following variables to assess erosion potential:

- soil type
- slope
- change in water velocity or wave height (water velocity was used in the upstream tributary areas whereas in the main reservoir wave erosion was considered to be more of an erosional force)
- change in vegetation cover.

Generally, the existing erosion potential of the catchment is relatively low as:

- the catchment is well vegetated, which reduces erosion
- water velocities and wave heights are generally low which reduces the hydrological forces causing erosion.

The small areas that currently have a high erosion potential are predominately steep slopes with erosive soils.

Generally, the Project would result in a temporary decrease in water velocities outside of Lake Burragorang as there would be a larger backwater area behind the dam. This would result in a decrease in the erosive potential of flows in the tributaries where flows are generally the highest. Where vegetation cover is reduced as a result of flood stress there may be an increase in erosion potential in those areas.

Deposition of sediments generally occurs when higher velocity sediment-laden water meets with a water area of lower velocity. As the Project would temporarily result in a larger ponded body of water (with a lower velocity), deposition zones would change and generally move upstream from their current locations along the tributaries. The tributaries that would be potentially be most affected would be the Wollondilly River and the Coxs River – as these two tributaries have the largest catchments and the highest proportion of cleared catchments upstream of the dam. They also have the highest sediment loads in comparison to other tributaries. While there may be some increase in sediment loads from the immediate catchment of the dam and tributaries due to the Project, the vast majority of sediment would still originate from areas upstream of the dam.

For most events (less than 1% AEP flood event) there would only be marginal changes in the velocity profiles along the tributaries so there would be little or no change in the current sediment deposition zones. For the larger events, the sediment depositions zone may move upstream in the Wollondilly River and in the Coxs River – with the other rivers largely unaffected.

The main potential impacts from changes in sediment deposition zones largely relate to smothering of vegetation and loss of soil stored seedbank. However, this impact is expected to be minimal at deposition locations in comparison to other potential impacts of the Project such as the increased depth, duration and extent of inundation.

7.1.2.5 Fauna mortality from inundation

As noted above the main potential impacts of the Project are on loss and modification of vegetation and the impacts of that on the habitat of threatened flora and fauna. Fauna mortality may also occur directly as a result of animals killed through injury or stress during flood events, particularly should the flood events occur during breeding periods where juveniles may have limited ability to flee flood water and can be sensitive to disturbance. More mobile species with generalist habitat requirements could relocate to adjacent habitat during a flood event.

7.1.3 Summary of potential impacts

Impacts of the Project during the ongoing operation could include:

- changes to the structure and condition of native vegetation communities including threatened ecological communities
- changes to the habitat of threatened and non-threatened flora and fauna species
- changes to erosion and sedimentation
- fauna and flora mortality from inundation
- other potential changes that could occur as a result of impacts to native vegetation including:
  - edge effects
  - weed invasion and encroachment
  - creating habitat conducive to invasive or over-abundant fauna
  - introduction or spread of diseases and pathogens
  - changes to natural fire regimes.

7.1.4 Identified impacts resulting from temporary inundation for flood mitigation

There is limited published information about the effects of temporary inundation for flood mitigation of terrestrial ecosystems. The assessment draws on a number of studies to infer potential impacts. These include a study commissioned by Infrastructure NSW to assess the environmental impacts of temporary inundation upstream of Queensland Flood Mitigation Dams (Hydrobiology 2020), a study commissioned by WaterNSW to examine the response to temporary inundation of *Eucalyptus benthamii* (Camden White Gum), which is a listed threatened species known to be potentially impacted by the Project, and surveys undertaken as part of this assessment for sites that have been impacted by temporary inundation under the current operation of Warragamba Dam.

Hydrobiology (2020) undertook a field based and literature review to investigate the effects of temporary flood inundation on flora and fauna surrounding flood mitigation dams in Queensland. The focus of the study was on the Hinze Dam on the Gold Coast however additional investigations were undertaken on Wivenhoe Dam north-west of

Brisbane. These dams include a flood mitigation function that results in temporary inundation of land upstream of the dam. The Hinze Dam is particularly relevant as it is predominately surrounded by native vegetation and has been subject to temporary inundation from a cyclone event in 2017. The study found that upstream of Hinze Dam the authors suggested that there had been impacts on vegetation health between 0–1 metre from the FSL from the inflow event. The event resulted in an elevated water level of around 5.7 metres above FSL which took more than two months to be released.

The report was not conclusive for the Hinze Dam study as to whether vegetation impacts resulted from inundation or edge effects and based on the limited evidence of the one event did not suggest that temporary inundation would inevitably cause substantial environmental impact.

For Wivenhoe Dam the flood event was Jan 2011 where water levels remained above FSL for about 17 days reaching 8.1 m above FSL. For 50 percent of the time water levels were up to two metres above FSL. The results showed no change to woody vegetation cover or noticeable change to ground cover (including erosion, weed recruitment or evidence of sediment deposition).

The authors indicated that these were preliminary findings and further long term monitoring would be required to determine if longer term changes to vegetation condition would result.

The tolerance of *Eucalyptus benthamii* to temporary inundation was investigated in a research study carried out between September 2017 and February 2018 in Deniliquin by the CSIRO on behalf of WaterNSW. The paper produced by the CSIRO is provided in Appendix H of this report. Specifically, the study examined the effects of temporary inundation for up to six weeks on the health and survival of a stand of 18 year-old *Eucalyptus benthamii* as well as the soil physical and chemical properties for up to one year after the initial flooding treatments (Bush and England 2019). Two separate experiments (Experiment 1 and Experiment 2) were conducted for the study. For Experiment 1, compartments of the trial site were temporarily flooded to a depth of 30 centimetres, commencing in March 2017, for duration of one, two, four, and six weeks. These treatments corresponded with flood scenarios determined by WaterNSW modelling. A control group of trees, which received no flooding treatment (Control A), was located adjacent to the flooded treatments. However, water from the flood treatments drained throughout the control site. As such, a second control site (Control B) was established. Experiment 2 was designed in the same way as Experiment 1 but commenced in August 2017.

Prior to the experiments commencing, baseline data was collected and them compared throughout the length of the study. Traits that were measured for each tree include growth and health traits such as DBH, height to live growth, epicormic shoots, lignotuberous shoots, and general heath. Experiment 1 was monitored for two years while Experiment 2 was monitored for 18 months. In addition to tree health, soil physical and chemical properties were measured before, during, and after the flooding treatments. The soil at the trail sites are described as being a Subnatric Brown Sodosol (Bush and England 2019). The A-horizon field texture was a silty clay loam and the B-horizon was a medium clay soil. The upper 100 centimetres of the soil was considered non-saline to slightly saline, whereas the 100-140-centimetre layer was moderately saline, meaning that salinity levels could adversely affect the growth of some plants. The soil from 0-40 centimetres was non-sodic, but from 40-140 centimetres depth the soil is sodic meaning that there are excessive amounts of exchangeable sodium present. This portion of the study found that the tree stands in both experiments were subject to anaerobic conditions over the course of the flood treatment.

The study found that there was no statistical evidence that temporary inundation to a depth of 30 centimetres led to a decline in *Eucalyptus benthamii* health and survival over a period of 24 months after the application of flooding treatments which led to anaerobic soil conditions. While there was some evidence of stress within the stands, as well as some limited mortality, this was attributed to protracted hot and dry conditions in Deniliquin as demonstrated by similar stress and loss in control stands.

While it appears that *Eucalyptus benthamii* may be tolerant to temporary inundation for up to six weeks duration to a depth of 30 centimetres (Bush and England 2019), there are some key differences between the scenario within which the experiment was carried out and the modelled conditions expected to occur *in situ* within the Kedumba River population of *Eucalyptus benthamii*. Specifically, the depth of inundation is expected to be more variable and potentially much greater than 30 centimetres. Under these circumstances the impacts on *Eucalyptus benthamii* may be greater than identified in the controlled study.

As noted in Section 4, 95 plots were surveyed across the study area. Each of these plots were assessed for a range of factors (species richness, presence of weeds etc) compared to a benchmark for the PCT, and a site value score generated for each vegetation zone. Notionally, the higher the score the closer to benchmark the plot is likely to be. All plots were considered to be in moderate to good condition – poor condition is a score 17 or below whereas the

Warragamba plots ranged between 50-100. There was minimal difference in score between plots close to the FSL and therefore subject to existing temporary inundation and plots not subject to existing temporary inundation. While this doesn't demonstrate that temporary inundation will not impact on vegetation it does indicate that any change is likely to be difficult to measure and observe and that change, where it occurs will be transitional.

7.1.5 Limitations of the assessment

A precautionary approach has been adopted in assessing potential upstream biodiversity impacts including the adoption of the precautionary principle where sufficient information does not to exist to confidently assess potential impacts. Application of the precautionary principle requires that a lack of scientific certainty about the potential impacts of an action does not itself justify a decision that the action is unlikely to have an impact.

The spatial and temporary impacts associated with temporary inundation may be variable depending on future rainfall events, making the future impacts associated with the Project difficult to quantify. In addition to this, key uncertainties and issues in the impact assessment are discussed as follows.

- The existing scientific literature has little definitive results confirming the extent of impacts of short-term inundation of flora and PCTs specific to the vegetation found in the study area. Any change is likely to occur over a long period of time subject to the large variability of the impact.
- While there is some research on inundation impacts for some vegetation found in the study area such as *Eucalyptus benthamii*, for the vast majority of vegetation there is no scientific literature. The study area has specific environmental characteristics such as rapidly draining alluvial soils in many areas – which may reduce certain impacts of temporary inundation (or improve recovery) such as impacts from waterlogged soils. This has resulted in conservative assumptions of the impacts of temporary inundation.
- Biodiversity information within the study area and the broader locality – Up until the biodiversity surveys undertaken for the Project, there was very little ground-truthed vegetation mapping and other biodiversity information available for the study area and surrounding area. While the biodiversity survey works included a substantial portion of the study area, not all of the study area was able to be visited due to its size and access constraints. Very few areas outside the study area were surveyed and therefore it was difficult to provide a context for some of the impacts with the regional presence of PCTs, flora and fauna.

The assessment takes into consideration and uses best available knowledge to input to the FBA. It takes a precautionary approach to impacts by assuming loss of all vegetation within the upstream impact area. However, because there will be no impact until the dam is raised and an actual flood occurs that fills the lake above FSL, there is opportunity to refine the assessment by undertaking:

- further vegetation mapping and assessment to refine the extents of key threatened PCTs
- additional biodiversity surveys to confirm the presence/absence of threatened flora and fauna.

7.2 Assessment of impacts

As discussed in Section 1.5.4 the upstream impact area has been defined as the area between 2.78 m above FSL (RL 119.5 mAHD) and 10.25 m above FSL (RL 126.97 mAHD). This reflects the difference between the likely inundation level with the Project over a 20-year period and the likely inundation level for the existing dam over a 20-year period. This area has been used to assess the impacts of the Project and calculate offsetting. For the purpose of the assessment it is assumed that the future site value of the native vegetation within the upstream impact area is zero (0). Thus, equivalent to full clearance of the site and loss of all native vegetation and threatened species values within the area and represents a precautionary approach to estimating impact and calculation of offsets for the Project.

7.2.1 Impacts on native vegetation

The Project's ongoing operation would result in potential impacts associated with temporary inundation to native vegetation across about 1,400 hectares.

Native vegetation types within the upstream impact area includes areas of all 18 PCTs mapped in the study area.

A summary of the areas within the upstream impact area is provided in Table 7-1.

Table 7-1. PCTs impacted within the upstream impact area

BVT code	PCT name	BC Act status	EPBC Act status	Area within upstream impact area
HN517 (PCT 769)	Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion	-	-	0.53
HN525 (PCT 832)	Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion	-	-	84.20
HN527 (PCT 840)	Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands	Critically Endangered	Critically Endangered	127.75
HN532 (PCT 860)	Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes on the Blue Mountains, Sydney Basin Bioregion	-	-	226.04
HN533 (PCT 862)	Grey Gum - Hard Leaved Scribbly Gum woodland of the Cox River Valley	-	-	10.97
HN535 (PCT 870)	Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountain gorges, Sydney basin Bioregion	-	--	22.17
HN536 (PCT 871)	Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	-	-	212.92
HN537 (PCT 875)	Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion	-	-	0.13
HN538 (PCT 877)	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East corner Bioregion	-	-	28.09
HN553 (PCT 941)	Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion	Endangered	Critically Endangered	107.09
HN564 (PCT 1081)	Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion	-	-	2.51
HN566 (PCT 1083)	Red bloodwood -scribbly gum heathy woodland on sandstone plateaux of the Sydney basin Bioregion	-	-	28.63
HN568 (PCT 1086)	Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion	-	-	31.21
HN574 (PCT 1105)	River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion	-	-	67.31
HN598 (PCT 1246)	Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion	-	-	9.71
HN606 (PCT 1284)	Turpentine - smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion	-	-	37.73
HN607 (PCT 1292)	Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion	-	-	73.60
HN557 (PCT 1401)	Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion	Critically Endangered	Critically Endangered	302.81

7.2.2 Impacts on threatened ecological communities

Of the 18 PCTs potentially impacted by temporary inundation, three have been assessed as conforming to two BC Act listed TECs. The same PCTs have been assessed as an EPBC Act listed TEC.

HN553 Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion has been identified in the study area as a component of River-Flat Eucalypt Forest on Coastal Floodplains, which is listed as an endangered ecological community under the BC Act and as a critically endangered ecological community (CEEC) under the EPBC Act. All areas of this PCT mapped in the broader study area have also been assessed as the EEC.

Within the study area, River-Flat Eucalypt Forest is distributed in two key locations: along the Kedumba River, and along the Nattai River.

Impacts associated with temporary inundation would potentially result in loss of and floristic and structural change to the threatened ecological community and its values.

- The area of the TEC within the upstream impact area is 107.09 hectares.

Two PCTs, HN527 Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands and HN557 Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion have been identified within the study area as components of White Box Yellow Box Blakely's Red Gum Woodland which is listed as a critically endangered ecological community under the BC Act.

These two PCTs, HN527 and HN557, have also been identified within the study area as components of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as a critically endangered ecological community (CEEC) under the EPBC Act.

Within the study area, the majority of White Box Yellow Box Blakely's Red Gum Woodland is distributed upstream from Higgins Bay, immediately surrounding Lake Burragorang and along the Wollondilly River.

Impacts associated with temporary inundation would potentially result in loss of, and floristic and structural change to the threatened ecological community and its values.

- The area of these TECs within the upstream impact area is 430.56 hectares.

7.2.3 Loss of threatened flora species and their habitat

The Project’s ongoing operation would result in potential impacts associated with temporary inundation of suitable habitat for threatened flora species. Generally, potential impacts to threatened flora species and their habitat associated with temporary inundation include flood stress, physical damage to individual plants, and loss of soil stored seed bank.

As noted in Section 1.5, the magnitude and extent of flooding will be variable depending on future rainfall events, making future impacts associated with the Project difficult to accurately characterise and quantify, particularly for the larger, less frequent events. Whilst the threatened flora species considered within this assessment are unlikely to tolerate long term inundation, including waterlogging, and may be adversely impacted during an inundation event; there is uncertainly relating to the timing, duration, and depth of inundation. Therefore, the consequence of any given event is difficult to accurately quantify and describe in detail.

A description of the impacts of temporary inundation on each threatened flora candidate species and its habitat is provided in Table 7-2.

Table 7-2. Description of Project impacts on flora species credit species

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Acacia baueri subsp. aspera	*Acacia baueri subsp. aspera*	V	-	Temporary inundation resulting from the Project may adversely impact this species.
Acacia bynoeana	Bynoe's Wattle	E	V	Temporary inundation resulting from the Project may adversely impact this species.
Acacia clunies-rossiae	Kanangra Wattle	V	-	During the current assessment, the species was recorded upstream of Green Wattle Creek, around the shores of Lake Burragorang and along the main tributaries, including Kedumba, Cox, and Kowmung Rivers, however suitable habitat for the species is found along the western shores of Lake Burragorang from the Wollondilly River to Coxs River. Temporary inundation resulting from the Project may adversely impact this species.
Acacia flocktoniae	Flockton Wattle	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Acacia gordonii	*Acacia gordonii*	E	E	Temporary inundation resulting from the Project may adversely impact this species.
Acacia pubescens	Downy Wattle	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Acrophyllum australe	*Acrophyllum australe*	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Ancistrachne maidenii	*Ancistrachne maidenii*	V	-	Temporary inundation resulting from the Project may adversely impact this species.
Asterolasia buxifolia	*Asterolasia buxifolia*	E	-	Temporary inundation resulting from the Project may adversely impact this species.
Asterolasia elegans	*Asterolasia elegans*	E	E	Temporary inundation resulting from the Project may adversely impact this species.
Astrotricha crassifolia	Thick-leaf Star-hair	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Baloskion longipes	Dense Cord-rush	V	V	Temporary inundation resulting from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Bossiaea oligosperma	Few-seeded Bossiaea	V	V	During the current assessment, the species was recorded upstream of Murphys Crossing on the Wollondilly River, around the shores of Lake Burragorang to around Higgins Bay. Temporary inundation resulting from the Project may adversely impact this species.
Caesia parviflora var. *minor*	Small Pale Grass-lily	E	-	Temporary inundation resulting from the Project may adversely impact this species.
Callistemon linearifolius	Netted Bottle Brush	V	-	During the current assessment, the species was recorded in three locations: Little River, Tonalli Cove, and along Green Wattle Creek. . Temporary inundation resulting from the Project may adversely impact this species.
Callistemon megalongensis	Megalong Valley Bottlebrush	CE	CE	Temporary inundation resulting from the Project may adversely impact this species.
Calomnion complanatum	*Calomnion complanatum*	E	-	Temporary inundation resulting from the Project may adversely impact this species.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Cynanchum elegans	White-flowered Wax Plant	E	E	None – no habitat for this species within the study area.
Darwinia biflora	*Darwinia biflora*	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Darwinia peduncularis	*Darwinia peduncularis*	V	-	Temporary inundation resulting from the Project may adversely impact this species.
Dillwynia tenuifolia	*Dillwynia tenuifolia*	V	-	Temporary inundation resulting from the Project may adversely impact this species.
Epacris hamiltonii	*Epacris hamiltonii*	E	E	Temporary inundation resulting from the Project may adversely impact this species.
Epacris purpurascens subsp. *purpurascens*	*Epacris purpurascens* subsp. *purpurascens*	V	-	Temporary inundation resulting from the Project may adversely impact this species.
Epacris sparsa	Sparse Heath	V	V	Temporary inundation resulting from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Eucalyptus benthamii	Camden White Gum	V	V	During the current assessment, the species was recorded within the riparian area of the Kedumba River. Stands of 18 year-old *Eucalyptus benthamii* appear to be able to tolerate temporary inundation for up to 6 weeks to a depth of approximately 30 cm (CSIRO, 2019). This suggests that the species has some tolerance to temporary inundation, which may be expected given its association with forested wetlands. However, impacts to the species due to inundation to greater depths, is unknown.
Eucalyptus glaucina	Slaty Red Gum	V	V	During the current assessment, the species was recorded across much of the study area, around the shores of Lake Burragorang and along the main tributaries, including Wollondilly, Nattai, Kedumba, Cox, and Kowmung Rivers. The species may possess some adaptions to flood stress including temporary water logging, however, the Project may still adversely impact this species.
Eucalyptus pulverulenta	Silver-leafed Gum	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Euphrasia bowdeniae	*Euphrasia bowdeniae*	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Genoplesium baueri	Bauer's Midge Orchid	E	E	Temporary inundation resulting from the Project may adversely impact this species.
Genoplesium superbum	Superb Midge Orchid	E	-	Temporary inundation resulting from the Project may adversely impact this species.
Grammitis stenophylla	Narrow-leaf Finger Fern	E	-	During the current assessment, the species was found along West Warragamba Wall, and along Werriberri Creek. Temporary inundation resulting from the Project may adversely impact this species.
Grevillea evansiana	Evans Grevillea	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	Temporary inundation resulting from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Gyrostemon thesioides	*Gyrostemon thesioides*	E	-	Temporary inundation resulting from the Project may adversely impact this species.
Hakea dohertyi	Kowmung Hakea	E	E	During the current assessment, *Hakea dohertyi* was recorded in one location: Tonalli Cove. Temporary inundation resulting from the Project may adversely impact this species.
Haloragodendron lucasii	Hal	V	V	Temporary inundation resulting from this Project may adversely impact this species.
Hibbertia puberula	*Hibbertia puberula*	E	-	Temporary inundation resulting from this Project may adversely impact this species.
Hygrocybe anomala subsp. *ianthinomarginata*	*Hygrocybe anomala* subsp. *ianthinomarginata*	V	-	Temporary inundation resulting from this Project may adversely impact this species.
Hygrocybe aurantipes	*Hygrocybe aurantipes*	V	-	Temporary inundation resulting from this Project may adversely impact this species.
Hygrocybe reesiae	*Hygrocybe reesiae*	V	-	Temporary inundation resulting from this Project may adversely impact this species.
Isopogon fletcheri	Fletcher’s Drumsticks	V	V	Temporary inundation resulting from this Project may adversely impact this species.
Kunzea rupestris	*Kunzea rupestris*	V	V	Temporary inundation resulting from this Project may adversely impact this species.
Lastreopsis hispida	Bristly Shield Fern	E	-	Temporary inundation resulting from this Project may adversely impact this species.
Leionema lachnaeoides	*Leionema lachnaeoides*	E	E	Temporary inundation resulting from the Project may adversely impact this species.
Lepidosperma evansianum	Evans Sedge	V	E	Temporary inundation resulting from the Project may adversely impact this species.
Leucopogon exolasius	Woronora Beard-heath	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Leucopogon fletcheri subsp. *fletcheri*	*Leucopogon fletcheri* subsp. *fletcheri*	E	-	Temporary inundation resulting from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Melaleuca deanei	Deane's Paperbark	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Melaleuca groveana	Grove's Paperbark	V	-	Temporary inundation resulting from the Project may adversely impact this species.
Micromyrtus blakelyi	*Micromyrtus blakelyi*	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Olearia cordata	*Olearia cordata*	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Persicaria elatior	Tall Knotweed	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Persoonia acerosa	Needle Geebung	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Persoonia bargoensis	Bargo Geebung	E	V	Temporary inundation resulting from the Project may adversely impact this species.
Persoonia glaucescens	Mittagong Geebung	E	V	Temporary inundation resulting from the Project may adversely impact this species.
Persoonia hirsuta	Hairy Geebung	E	E	Temporary inundation resulting from the Project may adversely impact this species.
Pherosphaera fitzgeraldii	Dwarf Mountain Pine	E	E	Temporary inundation resulting from the Project may adversely impact this species.
Phyllota humifusa	Dwarf Phyllota	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Pimelea curviflora var. *curviflora*	*Pimelea curviflora* var. *curviflora*	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Pomaderris brunnea	Brown Pomaderris	E	V	During the current assessment, the species was recorded along the Nattai River, at Tonalli Cover, Higgins Bay, and around Butchers Creek. Temporary inundation resulting from the Project may impact this species. Note local population may have increased as a result of existing inundation.
Pterostylis saxicola	Sydney Plains Greenhood	E	E	Temporary inundation resulting from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Pultenaea glabra	Smooth Bush-pea	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Pultenaea parviflora	*Pultenaea parviflora*	E	V	Temporary inundation resulting from the Project may adversely impact this species.
Pultenaea sp. Olinda	*Pultenaea sp. Olinda*	E	-	Temporary inundation resulting from the Project may adversely impact this species.
Pultenaea villifera – endangered population	*Pultenaea villifera* population in the Blue Mountains Local Government Area	EP	-	None – no habitat for this endangered population within the study area.
Rhizanthella slateri	Eastern Australian Underground Orchid	V	E	Temporary inundation resulting from the Project may adversely impact this species.
Rhodamnia rubescens	Scrub Turpentine	CE	-	Temporary inundation resulting from the Project may adversely impact this species.
Solanum amourense	*Solanum armourense*	E	-	During the current assessment, the species was recorded upstream of Murphys Crossing on the Wollondilly River, around the shores of Lake Burragorang. Temporary inundation resulting from the Project may adversely impact this species.
Tetratheca glandulosa	*Tetratheca glandulosa*	V	-	Temporary inundation resulting from the Project may adversely impact this species.
Trachymene scapigera	Mountain Trachymene			Temporary inundation resulting from the Project may adversely impact this species.
Velleia perfoliata	*Velleia perfoliata*	V	V	Temporary inundation resulting from the Project may adversely impact this species.
Xanthosia scopulicola	*Xanthosia scopulicola*	V	-	Temporary inundation resulting from the Project may adversely impact this species.
Zieria covenyi	Coveny's Zieria	E	E	Temporary inundation resulting from the Project may adversely impact this species.
Zieria involucrata	*Zieria involucrata*	E	V	Temporary inundation resulting from the Project may adversely impact this species.
Zieria murphyi	Velvet Zieria	V	V	Temporary inundation resulting from the Project may adversely impact this species.

Threatened species polygons (Appendix B) were derived for each of the threatened flora candidate species in accordance with 6.5.1.14 of the FBA based on the following filters:

- associated PCTs in BioNET Vegetation Classification System and Threatened Biodiversity Data Collection
- associated PCTs based on field observations
- associated PCTs described in Appendix C of NPWS (2003a)
- distribution patterns.
- from field observations.
- from records (Atlas of Living Australia, BioNet Wildlife Atlas, Australian Virtual Herbarium):
- distributions patterns further refined by geographical/abiotic features/barriers
- known and/or predicted IBRA subregions
- species specific habitat features, or components listed within the Threatened Species Profile Database,
- catchments
- landforms
- soils
- aspect
- Known microhabitats where known (that is, riparian areas, cliffs, etc).

A summary of the habitat impacted within the upstream impact area, and a description of how these areas were derived is shown in Table 7-3.

Table 7-3. Summary of species credit species habitat impacted by the Project

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
Acacia baueri subsp. aspera	-	Associated PCTs: HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within Wollemi IBRA subregion	7 ha
Acacia bynoeana	Bynoe's Wattle	Associated PCTs: HN564; HN566; HN568; HN604 Associated IBRA subregion: Burragorang and Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within Burragorang and Wollemi IBRA subregions	35 ha
Acacia clunies-rossiae	Kanangra Wattle	Associated PCTs: HN525; HN527; HN532; HN535; HN536; HN537; HN538; HN557; HN574; HN598 Associated IBRA subregion: Burragorang, Kanangra, Bungonia Onsite distribution: Coxs River Catchment (above the confluence with the Wollondilly), western side of Wollondilly arm of Lake Burragorang north from Murphies Crossing	All associated PCTs in the Coxs River Catchment (above the confluence with the Wollondilly), western side of Wollondilly arm of Lake Burragorang north from Murphies Crossing - within Burragorang, Kanangra, Bungonia subregions	770 ha
Acacia flocktoniae	Flockton Wattle	Associated PCTs: HN525; HN527; HN533; HN535; HN536; HN564; HN568; HN598 Associated IBRA subregion: Burragorang, Bungonia, Kanangra and Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within all IBRA subregions	371 ha
Acacia gordonii	-	Associated PCTs: HN564; HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	8 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
Acacia pubescens	Downy Wattle	Associated PCTs: HN564; HN566; HN568; HN604 Associated IBRA subregion: Burragorang and Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Burragorang and Wollemi IBRA subregions	35 ha
Acrophyllum australe	-	Associated PCTs: HN517; HN566; HN606 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present. Habitat constraint: within 500 m of south-facing cliff lines	All PCTs within 500m buffer of south-facing cliff-lines – within Wollemi IBRA subregion	13 ha
Ancistrachne maidenii	-	Associated PCTs: HN564; HN566; HN606 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	29 ha
Asterolasia buxifolia	-	Associated PCTs: HN574 Associated IBRA subregion: Burragorang Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Burragorang IBRA subregion	14 ha
Asterolasia elegans	-	Associated PCTs: HN517; HN566; HN606 Associated IBRA subregion: Wollemi Associated soil landscapes: Hawkesbury sandstone Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within study area that occur on mapped Hawkesbury sandstone soil landscape	6 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
Astrotricha crassifolia		Associated PCTs: HN566; HN607 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	8 ha
Baloskion longipes	Dense Cord-rush	Associated PCTs: HN574 Associated IBRA subregion: Burragorang and Kanangra Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Burragorang and Kanangra IBRA subregions	31 ha
Bossiaea oligosperma	Few-seeded Bossiaea	Associated PCTs: HN525; HN527; HN532; HN536; HN557; HN574 Associated IBRA subregion: Burragorang, Bungonia Onsite distribution: Coxs River Catchment (above the confluence with the Wollondilly), western side of Wollondilly arm of Lake Burragorang north from Murphies Crossing	All associated PCTs in the Wollondilly River Catchment: from confluence of Nattai River, south to Murphy's Crossing – within Burragorang and Bungonia IBRA subregions	483 ha
Caesia parviflora var. minor		Associated PCTs: HN536; HN564; HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	15 ha
Callistemon linearifolius	Netted Bottle Brush	Associated PCTs: HN574; HN604; HN553 Associated IBRA subregion: Nil Onsite distribution: Nattai River and Little River Tonalli River Green Wattle Creek	All associated PCTs in three disjunct distributions: To the confluence of Nattai River and Little River Tonalli River Green Wattle Creek	1,968 ind

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
Callistemon megalongensis	Megalong Valley Bottlebrush	Associated PCTs: HN533 Associated IBRA subregion: Burragorang and Wollemi Habitat constraint: within 300 m of creek lines Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within 300 m of 3rd order streams or larger - within Wollemi and Burragorang IBRA subregions	6 ha
Calomnion complanatum	-	Associated PCTs: HN517 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	1 ha
Cryptostylis hunteriana	Leafless Tongue Orchid	Associated PCTs: HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	7 ha
Cynanchum elegans	White-flowered Wax Plant	Associated PCTs: HN537; HN538 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	0 ha
Darwinia biflora		Associated PCTs: HN564; HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	80 ha
Darwinia peduncularis		Associated PCTs: HN536; HN566; HN607; HN598 Associated IBRA subregion: Wollemi	All associated PCTs within Wollemi IBRA subregion	15 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
		Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.		
Dillwynia tenuifolia	-	Associated PCTs: HN564 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	2 ha
Epacris hamiltonii		Associated PCTs: HN517; HN607 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	3 ha
Epacris purpurascens subsp. *purpurascens*	-	Associated PCTs: HN564; HN566; HN604; HN607 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys, however, there are two records within the study area on Werriberri Creek. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	300 ind
Epacris sparsa	Sparse Heath	Associated PCTs: HN607 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys, however. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	2 ind
Eucalyptus benthamii	Camden White Gum	Associated PCTs: HN533; HN532; HN536 Associated IBRA subregion: Burragorang, Wollemi Onsite distribution: species present within Kedumba River catchment.	All PCTs north of southern most *Eucalyptus benthamii* record – within Wollemi, Burragorang IBRA subregions	44 ha
Eucalyptus glaucina	Slaty Red Gum	Associated PCTs: HN557; HN525; HN527; HN532; HN535; HN536; HN538; HN553	All PCTs within Wollemi, Burragorang, Kanangra, Bungonia IBRA subregions	10,970 ind

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
		Associated IBRA subregion: Burragorang, Kanangra, Bungonia, Wollemi Onsite distribution: species present around Lake Burragorang, plus along Nattai River/Little River area, Butchers Creek, Cox River including west of Kelpie Point, and Wollondilly River.		
Eucalyptus pulverulenta	Silver-leafed Gum	Associated PCTs: HN533 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys, however. Assumed to be present.	All associated PCTs within Wollemi IBRA subregion	275 ind
Euphrasia bowdeniae		Associated PCTs: HN517; HN536 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present. Habitat constraint: within 500 m of south-facing cliff lines	All PCTs within 500 m buffer of south-facing cliff-lines – within Wollemi IBRA subregion	3 ha
Genoplesium baueri	Bauer's Midge Orchid	Associated PCTs: HN566 Associated IBRA subregion: Burragorang Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Burragorang subregion	223 ha
Genoplesium superbum	Superb Midge Orchid	Associated PCTs: HN566; HN532 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Wollemi subregion	10 ha
Grammitis stenophylla	Narrow-leaf Finger Fern	Associated PCTs: HN517; HN538; HN606; HN607; HN568 Associated IBRA subregion: Wollemi	All associated PCTs in Wollemi subregion	41 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
		Onsite distribution: East Warragamba Wall and tributary to Werriberri Creek		
Grevillea evansiana	Evans Grevillea	Associated PCTs: HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Wollemi subregion	7 ha
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	Associated PCTs: HN564; HN566; HN604 Associated IBRA subregion: Burragorang and Wollemi Onsite distribution: not observed within the survey area during current surveys, however, the species was recorded within the construction area. Assumed to be present.	All associated PCTs in Burragorang and Wollemi subregion	9 ha
Gyrostemon thesioides	-	Associated PCTs: HN532; HN535; HN536; HN553; HN557; HN564; HN574; HN604; HN607; HN598 Associated IBRA subregion: Burragorang Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Burragorang subregion	886 ha
Hakea dohertyi	Kowmung Hakea	Associated PCTs: HN517; HN527; HN538; HN606; HN607; HN557 Associated IBRA subregion: Bungonia, Burragorang, Kanangra Onsite distribution: Tonalli Cove	All associated PCTs along western side of Wollondilly arm of Lake Burragorang north from Murphies Crossing, until just north of Higgins Bay – within Bungonia, Burragorang, Kanangra IBRA subregions	199 ha
Haloragodendron lucasii		Associated PCTs: HN566; HN607 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Wollemi subregion	8 ha
Hibbertia puberula		Associated PCTs: HN564; HN566; HN568; HN604	All associated PCTs in Wollemi subregion	35 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
		Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.		
Hygrocybe anomala subsp. *ianthinomarginata*	-	Associated PCTs: HN517; HN536; HN566; HN606; HN607; HN598 Associated IBRA subregion: Burragorang, Wollemi, Kanangra Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Burragorang, Wollemi, and Kanangra subregions	267 ha
Hygrocybe aurantipes	-	Associated PCTs: HN517; HN536; HN566; HN606; HN607; HN598 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Wollemi subregion	35 ha
Hygrocybe reesiae	-	Associated PCTs: HN517; HN536; HN566; HN606; HN607; HN598 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Wollemi subregion	35 ha
Isopogon fletcheri		Associated PCTs: HN536 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present. Habitat constraint: within 500 m of south-facing cliff lines.	All associated PCTs within 500 m buffer of south-facing cliff-lines – within Wollemi IBRA subregion	3 ha
Kunzea rupestris		Associated PCTs: HN564; HN566 Associated IBRA subregion: Wollemi	All associated PCTs in Wollemi subregion	8 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
		Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.		
Lastreopsis hispida	Bristly Shield Fern	Associated PCTs: HN517; HN606; HN607 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs in Wollemi subregion	23 ha
Leionema lachnaeoides	-	Associated PCTs: HN517; HN598 Associated IBRA subregion: Burragorang and Wollemi Geology: Narrabeen sandstone Habitat constraint: within 200 m of cliff lines Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within 200 m of cliff lines on Narrabeen sandstone – within Wollemi and Burragorang IBRA subregions	1 ha
Lepidosperma evansianum	Evans Sedge	Associated PCTs: HN517 Associated IBRA subregion: Wollemi Habitat constraint: within 200 m of cliff lines Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs within 200 m of cliff lines– within Wollemi IBRA subregion	1 ha
Leucopogon exolasius	Woronora Beard-heath	Associated PCTs: HN564; HN566; HN568; HN607 Associated IBRA subregion: Burragorang and Wollemi Onsite distribution: not observed within the survey area during current surveys, however, there is one record immediately outside the survey area along Sheehy's Creek Road. Assumed to be present.	All associated PCTs – within Wollemi and Burragorang IBRA subregions	50 ha
Leucopogon fletcheri subsp. *fletcheri*	-	Associated PCTs: HN564; HN566 Associated IBRA subregion: Wollemi	All associated PCTs – within Wollemi IBRA subregion	8 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
		Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.		
Melaleuca deanei	Deane's Paperbark	Associated PCTs: HN564; HN566 Associated IBRA subregion: Wollemi, Burragorang (observed) Onsite distribution: Not recorded within the survey area but approximately 2.5 km outside between the Kedumba River and Kelpie Point	All associated PCTs in Wollemi and Burragorang IBRA subregions	9 ha
Melaleuca groveana	-	Associated PCTs: HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	6 ind
Micromyrtus blakelyi	-	Associated PCTs: HN564; HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	8 ha
Olearia cordata	-	Associated PCTs: HN564; HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	8 ha
Persicaria elatior	Tall Knotweed	Associated PCTs: Associated IBRA subregion: Burragorang Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	Within 50 metres of Lake Burragorang and tributaries within Burragorang IBRA subregion	896 ha
Persoonia acerosa	Needle Geebung	Associated PCTs: HN566; HN568	All associated PCTs – within Wollemi and Burragorang IBRA subregions	33 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
		Associated IBRA subregion: Burragorang and Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.		
Persoonia bargoensis	Bargo Geebung	Associated PCTs: HN564; HN566; HN568; HN606; HN607 Associated IBRA subregion: Burragorang Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Burragorang IBRA subregion	22 ha
Persoonia glaucescens	Mittagong Geebung	Associated PCTs: HN564; HN566; HN568 Associated IBRA subregion: Burragorang Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Burragorang IBRA subregion	9 ha
Persoonia hirsuta	Hairy Geebung	Associated PCTs: HN564; HN566; HN568; HN604 Associated IBRA subregion: Burragorang and Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi and Burragorang IBRA subregions	35 ha
Pherosphaera fitzgeraldii	-	Associated PCTs: HN517 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	1 ha
Phyllota humifusa	Dwarf Phyllota	Associated PCTs: HN568 Associated IBRA subregion: Burragorang Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Burragorang IBRA subregion	8 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
Pimelea curviflora var. curviflora	-	Associated PCTs: HN564; HN566; HN604 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	8 ha
Pomaderris brunnea	Brown Pomaderris	Associated PCTs: HN525; HN527; HN532; HN536; HN557; HN553; HN564; HN574; HN607 Associated IBRA subregion: Burragorang, Wollemi, Bungonia Onsite distribution: species recorded around Tonalli Cove, Higgins Bay, Nattai River, Butcher's Creek area	All associated PCTs within Wollemi, Burragorang, Bungonia IBRA subregions	1,146 ha
Pterostylis saxicola	Sydney Plains Greenhood	Associated PCTs: HN525; HN532; HN535; HN564 Associated IBRA subregion: Burragorang, Wollemi, Bungonia, Kanangra Habitat constraint: geology Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	HN525, HN532, HN535 on Lambie Group geology. HN564 on Hawkesbury sandstone. Within Wollemi, Burragorang, Bungonia, Kanangra IBRA subregions	111 ha
Pultenaea glabra	Smooth Bush-pea	Associated PCTs: HN566; HN568 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	33 ha
Pultenaea parviflora	-	Associated PCTs: HN566 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	7 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
Pultenaea sp. Olinda	-	Associated PCTs: HN566; HN598 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	7 ha
Rhizanthella slateri	Eastern Australian Underground Orchid	Associated PCTs: HN517; HN606; HN607 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	23 ha
Rhodamnia rubescens	Scrub Turpentine	Associated PCTs: HN517, HN537, HN538, HN606 Associated IBRA subregion: Burragorang, Bungonia, Wollemi, and Kanangra Onsite distribution: not observed within the survey area during current surveys, however, there are records at Yerranderie and Jenolan Caves. Assumed to be present.	All associated PCTs – within Burragorang, Bungonia, Wollemi, and Kanangra IBRA subregions	78 ha
Solanum amourense	-	Associated PCTs: HN525; HN527; HN532; HN535; HN536; HN538; HN557; HN568 Associated IBRA subregion: Burragorang, Kanangra, Bungonia Onsite distribution: east of Wollondilly River near Murphy's Crossing	All associated PCTs in the Wollondilly River Catchment: from confluence of Nattai River, south to extent of study area of Wollondilly River – within Burragorang, Kanangra, Bungonia subregions	470 ha
Tetratheca glandulosa	-	Associated PCTs: HN517; HN532; HN564; HN566; HN568; HN604; HN606; HN607; HN598 Associated IBRA subregion: Burragorang and Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Wollemi and Burragorang IBRA subregions	305 ha
Trachymene scapigera	-	Associated PCTs: HN553; HN557; HN574 Associated IBRA subregion: Kanangra	All associated PCTs – within Kanangra IBRA subregion	19 ha

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha) or number of Individuals (Ind)
		Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.		
Velleia perfoliata	-	Associated PCTs: HN532; HN536; HN564; HN566; HN598 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys, however. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	18 ha
Xanthosia scopulicola	-	Associated PCTs: HN606; HN598 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys, however. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	21 ha
Zieria covenyi	Coveny's Zieria	Associated PCTs: HN566; HN598 Associated IBRA subregion: Burragorang Onsite distribution: not observed within the survey area during current surveys. Assumed to be present.	All associated PCTs – within Burragorang IBRA subregion	11 ha
Zieria involucrata	-	Associated PCTs: HN606 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys, however. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	21 ha
Zieria murphyi	Velvet Zieria	Associated PCTs: HN566; HN598 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys, however. Assumed to be present.	All associated PCTs – within Wollemi IBRA subregion	7 ha

7.2.4 Impacts on threatened fauna species and their habitat

The Project's ongoing operation would result in result impacts associated with of temporary inundation to suitable habitat for threatened fauna species

Important fauna habitat features that may be impacted by the Project include:

- Understory vegetation: this includes grasses, sedges, forbs, herbs and small shrubs. This understory vegetation could be used as foraging habitat, breeding habitat and shelter by invertebrates, amphibians, reptiles, small birds and terrestrial mammals.
- Fallen logs, woody debris and leaf litter: These habitat features may be used as foraging habitat, breeding habitat and shelter by invertebrates, amphibians, reptiles, small birds and terrestrial mammals.
- Hollow-bearing living trees and stags: used as habitat by a range of fauna species which may rely on them for shelter, breeding or roosting. Loss of mature hollow-bearing trees has the potential to impact on breeding and shelter habitat for threatened species of birds, arboreal mammals, frogs, reptiles and microbats.
- Nectar-producing trees and shrubs: these are a food resources for blossom-dependant birds, arboreal mammals and mega chiropteran bats.
- Ephemeral drainage lines: used for shelter and breeding habitat for threatened amphibians.

As noted in Section 1.4.4, the magnitude and extent of flooding will be variable depending on future rainfall events, making future impacts associated with the Project difficult to accurately characterise and quantify, particularly for the larger, less frequent events. Therefore, the consequence of any given event is difficult to accurately quantify and describe in detail.

A description of the potential impacts of temporary inundation on each threatened fauna candidate species and its habitat is provided in Table 7-4.

Table 7-4. Description of potential Project impacts on fauna species credit species

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Anthochaera phrygia	Regent Honeyeater	CE	CE	During the current assessment a large breeding population of Regent Honeyeaters was recorded around Tonalli Cove. Impacts from temporary inundation may include loss of structural components of the vegetation (for example, *Amyema pendula* and *Amyema cambagei*) within areas of suitable breeding habitat, mortality of nestlings should a flood occur during a breeding event, and potential loss of suitable foraging habitat, specifically feed tree species such as *Eucalyptus melliodora, Eucalyptus albens, and Eucalyptus eugenioides.* Further consideration of the impacts to Regent Honeyeater can be found in Appendix K.
Cercartetus nanus	Eastern Pygmy-possum	V	-	Eastern Pygmy-possums were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area and across the study area may result in a reduction in the availability of foraging resources and breeding sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during a flood event, and loss of suitable foraging habitat.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	During the current assessment, the species was recorded across much of the study area: around the shores of Lake Burragorang, along the main tributaries, including Wollondilly, Nattai, Kedumba, Cox, and Kowmung Rivers, and Warragamba Dam. Temporary inundation may modify the structure and composition of suitable foraging habitat. It is expected that limited roosting and breeding habitat occurs within the study area, however, it should be noted that t surveys did not specifically target this type of habitat during the current assessment. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during a flood event, and loss of suitable foraging habitat.
Heleioporus australiacus	Giant Burrowing Frog	V	V	Giant Burrowing Frogs were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may result in a reduction in the availability of foraging resources and breeding sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during a flood event, and loss of suitable foraging habitat.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Broad-headed Snakes were not recorded during current surveys but are assumed to be present. Low quality habitat for Broad-headed Snake may be impacted. The affected habitat is confined to the lower reaches of Lake Burragorang and consists of small ledges with few exfoliated rocks and is moderately to well shaded. The most important areas of habitat in the study area occur along the top edges of the sandstone escarpments, where there are more extensive areas of rock shelf and little shading. These areas are well above the proposed inundation area. Impacts may include loss of habitat components such as exfoliated rocks and hollows, and potential mortality during flood events.
Isoodon obesulus subsp. *obesulus*	Southern Brown Bandicoot (eastern)	E	E	Southern Brown Bandicoots were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may result in a reduction in the availability of foraging resources and breeding sites for the Southern Brown Bandicoot. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Ixobrychus flavicollis	Black Bittern	V	-	Black Bitterns were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may result in a reduction in the availability of roosting and sheltering sites for Black Bitterns. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Littlejohn's Tree Frog were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may result in a reduction in the availability of foraging resources and breeding sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Macropus parma	Parma Wallaby	V	-	Parma Wallabies were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may result in a reduction in the availability of foraging resources and shelter sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Myotis macropus	Southern Myotis	V	-	Temporary inundation may modify the structure and composition of suitable foraging habitat for Southern Myotis within the study area. Most of the habitat impacted comprises of suitable foraging habitat. It is expected that some roosting and breeding habitat occurs within the study area, however, it should be noted that surveys did not specifically target this type of habitat during the current assessment. Impacts may include loss of large areas of the structural components of the vegetation within areas of suitable foraging habitat, loss of suitable breeding and roosting habitat, and potential mortality of individuals during flood events.
Petaurus norfolcensis	Squirrel Glider	V	-	Squirrel Gliders were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may result in a reduction in the availability of foraging resources and nesting sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Brush-tailed Rock Wallabies were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may result in a reduction in the availability of foraging resources and shelter sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	Brush-tail Phascogale were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may result in a reduction in the availability of foraging resources and nesting sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Phascolarctos cinereus	Koala	V	V	Koalas were not recorded during current surveys but are assumed to be present. Modification of habitat within the study area may impact on koalas due to the potential reduction in the availability of foraging resources. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat- specifically suitable feed tree species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Pseudophryne australis	Red-crowned Toadlet	V	-	Red-crowned Toadlet were recorded during current surveys, calling from East Warragamba Wall and West Warragamba Wall. Modification of habitat within the study area may result in a reduction in the availability of foraging resources and breeding sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Varanus rosenbergi	Rosenberg's Goanna	V	-	During the current assessment, Rosenberg's Goanna was recorded near the confluence of the Coxs and Kedumba Rivers. Modification of habitat within the study area may result in a reduction in the availability of breeding sites for Rosenberg's Goanna. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.

Threatened species polygons were derived for each of the threatened fauna candidate species in accordance with Section 6.5.1.14 of the FBA based on the following filters:

- associated PCTs in BioNET Vegetation Classification System and Threatened Biodiversity Data Collection
- associated PCTs based on field observations
- distribution patterns
- from field observations
- from records (Atlas of Living Australia, BioNet Wildlife Atlas, Australian Virtual Herbarium)
- distribution patters further refined by geographical/abiotic features/barriers
- known and/or predicted IBRA subregions
- species specific habitat features, or components listed within the Threatened Species Profile Database,
- catchments
- landforms
- soils
- aspect
- known microhabitats where known (that is, riparian areas, cliffs, etc).

A summary of the habitat impacted within the upstream impact area, and a description of how these areas were derived is shown in Table 7-5.

Table 7-5. Summary of species credit species habitat impacted by the Project

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha)
Anthochaera phrygia	Regent Honeyeater	Associated PCTs: HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN538; HN553; HN557; HN564; HN566; HN568; HN574; HN604; HN606; HN607; HN598 Associated IBRA subregions: Burragorang, Bungonia, Wollemi, Kanangra Onsite distribution: breeding population of minimum 21-25 individuals recorded around Tonalli Cove	All associated PCTs within Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	1,264.55
Cercartetus nanus	Eastern Pygmy-possum	Associated PCTs: HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN553; HN557; HN564; HN566; HN568; HN604; HN606; HN607; HN598 Associated IBRA subregions: Burragorang, Bungonia, Wollemi, Kanangra Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	1,296.12
Chalinolobus dwyeri	Large-eared Pied Bat	Associated PCTs: HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN538; HN553; HN557; HN564; HN566; HN568; HN574; HN604; HN606; HN607; HN598 Associated IBRA subregions: Burragorang, Bungonia, Wollemi, Kanangra Habitat constraint: 2 kilometres of mapped cliff lines Onsite distribution: Nattai River, Wollondilly River, Tonalli Cove, Coxs River between Kelpie Point and Butcher's Creek, East and West Warragamba Walls	All associated PCTs within 2km of mapped cliff lines – in Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	1,203.02
Heleioporus australiacus	Giant Burrowing Frog	Associated PCTs: HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN553; HN557; HN564; HN566; HN568; HN604; HN606; HN607; HN598 Associated IBRA subregions: Burragorang, Wollemi, Kanangra Habitat constraint: all areas of native vegetation within 300 metres 2nd and 3rd order streams on sandstone or upland swamps Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All native vegetation within 300 metres of 2nd and 3rd order streams on sandstone – in Burragorang, Wollemi, Kanangra IBRA subregions	883.64

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha)
Hoplocephalus bungaroides	Broad-headed Snake	Associated PCTs: HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN553; HN564; HN566; HN568; HN574; HN604: HN606; HN607; HN598 Associated IBRA subregions: Burragorang, Wollemi, Kanangra Habitat constraint: land within 500 m of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges and sandstone outcropping Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within 500 m of mapped cliff lines – in Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	124.71
Isoodon obesulus subsp. *obesulus*	Southern Brown Bandicoot (eastern)	Associated PCTs: HN525; HN527; HN532; HN533; HN535; HN536; HN553; HN557; HN566 Associated IBRA subregions: Burragorang, Wollemi, Kanangra Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within Burragorang, Wollemi, Kanangra IBRA subregions	1,167.29
Ixobrychus flavicollis	Black Bittern	Associated PCTs: HN553; HN574; HN607 Associated IBRA subregion: Wollemi Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within Wollemi IBRA subregion	1.84
Litoria littlejohni	Littlejohn's Tree Frog	Associated PCTs: HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN553; HN564; HN566; HN568; HN574; HN604: HN606; HN607; HN598 Associated IBRA subregions: Burragorang, Wollemi Habitat constraint: all areas of native vegetation within 300 metres 3rd and 4th order streams with a rocky base on sandstone Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within 300 metres of 3rd and 4th order streams on sandstone – in Burragorang and Wollemi IBRA subregions	420.32
Macropus parma	Parma Wallaby	Associated PCTs: HN607 Associated IBRA subregion: Wollemi	All associated PCTs within Wollemi IBRA subregion	1.84

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha)
		Onsite distribution: not observed within the survey area during current surveys. Assumed to be present		
Myotis macropus	Southern Myotis	Associated PCTs: HN517; HN525; HN527; HN532; HN533; HN535; HN537; HN538; HN553; HN564; HN568; HN574; HN598; HN606; HN607 Associated IBRA subregions: Burragorang, Bungonia, Wollemi, Kanangra Habitat constraint: Hollow-bearing trees, bridges, caves or artificial structures within 200 metres of riparian zone Onsite distribution: not observed within the survey area during current surveys, however, there are recent records within the study area. Assumed to be present	All associated PCTs within 200 m of riparian zone – in Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	863.70
Petaurus norfolcensis	Squirrel Glider	Associated PCTs: HN525; HN527; HN532; HN533; HN535; HN536; HN553; HN557; HN566; HN568; HN604; HN606; HN598 Associated IBRA subregions: Burragorang, Bungonia, Wollemi, Kanangra Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	1,238.37
Petrogale penicillata	Brush-tailed Rock-wallaby	Associated PCTs: HN517; HN525; HN527; HN533; HN535; HN536; HN537; HN538; HN557; HN566; HN568; HN606; HN598 Associated IBRA subregions: Burragorang, Bungonia, Wollemi, Kanangra Habitat constraint: land within 1 km of rock outcrops or cliff lines Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within 1 kilometres of mapped cliff lines – in Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	411.70
Phascogale tapoatafa	Brush-tailed Phascogale	Associated PCTs: HN532; HN533; HN564; HN566; HN604; HN606 Associated IBRA subregion: Burragorang, Wollemi, Kanangra Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within Burragorang, Wollemi, Kanangra IBRA subregions	32.98

Species name	Common name	Threatened species polygon filters	Decision	Upstream impact area (ha)
Phascolarctos cinereus	Koala	Associated PCTs: HN517; HN525; HN527; HN532; HN533; HN535; HN536; HN537; HN538; HN553; HN557; HN564; HN566; HN568; HN574; HN604; HN606; HN607; HN598 Associated IBRA subregion: Burragorang, Bungonia, Wollemi, Kanangra Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All associated PCTs within Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	1,380.35
Pseudophryne australis	Red-crowned Toadlet	Associated PCTs: HN517; HN532; HN533; HN536; HN564; HN566; HN568; HN606; HN607; HN598 Associated IBRA subregions: Burragorang, Wollemi, Kanangra Habitat constraint: all areas of native vegetation within 100 metres 1st and 2nd order drainage lines, swamps or soaks on sandstone geology Onsite distribution: not observed within the survey area during current surveys. Assumed to be present	All native vegetation within 100 metres of 1st and 2nd order drainage lines, swamps or soaks on sandstone geology – within the Burragorang, Wollemi, and Kanangra subregions	760.31
Varanus rosenbergi	Rosenberg's Goanna	Associated PCTs: HN525; HN527; HN533; HN535; HN536; HN553; HN557; HN564; HN566; HN568; HN574; HN604; HN606; HN607; HN598 Associated IBRA subregions: Burragorang, Wollemi, Kanangra, Bungonia Habitat constraint: land within 250 metres of termite mounds or rock outcrops Onsite distribution: Coxs River	All associated PCTs within Burragorang, Bungonia, Wollemi, Kanangra IBRA subregions	1,111.39

7.3 Cumulative impacts

Cumulative impacts on biodiversity values from the Project across the construction area, upstream operational area, and downstream area, as well as projects within the same IBRA subregions have been considered. Table 7-6 provides a summary of these projects and their determined/proposed impact. For the purposes of the cumulative impact assessment, the impacted area provided in the table encompasses all types of impacts, including the impacts associated with temporary inundation and alterations to hydrological flows discussed in detail within this report and the Downstream ecological assessment, as well as vegetation clearing related impacts from construction activities.

The projects included within the cumulative impact assessment are listed as follows. It should be noted that only key infrastructure projects have been included within the assessment. Therefore, this assessment is not a comprehensive assessment of all other proposed or determined projects within the IBRA subregions associated with the Project. Furthermore, for some projects, there is no publicly available information about the extent of the construction and operational impacts of the Project, or they are yet to be determined. Lastly, only impacts to threatened biota across multiple projects, or areas of the Project (upstream area vs. downstream area) are included within the cumulative impact assessment tables.

Table 7-6. Past, present and future projects

Project	Construction impact	Operational impact
Warragamba Dam Raising – Upstream ▪ Upstream operational impacts associated within the Project.	▪ N/A	▪ Flood stress of native vegetation due to temporary inundation of around two weeks. ▪ Long term erosion. ▪ Changes to vegetation structure and floristics. ▪ Physical damage to vegetation. ▪ Loss of threatened species and their habitat.
Warragamba Dam Raising – Construction ▪ Construction impacts associated within the Project.	▪ Removal of 22.51 hectares of native vegetation, including one CEEC. ▪ Removal of threatened flora and fauna habitat.	▪ N/A
Warragamba Dam Raising – Downstream ▪ Downstream operational impacts associated within the Project.	▪ N/A	▪ Alterations of hydrological flows. ▪ Changes to vegetation structure and floristics. ▪ Long term erosion. ▪ Loss of threatened species and their habitat.
Western Sydney Airport ▪ Located about 8.5 kilometres east of Warragamba Dam. ▪ Construction commenced.	▪ Removal of 318.50 hectares of native vegetation. ▪ Removal of 141.80 hectares of fauna habitat. ▪ Direct and indirect impacts to threatened biota.	▪ Bird and bat strike. ▪ Terrestrial fauna strike. ▪ Noise and vibration. ▪ Light. ▪ Alterations to hydrology and GDEs.
M12 Motorway ▪ 16 kilometre motorway between M7 at Cecil Hills and Northern Road, Luddenham. ▪ Located about 10 kilometres east of Warragamba Dam. ▪ Proposal under assessment	▪ Removal of 73.65 hectares of native vegetation, including one CEEC. ▪ Removal of 334.312 hectares of fauna habitat. ▪ Direct and indirect impacts to threatened biota.	▪ Fauna injury and mortality from vehicle collisions ▪ Changes to aquatic habitat and hydrology ▪ Impacts on riparian corridors ▪ Noise, light and vibration impacts

Project	Construction impact	Operational impact
Northern Road Upgrade ▪ Upgrade of Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park. ▪ Located about 10 kilometres east of Warragamba Dam. ▪ Construction commenced.	▪ Removal of 39.61 hectares of native vegetation. ▪ Removal of threatened flora and fauna habitat. ▪ Removal of 39 threatened plants.	▪ Changes to hydrology. ▪ Habitat fragmentation. ▪ Edge effects. ▪ Fauna mortality. ▪ Establishment of weeds and pathogens.
Hume Coal Project ▪ Development of an underground mine to extract metallurgical and industrial coal. ▪ Located approximately 70 kilometres south-west of Warragamba Dam. ▪ Proposal under assessment.	▪ Removal of 64 paddock trees. ▪ Removal of 8.3 hectares of threatened fauna habitat.	▪ Potential changes to surface and subterranean hydrology. ▪ Habitat fragmentation. ▪ Edge effects. ▪ Fauna mortality. ▪ Establishment of weeds and pathogens.
Gunlake Quarry Extension ▪ Extension of operations at Gunlake Quarry. ▪ Located approximately 170 kilometres south-west of Warragamba Dam. ▪ Proposal determined.	▪ Removal of 54.10 hectares of native vegetation. ▪ Removal of threatened flora and fauna habitat.	▪ Erosion and sedimentation. ▪ Habitat fragmentation. ▪ Edge effects. ▪ Fauna mortality. ▪ Establishment of weeds and pathogens.

7.4 Key threatening processes

In accordance with Section 6.4 of the SEARs, the assessment must identify whether the Project as a whole, or any component of the Project, would be classified as a key threatening process (KTP) in accordance with the listings in the TSC Act, FM Act or EPBC Act.

Under Part 2 of the TSC Act, KTPs are described as those threatening processes that are most likely to jeopardise the survival of those species, populations and ecological communities listed under that Act. Under section 4.32 of the BC Act, a threatening process is eligible to be listed as a KTP if, in the opinion of the Scientific Committee:

- it adversely affects threatened species or ecological communities, or
- it could cause species or ecological communities that are not threatened to become threatened.

DECC (2007e, p11) requires consideration as to 'whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process'. Schedule 3 of the TSC Act provides a list of KTPs, with Schedule 4 of the BC Act listing KTPs under that Act. There is one additional KTP listed under the BC Act compared to the TSC Act, namely Habitat degradation and loss by Feral Horses (brumbies, wild horses), *Equus caballus* Linnaeus 1758, which has also been considered in the current report.

Impacts to biodiversity values associated with the FM Act are provided in Appendix F4 (Aquatic ecology).

Under the EPBC Act a threatening process is defined as a KTP if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community. A process can be listed as a KTP if it could:

- cause a native species or ecological community to become eligible for inclusion in a threatened list (other than the conservation dependent category); or
- cause an already listed threatened species or threatened ecological community to become more endangered; or
- adversely affect two or more listed threatened species or threatened ecological communities.

All KTPs listed under the EPBC Act that are associated with the Project have equivalent KTPs listed under the BC Act, however not all KTPs listed under the BC Act have equivalent KTPs listed on the EPBC Act.

The Project would result in actions that constitute, or are part of, or may result in the operation of or increase the impact of two KTPs. These are sumamrised in Table 7-7.

Table 7-7. Key threatening processes associated with the Project

Key threatening process	BC Act	EPBC Act	EPBC Act equivalent	Details
Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.	Yes	Yes	-	The change in the depth and duration of inundation, especially within forested wetland communities along the major tributaries of Lake Burragorang, would constitute an 'alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' as defined within the Scientific Determination of the KTP.
Clearing of native vegetation	Yes	Yes	Land clearance	The change in the depth and duration of inundation as a result of the Project result in the loss of vegetation such that the structure and floristic composition of the PCTs would be modified.

Changes to vegetation community and structure that may result from temporary inundation may create conditions more conducive to the operation of a range of additional KTPs (refer Table 7-8). The operation of these KTPs would depend on a range of factors including presence of catchment sources for weeds, pests and diseases and the extent to which the inundation makes the vegetation communities or species more susceptible to the threatening process.

Table 7-8. Other key threatening processes

Key threatening process	BC Act	EPBC Act	EPBC Act equivalent
Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners (*Manorina melanocephala*).	Yes	Yes	Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala)*
Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus* (L.)	Yes	Yes	Competition and land degradation by rabbits
Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758	Yes	Yes	Competition and land degradation by unmanaged goats
Competition from feral honey bees, *Apis mellifera* L.	Yes	Yes	-
Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	Yes	Yes	-
Habitat degradation and loss by Feral Horses (brumbies, wild horses), *Equus caballus* Linnaeus 1758	No	Yes	-
Herbivory and environmental degradation caused by feral deer	Yes	Yes	-
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	Yes	Yes	Not listed (Fire regimes that cause biodiversity decline currently on the finalised priority assessment list)
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	Yes	Yes	Infection of amphibians with chytrid fungus resulting in chytridiomycosis
Infection of native plants by *Phytophthora cinnamomi*	Yes	Yes	Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	Yes	Yes	-

Key threatening process	BC Act	EPBC Act	EPBC Act equivalent
Invasion and establishment of exotic vines and scramblers	Yes	Yes	-
Invasion and establishment of Scotch Broom (*Cytisus scoparius*)	Yes	Yes	-
Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif.	Yes	Yes	-
Invasion of native plant communities by *Chrysanthemoides monilifera*	Yes	Yes	-
Invasion of native plant communities by exotic perennial grasses	Yes	Yes	-
Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)	Yes	Yes	-
Loss of hollow-bearing trees	Yes	Yes	-
Predation by *Gambusia holbrooki* Girard, 1859 (Plague Minnow or Mosquito Fish)	Yes	Yes	-
Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)	Yes	Yes	-
Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)	Yes	Yes	-
Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758	Yes	Yes	Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs

7.5 Thresholds for assessing unavoidable impacts

Unavoidable impacts of the Project have been considered and a determination made of the assessment and offsetting requirements of such impacts. Table 7-9 summarises these requirements which include:

- Impacts that require further consideration by consent authority
- Impacts for which the assessor is required to determine an offset
- Impacts for which the assessor is not required to determine an offset
- Impacts that do not require further assessment by the assessor.

A discussion of each of these components is provided as follows. The Biodiversity Credit Report generated by the Project is provided in Appendix A of this report.

Table 7-9. Summary of areas impacted by the Project

Threshold	Biodiversity value	Criteria	Applicable to the Project
I. Impacts that require further consideration by consent authority	Landscape features	Impacts that would substantially reduce the width of vegetation in the riparian buffer zone bordering rivers and streams 4th order or greater	Yes- The Project may impact on vegetation within the riparian buffer zone of a 9th order stream.
		Impacts in state biodiversity links	No
		Impacts on important wetlands and their buffers	No
		Impacts in the buffer zone along estuaries	No
	Native vegetation	Any impact on a CEEC (unless specifically excluded in the SEARs) because it is likely to: cause the extinction of the CEEC from the IBRA subregion, or significantly reduce the viability of the CEEC	Yes – The Project may impact on a CEEC as a result of potential impacts to: ▪ White Box Yellow Box Blakely's Red Gum Woodland CEEC These impacts are unlikely to cause the extinction of the CEEC from the IBRA subregion or significantly reduce the viability of the CEEC.
		Any impact on an EEC nominated in the SEARs because it is likely to: cause the extinction of the EEC from the IBRA subregion, or significantly reduce the viability of the EEC	No
	Species and Populations	Impacts on areas of land that the Minister for Environment has declared as critical habitat in accordance with section 46 of the TSC Act and which is listed on the Register of Critical Habitat in NSW	No
		Any impact on a critically endangered species (unless specifically excluded in the SEARs)	Yes – The Project may impact on suitable breeding and foraging habitat for Regent Honeyeater.
		Any impact on a threatened species or population nominated in the SEARs because it is likely to: ▪ cause the extinction of a species or population from an IBRA subregion, or ▪ significantly reduce the viability of a species or population	Yes – the Project would potentially impact on the following species: ▪ *Hakea dohertyi* ▪ *Eucalyptus benthamii* ▪ *Solanum amourense*
		Any impact on a threatened species or population that has not previously been recorded in the IBRA subregion according to records in the NSW Wildlife Atlas	Yes – the Project would potentially impact upon four threatened species that have not previously been recorded within the IBRA subregions within which the Project occurs. These species are: ▪ *Eucalyptus glaucina* ▪ *Callistemon linearifolius*

Threshold	Biodiversity value	Criteria	Applicable to the Project
			▪ *Grammitis stenophylla* ▪ *Pomaderris brunnea*
II. Impacts for which the assessor is required to determine an offset	Landscape Features	Not applicable to the FBA	N/A
	Native Vegetation	Impacts on CEECs that are specifically excluded from requiring further consideration in the SEARS	No
		Impacts on PCTs that are EECs not specifically nominated as requiring further consideration in the SEARs	The Project would potentially impact on three PCTs associated with EECs: HN553, HN527, HN557, that are not specifically nominated as requiring further consideration in the SEARs.
		Impacts on PCTs associated with threatened species habitat and which have a site value score ≥17	All PCTs have a site value score of ≥17 and are associated with threatened species habitat.
	Species and populations	Impacts on a critically endangered species that have been specifically excluded from requiring further consideration in the SEARS	No
		Impacts on threatened species, populations and threatened species habitat not specifically nominated as requiring further consideration in the SEARs	The Project would potentially impact upon threatened species and their habitat not specifically nominated requiring further consideration in the SEARs.
		Impacts on threatened species habitat associated with a PCT and which has a site value score of ≥17	All PCTs have a site value score of ≥17 and are associated with threatened species habitat.
III. Impacts for which the assessor is not required to determine an offset	Landscape Features	Not applicable to the FBA	N/A
	Native Vegetation	Impacts on PCTs that: have a site value score <17, or are not identified as CEECs / EECs	All PCTs have a site value score >17.
		Impacts on PCTs that are not associated with threatened species habitat and are not identified as CEECs / EECs	All PCTs within the study area are associated with threatened species habitat.
	Species and Populations	Impacts on non-threatened species and populations that do not form part of a CEEC or EEC	Yes – the Project would potentially impact on non-threatened species within the three non-threatened PCTs.
		Impacts on threatened species habitat associated with a PCT within a vegetation zone with a site value score of <17	All PCTs have a site value score >17.
V. Impacts that do not require further assessment by the assessor	Landscape Features	Areas of land without native vegetation, unless the area of land requires assessment under the SEARs issued for the Major Project	No areas of cleared land have been specifically outlined within the SEARs as requiring assessment.
	Native Vegetation	Areas of land without native vegetation, unless the area of land requires assessment under the SEARs issued for the Major Project	No areas of cleared land have been specifically outlined within the SEARs as requiring assessment.

Threshold	Biodiversity value	Criteria	Applicable to the Project
	Species and populations	Not applicable since all areas of land must be assessed for threatened species, even if they do not contain native vegetation	N/A

7.6 Impacts that require further consideration

7.6.1 Landscape features

7.6.1.1 Impacts reducing the width of riparian buffer of important rivers, streams, and estuaries

This consideration applies to impacts of development on areas within native vegetation within:

a. 20 metres either side of 4th or 5th order stream
b. 50 metres either side of a 6th order stream or higher
c. 50 metres around an estuarine area.

As the Project would potentially impact upon native vegetation within the 50 metre riparian buffer of a 6th order stream or higher, the following matters outlined within Table 7-10 are to be considered.

Table 7-10. Further consideration of impacts to riparian buffers

FBA section 9.2.3.3 - criteria	Consideration
(a) the name and stream order of the riparian buffer being impacted	The following rivers are greater than a 6th order stream at the point of its extent at which the impact would occur: ▪ Wollondilly River: 8th order Strahler stream ▪ Nattai River: 7th order Strahler stream ▪ Little River: 6th order Strahler stream ▪ Coxs River: 8th order Strahler stream ▪ Kowmung River: 7th order Strahler stream ▪ Kedumba River: 6th order Strahler stream ▪ Warragamba River: 9th order Strahler stream.
(b) the total area of the riparian buffer that is impacted by the Major Project, the extent to which the width of the link will be reduced and over what length, and the size of the gaps being created or expanded	The total area of riparian buffer within the study area is 4,239.87 hectares . The Project would increase the extent (in relation to width from the FSL), depth, and duration of temporary inundation within the riparian buffer from existing conditions. The additional width of impact is variable across the study area and will depend on the variability of the flood event. As discussed in Section 1.5.4 the upstream impact area has been defined as the area between RL 119.5 AHD and RL 126.97. Note that the riparian areas adjacent to the existing FSL of Warragamba are subject to temporary inundation from the existing dam however with the Project, inundation would occur further up the reaches of a number of rivers and creeks.
(c) the PCT and condition of the vegetation in the riparian buffer being impacted.	The identified PCTs within the upstream impact area are detailed in Section 7.2.1. The condition of the PCTs has been assessed as moderate to good within the riparian buffer
(d) any direct impacts on wetlands or watercourses downstream of the development site	N/A to Upstream BAR
(e) mitigation measures proposed to minimise the impact on the biodiversity values of the riparian or downstream area.	The riparian area would be managed as part of an Environmental Management Plan. It is expected that the plan would include measures that would minimise erosion, bank slumping, and re-establish native vegetation within certain areas of the study area.

7.6.2 Native vegetation

Impacts on native vegetation that require further consideration include impacts on:

- any CEEC, unless the CEEC is specifically excluded by the SEARs
- an EEC specifically nominated in the SEARs as an EEC that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by the development.

The SEARs exclude the following CEECs from matters for further consideration:

- Wollemi IBRA Subregion
  - Sun Valley Cabbage Gum Forest in the Sydney Basin Bioregion
- Burragorang IBRA subregion
  - Cumberland Plain Woodland in the Sydney Basin Bioregion.
  - Robertson Basalt Tall Open-forest in the Sydney Basin and South Eastern Highlands bioregions.

However, the Project would impact upon two PCTs, considered to align with White Box Yellow Box Blakely's Red Gum Woodland (Critically Endangered – BC Act and EPBC Act):

- PCT 840/HN527: Narrow-leaved Ironbark – Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion.
- PCT 1401/HN557: Forest Red Gum – Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands.

White Box Yellow Box Blakely's Red Gum Woodland CEEC is not specifically listed in the SEARs as a matter requiring consideration. However, as it is preliminarily listed as Critically Endangered under the BC Act, and listed as Critically Endangered under the EPBC Act, it meets the requirements for inclusion as per Section 9.2.4.1 of the FBA.

As such, this CEEC has been considered further (based on the criteria in Section 9.2.4.2 of the FBA) in Table 7-11.

The SEARs did not specifically nominate any EEC that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by the development.

Table 7-11. Further consideration of impacts to White Box Yellow Box Blakely's Red Gum Woodland CEEC

FBA section 9.2.4.2 criteria	Consideration
(a) the area and condition of the CEEC or EEC to be impacted directly and indirectly by the proposed development	The Project would impact approximately 430.56 ha of White Box Yellow Box Blakely's Red Gum Woodland CEEC within the upstream impact area. The area includes: ▪ 70.70 ha of HN527: Forest Red Gum - Yellow Box woodland of dry gorge slopes southern Sydney Basin Bioregion and South Eastern Highlands Bioregion (Moderate/Good condition) ▪ 57.05 ha of HN527 (Moderate/Good_DNG condition) ▪ 302.81 ha of HN557: Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge Sydney Basin Bioregion (Moderate). Within the study area, the majority of White Box Yellow Box Blakely's Red Gum Woodland is distributed upstream from Higgins Bay, immediately surrounding Lake Burragorang and along the Wollondilly River.
(b) the extent and overall condition of the CEEC or EEC within an area of 1,000 ha and then 10,000 ha surrounding the proposed development footprint.	***Note****: It was not possible to derive an extent and overall condition of the EEC within an area of 1,000 ha and then 10,000 ha of the Project due to it being a linear, large-scale extent. SMEC have instead derived an` extent and overall condition of the EEC within a 1 kilometre and then a 5 kilometres buffer applied to the study area boundary.* The GIS layer '*Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands*' (Tozer *et al.* 2010) was used to calculate the area of White Box Yellow Box Blakely's Red Gum Woodland CEEC within a one kilometre and then a five kilometre buffer of the study area. Using Tozer *et al.* (2010), the map units considered equivalent to this CEEC are: ▪ GW p24: Tableland Grassy Box-Gum Woodland ▪ DSF p35: Wollondilly-Cox-Shoalhaven Gorge Woodland

FBA section 9.2.4.2 criteria	Consideration
	▪ GW p420: Tableland Granite Grassy Woodland ▪ DSF p202: Burragorang Rocky Slopes Woodland An analysis of this mapping estimated that there is approximately: ▪ 2,817.23 hectares of the EEC within a buffer of one kilometre of the study area ▪ 9,589.21 hectares of the EEC within a buffer of five kilometres of the study area. However, given the broad-scale nature of the Tozer *et al*. (2010) GIS layer, it should be noted that it is possible that there are additional occurrences of the EEC not mapped within each one kilometre and five kilometre buffer. The mapping by Tozer *et al*. (2010) does not provide information on the 'vegetation condition' for each mapped occurrence of the EEC. According to the Final Determination for White box Yellow Box Blakely's Red Gum Woodland EEC '*the condition of remnants ranges from relatively good to highly degraded*' where '*less degraded remnants occur in Travelling Stock Routes, cemeteries and reserves*' (NSW Scientific Committee 2011d). A desktop analysis of the mapped occurrences of the CEEC within the one kilometre and five kilometre buffered areas identified many patches as occurring adjacent to the south-west portion of the study area along the Wollondilly River near Coleman's Bend, Douglas Flat, Bridge Point and Tonalli Cove with smaller extents mapped along the Little River and near to the confluence between the Kedumba River and Cox River. All mapped extents of the CEEC occurring within the one kilometre and five kilometre buffered areas are likely to be in relatively good condition due to their isolation and reservation on National Park estate. However, historically these areas may have been subjected to light grazing by stock due to previously having been private landholdings.
(c) an estimate of the extant area and overall condition of the CEEC or EEC remaining in the IBRA subregion after the impact of the proposed development has been taken into consideration	Current mapping and literature do not provide an accurate estimate of the extant area of this CEEC in the Bungonia, Burragorang and Kanangra IBRA subregions. Due to the CEECs' occurrence on high fertility soils, much of the community is on privately owned land, existing as isolated patches within an agricultural matrix of cropping, improved pastures and/or disturbed vegetation communities (DECCW 2010b). Thomas *et al*. (2000) estimated that in south-eastern NSW the extent of White Box Yellow Box Blakely's Red Gum Woodland EEC has been reduced to around 5 percent of its pre-1750 distribution totalling 59,468 hectares. Further, it is considered that only 0.05 percent of the EEC in NSW remains in near to original condition (Prober and Thiele 2005). The map units equivalent to the CEEC as per Tozer *et al*. were therefore considered for the purposes of estimating the extant area of the EEC within each IBRA subregion. According to this mapping (Tozer *et al*. 2010), there is: ▪ 42,811.87 hectares of CEEC within the Bungonia IBRA subregion ▪ 6,257.00 hectares of CEEC within the Burragorang IBRA subregion ▪ 2,533.80 hectares of CEEC within the Kanangra IBRA subregion. However, this mapping may contain inaccuracies in extent and does not provide an indication of the condition of the mapped occurrences of the EEC. Given the occurrence of the CEEC is predominantly on privately owned land, the quality of remnants remains largely unknown (DECCW 2010b). The Project would impact 430.56 ha of White Box Yellow Box Blakely's Red Gum Woodland CEEC within the upstream impact area. Where the impacts associated with the Project have been taken into consideration (assuming that all extents of this CEEC would cease to exist following inundation), it is estimated that there is: ▪ 41,364.24 hectares of the CEEC outside of the impact area within the Bungonia IBRA subregion ▪ 4,809.27 hectares of CEEC within the Burragorang IBRA subregion ▪ 1,086.07 hectares within the Kanangra IBRA subregion.
(d) the development proposal impact on: i) abiotic factors critical to the long-term survival of the	Within the study area, the majority of White Box Yellow Box Blakely's Red Gum Woodland is distributed upstream of Higgins Bay, immediately surrounding Lake Burragorang and along the Wollondilly River

FBA section 9.2.4.2 criteria	Consideration
CEEC or EEC. For example, will the impact lead to a reduction of groundwater levels or substantial alteration of surface water patterns?	The Project may alter abiotic factors that may impact on the long-term survival of the CEEC. Such abiotic factors include (but not limited to) changes to soil properties (such as the chemistry, structure etc.), hydrological processes (including surface water patterns) and nutrient cycling, with the extent to which the changes occurring dependent upon the depth and duration temporary inundation. However, there is little information available to understand the extent of changes to abiotic factors that would be required to consequently have a detrimental effect on the long-term survival of the CEEC. Therefore, in applying the precautionary principle it has been assumed that any change to abiotic factors may detrimentally affect the quality and integrity of the CEEC within the impact area.
ii) characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire regimes, removal of understory species, or harvesting of plants	Temporary inundation from the Project would impact approximately 430.56 ha of moderate to good condition HN527 and HN557 equivalent to White Box Yellow Box Blakely's Red Gum woodland CEEC within the impact area. As discussed in Section 4.4.2.1, the CEEC within the study area contains functionally important species such as *Cheilanthes distans, Themeda triandra*, and *Arthropodium milleflorum*, some of which may be intolerant to waterlogging and temporary inundation (Benson and McDougall 1993; 1996; 2005). The protected status of the catchment will remain unchanged and access will be restricted so it is not expected that the Project will result in inappropriate fire regimes, removal of understory species or harvesting of plants.
iii) the quality and integrity of an occurrence of the CEEC or EEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the CEEC or EEC.	The quality and integrity of White Box Yellow Box Blakely's Red Gum Woodland CEEC may be impacted by temporary inundation via various pathways following inundation events. The Project will not increase sources of invasive flora and fauna species or cause mobilisation of fertilisers, herbicides or other chemical or pollutants which may harm or inhibit growth of species. Flood stress may lead to increased risk of weed encroachment and susceptibly of flora and fauna species tp diseases and pathogens. The CEEC within the study area was found to be high quality due to having high species diversity, structural intactness and a demonstrated resilience to past agricultural land use practices.
(e) direct or indirect fragmentation and isolation of an important area of the EEC.	The White Box Yellow Box Blakely's Red Gum Woodland within the study area is an important area of the TEC as defined by the FBA. An important area comprises an area of the TEC that is necessary for the entities' long-term persistence and recovery. This may include areas identified in recovery plans, and/or an area large in comparison to other stands of the CEEC or EEC or occurrences of the CEEC or EEC at the limit of the community's range. The National Recovery Plan for White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland identifies habitat critical for the survival of the CEEC, and states that given the highly degraded state of the ecological community, all areas of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland which meet the minimum condition requirements under the EPBC Act should be considered critical for the survival of the TEC. Both HN527 and HN557 conform to the Final Determination of the CEEC under the EPBC . The areas of TEC that occur within the study area are contiguous with larger tracts of the TEC within the locality.
(f) the measures proposed to contribute to the recovery of the EEC in the IBRA subregion	White Box Yellow Box Blakely's Red Gum Woodland has been assigned to the threatened ecological community management stream under the Saving our Species (SoS) program. This SoS strategy aims to secure the ecological community in the long term. The proponent of the Project plans to offset for the impacts to White Box Yellow Box Blakely's Red Gum Woodland within the upstream impact area in accordance with the steps outlined in the biodiversity offset strategy (BOS).

7.6.3 Threatened species and populations

Impacts on threatened species that require further consideration include:

- any impacts on critically endangered species, unless the critically endangered species is specifically excluded in the SEARs.
- impacts on a threatened species or population that is specifically nominated by the SEARs as a species or population that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by the development.
- where the survey or expert report undertaken in accordance with Section 6.6 of the FBA confirms that the threatened species is present in the proposed study area, and the threatened species has not previously been recorded in the IBRA subregion according to records in the NSW Wildlife Atlas.

The Project may impact upon the following threatened species listed in Attachment C to the SEARs as follows**:**

- *Ancistrachne maidenii*
- *Eucalyptus benthamii*
- *Bossiaea oligosperma*
- *Solanum amourense*
- *Hakea dohertyi*
- *Dillwynia tenuifolia*
- *Epacris purpurascens var. purpurascens*
- *Gyrostemon thesioides*
- *Hibbertia puberula*
- *Melaleuca deanei*
- *Genoplesium baueri*
- *Tetratheca glandulosa.*

The Project may also impact upon:

- suitable breeding and foraging habitat for the Critically Endangered Regent Honeyeater
- *Eucalyptus glaucina, Pomaderris brunnea*, and *Callistemon linearifolious*, all of which were found incidentally outside of their normal IBRA Subregion distribution.

One critically endangered species, Regent Honeyeater, was recorded within the study area while another, *Rhodamnia rubescens*, is assumed to be present. These species were not listed in the SEARs as matters for further consideration however they meet the requirements for further consideration under Section 9.2.5 of the FBA.

The SEARs for the Project exclude the following matters for further consideration:

- Elusive Bush-pea (*Pultenaea elusa*) (excluded for Burragorang IBRA subregion only)
- Megalong Valley Bottlebrush (*Callistemon megalongensis*) (excluded for Burragorang IBRA subregion only)
- Wingecarribee Gentian (*Gentiana wingecarribiensis*) (excluded for Burragorang IBRA subregion only).

Species listed in the SEARs as matters for further consideration that were not listed in the upstream IBRA Subregions have been excluded.

Matters for further consideration for threatened species are provided in Appendix K.

8 Impacts requiring offsetting

8.1 Native vegetation

The assessment as identified the ecosystem credits required to offset the potential impacts native vegetation through the use of the FBA Calculator.

The offset requirement for each PCT was calculated using the BBCC across the four IBRA subregions as discussed in Section 3.2.1. A summary of the loss in site value, and the number of ecosystem credits required for the impacts for each IBRA calculator are detailed in Table 8-1, Table 8-2, Table 8-3, and Table 8-4.

Table 8-1. Ecosystem credit requirements within Bungonia IBRA as a result of the Project

Veg Zone	PCT	Condition	Impact area (ha)	Current site value	Future site value	Credit requirement
6	HN553	Moderate/Good	2.58	68.12	0	150
7	HN538	Moderate/Good	0.92	84.44	0	65
13	HN527	Moderate/Good	6.43	72.22	0	392
14	HN527	Moderate/Good_DNGL	18.0	53.38	0	844
17	HN557	Moderate/Good	1.89	73.44	0	117
21	HN574	Moderate/Good	54.29	74.64	0	3,412
Total			**84.10**			**4,980**

Table 8-2. Ecosystem credit requirements within Kanangra IBRA as a result of the Project

Veg Zone	PCT	Condition	Impact area (ha)	Current site value	Future site value	Credit requirement
1	HN564	Moderate/Good	0.59	68.12	0	34
2	HN566	Moderate/Good	22.07	84.44	0	1,549
3	HN568	Moderate/Good	5.49	100.00	0	449
9	HN536	Moderate/Good	1.52	86.28	0	109
11	HN535	Moderate/Good	5.90	100.00	0	483
12	HN532	Moderate/Good	0.62	59.42	0	32
16	HN607	Moderate/Good	58.94	76.09	0	3,767
18	HN557	Moderate/Good	0.53	73.44	0	33
19	HN606	Moderate/Good	16.92	74.64	0	1,063
Total			**112.58**			**7,519**

Table 8-3. Ecosystem credit requirements within Wollemi IBRA as a result of the Project

Veg Zone	PCT	Condition	Impact area (ha)	Current site value	Future site value	Credit requirement
1	HN564	Moderate/Good	1.92	60.63	0	100
2	HN566	Moderate/Good	6.04	77.08	0	343
3	HN568	Moderate/Good	17.84	91.06	0	1,339
9	HN536	Moderate/Good	6.19	82.28	0	442
11	HN533	Moderate/Good	1.28	75.36	0	81
12	HN532	Moderate/Good	3.19	59.42	0	164
16	HN517	Moderate/Good	0.34	78.26	0	22
18	HN607	Moderate/Good	1.84	64.98	0	102
19	HN606	Moderate/Good	20.54	85.99	0	1463
Total			**59.19**			**4,056**

Table 8-4. Ecosystem credit requirements within Burragorang IBRA as a result of the Project

Veg Zone	PCT	Condition	Impact area (ha)	Current site value	Future site value	Credit requirement
2	HN566	Moderate/Good	0.52	77.08	0	31
3	HN568	Moderate/Good	7.88	91.06	0	590
6	HN553	Moderate/Good	104.51	68.12	0	6,019
7	HN538	Moderate/Good	27.17	84.44	0	1,897
8	HN537	Moderate/Good	0.13	100.00	0	11
9	HN536	Moderate/Good	205.21	82.28	0	14,613
10	HN535	Moderate/Good	16.27	100.0	0	1,326
11	HN533	Moderate/Good	9.69	75.36	0	610
12	HN532	Moderate/Good	222.23	59.42	0	11,348
13	HN527	Moderate/Good	64.27	72.22	0	13,899
14	HN527	Moderate/Good_DNGL	39.05	53.38	0	1,818
15	HN525	Moderate/Good	84.20	76.09	0	5,352
16	HN517	Moderate/Good	0.19	78.26	0	11
17	HN557	Moderate/Good	300.39	73.44	0	18,499
18	HN607	Moderate/Good	12.82	64.98	0	710
19	HN606	Moderate/Good	0.27	85.99	0	20
20	HN598	Moderate/Good	9.71	83.51	0	670
21	HN574	Moderate/Good	13.02	74.64	0	813
Total			**1,117.54**			**68,236**

8.2 Species and populations

The assessment has identified the species credits required to offset the potential impacts native vegetation through the use of the FBA Calculator

The Offset Package is detailed in Appendix F6 Offset strategy but will be based on establishing credits to offset for the following impacts within the upstream impact area:

8.2.1 Species credit species

Seventeen species credit species were recorded within the study area. However, as outlined in Section 5.8.2, 80 candidate species credit species were assumed to be present. Species credit species requirements are detailed in the following table. Note that *Acronychia littoralis* (Scented Acronychia) has been used as a surrogate for *Rhodamnia rubescens* as the latter species is not available in the BBCC.

Table 8-5. Species credit species

Species name	Common name	BC Act status	EPBC Act status	Area to be removed (ha) or number of individuals (ind)	Credit requirement
FLORA					
Acacia baueri subsp. aspera	*Acacia baueri subsp. aspera*	V	-	7.00	280
Acacia bynoeana	Bynoe's Wattle	E	V	35.00	2,695
Acacia clunies-rossiae	Kanangra Wattle	V	-	770.00	10,010
Acacia flocktoniae	Flockton Wattle	V	V	371.00	6,678
Acacia gordonii	*Acacia gordonii*	E	E	8.00	208
Acacia pubescens	Downy Wattle	V	V	35.00	665
Acronychia littoralis	Scented Acronychia	-	-	78.00	3,878
Acrophyllum australe	*Acrophyllum australe*	V	V	13.00	234
Ancistrachne maidenii	*Ancistrachne maidenii*	V	-	29.00	638
Asterolasia buxifolia	*Asterolasia buxifolia*	E	-	14.00	1,078
Asterolasia elegans	*Asterolasia elegans*	E	E	6.00	108
Astrotricha crassifolia	Thick-leaf Star-hair	V	V	8.00	616
Baloskion longipes	Dense Cord-rush	V	V-	31.00	558
Bossiaea oligosperma	Few-seeded Bossiaea	V	V	483.00	7,245
Caesia parviflora subsp. minor	Small Pale Grass-lily	E	-	15.00	210
Callistemon linearifolius	Netted Bottle Brush	V	-	1,968 (ind)	13,252
Callistemon megalongensis	Megalong Valley Bottlebrush	CE	CE	6.00	462
Calomnion complanatum	*Calomnion complanatum*	E	-	1.00	77
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	7.00	280
Darwinia biflora	*Darwinia biflora*	V	V	8.00	160
Darwinia peduncularis	*Darwinia peduncularis*	V	-	15.00	270
Dillwynia tenuifolia	*Dillwynia tenuifolia*	V	-	2.00	36
Epacris hamiltonii	*Epacris hamiltonii*	E	E	3.00	54

Species name	Common name	BC Act status	EPBC Act status	Area to be removed (ha) or number of individuals (ind)	Credit requirement
Epacris purpurascens subsp. purpurascens	*Epacris purpurascens subsp. purpurascens*	V	-	300.00	5,100
Epacris sparsa	Sparse Heath	V	V	2.00	36
Eucalyptus benthamii	Camden White Gum	V	V	44.00	616
Eucalyptus glaucina	Slaty Red Gum	V	V	10,970 (ind)	23,505
Eucalyptus pulverulenta	Silver-leafed Gum	V	V	170.44 275 (ind)	30
Euphrasia bowdeniae	*Euphrasia bowdeniae*	V	V	3.00	231
Genoplesium baueri	Bauer's Midge Orchid	E	E	223.00	2,899
Genoplesium superbum	Superb Midge Orchid	E	-	10.00	770
Grammitis stenophylla	Narrow-leaf Finger Fern	E	-	41.00	533
Grevillea evansiana	Evans Grevillea	V	V	7.00	105
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	9.00	126
Gyrostemon thesioides	*Gyrostemon thesioides*	E	-	886.00	68,222
Hakea dohertyi	Kowmung Hakea	E	E	199.00	3,781
Haloragodendron lucasii	*Haloragodendron lucasii*	V	V	8.00	616
Hibbertia puberula	*Hibbertia puberula*	E	-	35.00	1,400
Hygrocybe anomala subsp. ianthinomarginata	*Hygrocybe anomala subsp. ianthinomarginata*	V	-	267.00	20,559
Hygrocybe aurantipes	*Hygrocybe aurantipes*	V	-	35.00	1,400
Hygrocybe reesiae	*Hygrocybe reesiae*	V	-	35.00	1,400
Isopogon fletcheri	Fletcher's Drumsticks	V	V	3.00	69
Kunzea rupestris	*Kunzea rupestris*	V	V	8.00	208
Lastreopsis hispida	Bristly Shield Fern	E	-	23.00	1,771
Leionema lachnaeoides	*Leionema lachnaeoides*	E	E	1.00	77
Lepidosperma evansianum	Evans Sedge	V	E	1.00	77
Leucopogon exolasius	Woronora Beard-heath	V	V	50.00	392
Leucopogon fletcheri subsp. fletcheri	*Leucopogon fletcheri subsp. fletcheri*	E	-	8.00	128
Macropus parma	Parma Wallaby	V	-	1.84	48
Melaleuca deanei	Deane's Paperbark	V	V	9.00	693
Melaleuca groveana	Grove's Paperbark	V	-	6.00	84
Micromyrtus blakelyi	*Micromyrtus blakelyi*	V	V	8.00	208
Olearia cordata	*Olearia cordata*	V	V	8.00	104
Persicaria elatior	Tall Knotweed	V	V	896.00	11,648

Species name	Common name	BC Act status	EPBC Act status	Area to be removed (ha) or number of individuals (ind)	Credit requirement
Persoonia acerosa	Needle Geebung	V	V	33.00	429
Persoonia bargoensis	Bargo Geebung	E	V	22.00	1,694
Persoonia glaucescens	Mittagong Geebung	E	V	9.00	693
Persoonia hirsuta	Hairy Geebung	E	E	35.00	2,695
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	32.98	660
Pherosphaera fitzgeraldii	Dwarf Mountain Pine	E	E	1.00	26
Phyllota humifusa	Dwarf Phyllota	V	V	8.00	144
Pimelea curviflora subsp. curviflora	*Pimelea curviflora subsp. curviflora*	V	V	8.00	616
Pomaderris brunnea	Brown Pomaderris	E	V	1,146.00	17,190
Pterostylis saxicola	Sydney Plains Greenhood	E	E	111.00	4,440
Pultenaea glabra	Smooth Bush-Pea	V	V	33.00	495
Pultenaea parviflora	*Pultenaea parviflora*	E	V	7.00	105
Pultenaea sp. Olinda	*Pultenaea sp. Olinda*	E		7.00	280
Rhizanthella slateri	Eastern Australian Underground Orchid	V	E	23.00	1,771
Solanum amourense	*Solanum amourense*	E	-	470.00	6,110
Tetratheca glandulosa	*Tetratheca glandulosa*	V	-	305.00	4,880
Trachymene scapigera	Mountain Trachymene	E	E	19.00	760
Velleia perfoliata	*Velleia perfoliata*	V	V	18.00	306
Xanthosia scopulicola	*Xanthosia scopulicola*	V		21.00	315
Zieria covenyi	Coveny's Zieria	E	E	11.00	1,100
Zieria involucrata	*Zieria involucrata*	E	V	21.00	315
Zieria murphyi	Velvet Zieria	V	V	7.00	105
FAUNA					
Anthochaera phrygia	Regent Honeyeater	CE	CE	1,264.55	97,370
Cercartetus nanus	Eastern Pygmy-possum	V	-	1,296.12	25,923
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	1,203.02	15,640
Heleioporus australiacus	Giant Burrowing Frog	V	V	883.64	11,487
Hoplocephalus bungaroides	Broad-Headed Snake	E	V	124.71	4,116
Isoodon obesulus subsp. obesulus	Southern Brown Bandicoot (Eastern)	E	E	1,167.29	30,348
Ixobrychus flavicollis	Black Bittern	V	-	1.84	24
Litoria littlejohniilittlejohni	Littlejohn's Tree Frog	V	V	420.32	10,935
Myotis macropus	Southern Myotis	V	-	863.79	19,004
Petaurus norfolcensis	Squirrel Glider	V	-	1,238.37	27,244

Species name	Common name	BC Act status	EPBC Act status	Area to be removed (ha) or number of individuals (ind)	Credit requirement
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	411.70	10,706
Phascolarctos cinereus	Koala	V	V	1,380.35	35,890
Pseudophryne australis	Red-crowned Toadlet	V	-	760.31	9,874
Varanus rosenbergi	Rosenbergs Goanna	V	-	1,111.39	36,676

1 *Acronychia littoralis* (Scented Acronychia) has been used as a surrogate for *Rhodamnia rubescens* as the latter species is not available in the BBCC.

8.3 Impacts that do not require further assessment

The study area includes 5.23 hectares of cleared and modified land which is not considered to contain native vegetation or habitat for threatened species and populations. In accordance with Section 9.5.1.1 of the FBA this area of land does not require further assessment.

9 References

Anderson, G. J. and Symon, D., 1988. Insect Foragers on Solanum Flowers in Australia. *Annals of the Missouri Botanical Garden,* 75(3), pp. 842-852.

Argent, R. M., 2016. *Water flows and levels.* [Online]
Available at: https://soe.environment.gov.au/theme/inland-water/topic/2016/water-flows-and-levels
[Accessed 28 January 2020].

Atlas of Living Australia, n.d.. *Eucalyptus benthamii Maiden & Cambage.* [Online]
Available at: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2899512
[Accessed 2019].

Auld, T. D., 1996. Ecology of the Fabaceae in the Sydney region: Fire, ants and the soil seedbank. *Cunninghamia,* 4(4), pp. 531-551.

Australian Water Technologies and SKM, 2003. *Warragamba Dam Auxiliary Spillway - Construction Environmental Management Plan Framework,* Sydney: Sydney Catchment Authority.

Ball, J. *et al*. eds., 2019. *Australian Rainfall and Runoff: A Guide to Flood Estimation.* Barton: Geoscience Australia.

Bannerman, S. M. and Hazelton, P. A., 1990. *Soil Landscapes of the Penrith 1:100,000 Sheet map and report.* Sydney: Soil Conservation Service of NSW.

Barker, R. M., Haegi, L. and Barker, W. R., 1999. Hakea. In: A. Wilson, ed. *Flora of Australia Volume 17B-Proteaceae 3 - Hakea to Dryandra.* Collingwood: CSIRO Publishing, pp. 31-170.

Beekman, M. and Ratnieks, F. L. W., 2000. Long-range foraging by the honey-bee, Apis mellifera L.. *Functional Ecology,* 14(4), pp. 490-496.

Benson, D. H., 1985. Aspects of the ecology of a rare tree species, Eucalyptus benthamii, at Bents Basin, Wallacia. *Cunninghamia,* Volume 1, pp. 371-383.

Benson, D., and McDougall, L., 1993. Ecology of Sydney plant species part 1: Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. *Cunninghamia*, *3*(2), 257–422.

Benson, D. and McDougall, L., 1996. Ecology of Sydney plant species: Part 4 Dicotyledon family Fabaceae. *Cunninghamia,* 4(4), pp. 553-756.

Benson, D. and McDougall, L., 2000. Ecology of Sydney plant species Part 7b Dicotyledon families Proteaceae to Rubiaceae. *Cunninghamia,* Volume 6, pp. 1017-1202.

Benson, D., and McDougall, L., 2005. Ecology of Sydney plant species: Part 10 Monocotyledon families Lemnaceae to Zosteraceae. Cunninghamia, 9(1), 16–212.

Berg, R. Y., 1975. Myrmecochorous plants in Australia and their dispersal by ants. *Australian Journal of Botany,* Volume 23, pp. 475-508.

Blake, W. H. *et al*., 2006. Tracing Eroded Soil in a Burnt Water Supply Catchment, Sydney, Australia: Linking Magnetic Enhancement to Soil Water Repellency. In: P. N. Owens and A. J. Collins, eds. *Soil Erosion and Sediment Redistribution in River Catchments: Measurement, Modelling and Management.* Wallingford: CAB Books, pp. 62-69.

BMT WBM Pty Ltd, 2016. *Warragamba Dam Raising Preliminary Environmental Assessment,* Sydney: WaterNSW.

Bureau of Meterology, 2018a. *Monthly Rainfall - 063036.* [Online]
Available at:
http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=063036 [Accessed 21 November 2018].

Bureau of Meterology, 2018b. *Monthly Rainfall - 067027.* [Online] Available at:
http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=067027 [Accessed 21 November 2018].

Bureau of Meterology, 2018c. *Monthly Rainfall - 068125.* [Online] Available at:
http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=068125 [Accessed 21 November 2018].

Bureau of Meterology, 2018d. *Monthly Rainfall - 070325.* [Online] Available at: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=070325 [Accessed 21 November 2018].

Bureau of Meterology, 2019. *Groundwater Dependent Ecosystems Atlas.* [Online] Available at: http://www.bom.gov.au/water/groundwater/gde/map.shtml [Accessed 6 May 2019].

Bureau of Meterology, 2020. *Water data: National Atlas of Groundwater Dependent Ecosystems.* [Online] Available at: http://www.bom.gov.au/water/awid/product-water-data-national-atlas-of-groundwater-dependent-ecosystems.shtml?_sm_au_=iVVPV37QPKJQWW72Q3QqjKst8fk1c [Accessed 28 January 2020].

Bremner, M. and Goeth, A., 2010. *National Recovery Plan: Melaleuca deanei F. Muell. (Deane's Paperbark),* Sydney.

Bush, D. *et al*., 2018. *Eucalyptus benthamii Inundation Experiment: Report on stand health and soil properties over a 12-month monitoring period,* Hobart: CSIRO.

Bush, D. and England, N., 2019. *Eucalyptus benthamii Inundation Experiment: Two-year report on stand growth and heath,* Canberra: CSIRO.

Butcher, P. A., Skinner, A. K. and Gardiner, C. A., 2005. Increased inbreeding and inter-species gene flow in remnant populations of the rare Eucalyptus benthamii. *Conservation Genetics,* Volume 6, pp. 213-226.

Catford, J. A., Downes, B. J., Gippel, C. J. and Vesk, P. A., 2011. Flow regulation reduces native plant cover and facilitates exotic invasion in riparian wetlands. *Journal of Applied Ecology,* Volume 48, pp. 432-442.

Catford, J. A. and Jansson, J., 2014. Drowned, buried and carried away: effects of plant traits on the distribution of native and alien species in riparian ecosystems. *New Phytologist,* 204(1), pp. 19-36.

Catford, J. *et al*., 2017. Wetland vegetation of inland Australia. In: D. A. Keith, ed. *Australian Vegetation.* Cambridge: Cambridge University Press, pp. 490-515.

Chippendale, G. M., 1988. *Flora of Australia Volume 19-Myrtaceae - Eucalyptus - Angophora.* Canberra: Australian Government Publishing Service.

Colmer, T. D. and Pedersen, O., 2008. Underwater photosynthesis and respiration in leaves of submerged wetland plants: gas films improve CO2 and O2 exchange. *New Phytologist,* 177(4), pp. 918-926.

Commonwealth of Australia, 1995. *National Forest Policy Statement: A new focus for Australia's forests,* Canberra: Department of Agriculture.

Council of Heads of Australasian Herbaria, n.d.. *The Australasian Virtual Herbarium.* [Online] Available at: https://avh.chah.org.au [Accessed 7 September 2019].

Crates, R. *et al*., 2017b. Undetected Allee effects in Australia's threatened birds: implications for conservation. *EMU,* Volume 117, pp. 1-15.

Crates, R. *et al*., 2018. Contemporary breeding biology of critically endangered Regent Honeyeaters: implications for conservation. *Ibis,* pp. 1-12.

Crates, R. *et al*., 2017a. An occupancy approach to monitoring regent honeyeaters. *Journal of Wildlife Management,* Volume 81, pp. 669-677.

Cremer, K. W., 1966. Dissemination of seed from Eucalyptus regnans. *Australian Forestry,* Volume 30, pp. 33-37.

CSIRO, n.d.. *Atlas of Living Australia.* [Online] Available at: https://www.ala.org.au/ [Accessed 7 September 2019].

Department of Environment and Conservation, 2004. *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft,* Sydney.

Department of Environment and Climate Change, 2002. *Descriptions for NSW (Mitchell) Landscapes Version 2.* [Online] Available at: https://www.environment.nsw.gov.au/resources/conservation/landscapesdescriptions.pdf [Accessed 7 May 2019].

Department of Environment and Climate Change, 2007a. *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region Volume 1: Background Report,* Hurstville.

Department of Environment and Climate Change, 2007b. *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region Volume 2: Fauna of Conservation Concern and Priority Pest Species,* Hurstville.

Department of Environment and Climate Change, 2007c. *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region Volume 3: The Fauna of the Warragamba Special Area: Summary of findings and recommendations,* Hurstville.

Department of Environment and Climate Change, 2007d. *Threatened and pest animals of Greater Southern Sydney,* Hurstville.

Department of Environment and Climate Change, 2007e. *Threatened species assessment guidelines: The assessment of significance,* Sydney.

Department of Environment, Climate Change and Water, 2008. Hygiene protocol for the control of disease in frogs. *Threatened Species Management Information Circular,* 6(April), pp. 1-16.

Department of Environment and Climate Change, 2010a. *Mitchell Landscapes NSW OEH v3 2011.* Sydney.

Department of Environment, Climate Change and Water, 2010b. *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland,* Sydney.

Department of Environment, Climate Change and Water, 2010c. Recovery Plan for Melaleuca deanei. Sydney. Available from: http://www.environment.gov.au/resource/national-recovery-plan-deanes-paperbark-melaleuca-deanei. In effect under the EPBC Act from 13-Aug-2010.

Department of Agriculture, Water and the Environment, 1999. *Melaleuca deanei F.Muell. (a shrub) listing advice.* [Online]
Available at: http://www.environment.gov.au/biodiversity/threatened/conservation-advices/melaleuca-deanei-f-muell [Accessed 2019].

Department of Finance and Services, 2017. *Spatial Information eXchange.* [Online]
Available at: https://maps.six.nsw.gov.au [Accessed 9 April 2018].

Department of the Environment, Water, Heritage and the Arts, 2008a. *Approved Conservation Advice for Bossiaea oligosperma.* [Online]
Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/10059-conservation-advice.pdf [Accessed 6 June 2019].

Department of the Environment, Water, Heritage and the Arts, 2008b. *Approved Conservation Advice for Eucalyptus glaucina (Slaty Red Gum).* [Online]
Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/5670-conservation-advice.pdf [Accessed 2019].

Department of the Environment, Water, Heritage and the Arts, 2008c. *Approved Conservation Advice for Hakea dohertyi.* [Online]
Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/66701-conservation-advice.pdf [Accessed 2019].

Department of Infrastructure, Planning and Natural Resources, 2005. *Floodplain Development Manual: the management of flood liable land,* Sydney.

Department of the Environment., 2013. *Matters of National Environmental Significance: Significant impact guidelines,* Canberra.

Department of the Environment, 2014a. Approved Conservation Advice for *Eucalyptus benthamii* (Camden white gum). Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/2821-conservation-advice.pdf. In effect under the EPBC Act from 11-Apr-2014.

Department of the Environment, 2014b. Conservation Advice: *Genoplesium baueri* (brittle midge orchid, yellow gnat orchid). Canberra.

Department of the Environment, 2016. *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia),* Canberra.

Department of the Environment and Energy, 2015. *Protected Matters Search Tool.* [Online]
Available at: http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf [Accessed 26 April 2019].

Department of the Environment and Energy, 2018. *Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (Regions).* [Online]
Available at: https://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B4A2321F0-DD57-454E-BE34-6FD4BDE64703%7D [Accessed 28 November 2018].

Department of the Environment and Energy, 2019. Species Profile and threats database – SPRAT Profile: *Genoplesium baueri* – Yellow Gnat Orchid.

Department of the Environment and Energy, 2020. *Wildlife and threatened species bushfire recovery research and resources.* [Online]
Available at: http://www.environment.gov.au/biodiversity/bushfire-recovery/research-and-resources [Accessed 17 March 2020].

Department of the Environment and Energy, n.d.a. *Australia's bioregions (IBRA).* [Online]
Available at: http://www.environment.gov.au/land/nrs/science/ibra [Accessed 27 November 2018].

Department of the Environment and Energy, n.d.b. *Species Profile and Threats Database.* [Online]
Available at: https://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl [Accessed 7 May 2019].

Department of Planning, Industry and Environment, 2019. *Biodiversity Assessment Method Operational Manual Stage 2,* Sydney.

Department of Planning, Industry and Environment, 2020a. *Understanding the effects of the 2019–20 fires.* [Online]
Available at: https://www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/fire/park-recovery-and-rehabilitation/recovering-from-2019-20-fires/understanding-the-impact-of-the-2019-20-fires [Accessed 17 March 2020].

Department of Planning, Industry and Environment, 2020b. *Google Earth Engine Burnt Area Map (GEEBAM) available via the Sharing and Enabling Environmental Data (SEED) Portal.* [Online]
Available at: https://datasets.seed.nsw.gov.au/dataset/google-earth-engine-burnt-area-map-geebam/resource/f2ca8072-e12a-4848-8622-0c2301812ad7 [Accessed 17 March 2020].

Department of Planning, Industry and Environment, 2020c. *Fire Extent and Severity Mapping (FESM) available via the Sharing and Enabling Environmental Data (SEED) Portal.* [Online]
Available at: https://datasets.seed.nsw.gov.au/dataset/fire-extent-and-severity-mapping-fesm [Accessed 25 May 2020].

Department of Planning, Industry and Environment, 2020d. *NPWS Fire History – Wildfires and Prescribed Burns available via the Sharing and Enabling Environmental Data (SEED) Portal.* [Online]
Available at: https://datasets.seed.nsw.gov.au/dataset/fire-history-wildfires-and-prescribed-burns-1e8b6 [Accessed 17 March 2020].

Department of Planning, Industry and Environment, 2020e. *NSW Fire and the Environment 2019–20 Summary: Biodiversity and landscape data and analyses to understand the effects of the fire events,* Sydney.

Department of Planning, Industry and Environment, n.d.. *Groundwater dependent ecosystems - water in NSW.* [Online]
Available at: https://www.industry.nsw.gov.au/water/science/groundwater/ecosystems [Accessed 28 January 2020].

Department of Primary Industries, 2014, *Hawkesbury-Nepean Valley Flood Management Review Stage One – Review Report*, DPI, Office of Water.

Eco Logical Australia, 2007. *A Review of 'Overcleared' Landscapes in the PVP-Developer Stage 2: Hawkesbury Nepean, Hunter/Central Rivers, Lower Murray/Darling, Murray/Murrumbidgee, Northern Rivers, Southern Rivers and Western Catchment Management Authority Areas,* Coffs Harbour: Department of Environment and Conservation.

ERM Mitchell McCotter, 1995. *Proposed Warragamba flood mitigation dam environmental impact statement,* Sydney: Sydney Water.

Evangelista, P. H. *et al*., 2008. Modelling invasion for a habitat generalist and a specialist plant species. *Diversity and Distribution,* Volume 14, pp. 808-817.

Fairfull, S., 2013. *Policy and guidelines for fish habitat conservation and management: Update 2013,* Wollongbar: Department of Primary Industries.

Fairfull, S. and Witheridge, G., 2003. *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings,* Cronulla: NSW Fisheries.

Felton, S. A., 1993. *The distribution, abundance and seed ecology of the rare plant Melaleuca deanei.* University of Wollongong: unpublished thesis.

Ford, H. A., Paton, D. C. and Forde, N., 1979. Birds as pollinators of Australian plants. *New Zealand Journal of Botany,* 17(4), pp. 509-519.

Geering, D. and French, K., 1998. Breeding biology of the regent honeyeater in the Capertee Valley, New South Wales. *EMU,* Volume 98, pp. 104-116.

Geoscience Australia, n.d.. *Groundwater Dependent Ecosystems.* [Online]
Available at: http://www.ga.gov.au/scientific-topics/water/groundwater/understanding-groundwater-resources/groundwater-dependant-ecosystems?_sm_au_=iVVPV37QPKJQWW72Q3QqjKst8fk1c [Accessed 28 January 2020].

GHD, 2013. *2013 Audit of the Sydney Drinking Water Catchment,* Parramatta: Water Sciences Group and GHD.

Gomez, C. and Espadaler, X., 2003. Myrmecochorous dispersal distances: a world survey. *Journal of Biogeography,* 25(3), pp. 573-580.

Greening Australia, 2018. *Native Seed Services.* [Online]
Available at: https://www.greeningaustralia.org.au/services-native-seed/ [Accessed 2019].

Hager, T. and Benson, D., 2010. The Eucalypts of the Greater Blue Mountains World Heritage Area: distribution, classification and habitats of the species of Eucalyptus, Angophora and Corymbia (family Myrtaceae) recorded in its eight conservation reserves. *Cunninghamia,* 11(4), pp. 425-444.

Hanley, M. E., Lamont, B. B. and Armbruster, W. S., 2009. Pollination and plant defence traits co-vary in Western Australian Hakeas. *New Phytologist,* Volume 182, pp. 251-260.

Harden, G., 2002. *Flora of New South Wales Volume 2.* Revised ed. Kensington: UNSW Press.

Harden, G. H., 1991. *Flora of New South Wales, Volume Two.* Kensington: UNSW Press.

Harden, G. J., 1990. *Flora of New South Wales Volume 1.* Kensington: UNSW Press.

Harden, G. J., 2000. *Flora of New South Wales Volume 1.* Revised ed. Kensington: UNSW Press.

Hewitt, A. *et al*., 2014. Plant-level fecundity and andromonoecy in three common (Melaleuca styphelioides, M. thymifolia, M. nodosa) and one rare (M. deanei) Melaleuca (Myrtaceae) species of the Sydney region. *Australian Journal of Botany,* 62(4), pp. 276-285.

Howell, J. and Benson, D., 2000. Predicting potential impacts of environmental flows on weedy riparian vegetation of the Hawkesbury-Nepean River, south-eastern Australia. *Austral Ecology,* Volume 25, pp. 463-475.

Hydrobiology, 2020. Literature and Field Assessment of Environmental Impacts of Temporary Inundation Upstream of Queensland Flood Mitigation Dams,

INSW, 2012. *The State Infrastructure Strategy 2012-2032,* Sydney: Infrastructure NSW.

Jackson, M. B. and Colmer, T. D., 2005. Response and Adaptation by Plants to Flooding Stress. *Annals of Botany,* 96(4), pp. 501-505.

Johnson, L. A. S., 1962. Studies in the Taxonomy of Eucalyptus. *Contributions from the New South Wales National Herbarium,* 3(3), pp. 103-126.

Keith, D., 2004. *Ocean Shores to Desert Dunes: The Native Vegetation of New South Wales and the ACT,* Hurstville: Department of Environment and Conservation.

Keith, D. A., Chalson, J. M. and Auld, T. D., 1997. *Assessing the Status of Threatened Plants: A New Methodology and an Application to the Vascular Flora of New South Wales,* Canberra: Environment Australia.

King, D. P., 1994. *Soil Landscapes of the Katoomba 1:100,000 Sheet map and report.* Sydney: Soil Conservation Service of NSW.

Kozlowski, T. T., 1997. Responses of woody plants to flooding and salinity. *Tree Physiology,* 17(7), pp. 490-507.

Kvistad, L. *et al*., 2015. Very Low Population Structure in a Highly Mobile and Wide-Ranging Endangered Bird Species. *PLoS ONE,* 10(12), pp. 1-20.

Lamont, B. B., Le Maitre, D. C., Cowing, R. M. and Enright, N. J., 1991. Canopy seed storage in woody plants. *The Botanical Review,* Volume 57, pp. 277-317.

Lind, L., Nilsson, C. and Weber, C., 2014. Effects of ice and floods on vegetation in streams in cold regions: implications for climate change. *Ecology and Evolution,* 4(21), pp. 4173-4184.

Loreti, E., van Veen, H. and Perata, P., 2016. Plant responses to flooding stress. *Current Opinion in Plant Biology,* Volume 33, pp. 64-71.

Makinson, R. O., 2018. *Myrtle Rust reviewed: The impacts of the invasive plant pathogen Austropuccinia psidii on the Australian environment,* Canberra: Plant Biosecurity Cooperative Research Centre.

Marcar, N., 1995. *Glasshouse Evaluation of Inundation Tolerance of Camden white gum (Eucalyptus benthamii),* Canberra: CSIRO.

Mills, K., 2008. *Rare Plants of the Illawarra 3: The Endangered Shrub Hakea dohertyi (Proteaceae) in the Shoalhaven Region.* Jamberoo: Coachwood Publishing.

Mount King Ecological Surveys, 1992. *Warragamba Dam EIS - Dam Site Environmental Studies Flora and Fauna,* Bathurst: Mount King Ecological Surveys.

Murcia, C., 1995. Edge Effects in Fragmented Forests: Implications for Conservation. *Trends in Ecology and Evolution,* 10(2), pp. 58-62.

Myerscough, P. J., 1998. Ecology of Myrtaceae with special reference to the Sydney region. *Cunninghamia,* 5(4), pp. 787-805.

Nicol, J., Doody, T. and Overton, I., 2010. *An Evaluation of the Chowilla Creek Environmental Regulator on Floodplain Understorey Vegetation,* West Beach: South Australian Research and Development Institute.

National Parks and Wildife Service, 2002a. *Environmental Assessment Guidelines: Epacris purpurascens var. purpurascens.* [Online]
Available at: https://www.environment.nsw.gov.au/resources/nature/EpurpurascensEia0502.pdf [Accessed 27 May 2019].

National Parks and Wildife Service, 2002b. *Environmental Impact Assessment Guidelines: Dillwynia tenuifolia.* [Online]
Available at: https://www.environment.nsw.gov.au/resources/nature/DtenuifoliaEia0502.pdf [Accessed 2019].

National Parks and Wildife Service, 2003a. *The Native Vegetation of the Warragamba Special Area,* Sydney.

National Parks and Wildife Service, 2003b. *South Eastern Highlands Biogeographic Region (IBRA) - Location.* [Online]
Available at: https://www.environment.nsw.gov.au/resources/nature/SouthEasternHighlandsMapsLocation.pdf [Accessed 27 December 2018].

National Parks and Wildife Service, 2019. *Greater Blue Mountains.* [Online]
Available at: https://www.nationalparks.nsw.gov.au/conservation-and-heritage/greater-blue-mountains [Accessed 3 May 2019].

NSW Scientific Committee, 1999a. *Ancistrachne maidenii (a perennial grass) - vulnerable species listing.* [Online]
Available at: https://www.environment.nsw.gov.au/Topics/Animals-and-plants/Threatened-species/NSW-Threatened-Species-Scientific-Committee/Determinations/Final-determinations/1996-1999/Ancistrachne-maidenii-a-perennial-grass-vulnerable-species-listing [Accessed 2019].

NSW Scientific Committee, 1999b. *Callistemon linearifolius (a shrub) - vulnerable species listing.* [Online]
Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/1996-1999/callistemon-linearifolius-a-shrub-vulnerable-species-listing [Accessed 2019].

NSW Scientific Committee, 1999c. *Epacris purpurascens var. purpurascens (a shrub) - vulnerable species listing.* [Online]
Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/1996-1999/epacris-purpurascens-var-purpurascens-a-shrub-vulnerable-species-listing [Accessed 27 May 2019].

NSW Scientific Committee, 1999d. *Melaleuca deanei (a shrub) - vulnerable species listing.* [Online] Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/1996-1999/melaleuca-deanei-a-shrub-vulnerable-species-listing [Accessed 28 May 2019].

NSW Scientific Committee, 2000. *High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition - profile.* [Online] Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=20014 [Accessed 29 June 2019].

NSW Scientific Committee, 2002. *Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands - key threatening process listing.* [Online] Available at: https://www.environment.nsw.gov.au/Topics/Animals-and-plants/Threatened-species/NSW-Threatened-Species-Scientific-Committee/Determinations/Final-determinations/2000-2003/Alteration-to-the-natural-flow-regimes-key-threatening-process-listing [Accessed 2019].

NSW Scientific Committee, 2003. *Hibbertia puberula - endangered species listing.* [Online] Available at: https://www.environment.nsw.gov.au/Topics/Animals-and-plants/Threatened-species/NSW-Threatened-Species-Scientific-Committee/Determinations/Final-determinations/2000-2003/Hibbertia-puberula-endangered-species-listing [Accessed 28 May 2019].

NSW Scientific Committee, 2011a. *Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion - Determination to make a minor amendment to Part 3 of Schedule 1 of the Threatened Species Conservation Act.* [Online] Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/2011-2012/blue-mountains-shale-cap-forest-in-the-sydney-basin-bioregion-minor-amendment-determination [Accessed 2019].

NSW Scientific Committee, 2011b. *River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - Determination to make a minor amendment to Part 3 of Schedule 1 of the Threatened Species Conservation Act.* [Online] Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/2011-2012/river-flat-eucalypt-forest-on-coastal-floodplains-minor-amendment-determination [Accessed 2019].

NSW Scientific Committee, 2011c. *Western Sydney Dry Rainforest in the Sydney Basin Bioregion - Determination to make a minor amendment to Part 3 of Schedule 1 of the Threatened Species Conservation Act.* [Online] Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/2011-2012/western-sydney-dry-rainforest-in-the-sydney-basin-bioregion-minor-amendment-determination [Accessed 2019].

NSW Scientific Committee, 2011d. *White Box Yellow Box Blakely's Red Gum Woodland - Determination to make a minor amendment to Part 3 of Schedule 1 of the Threatnened Species Conservation Act.* [Online] Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/2011-2012/white-box-yellow-box-blakelys-red-gum-woodland-minor-amendment-determination [Accessed 2019].

NSW Threatened Species Scientific Committee, 2019. *Sydney Turpentine Ironbark Forest.* [Online] Available at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Scientific-Committee/Determinations/2019/sydney-turpentine-ironbark-forest-final-determination-CEEC.pdf?la=en&hash=25B534BBC97EB38056E2CE5FB7385F842A48A0EF [Accessed 2019].

Office of Environment and Heritage, 2010. *NSW Wetlands.* Sydney.

Office of Environment and Heritage, 2011. *Management plan for myrtle rust on the national parks estate,* Sydney.

Office of Environment and Heritage, 2012. NSW Scientific Committee – final determination: *Genoplesium baueri*.

Office of Environment and Heritage, 2013. *The native vegetation of the Sydney metropolitan area.* Sydney.

Office of Environment and Heritage, 2014. *NSW Biodiversity Offsets Policy for Major Projects,* Sydney.

Office of Environment and Heritage, 2016. *Addendum to NSW Biodiversity Offsets Policy for Major Projects - Upland Swamps impacted by longwall mining subsidence,* Sydney.

Office of Environment and Heritage, 2016a. *NSW Guide to Surveying Threatnened Plants,* Sydney.

Office of Environment and Heritage, 2016b. *South Eastern Highlands Bioregion.* [Online]
Available at: https://www.environment.nsw.gov.au/bioregions/SouthEasternHighlandsBioregion.htm [Accessed 27 December 2018].

Office of Environment and Heritage, 2016c. *Sydney Basin - subregions.* [Online]
Available at: https://www.environment.nsw.gov.au/bioregions/SydneyBasin-Subregions.htm [Accessed 8 May 2019].

Office of Environment and Heritage, 2016d. *Sydney Basin Bioregion.* [Online]
Available at: https://www.environment.nsw.gov.au/bioregions/SouthEasternHighlandsBioregion.htm [Accessed 27 December 2018].

Office of Environment and Heritage, 2017a. *Ancistrachne maidenii - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10050 [Accessed 2019].

Office of Environment and Heritage, 2017b. *BioNet Atlas.* [Online]
Available at: https://www.environment.nsw.gov.au/atlaspublicapp/ui_modules/atlas_/atlassearch.aspx [Accessed 22 January 2020].

Office of Environment and Heritage, 2017c. *BioNet Vegetation Classification System.* [Online]
Available at: http://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx [Accessed 9 April 2018].

Office of Environment and Heritage, 2017d. *Brown Pomaderris - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10647 [Accessed 2019].

Office of Environment and Heritage, 2017e. *Epacris purpurascens var. purpurascens - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10273 [Accessed 27 May 2019].

Office of Environment and Heritage, 2017f. *Glossary of Terms used in Soil and Landscape Science,* Sydney.

Office of Environment and Heritage, 2017g. *Threatened biodiversity profile search.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/ [Accessed 22 January 2020].

Office of Environment and Heritage, 2018a. *Few-seeded Bossiaea - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10104 [Accessed 6 June 2019].

Office of Environment and Heritage, 2018b. *Framework for Biodiversity Assessment,* Sydney.

Office of Environment and Heritage, 2018c. *Wild rivers.* [Online]
Available at: https://www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/types-of-protected-areas/wild-rivers [Accessed 7 May 2019].

Office of Environment and Heritage, 2018d. *Bauer's Midge Orchid – profile.* [Online] Obtained from https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10875 [Accessed 2 August 2019]

Office of Environment and Heritage, 2019a. *Biodiversity Values Map and Threshold Tool.* [Online]
Available at: https://lmbc.nsw.gov.au/Maps/index.html?viewer=BOSETMap [Accessed 3 May 2019].

Office of Environment and Heritage, 2019b. *Camden White Gum - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10284 [Accessed 2019].

Office of Environment and Heritage, 2019c. *Deane's Paperbark - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10515 [Accessed 28 May 2019].

Office of Environment and Heritage, 2019d. *Dillwynia tenuifolia - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10226 [Accessed 2019].

Office of Environment and Heritage, 2019e. *Gyrostemon thesioides - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10384 [Accessed 11 January 2019].

Office of Environment and Heritage, 2019f. *Hibbertia puberula - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10402 [Accessed 28 May 2019].

Office of Environment and Heritage, 2019g. *Kowmung Hakea - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10388 [Accessed 2019].

Office of Environment and Heritage, 2019h. *Netted Bottle Brush - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10129 [Accessed 2019].

Office of Environment and Heritage, 2019i. *Slaty Red Gum - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10295 [Accessed 2019].

Office of Environment and Heritage, 2019j. *Solanum armourense - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10760 [Accessed 2019].

Office of Environment and Heritage, 2019k. *Tetratheca glandulosa - profile.* [Online]
Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10798 [Accessed 2019].

Office of Environment and Heritage, 2019l. *Translocation operational policy,* Sydney.

Office of Environment and Heritage, n.d.a. *BioBanking Credit Calculator.* [Online]
Available at: http://www.environment.nsw.gov.au/bbccapp/ui/mynews.aspx [Accessed 22 January 2020].

Office of Environment and Heritage, n.d.b. *Help save the Few-seeded Bossiaea.* [Online]
Available at:
https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=334&ReportProfileID=10104 [Accessed 6 June 2019].

Office of Environment and Heritage, n.d.c. *Saving Our Species: Help save Epacris purpurascens var. purpurascens.* [Online]
Available at:
https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=272&ReportProfileID=10273 [Accessed 27 May 2019].

Office of Environment and Heritage, n.d.d. *Saving Our Species: Help save Gyrostemon thesioides.* [Online]
Available at:
https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=1211&ReportProfileID=10384 [Accessed 27 May 2019].

Office of Environment and Heritage, n.d.e. *Saving Our Species: Help save Hibbertia puberula.* [Online]
Available at:
https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=28&ReportProfileID=10402 [Accessed 28 May 2019].

Office of Environment and Heritage, n.d.f. *Saving Our Species: Help save Tetratheca glandulosa.* [Online]
Available at:
https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=317&ReportProfileID=10798 [Accessed 2019].

Offord, C. *et al.*, 2003. Germination and ex situ storage of Hakea dohertyi (Proteaceae) seed. *Cunninghamia,* 8(1), pp. 129-132.

Oliver, D., 1998. The breeding behaviour of the endangered regent honeyeater Xanthomyza phrygia near Armidale, New South Wales. *EMU,* Volume 46, pp. 153-170.

Parolin, P. & Wittmann, F., 2010. Struggle in the flood: tree responses to flooding stress in four tropical floodplain systems. *AoB Plants,* 2010(3), pp. 1-54.

Patykowski, J., Dell, M. and Gibson, M., 2016. Germination Ecology and Seed Dispersal of a Critically Endangered Plant: A Case Study of Pomaderris vacciniifolia (Round-Leaf Pomaderris). *PLOS One,* 11(8), pp. 1-12.

Perata, P., Armstrong, W. and Voesenek, L. A. C. J., 2011. Plants and flooding stress. *New Phytologist,* Volume 190, pp. 269-273.

Phillips, S. S. and Callaghan, J., 2011. The Spot Assessment Technique: A tool for determining localised levels of habitat use by Koalas Phascolarctos cinereus. *Australian Zoologist,* 35(3), pp. 774-780.

Prober, S. M. and Brown, A. H. D., 1994. Conservation of the grassy white box woodlands: population genetics and fragmentation of Eucalyptus albens. *Conservation Biology,* Volume 8, pp. 1003-1013.

Prober, S. M. and Thiele, K. R., 2005. Restoring Australia's temperate grasslands and grassy woodlands: integrating function and diversity. *Ecological Management and Restoration,* Volume 6, pp. 16-27.

Rice, B. and Westoby, M., 1981. Myrmechochory in sclerophyll vegetation of the West Head, New South Wales. *Australian Journal of Ecology,* Volume 6, pp. 291-298.

Riley J.J. and Banks D. P., 2002. Orchids of Australia. University of New South Wales Press, Sydney.

Rose, S. and Fairweather, P. G., 1997. Changes in Floristic Composition of Urban Bushland Invaded by Pittosporum undulatum in Northern Sydney, Australia. *Australian Journal of Botany,* 45(1), pp. 123-149.

Rymer, P. D., Morris, E. C. and Richardson, B. J., 2002. Breeding system and population genetics of the vulnerable plant Dillwynia tenuifolia (Fabaceae). *Austral Ecology,* 27(3), pp. 241-248.

Shakesby, R. A. *et al*., 2006. Hillslope Soil Erosion and Bioturbation after the Christmas 2001 Forest Fires near Sydney, Australia. In: P. N. Owens and A. J. Collins, eds. *Soil Erosion and Sediment Redistribution in River Catchments: Measurement, Modelling and Management.* Wallingford: CAB Books, pp. 51-61.

Smith, J. P., Heard, T. A., Beekman, M. and Gloag, R., 2017. Flight range of the Australian stingless bee Tetragonula carbonaria (Hymenoptera: Apidae). *Austral Entomology,* 56(1), pp. 50-53.

Steenbeeke, G. L., 1996. *Population Attributes of a Rare Serotinous Hakea Species.* University of Sydney: unpublished thesis.

Suddaby, T. and Liew, E., 2008. *Best Practice Management Guidelines for Phytophthora cinnamomi within the Sydney Metropolitan Catchment Management Authority Area,* Sydney: Botanic Gardens Trust.

Sutter, G., 2011. *National Recovery Plan for the Rufous Pomaderris Pomaderris brunnea,* Melbourne: State of Victoria Department of Sustainablity and Environment.

Sydney Water, 1996. *Safeguarding Warragamba Dam: proposed auxiliary spillway,* Sydney: Sydney Water Corporation Ltd.

Taylor-Wood, E. and Warner, R., 2003. *Regionally Significant Wetlands and Environmental Flows,* Sydney: Hawkesbury-Nepean River Management Forum.

Thomas, V., Gellie, N. and Harrison, T., 2000. *Forest ecosystem classification and mapping for the Southern CRA region.* Sydney: National Parks and Wildlife Service.

Tozer, M. G. *et al*., 2010. Native vegetation of southest NSW: a revised classification and map for the coast and eastern tablelands. *Cunninghamia,* Volume 11, pp. 359-406.

Virtue, J. G., 1991. *Melaleuca deanei: ecological studies on a rare plant.* University of Sydney: unpublished thesis.

Voesenek, L. A. and Bailey-Serres, J., 2015. Flood adaptive traits and processes: an overview. *New Phytologist,* 206(1), pp. 57-73.

Wallace, H. M. and Trueman, S. J., 1995. Dispersal of Eucalyptus torelliana seeds by the resin-collecting stingless bee, Trigona carbonaria. *Oecologia,* Volume 104, pp. 12-16.

WaterNSW, 2015. *Dams of Greater Sydney and Surrounds: Warragamba,* Penrith.

WaterNSW, 2017. *Weekly Verified Storage and Supply Report - Thursday 19 October 2017,* Parramatta.

WaterNSW, 2018. *Weekly Verified Storage and Supply Report - Thursday 15 March 2018,* Parramatta.

WaterNSW, n.d.. *Warragamba Catchment.* [Online]
Available at: https://www.waternsw.com.au/water-quality/catchment/sub-catchment/warragamba [Accessed 8 May 2019].

Woolfrey, A. and Ladd, P., 2001. Habitat preference and reproductive traits of a major Australian riparian tree species (Casuarina cunninghamiana). *Australian Journal of Botany,* Volume 49, pp. 705-715.

Appendix A BioBanking credit report

Biodiversity credit report

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

Date of report: 2/04/2020 Time: 6:50:21PM Calculator version: v4.0

Major Project details

Proposal ID:	174/2018/4906MP
Proposal name:	WDR_Bungonia V3
Proposal address:	Level 5, 20 Berry Street North Sydney NSW 2061
Proponent name:	Water NSW
Proponent address:	Level 5, 20 Berry Street North Sydney NSW 2061
Proponent phone:	0438746556
Assessor name:	Rachel Musgrave
Assessor address:	Level 5, 20 Berry Street North Sydney NSW 2010
Assessor phone:	02 9900 7115
Assessor accreditation:	174

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion	2.64	150.00
Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	0.51	36.00
Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion	0.02	1.00
Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion	0.12	7.40
River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion	34.48	2,159.00
Total	37.77	2,353

Credit profiles

1. Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion, (HN538)

Number of ecosystem credits created	36
IBRA sub-region	Bungonia - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion, (HN538) Whalebone Tree - Native Quince dry subtropical rainforest on dry fertile slopes, southern Sydney Basin Bioregion, (HN608)	Bungonia - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion, (HN557)

Number of ecosystem credits created	7
IBRA sub-region	Bungonia - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion, (HN557) White Box - Grey Gum - Kurrajong grassy woodland on slopes of the northern Capertee Valley, Sydney Basin Bioregion, (HN609) White Box - Narrow-leaved Ironbark grassy woodland of the Capertee Valley, Sydney Basin Bioregion, (HN610)	Bungonia - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527)

Number of ecosystem credits created	150
IBRA sub-region	Bungonia - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527)	Bungonia - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)

Number of ecosystem credits created	1
IBRA sub-region	Bungonia - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Bungonia - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion, (HN574)

Number of ecosystem credits created	2,159
IBRA sub-region	Bungonia - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion, (HN574)	Bungonia - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Biodiversity credit report

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

Date of report: 2/04/2020 Time: 6:46:03PM Calculator version: v4.0

Major Project details

Proposal ID:	174/2019/5016MP
Proposal name:	WDR_Burragorang V3
Proposal address:	20 Berry Street Level 5 North Sydney NSW 2060
Proponent name:	WaterNSW
Proponent address:	20 Berry Street Level 5 North Sydney NSW 2060
Proponent phone:	99007169
Assessor name:	Rachel Musgrave
Assessor address:	Level 5, 20 Berry Street North Sydney NSW 2010
Assessor phone:	02 9900 7115
Assessor accreditation:	174

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion	0.05	3.00
Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion	40.04	2,545.00
Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion	54.40	2,906.02
Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	93.59	4,779.00
Grey Gum - Hard-leaved Scribbly Gum woodland of the Coxs River Valley, Sydney Basin Bioregion	3.13	197.00
Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion	7.78	634.00
Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	80.13	5,706.00
Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	10.34	722.00
Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion	41.85	2,410.14
Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion	134.57	8,287.00
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	0.17	10.00
Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion	3.11	233.00
River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion	27.53	1,720.00
Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion	3.55	245.00
Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion	0.11	8.00
Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion	2.15	119.00
Total	502.50	30,524

Credit profiles

1. Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion, (HN517)

Number of ecosystem credits created	3
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion, (HN517) Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin Bioregion and South East Corner Bioregion, (HN547)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion, (HN538)

Number of ecosystem credits created	722
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion, (HN538) Whalebone Tree - Native Quince dry subtropical rainforest on dry fertile slopes, southern Sydney Basin Bioregion, (HN608)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion, (HN606)

Number of ecosystem credits created	8
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion, (HN606) Blackbutt - Narrow-leaved White Mahogany shrubby tall open forest of coastal ranges, northern Sydney Basin Bioregion, (HN505) Sydney Blue Gum - Blackbutt - Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin Bioregion, (HN596) Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion, (HN597) Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion, (HN598) Turpentine - Grey Myrtle forest of sheltered sandstone gullies of the Central Coast hinterland, Sydney Basin Bioregion, (HN605) Sydney Blue Gum - Deane's Gum - River Peppermint shrubby riparian tall forest of the lower Colo River, Sydney Basin Bioregion, (HN647) Deane's Gum - Mountain Grey Gum - Turpentine tall moist forest on shale, Sydney Basin Bioregion, (HN636)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion, (HN557)

Number of ecosystem credits created	8,287
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion, (HN557) White Box - Grey Gum - Kurrajong grassy woodland on slopes of the northern Capertee Valley, Sydney Basin Bioregion, (HN609) White Box - Narrow-leaved Ironbark grassy woodland of the Capertee Valley, Sydney Basin Bioregion, (HN610)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525)

Number of ecosystem credits created	2,545
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525) Eurabbie - stringybark shrubby woodland on limestone in the Jenolan Caves area, Sydney Basin Bioregion, (HN523) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531) Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535) Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536) Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

6. Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527)

Number of ecosystem credits created	2,906
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

7. Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532)

Number of ecosystem credits created	4,779
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	**Offset options - IBRA sub-regions**
Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

8. Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535)

Number of ecosystem credits created	634
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535) Eurabbie - stringybark shrubby woodland on limestone in the Jenolan Caves area, Sydney Basin Bioregion, (HN523) Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531) Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536) Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

9. Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536)

Number of ecosystem credits created	5,706
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536) Eurabbie - stringybark shrubby woodland on limestone in the Jenolan Caves area, Sydney Basin Bioregion, (HN523) Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531) Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535) Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

10. Grey Gum - Hard-leaved Scribbly Gum woodland of the Coxs River Valley, Sydney Basin Bioregion, (HN533)

Number of ecosystem credits created	197
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum - Hard-leaved Scribbly Gum woodland of the Coxs River Valley, Sydney Basin Bioregion, (HN533) Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion, (HN542) Narrow-leaved Apple - Hard-leaved Scribbly Gum heathy woodland on sand at Agnes Banks, Sydney Basin Bioregion, (HN555) Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion, (HN635)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

11. Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion, (HN598)

Number of ecosystem credits created	245
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion, (HN598)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

12. Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566)

Number of ecosystem credits created	10
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566) Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion, (HN587) Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (HN586) Spotted Gum - Grey Ironbark open forest in the Pittwater and Wagstaffe area, Sydney Basin Bioregion, (HN642) Sydney Peppermint - White Stringybark - Smooth-barked Apple forest on shale outcrops, Sydney Basin Bioregion, (HN644)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

13. Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion, (HN568)

Number of ecosystem credits created	233
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion, (HN568) Yellow Bloodwood - ironbark shrubby woodland of the dry hinterland of the Central Coast, Sydney Basin Bioregion, (HN612) Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion, (HN564)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

14. Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion, (HN607)

Number of ecosystem credits created	119
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion, (HN607) Tea-tree shrubland of drainage areas of the slopes and tablelands, (HN603) River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion, (HN574)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

15. Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)

Number of ecosystem credits created	2,410
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

16. River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion, (HN574)

Number of ecosystem credits created	1,720
IBRA sub-region	Burragorang (Part A)

Offset options - Plant Community types	Offset options - IBRA sub-regions
River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion, (HN574)	Burragorang (Part A) and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Biodiversity credit report

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

Date of report: 2/04/2020 Time: 6:48:14PM Calculator version: v4.0

Major Project details

Proposal ID:	174/2018/4905MP
Proposal name:	WDR_Wollemi V3
Proposal address:	Level 5, 20 Berry Street North Sydney NSW 2061
Proponent name:	Water NSW
Proponent address:	Level 5, 20 Berry Street North Sydney NSW 2061
Proponent phone:	0438746556
Assessor name:	Rachel Musgrave
Assessor address:	Level 5, 20 Berry Street North Sydney NSW 2010
Assessor phone:	02 9900 7115
Assessor accreditation:	174

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion	0.13	8.00
Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	1.39	71.00
Grey Gum - Hard-leaved Scribbly Gum woodland of the Coxs River Valley, Sydney Basin Bioregion	0.56	35.00
Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	2.44	174.00
Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion	0.88	46.00
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	2.61	148.00
Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion	7.71	577.00
Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion	9.15	650.00
Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion	0.39	22.00
Total	25.26	1,731

Credit profiles

1. Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion, (HN517)

Number of ecosystem credits created	8
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion, (HN517) Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin Bioregion and South East Corner Bioregion, (HN547)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion, (HN606)

Number of ecosystem credits created	650
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion, (HN606) Blackbutt - Narrow-leaved White Mahogany shrubby tall open forest of coastal ranges, northern Sydney Basin Bioregion, (HN505) Sydney Blue Gum - Blackbutt - Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin Bioregion, (HN596) Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion, (HN597) Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion, (HN598) Turpentine - Grey Myrtle forest of sheltered sandstone gullies of the Central Coast hinterland, Sydney Basin Bioregion, (HN605) Sydney Blue Gum - Deane's Gum - River Peppermint shrubby riparian tall forest of the lower Colo River, Sydney Basin Bioregion, (HN647) Deane's Gum - Mountain Grey Gum - Turpentine tall moist forest on shale, Sydney Basin Bioregion, (HN636)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532)

Number of ecosystem credits created	71
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536)

Number of ecosystem credits created	174
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536) Eurabbie - stringybark shrubby woodland on limestone in the Jenolan Caves area, Sydney Basin Bioregion, (HN523) Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531) Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535) Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Grey Gum - Hard-leaved Scribbly Gum woodland of the Coxs River Valley, Sydney Basin Bioregion, (HN533)

Number of ecosystem credits created	35
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum - Hard-leaved Scribbly Gum woodland of the Coxs River Valley, Sydney Basin Bioregion, (HN533) Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion, (HN542) Narrow-leaved Apple - Hard-leaved Scribbly Gum heathy woodland on sand at Agnes Banks, Sydney Basin Bioregion, (HN555) Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion, (HN635)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

6. Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion, (HN564)

Number of ecosystem credits created	46
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion, (HN564) Yellow Bloodwood - ironbark shrubby woodland of the dry hinterland of the Central Coast, Sydney Basin Bioregion, (HN612)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

7. Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566)

Number of ecosystem credits created	148
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566) Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion, (HN587) Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (HN586) Spotted Gum - Grey Ironbark open forest in the Pittwater and Wagstaffe area, Sydney Basin Bioregion, (HN642) Sydney Peppermint - White Stringybark - Smooth-barked Apple forest on shale outcrops, Sydney Basin Bioregion, (HN644)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

8. Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion, (HN568)

Number of ecosystem credits created	577
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion, (HN568) Yellow Bloodwood - ironbark shrubby woodland of the dry hinterland of the Central Coast, Sydney Basin Bioregion, (HN612) Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion, (HN564)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

9. Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion, (HN607)

Number of ecosystem credits created	22
IBRA sub-region	Wollemi - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion, (HN607) Tea-tree shrubland of drainage areas of the slopes and tablelands, (HN603) River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion, (HN574)	Wollemi - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Biodiversity credit report

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

Date of report: 2/04/2020 Time: 6:49:19PM Calculator version: v4.0

Major Project details

Proposal ID:	174/2018/4907MP
Proposal name:	WDR_Kanangra V3
Proposal address:	Level 5, 20 Berry Street North Sydney NSW 2061
Proponent name:	Water NSW
Proponent address:	Level 5, 20 Berry Street North Sydney NSW 2061
Proponent phone:	0438746556
Assessor name:	Rachel Musgrave
Assessor address:	Level 5, 20 Berry Street North Sydney NSW 2010
Assessor phone:	02 9900 7115
Assessor accreditation:	174

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion	30.05	1,910.00
Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	0.33	17.00
Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion	2.97	242.00
Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion	0.83	59.00
Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion	2.40	196.00
Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	12.04	841.00
Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion	2.89	166.00
Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion	0.20	12.32
River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion	18.05	1,128.00
Total	69.76	4,571

Credit profiles

1. Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion, (HN537)

Number of ecosystem credits created	196
IBRA sub-region	Kanangra - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Myrtle - Lilly Pilly dry rainforest in dry gullies of the Sydney Basin Bioregion and South East Corner Bioregion, (HN537) Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion, (HN538) Whalebone Tree - Native Quince dry subtropical rainforest on dry fertile slopes, southern Sydney Basin Bioregion, (HN608)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion, (HN538)

Number of ecosystem credits created	841
IBRA sub-region	Kanangra - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion, (HN538) Whalebone Tree - Native Quince dry subtropical rainforest on dry fertile slopes, southern Sydney Basin Bioregion, (HN608)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion, (HN557)

Number of ecosystem credits created	12
IBRA sub-region	Kanangra - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Narrow-leaved Ironbark - Forest Red Gum woodland on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion, (HN557) White Box - Grey Gum - Kurrajong grassy woodland on slopes of the northern Capertee Valley, Sydney Basin Bioregion, (HN609) White Box - Narrow-leaved Ironbark grassy woodland of the Capertee Valley, Sydney Basin Bioregion, (HN610)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525)

Number of ecosystem credits created	1,910
IBRA sub-region	Kanangra - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525) Eurabbie - stringybark shrubby woodland on limestone in the Jenolan Caves area, Sydney Basin Bioregion, (HN523) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531) Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535) Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536) Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532)

Number of ecosystem credits created	17
IBRA sub-region	Kanangra - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

6. Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535)

Number of ecosystem credits created	242
IBRA sub-region	Kanangra - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535) Eurabbie - stringybark shrubby woodland on limestone in the Jenolan Caves area, Sydney Basin Bioregion, (HN523) Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531) Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536) Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

7. Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536)

Number of ecosystem credits created	59
IBRA sub-region	Kanangra - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN536) Eurabbie - stringybark shrubby woodland on limestone in the Jenolan Caves area, Sydney Basin Bioregion, (HN523) Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN525) Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion, (HN527) Grey Gum - Blue-leaved Stringybark open forest on gorge slopes, southern Sydney Basin Bioregion and north east South Eastern Highlands Bioregion, (HN531) Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion, (HN532) Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion, (HN535) Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

8. Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)

Number of ecosystem credits created	166
IBRA sub-region	Kanangra - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion, (HN553)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

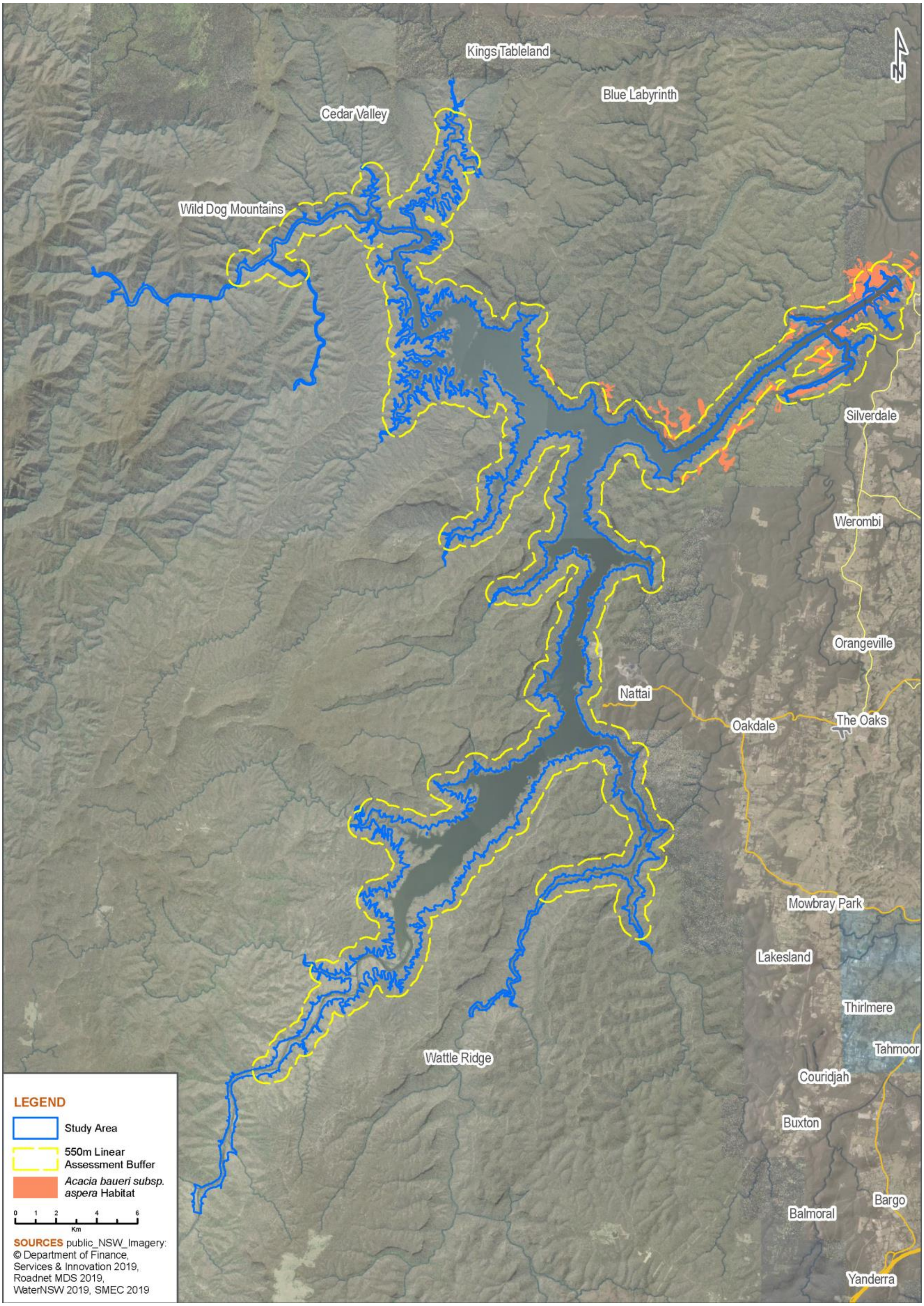
9. River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion, (HN574)

Number of ecosystem credits created	1,128
IBRA sub-region	Kanangra - Hawkesbury/Nepean

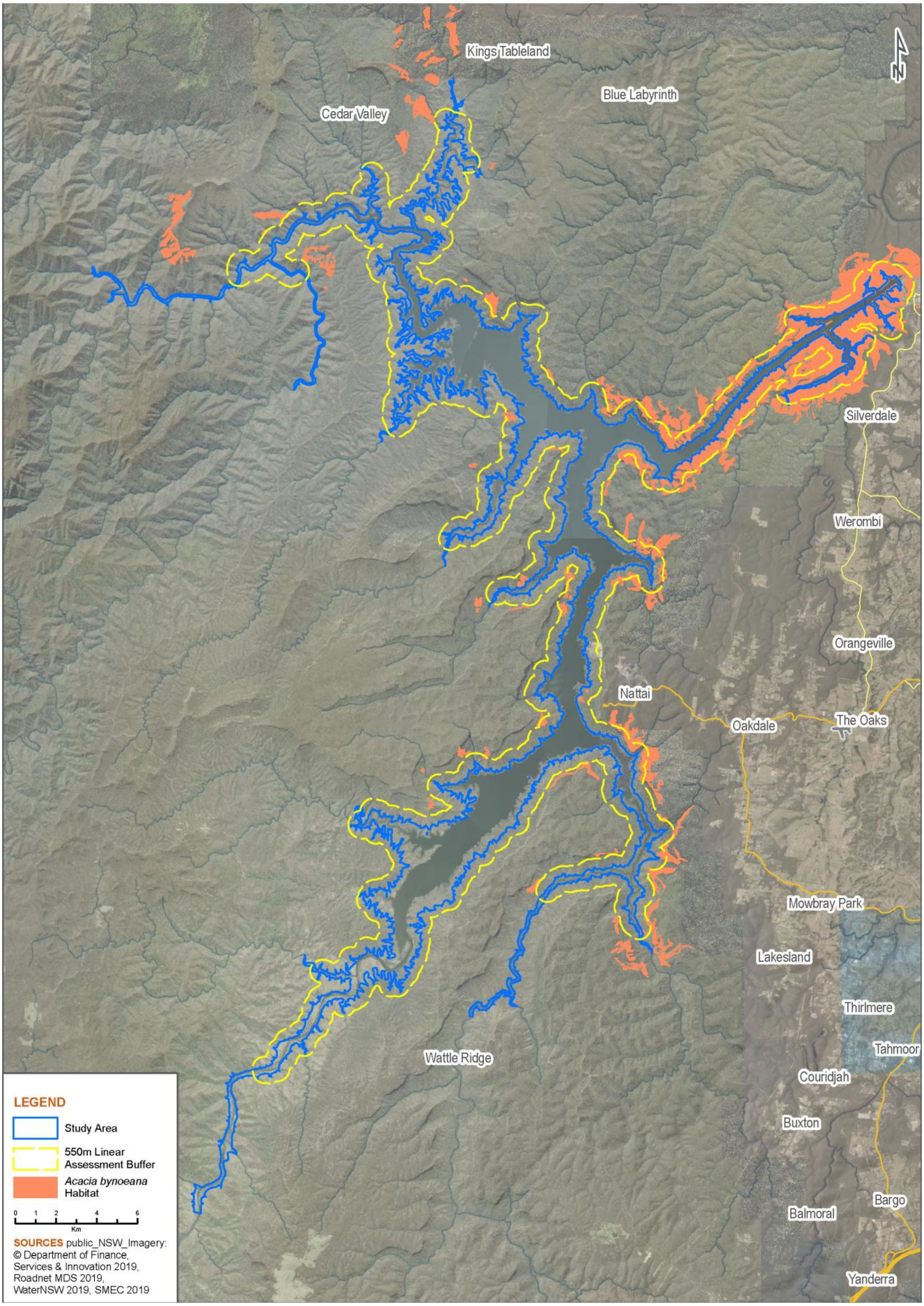
Offset options - Plant Community types	Offset options - IBRA sub-regions
River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion, (HN574)	Kanangra - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Appendix B
Threatened species habitat polygons

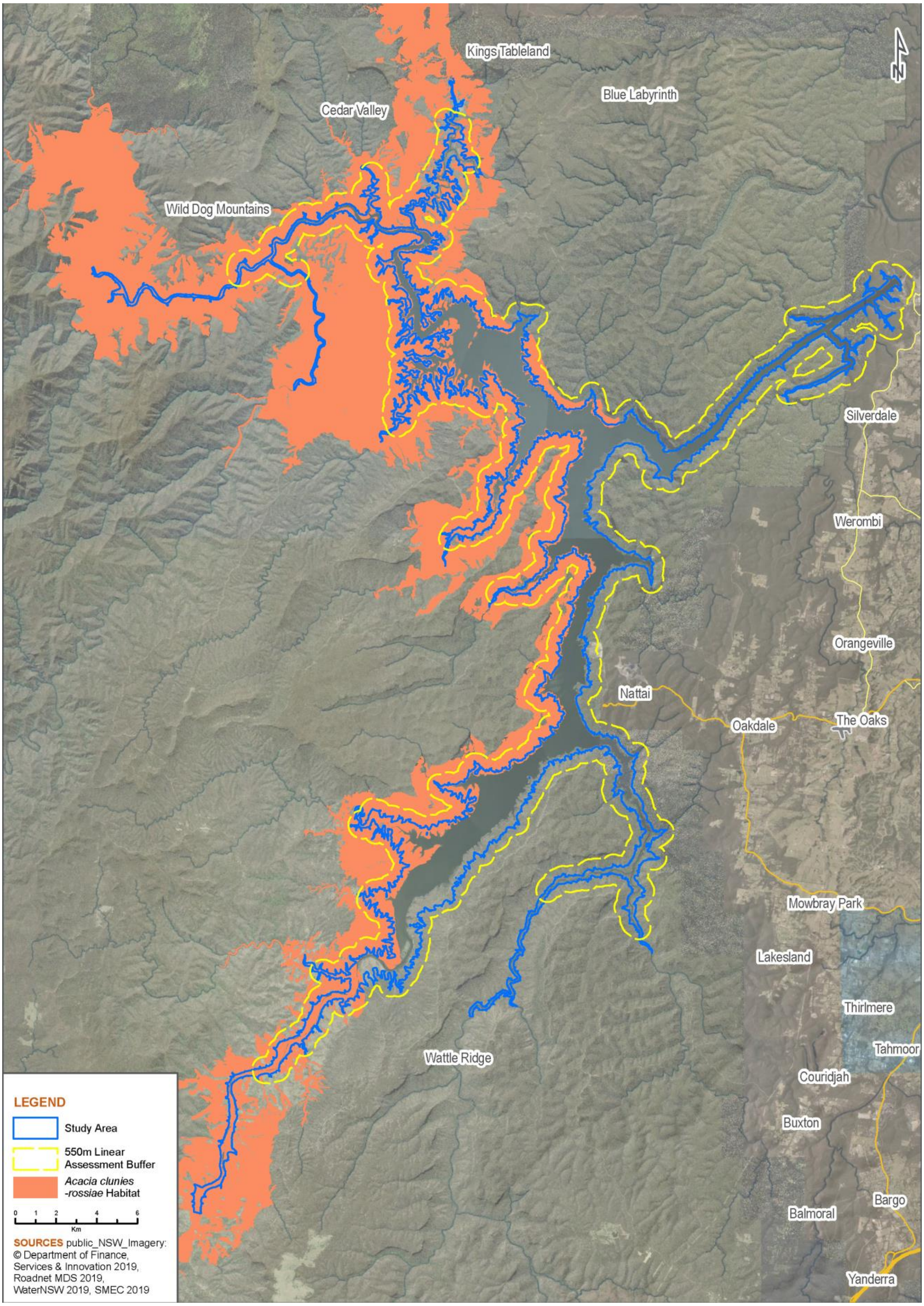
B.1 *Acacia baueri subsp. aspera* species polygon



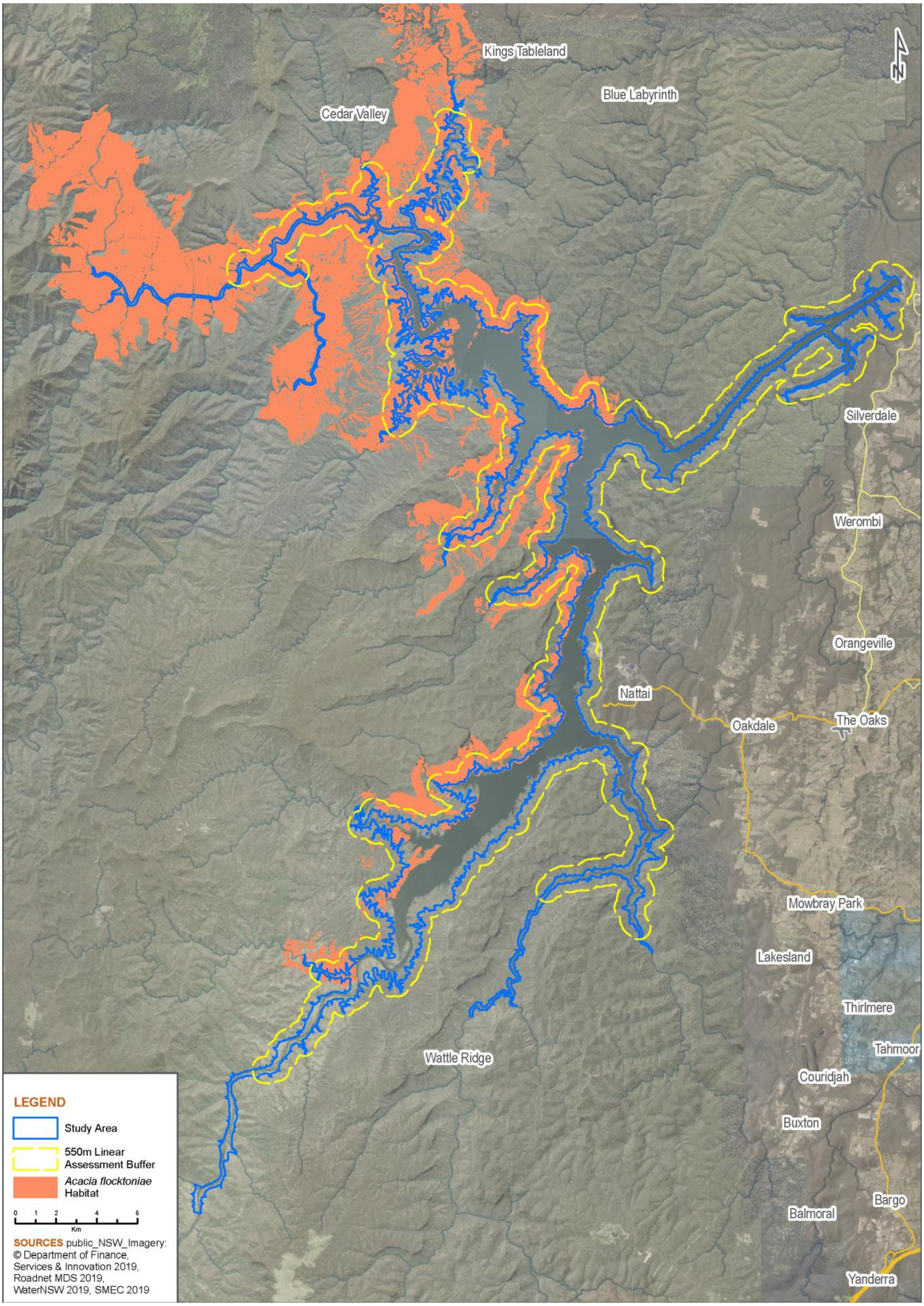
B.2 *Acacia bynoeana* species polygon



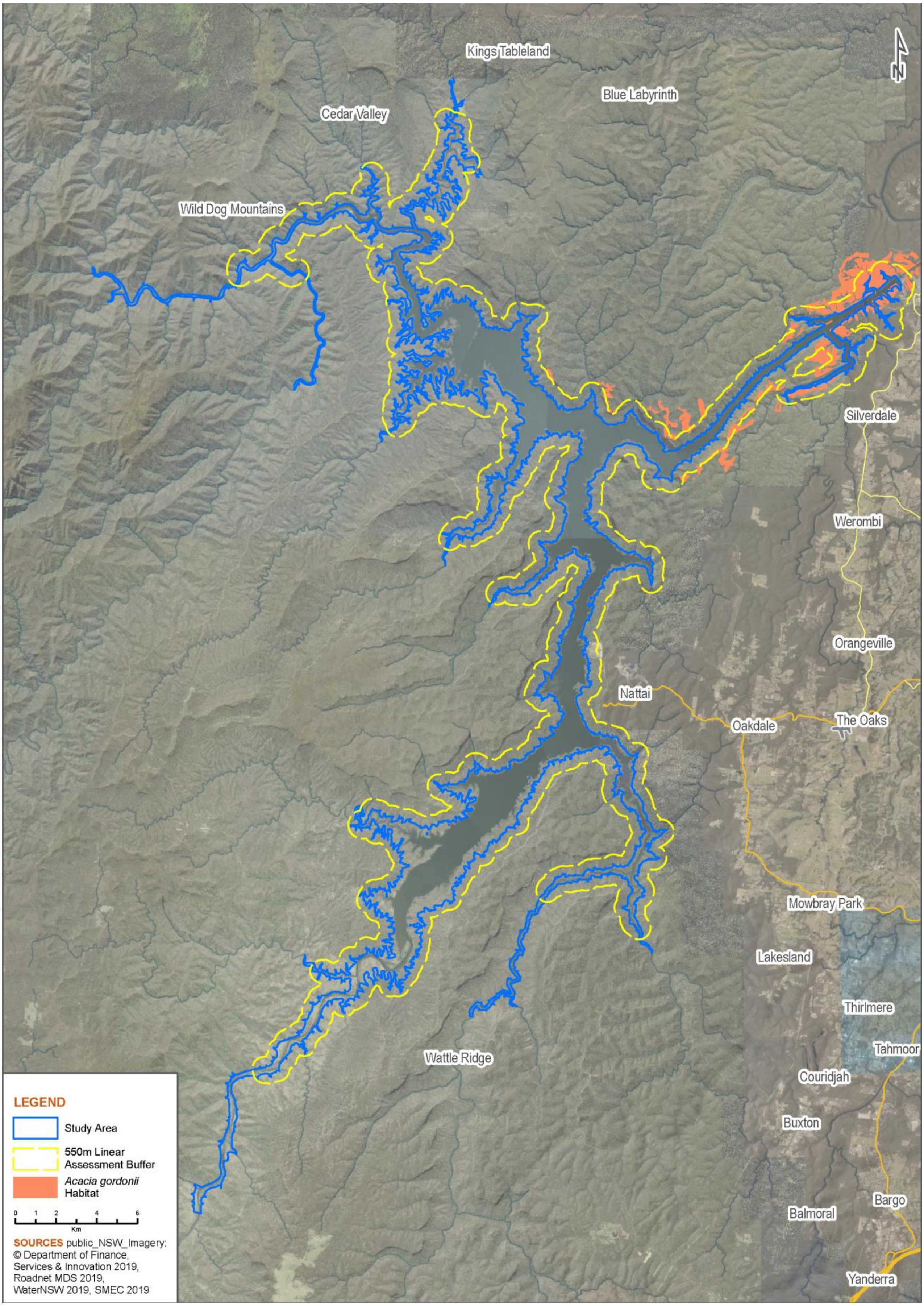
B.3 *Acacia clunies-rossiae* species polygon



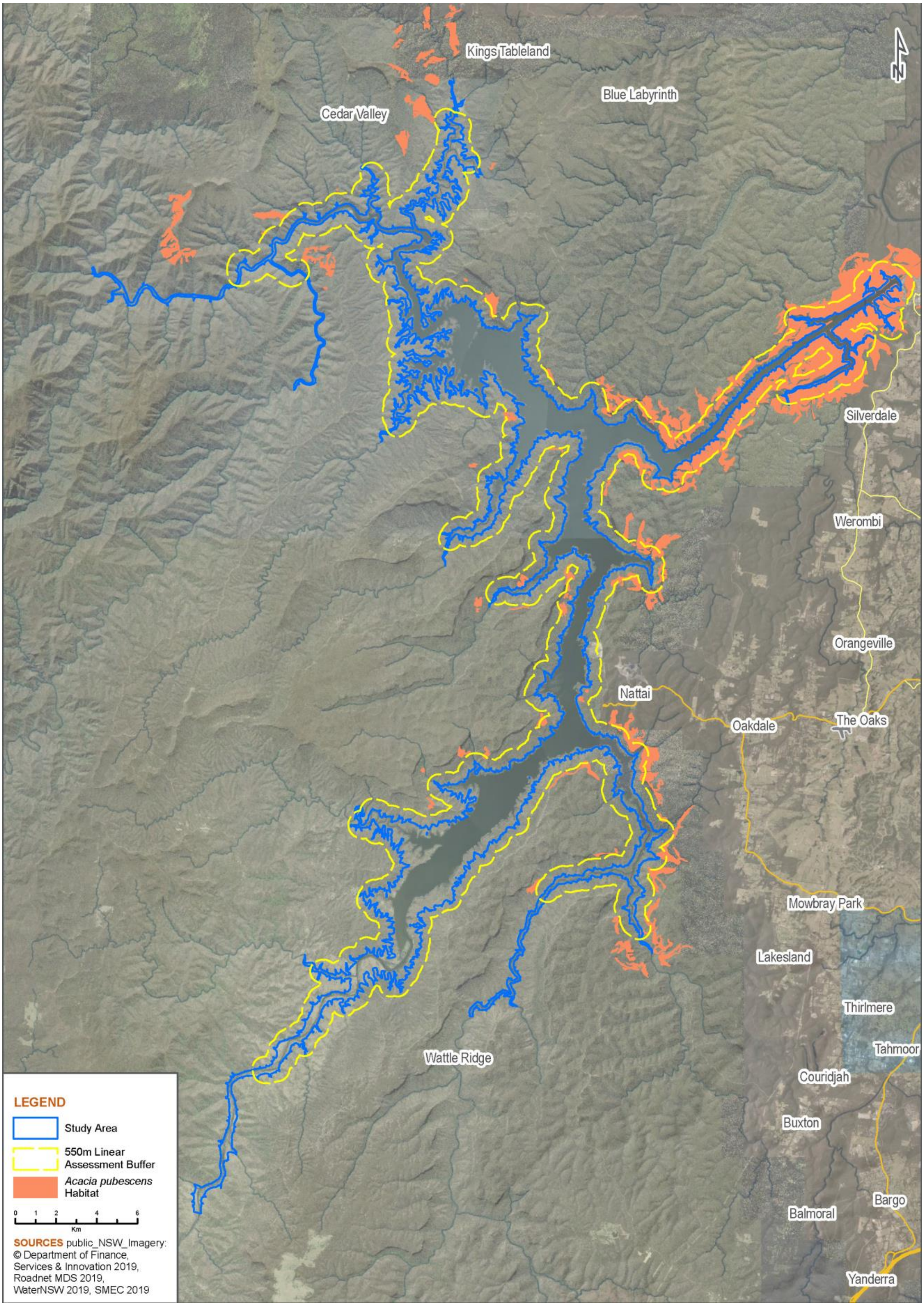
B.4 *Acacia flocktoniae* species polygon



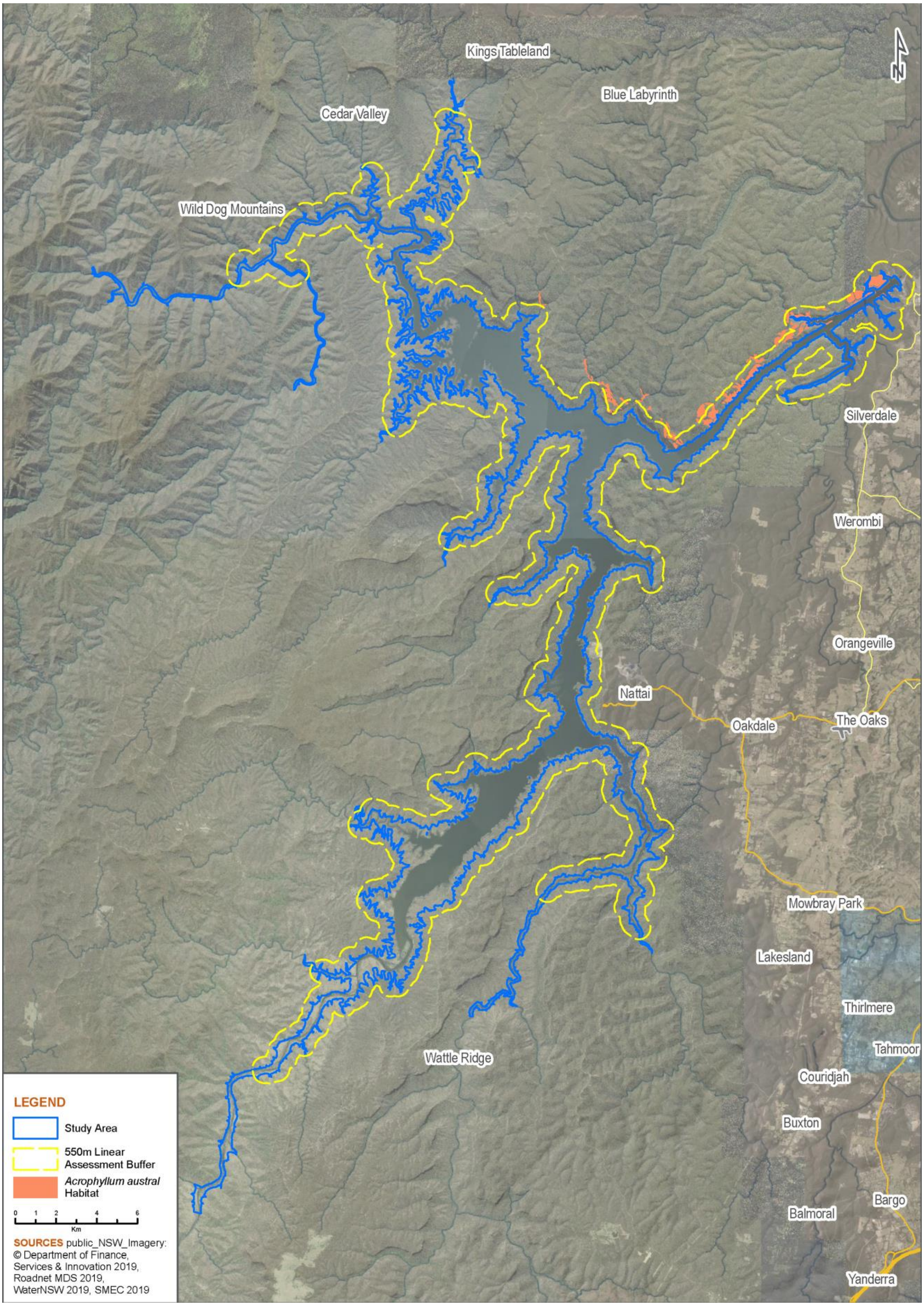
B.5 *Acacia gordonii* species polygon



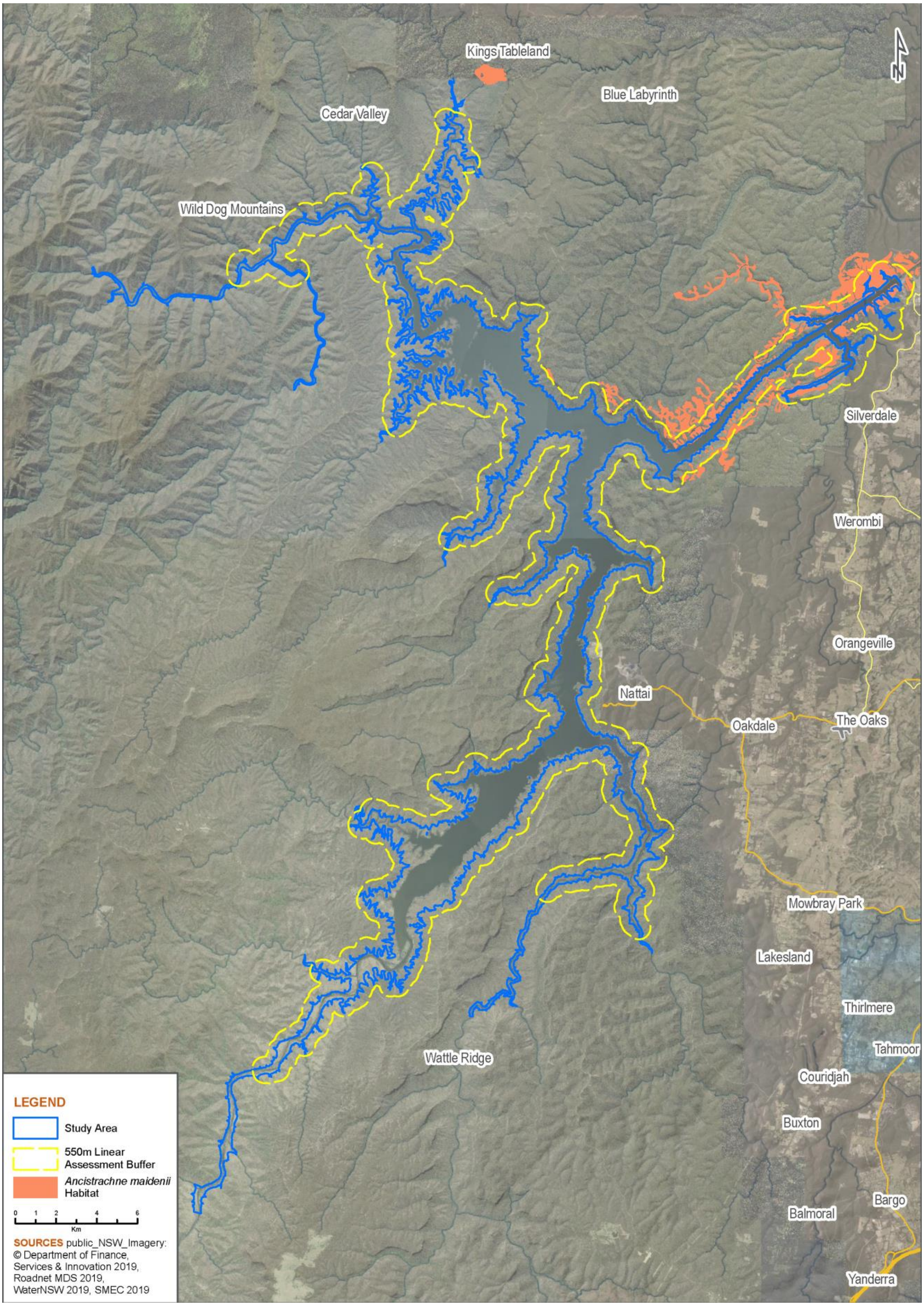
B.6 *Acacia pubescens* species polygon



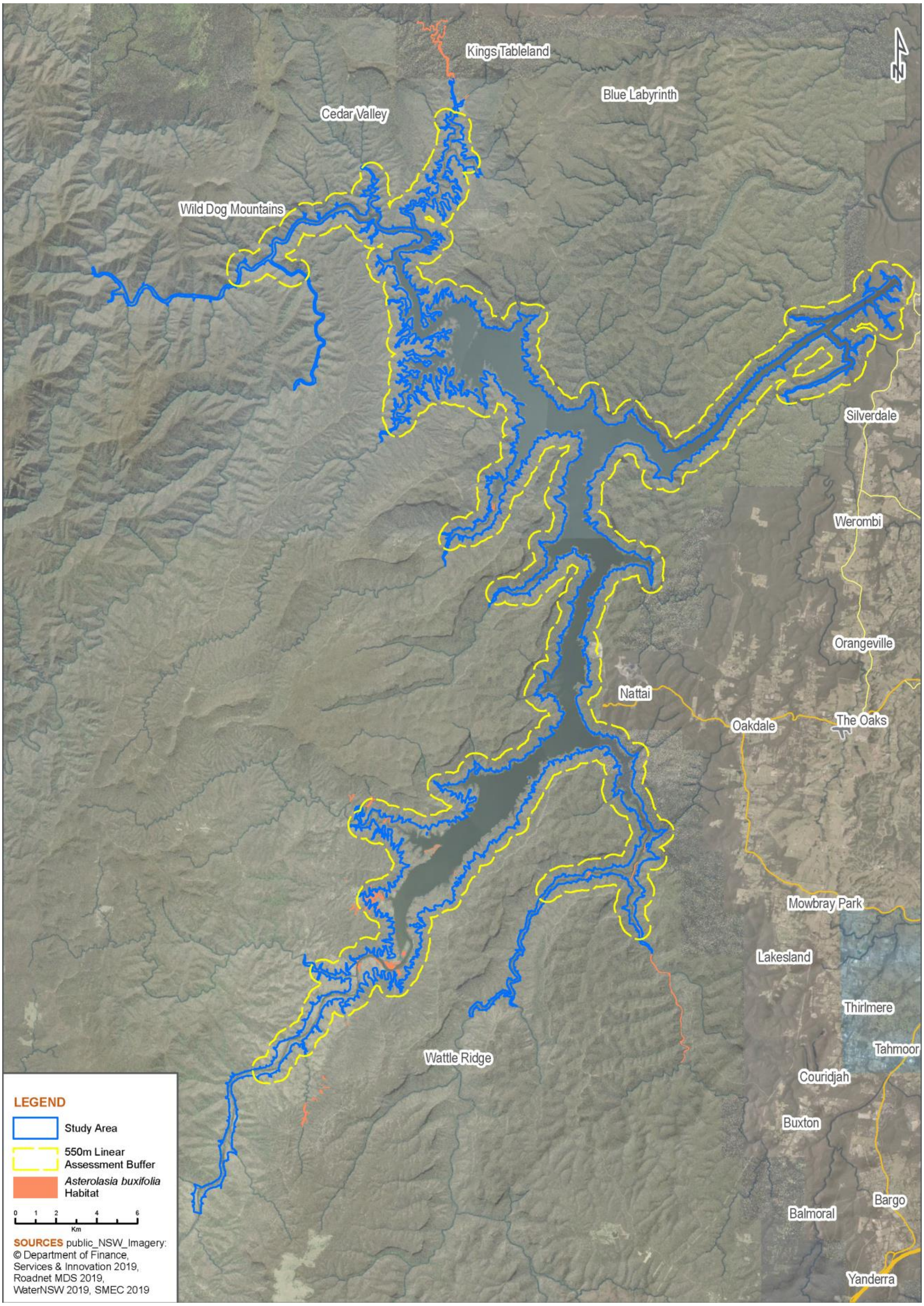
B.7 *Acrophyllum australe* species polygon



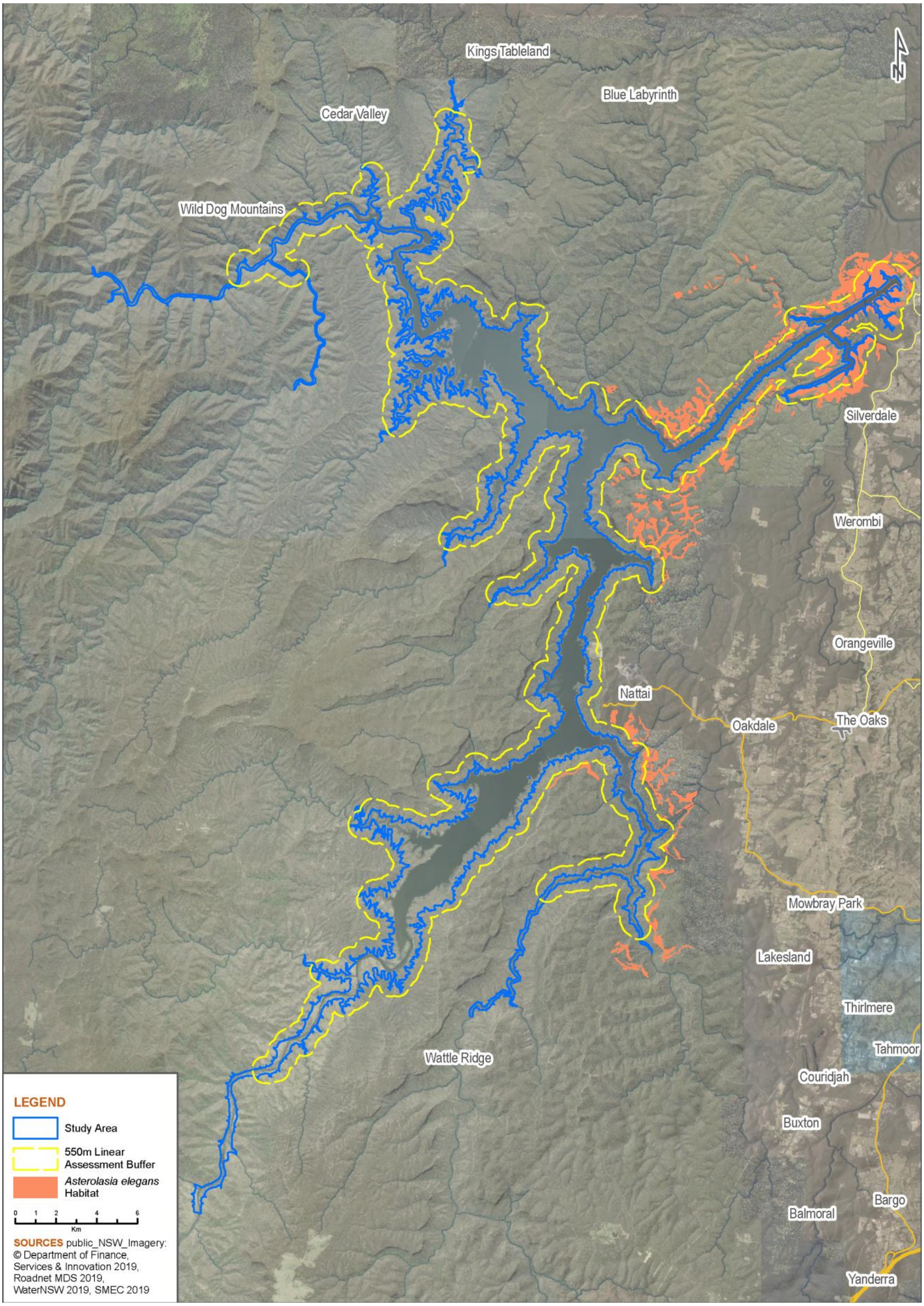
B.8 *Ancistrachne maidenii* species polygon



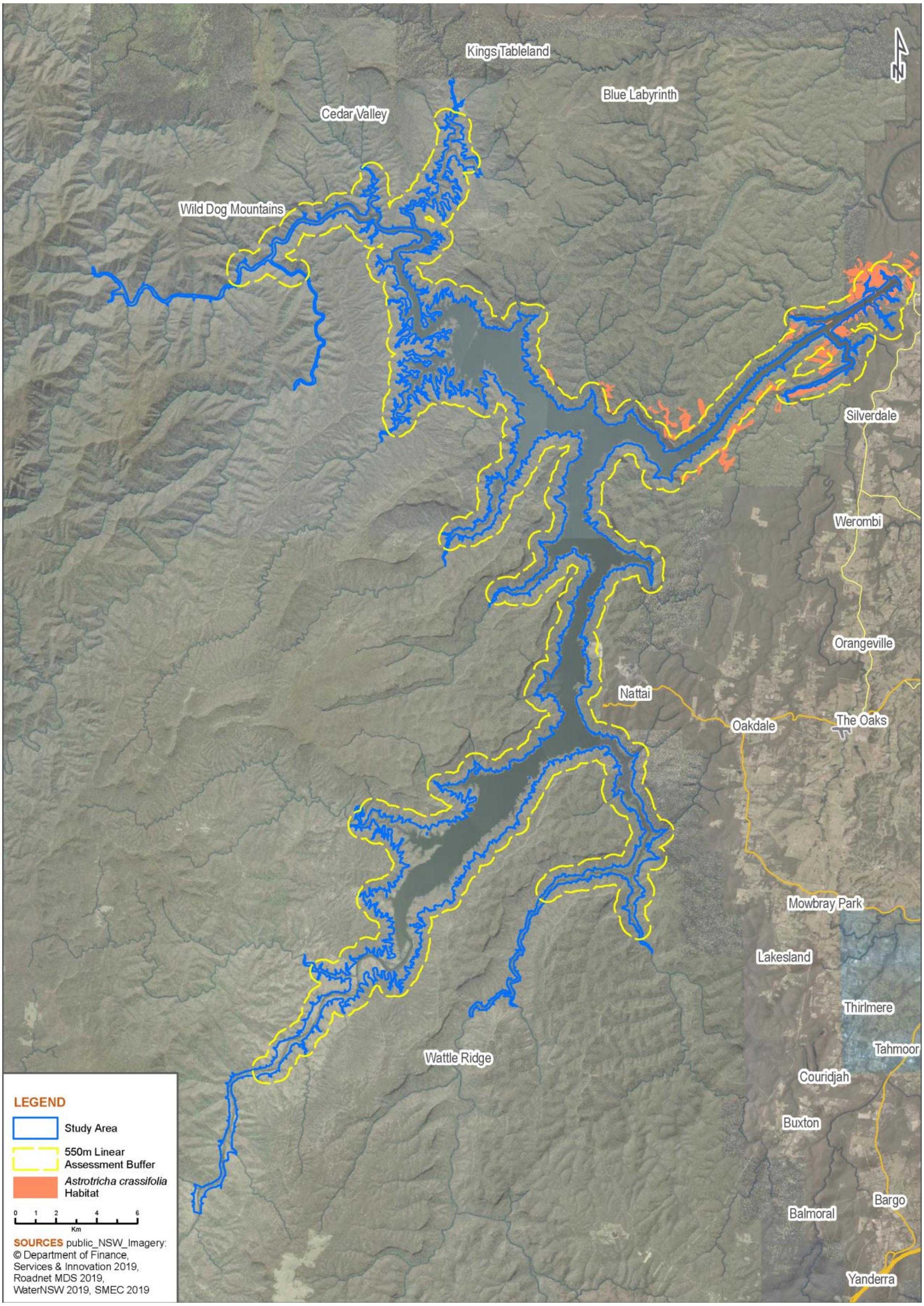
B.9 *Asterolasia buxifolia* species polygon



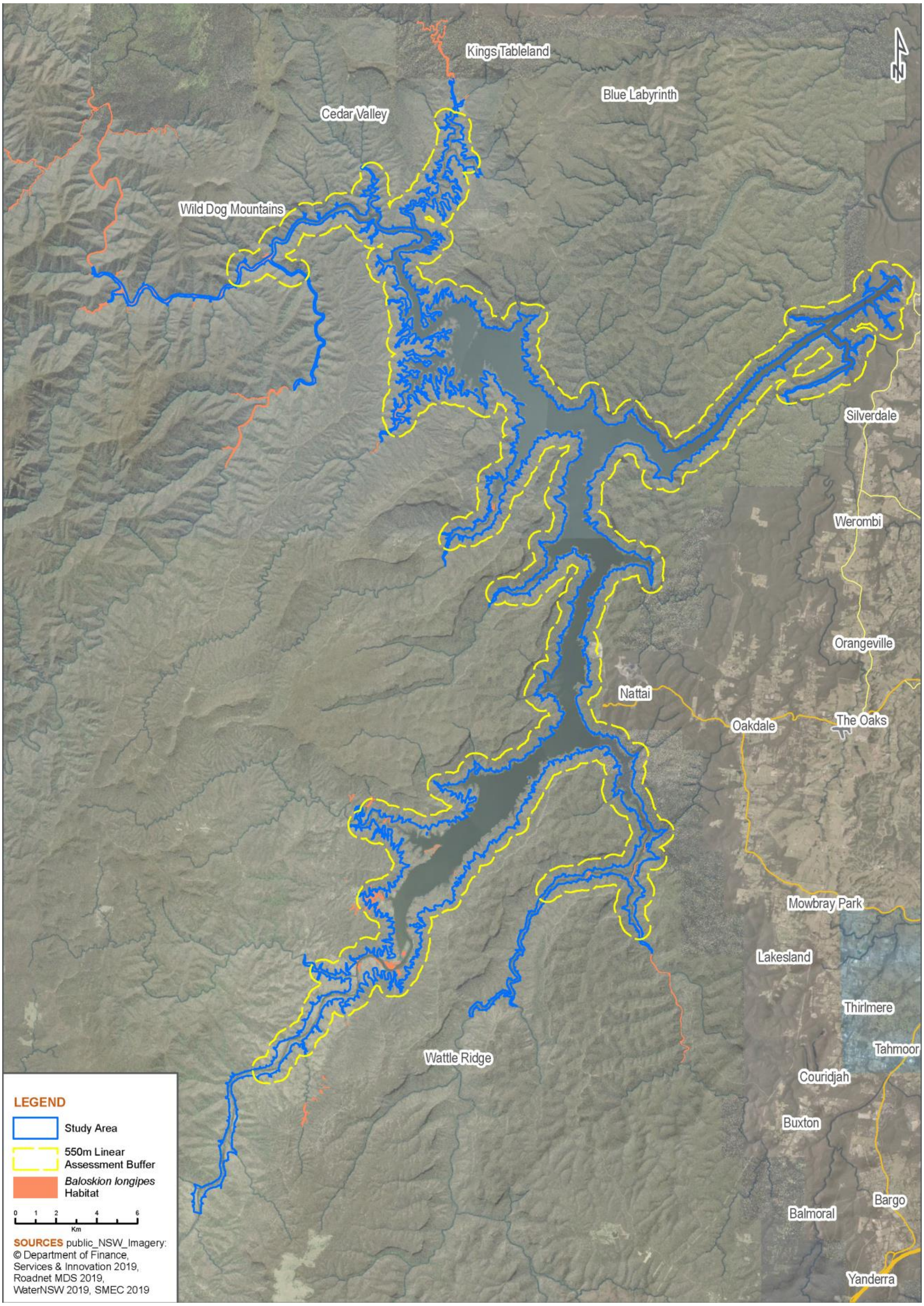
B.10 *Asterolasia elegans* species polygon



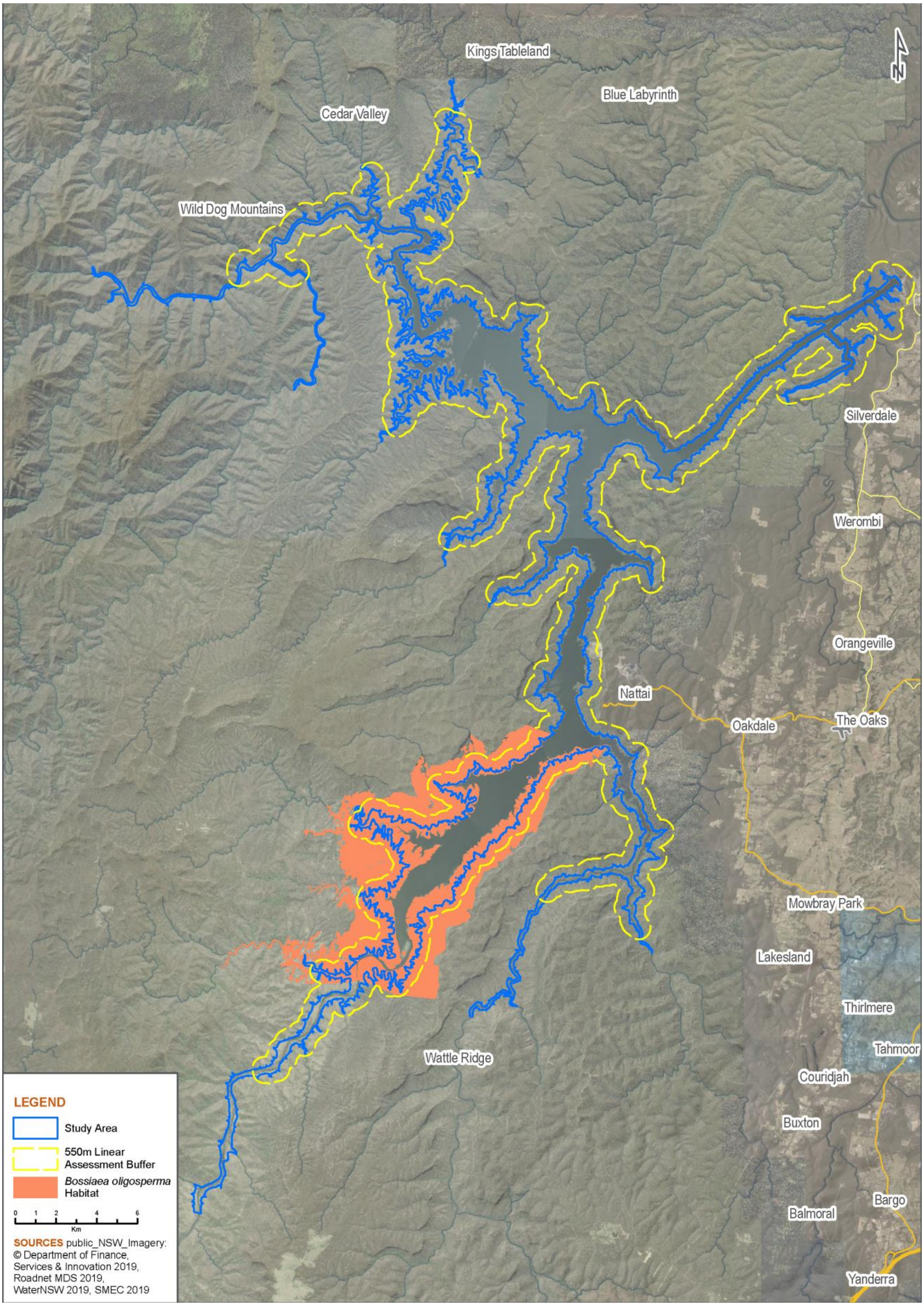
B.11 *Astrotricha crassifolia* species polygon



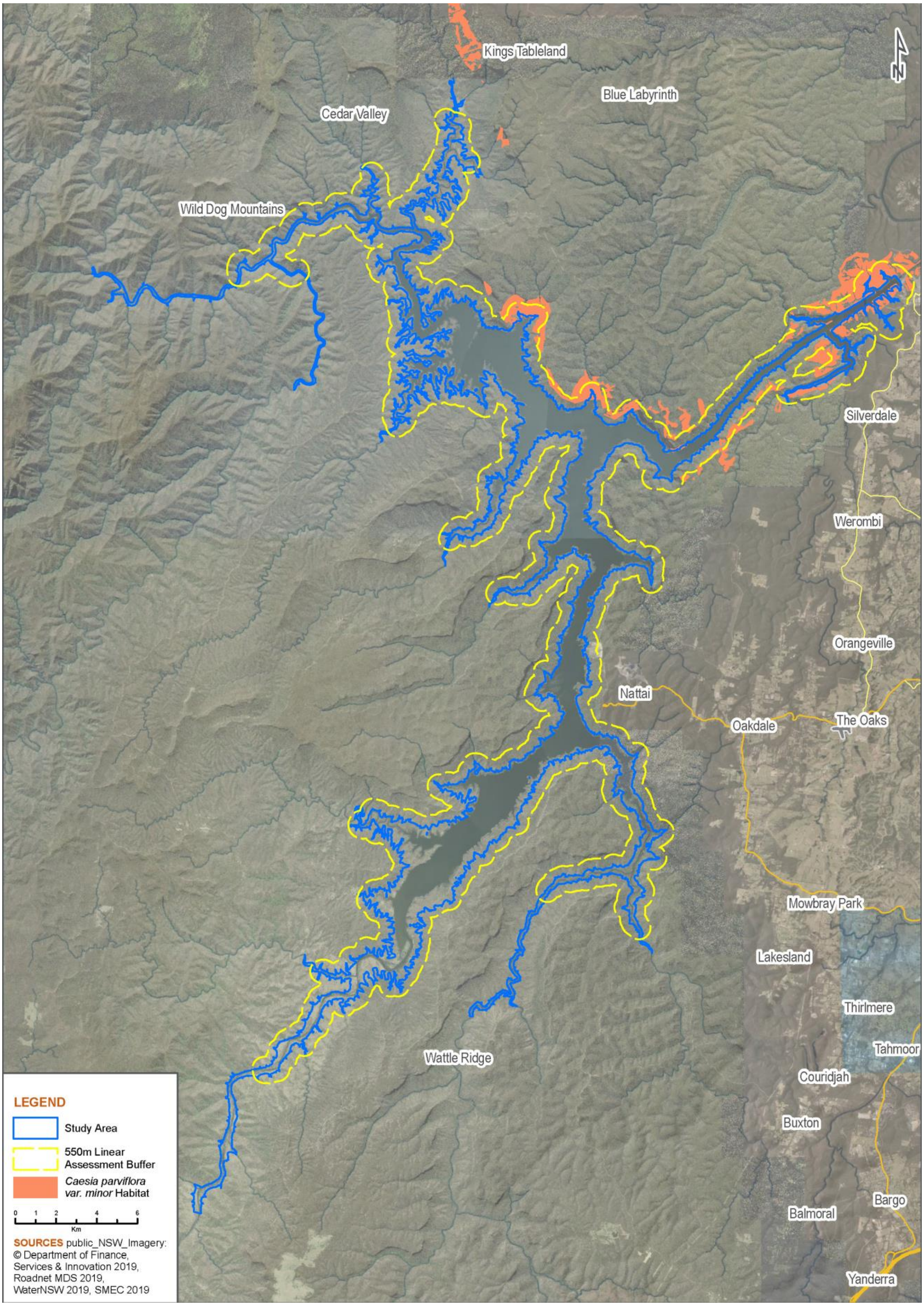
B.12 *Baloskion longipes* species polygon



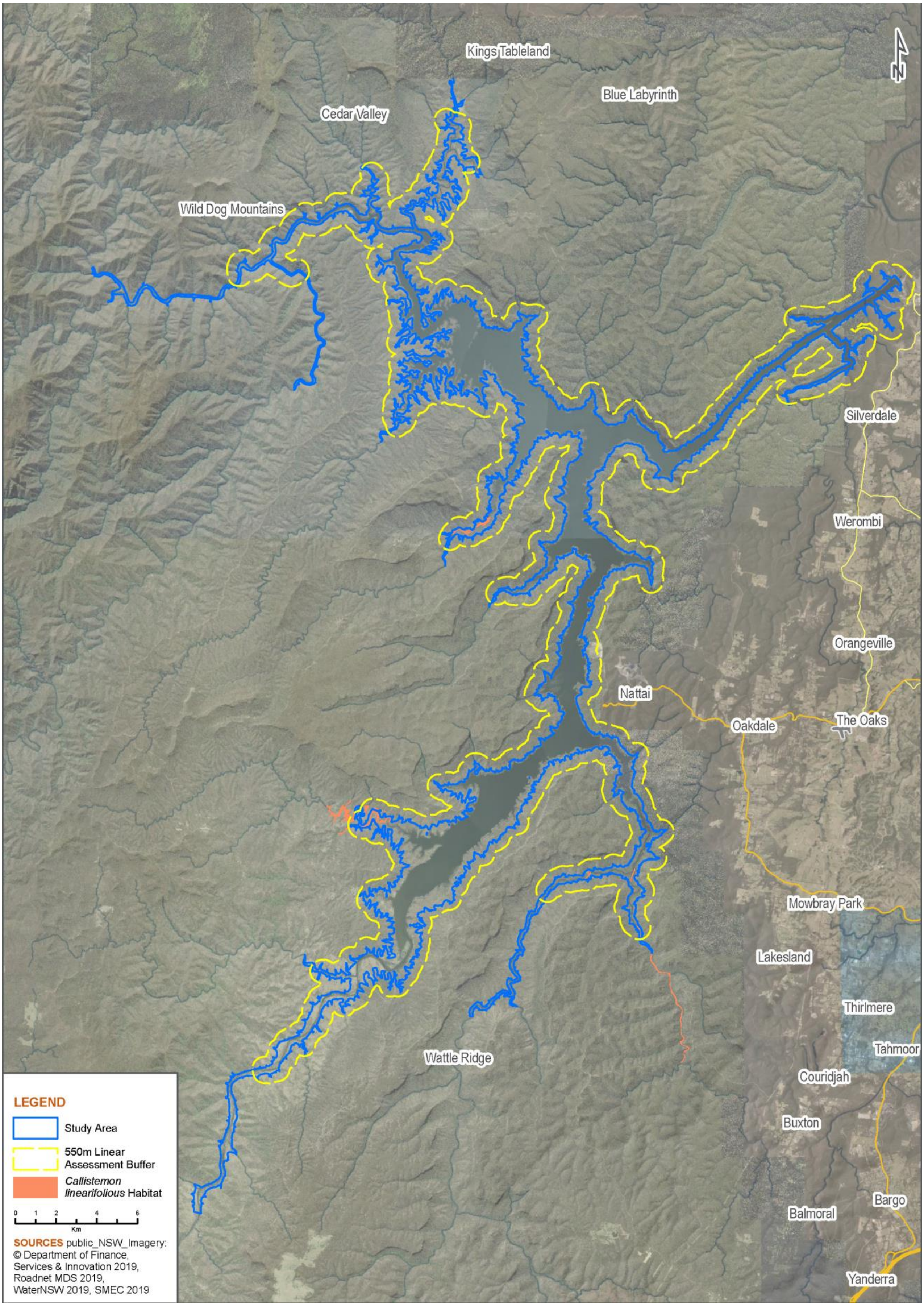
B.13 *Bossiaea oligosperma* species polygon



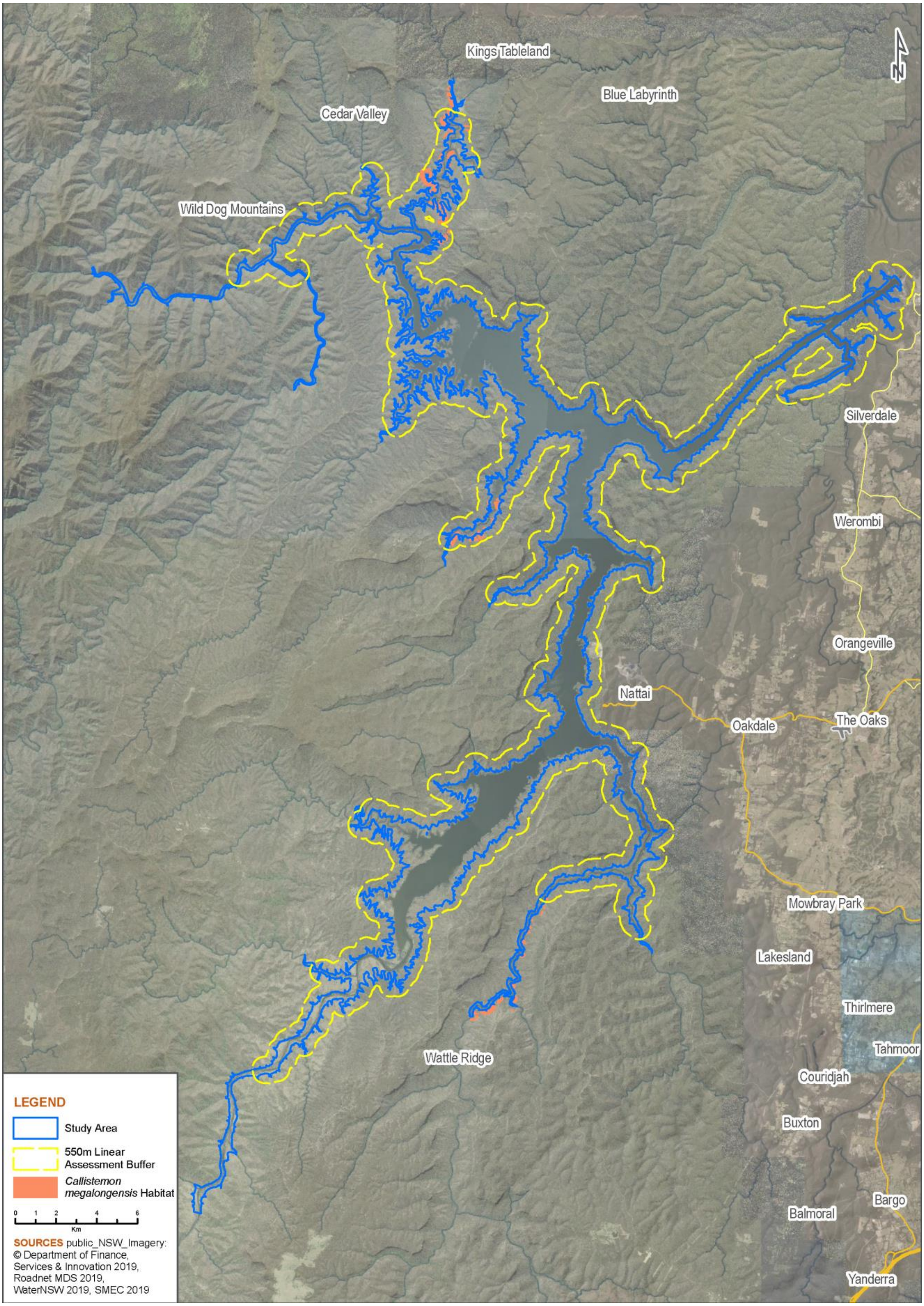
B.14 *Caesia parviflora var. minor* species polygon



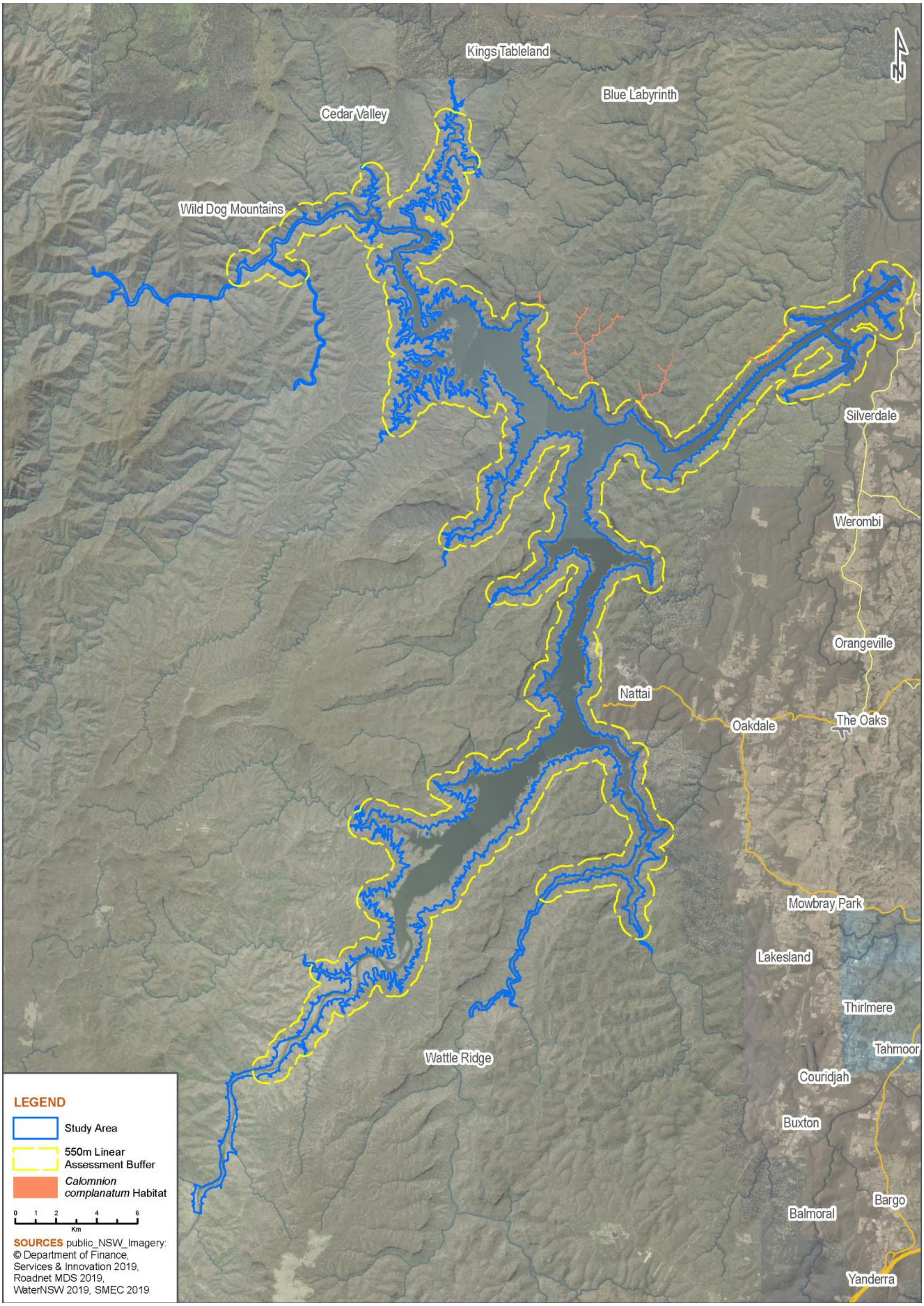
B.15 *Callistemon linearifolius* species polygon



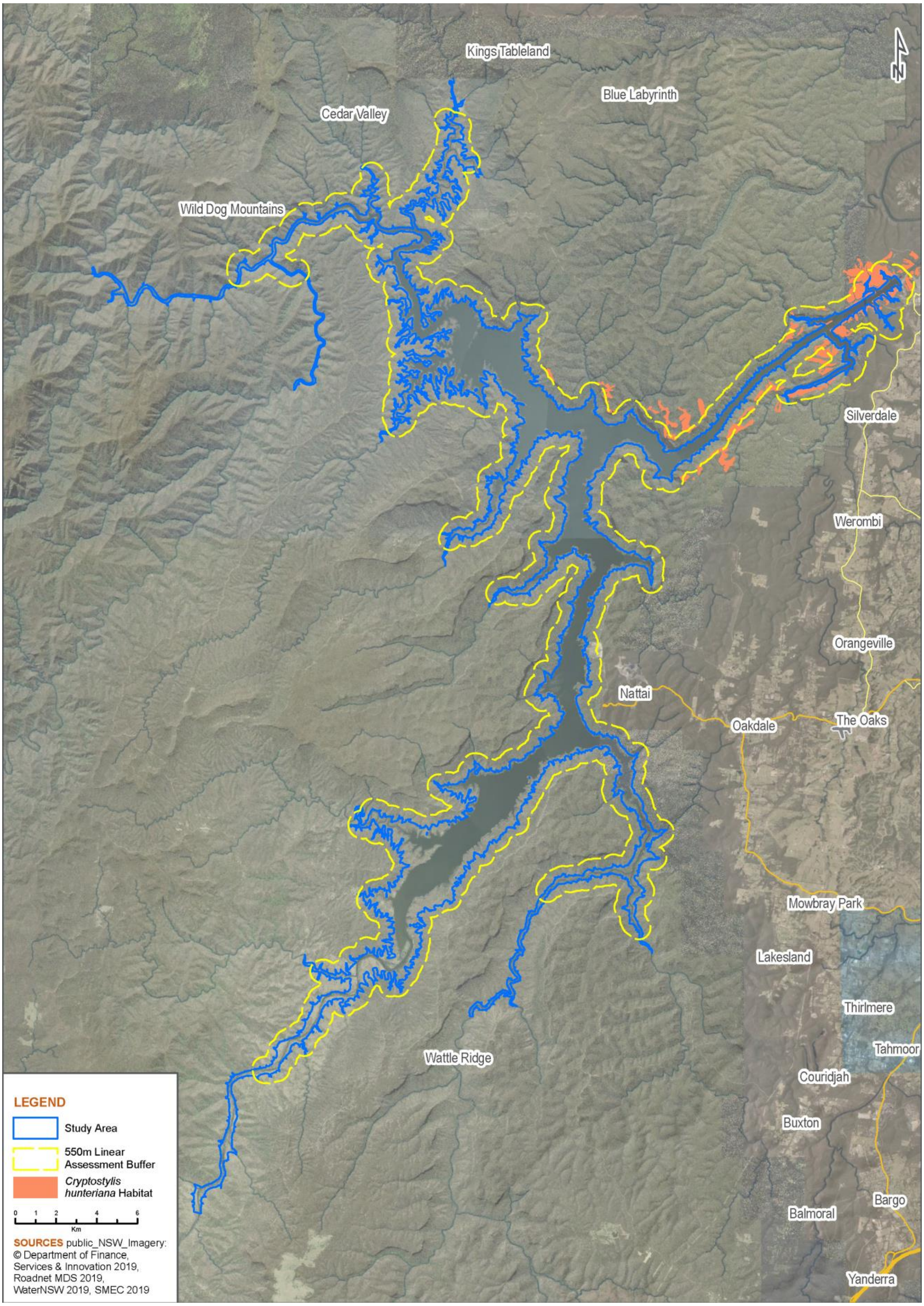
B.16 *Callistemon megalongensis* species polygon



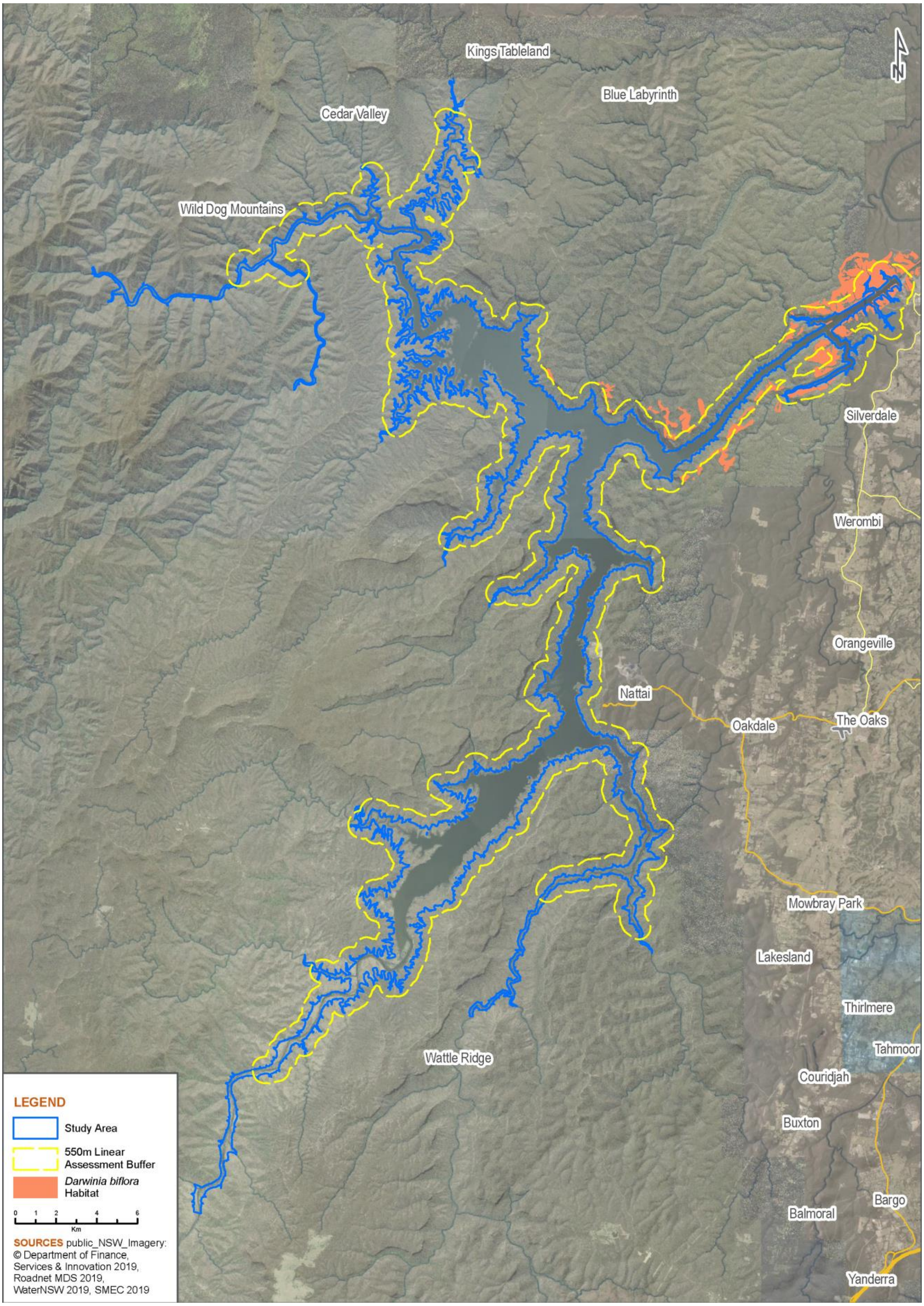
B.17 *Calomnion complanatum* species polygon



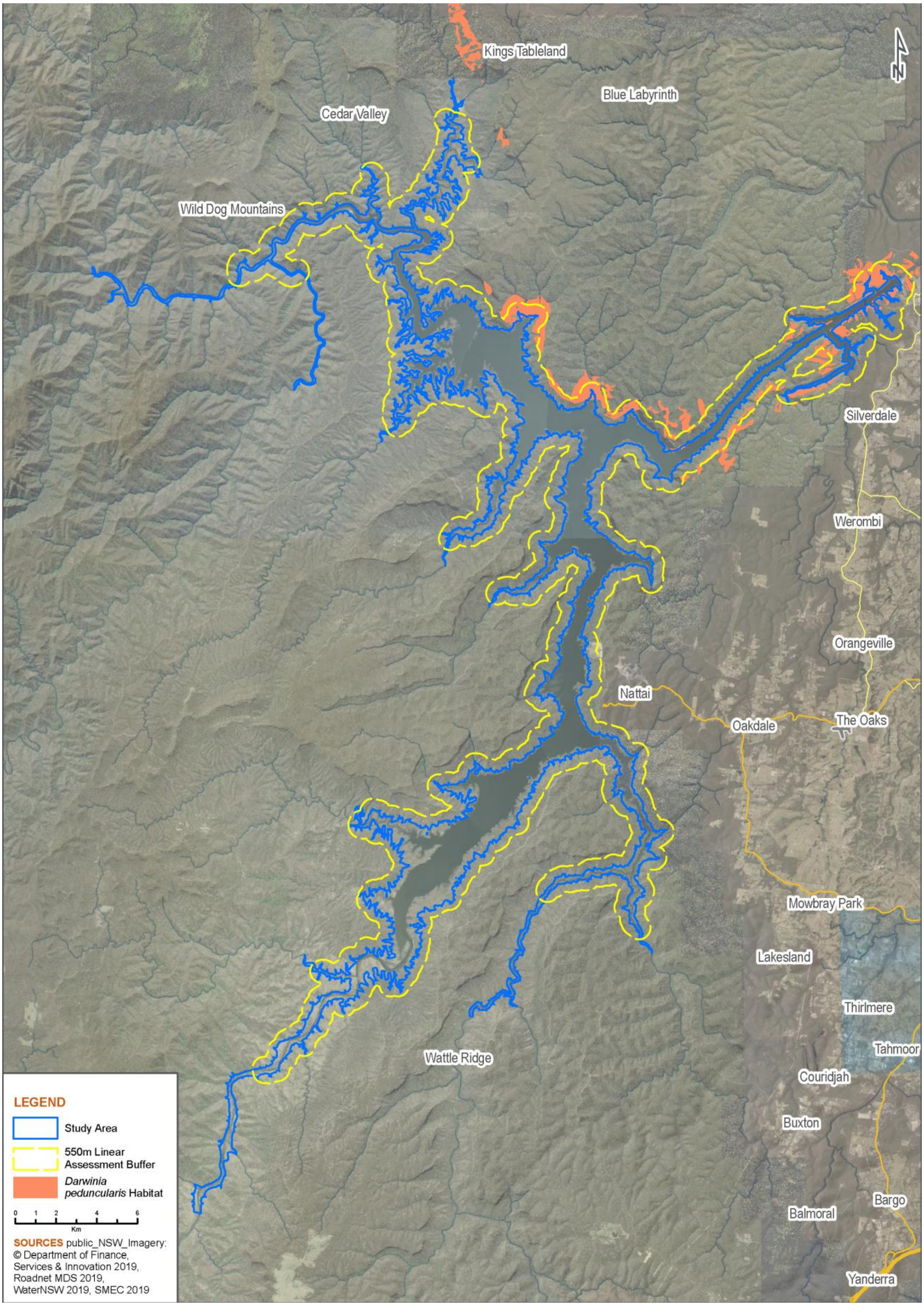
B.18 *Cryptostylis hunteriana* species polygon



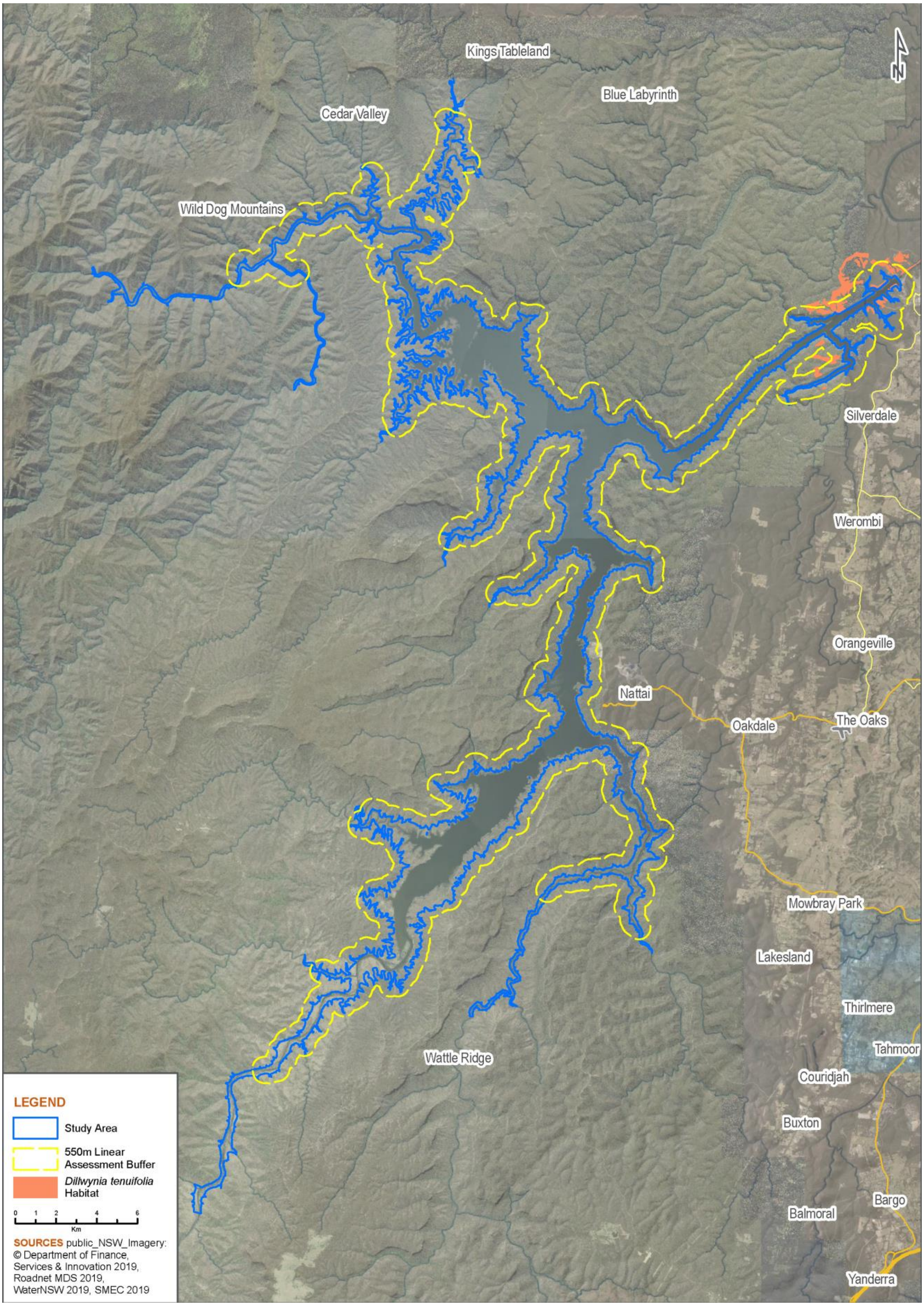
B.19 *Darwinia biflora* species polygon



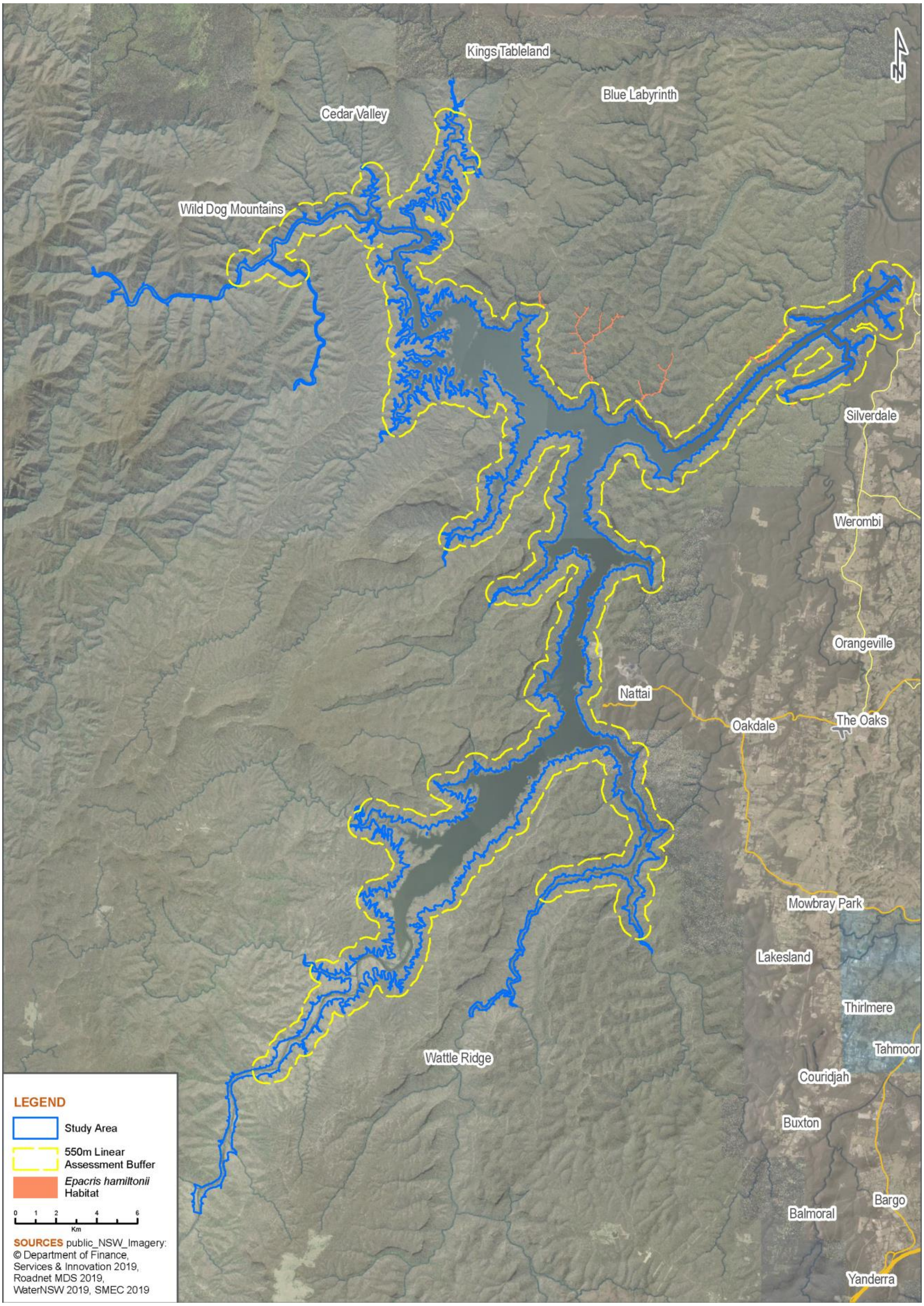
B.20 *Darwinia peduncularis* species polygon



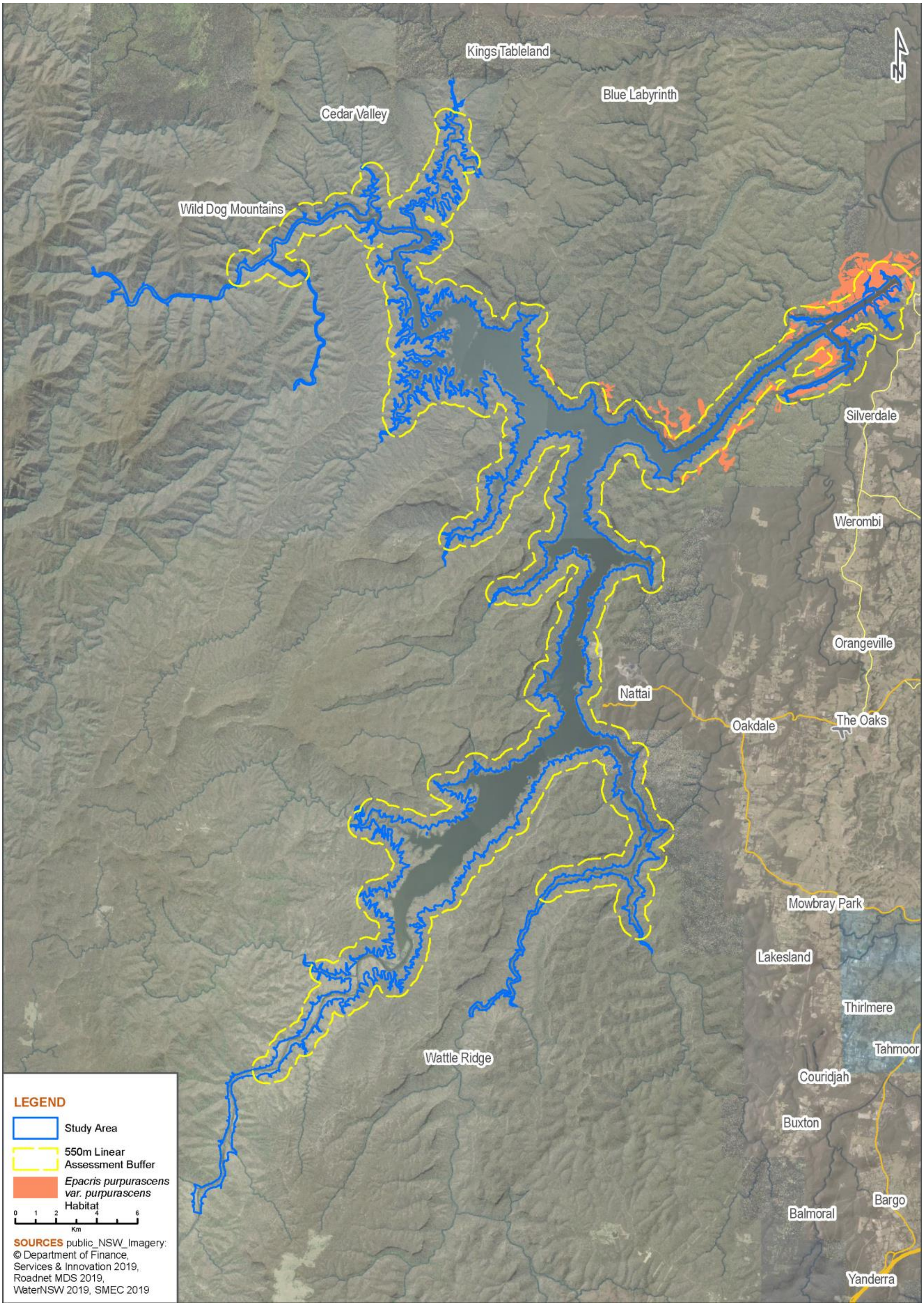
B.21 *Dillwynia tenuifolia* species polygon



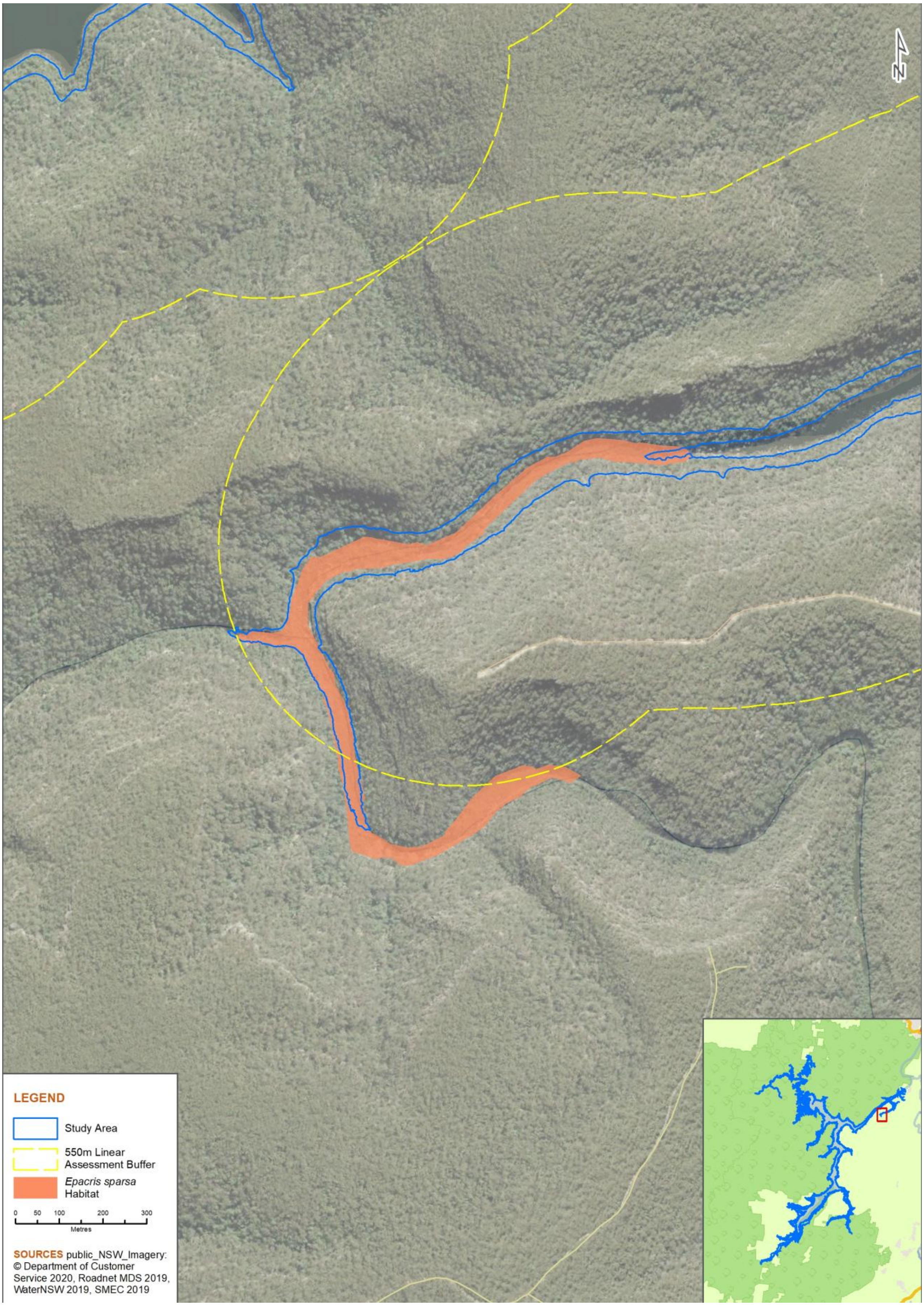
B.22 *Epacris hamiltonii* species polygon



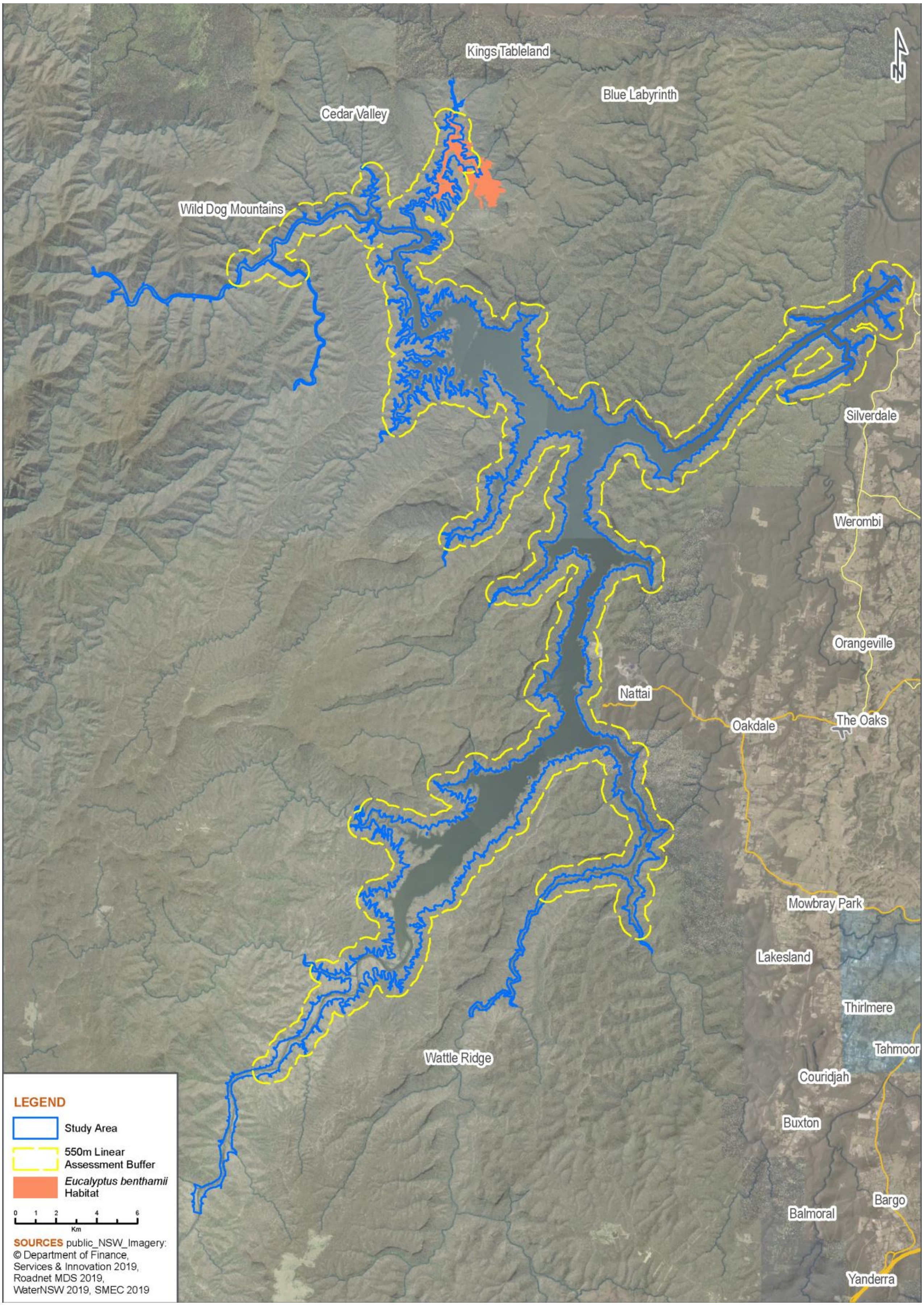
B.23 *Epacris purpurascens var purpurascens* species polygon



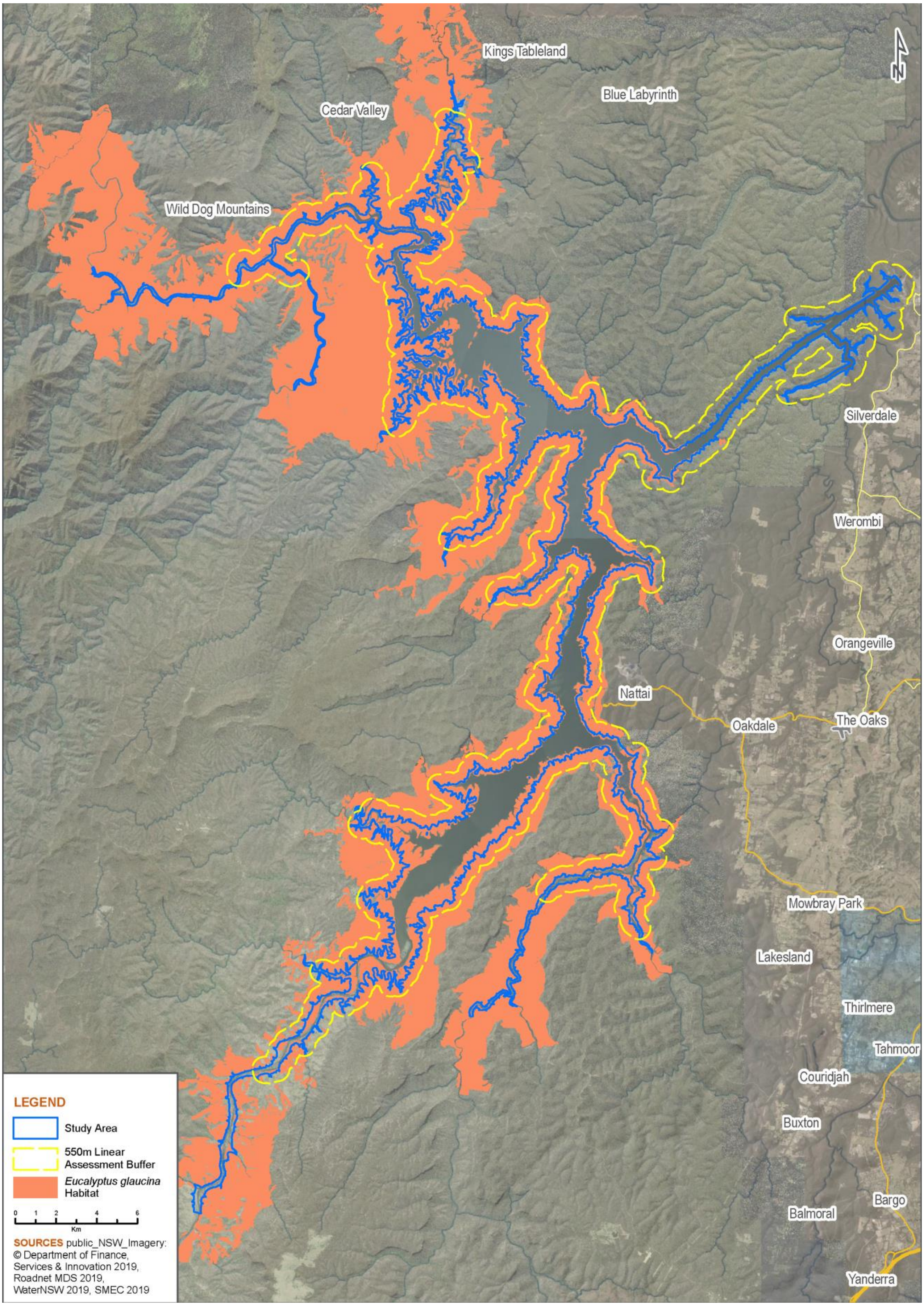
B.24 *Epacris sparsa* species polygon



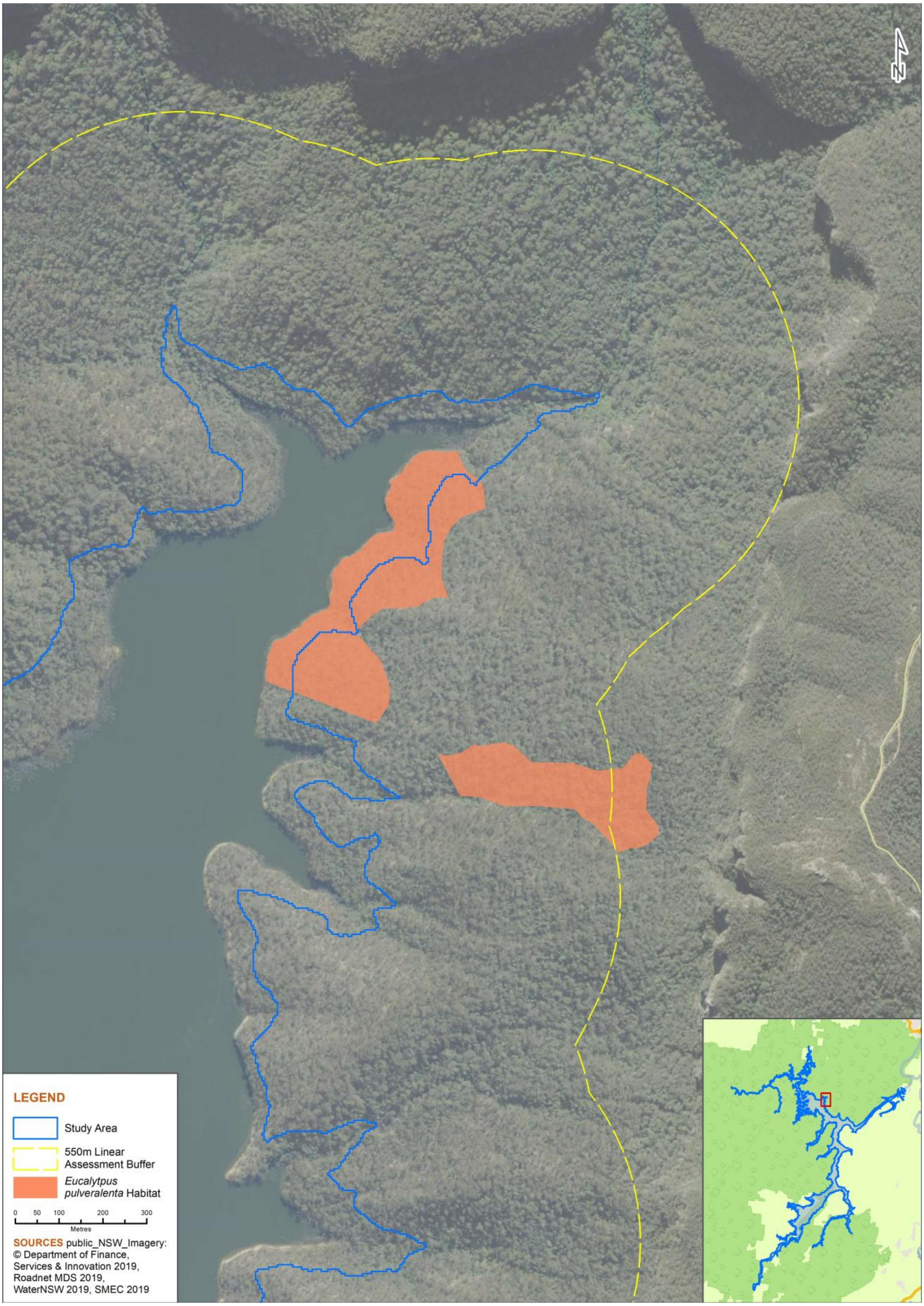
B.25 *Eucalyptus benthamii* species polygon



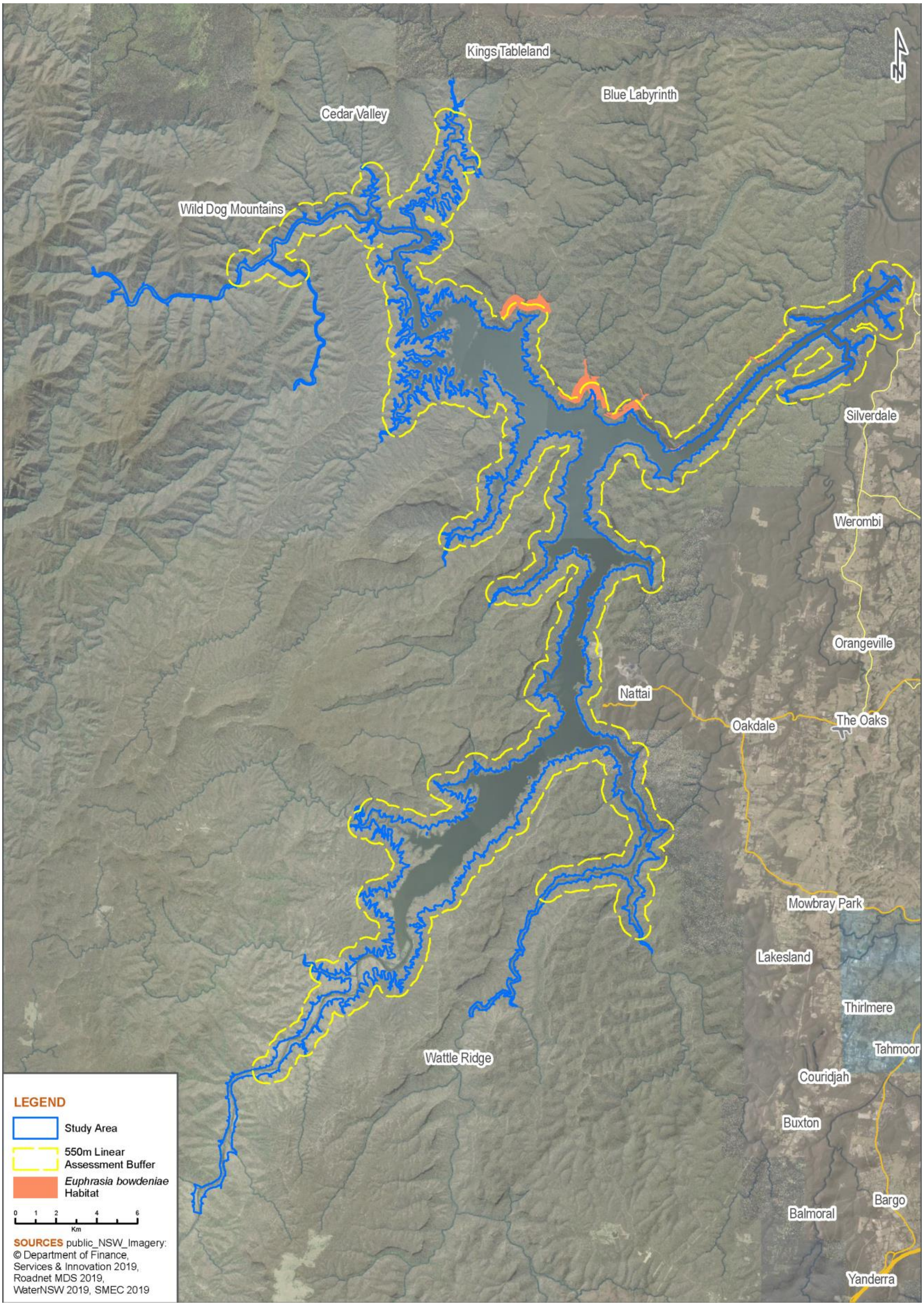
B.26 *Eucalyptus glaucina* species polygon



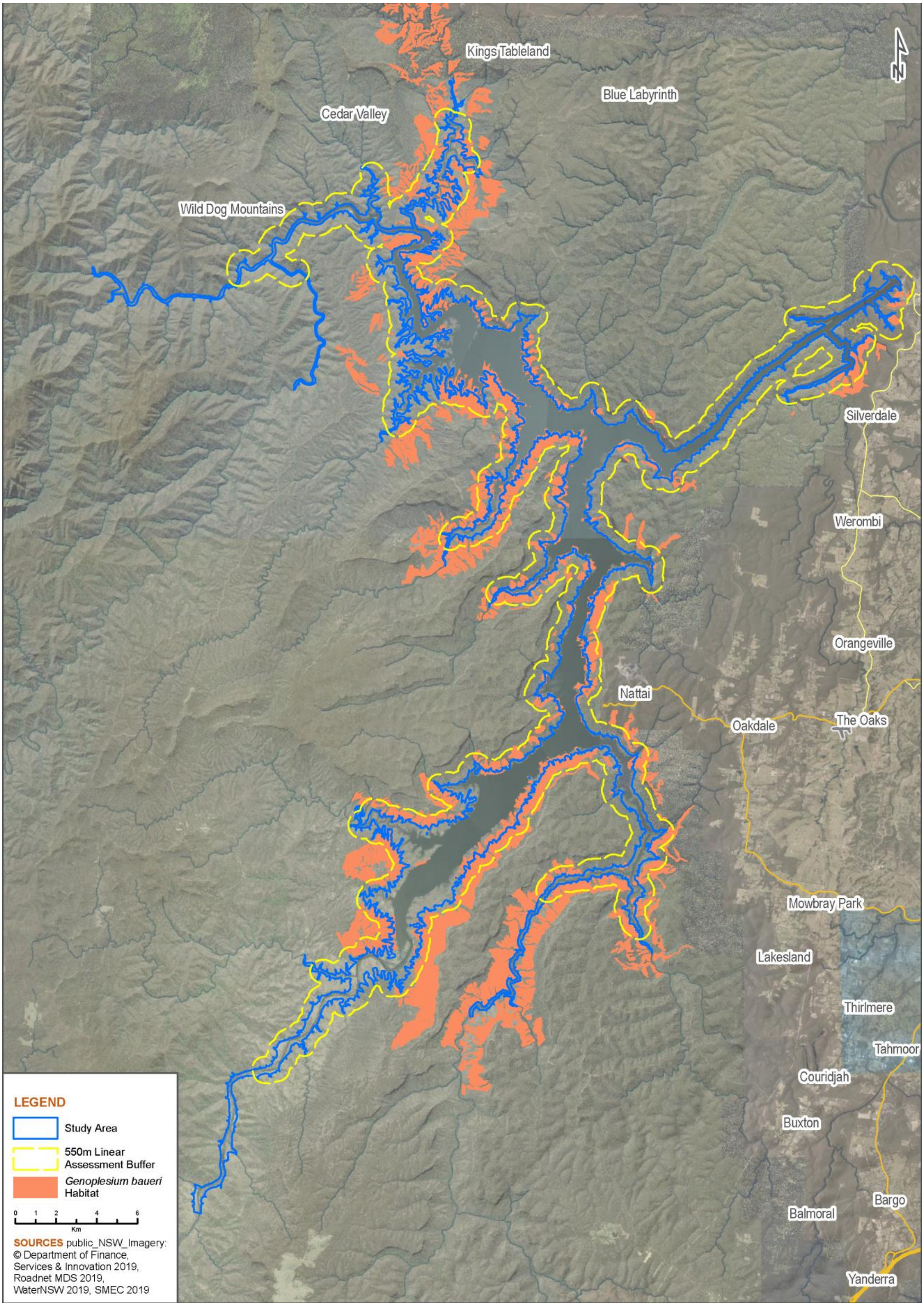
B.27 *Eucalyptus pulverulenta* species polygon



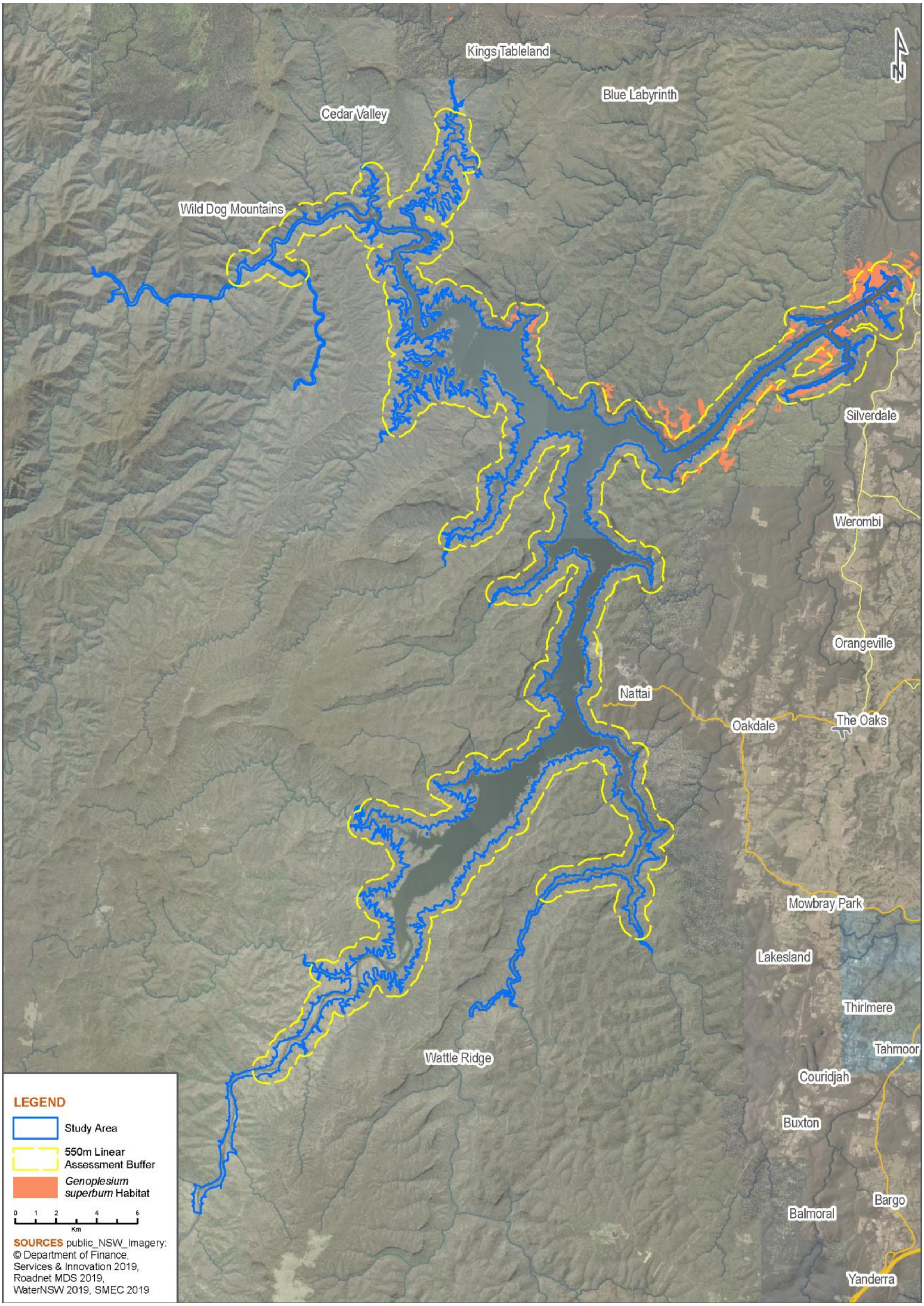
B.28 *Euphrasia bowdeniae* species polygon



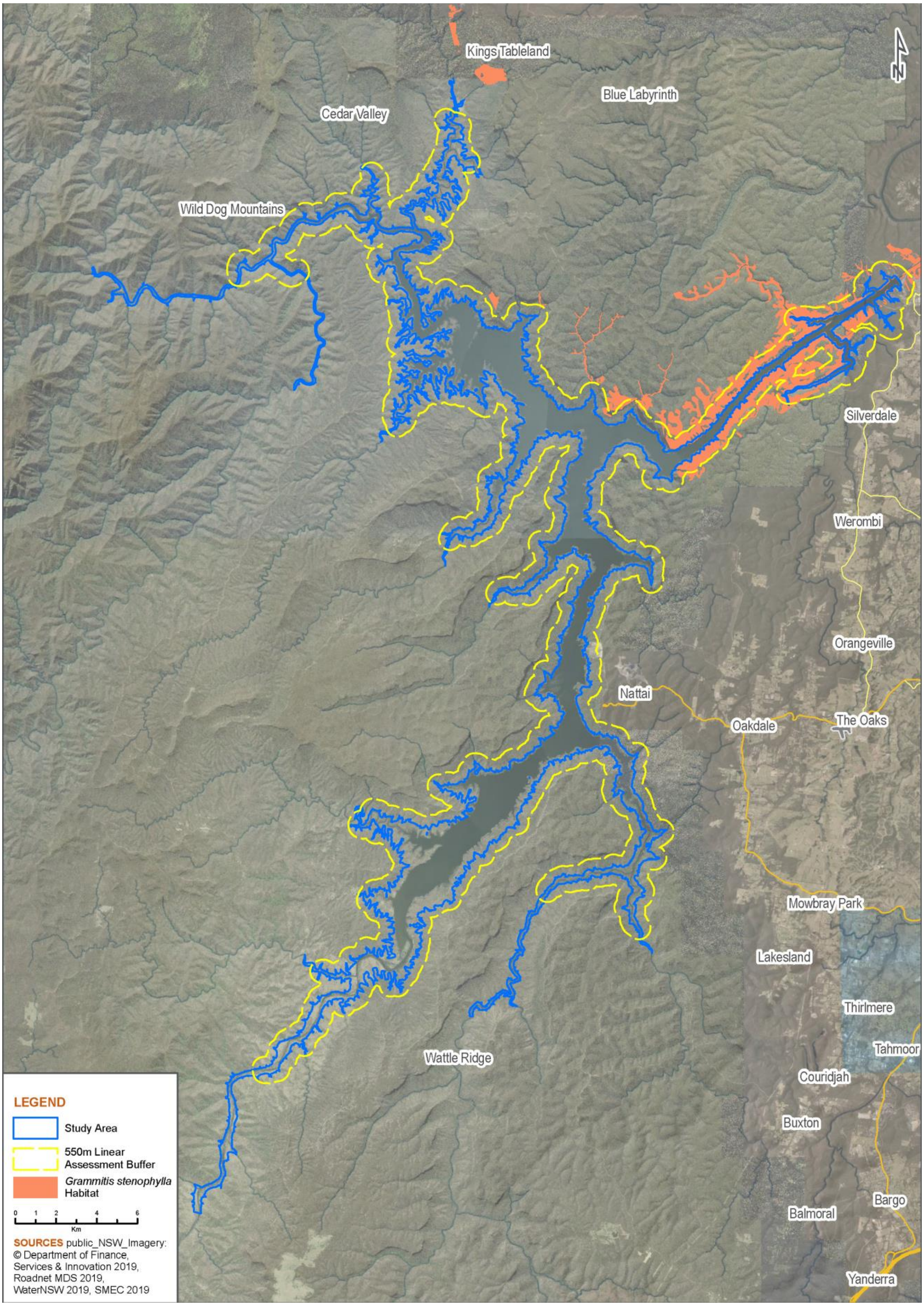
B.29 *Genoplesium bauera* species polygon



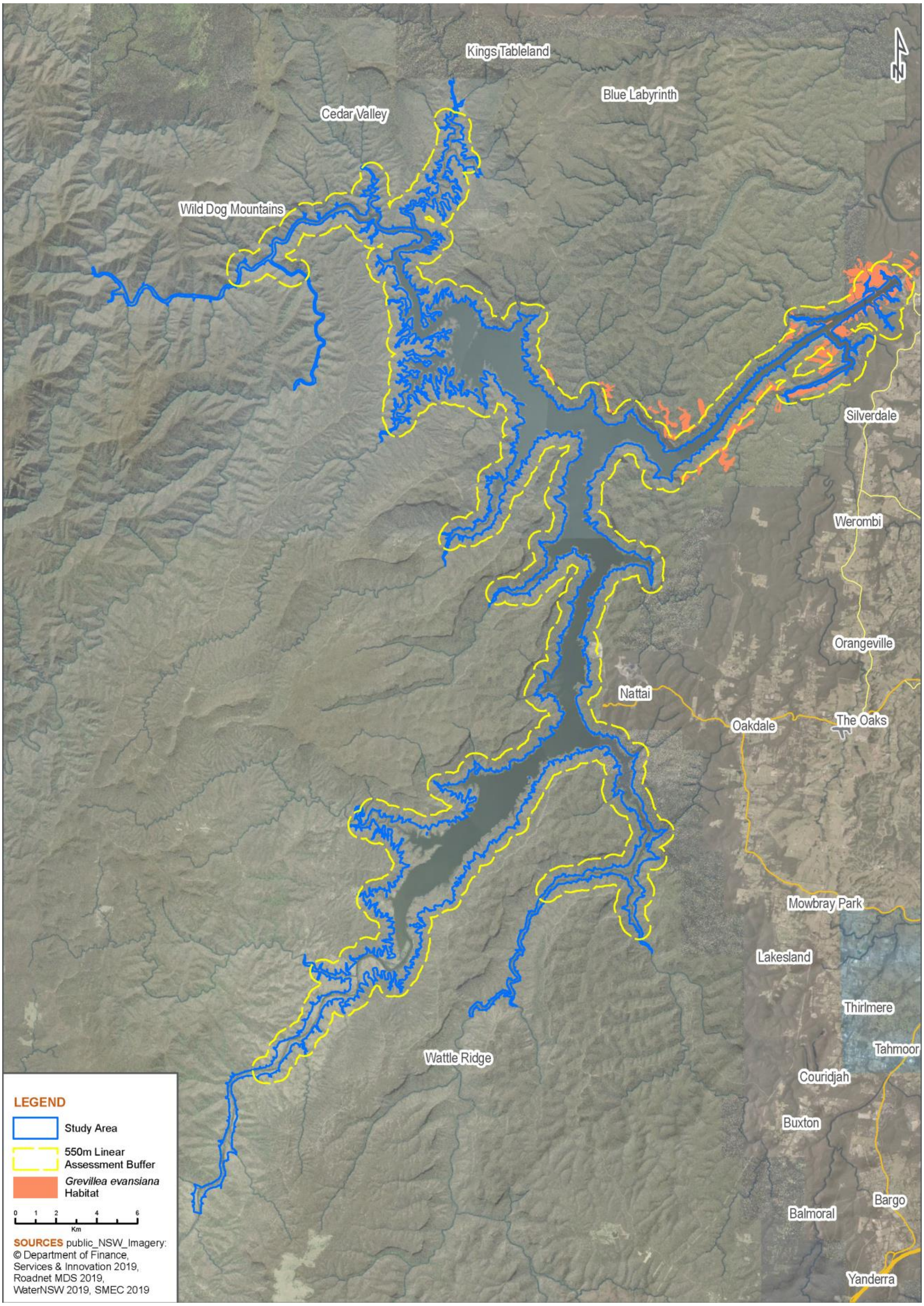
B.30 *Genoplesium superbum* species polygon



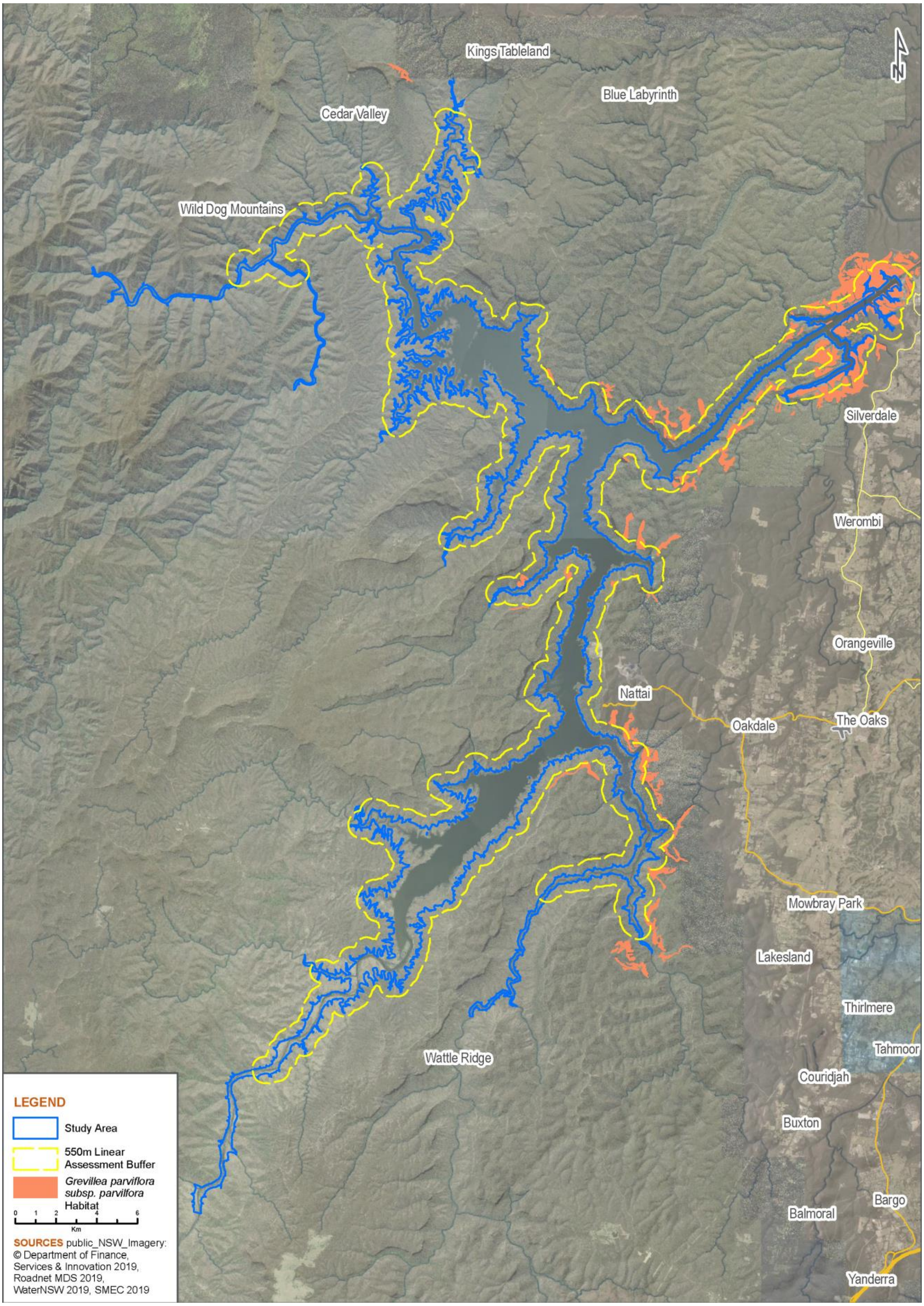
B.31 *Grammitis stenophylla* species polygon



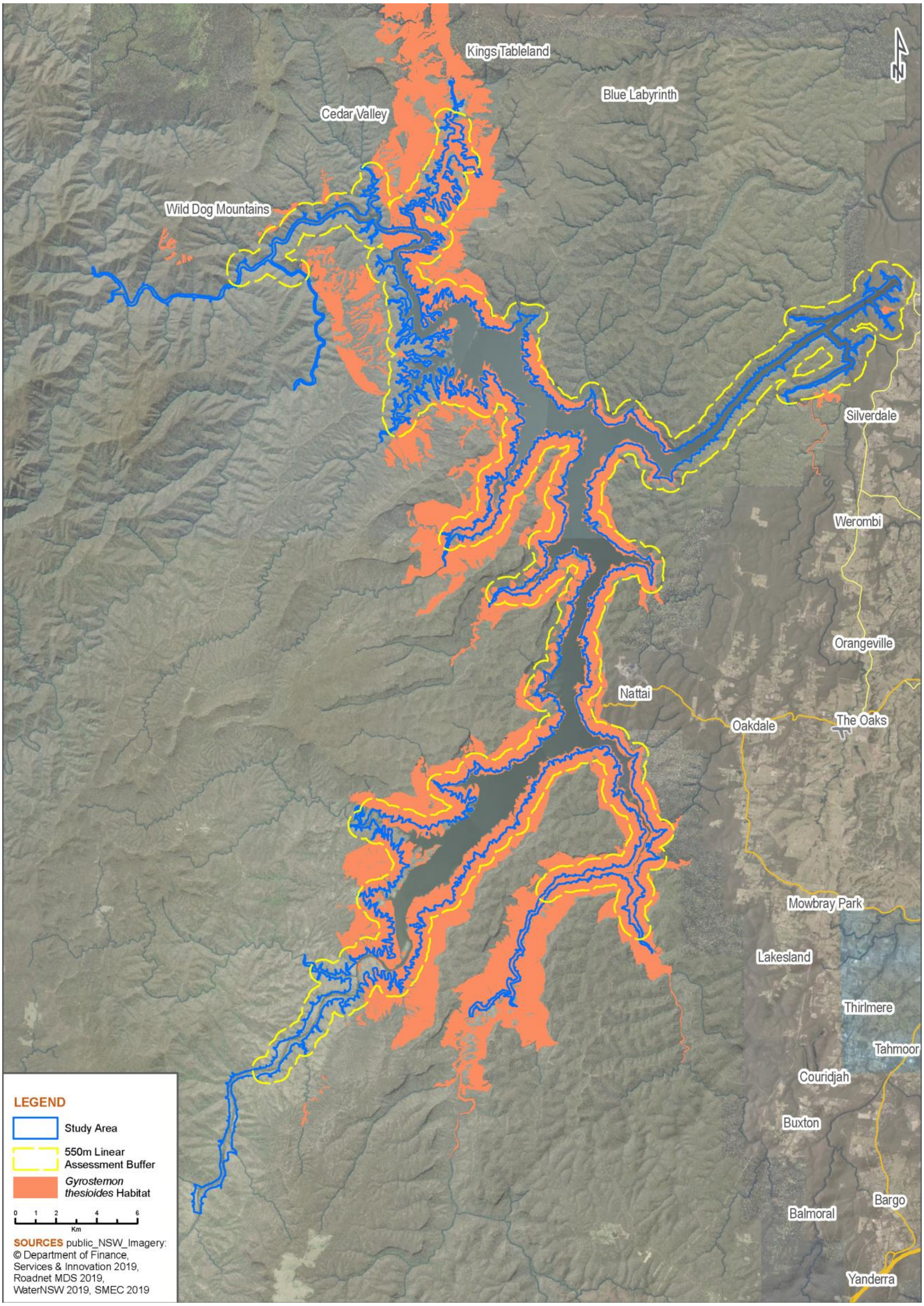
B.32 *Grevillea evaniana* species polygon



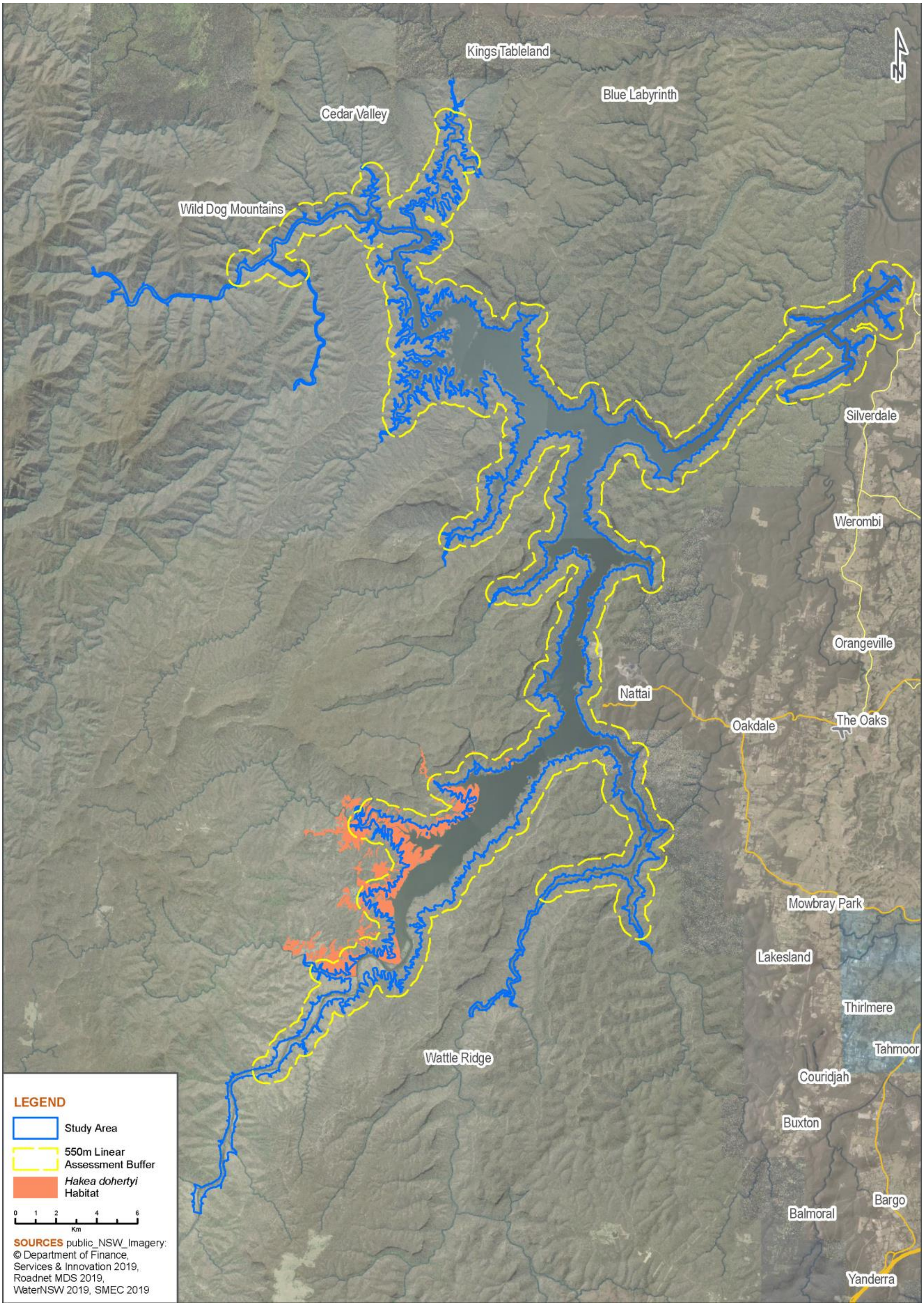
B.33 *Grevillea parviflora subsp. parviflora* species polygon



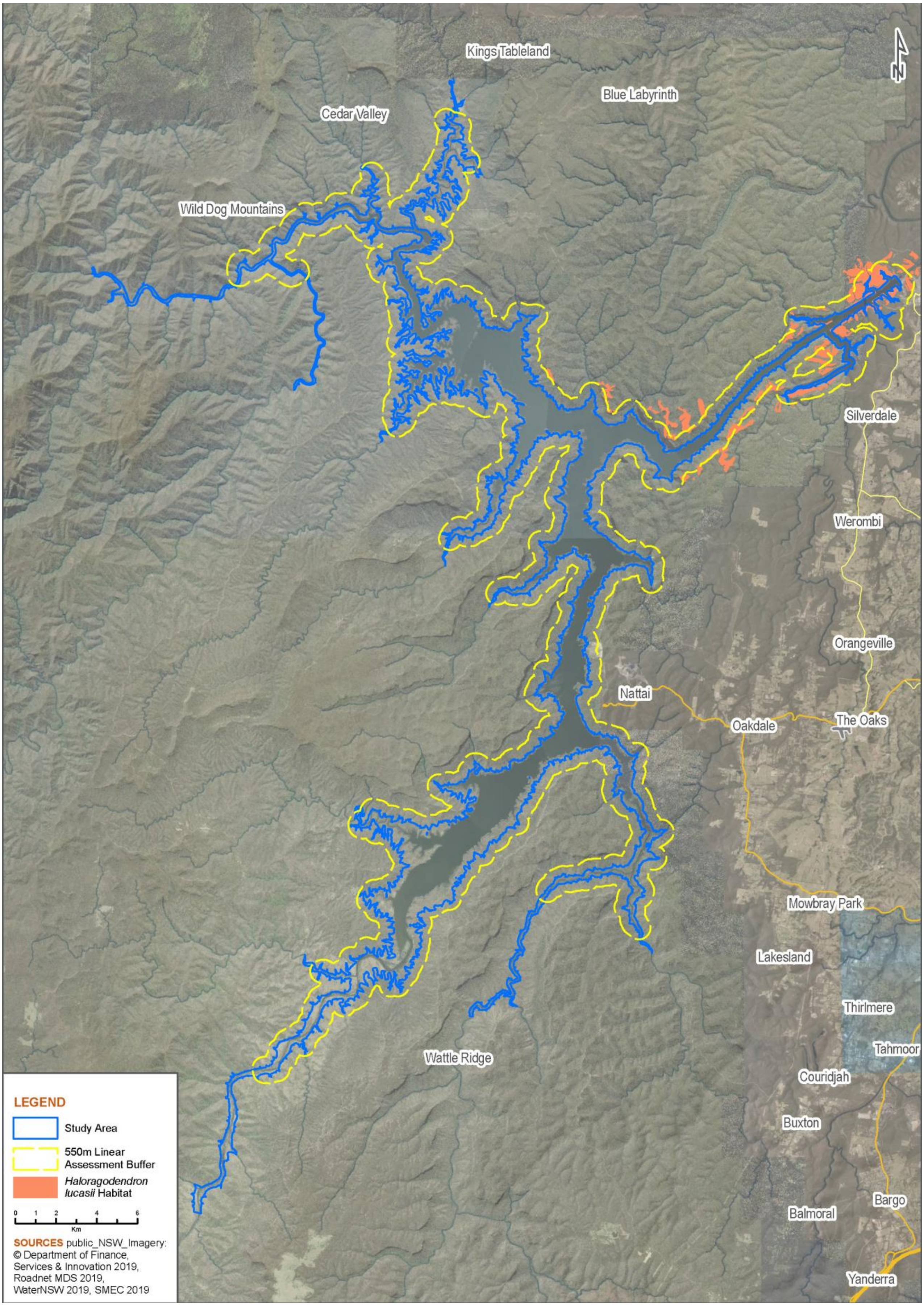
B.34 *Gyrostemon thesioides* species polygon



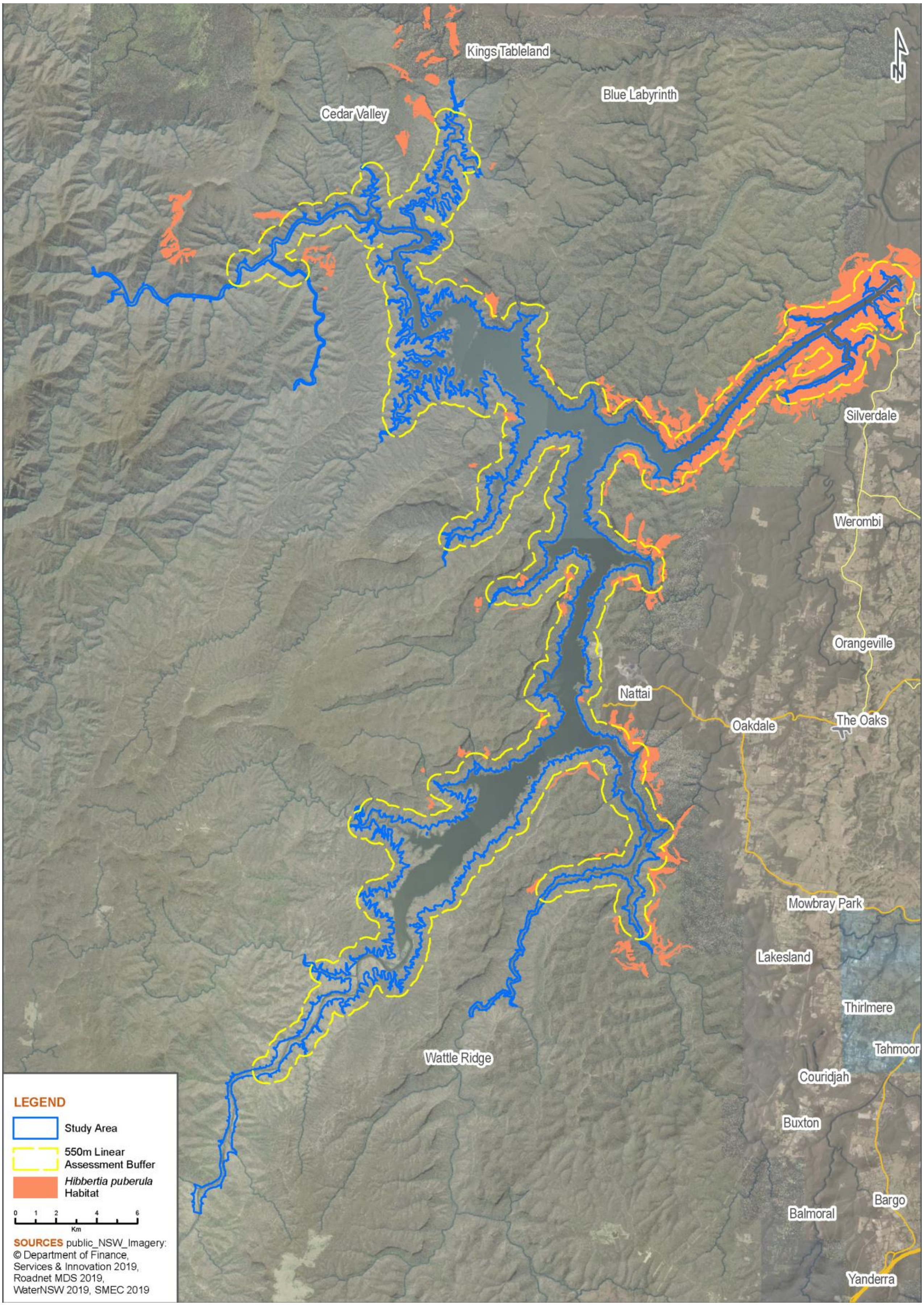
B.35 *Hakea dohertyi* species polygon



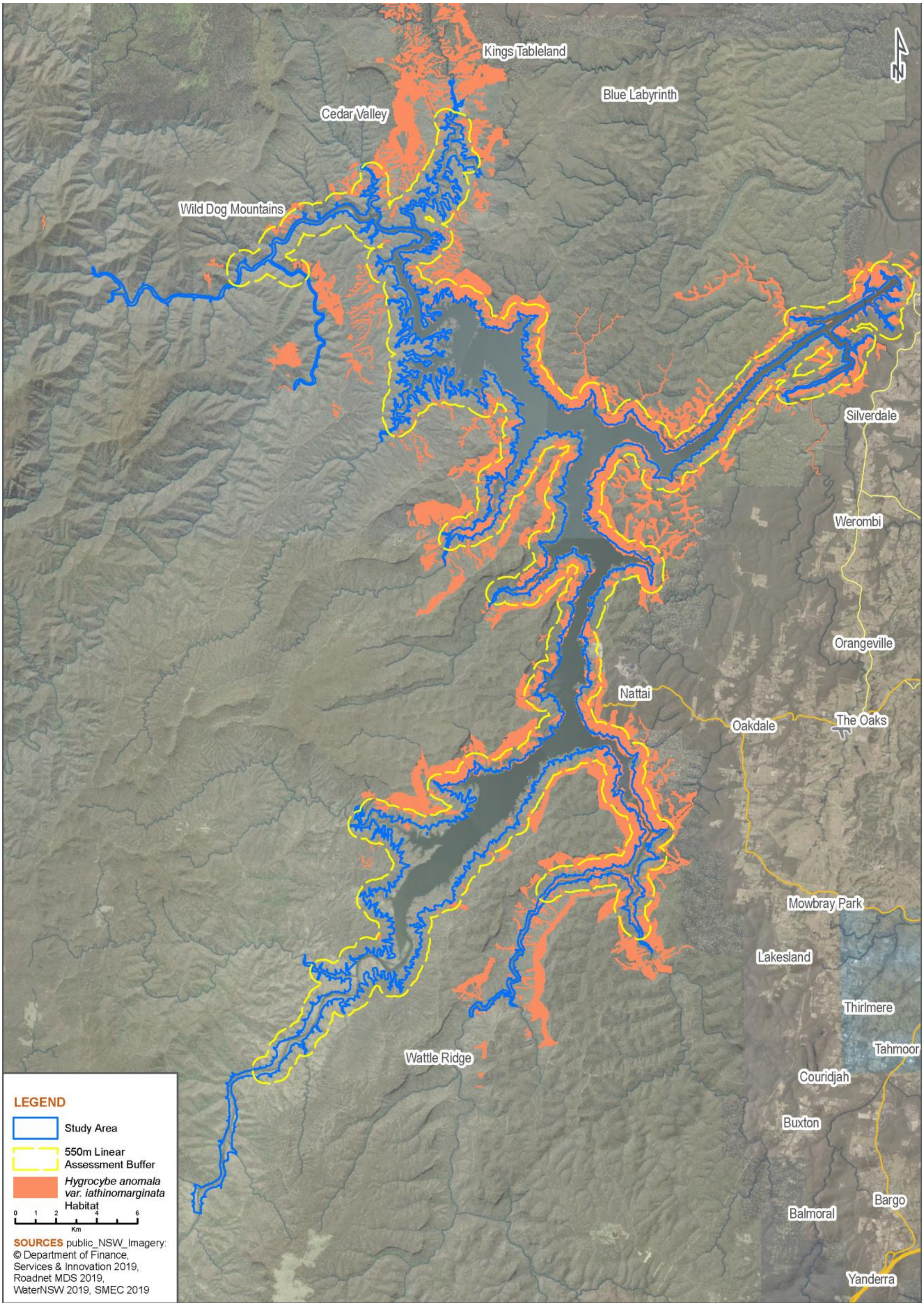
B.36 *Haloragodendron lucasii* species polygon



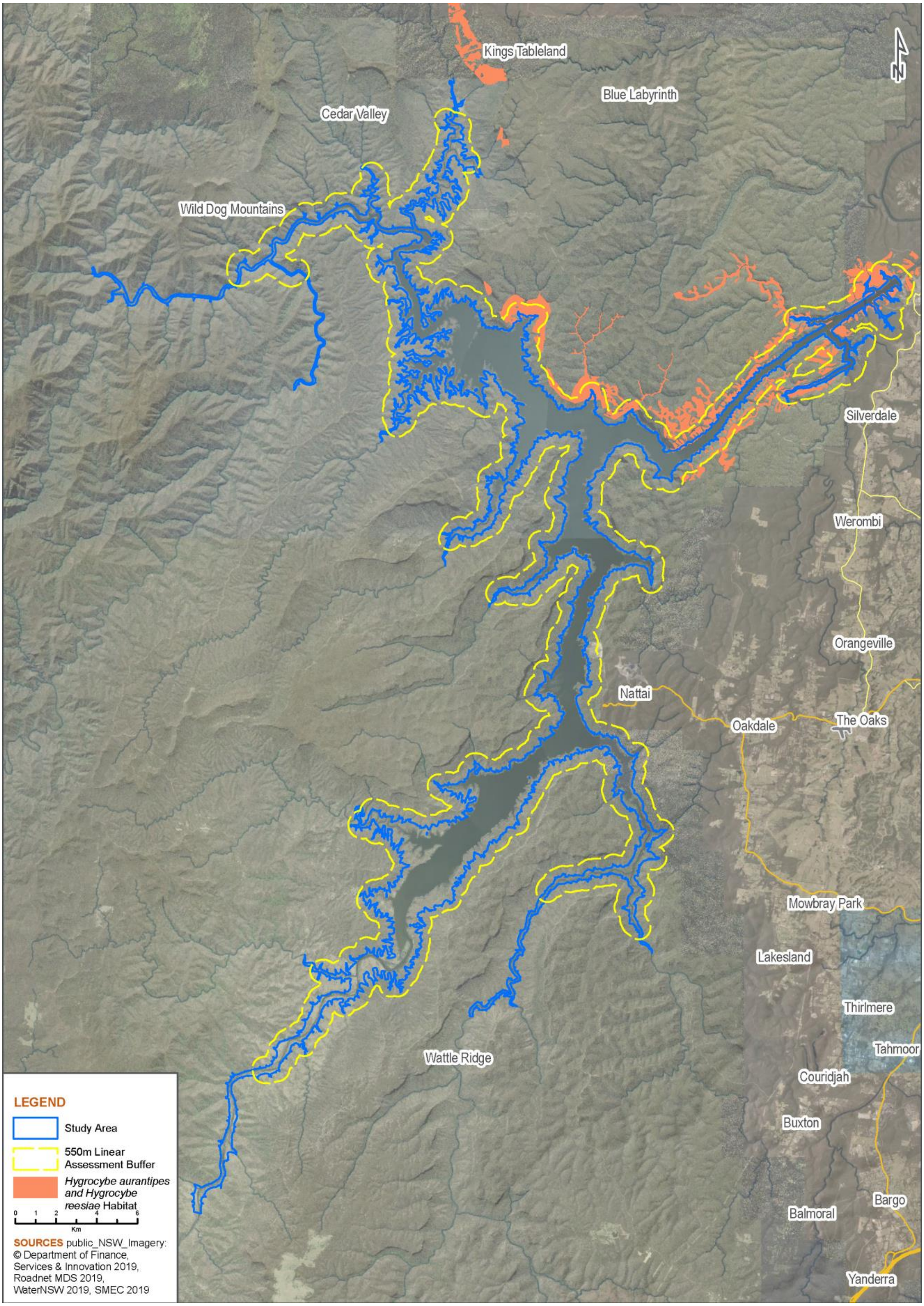
B.37 *Hibbertia puberula* species polygon



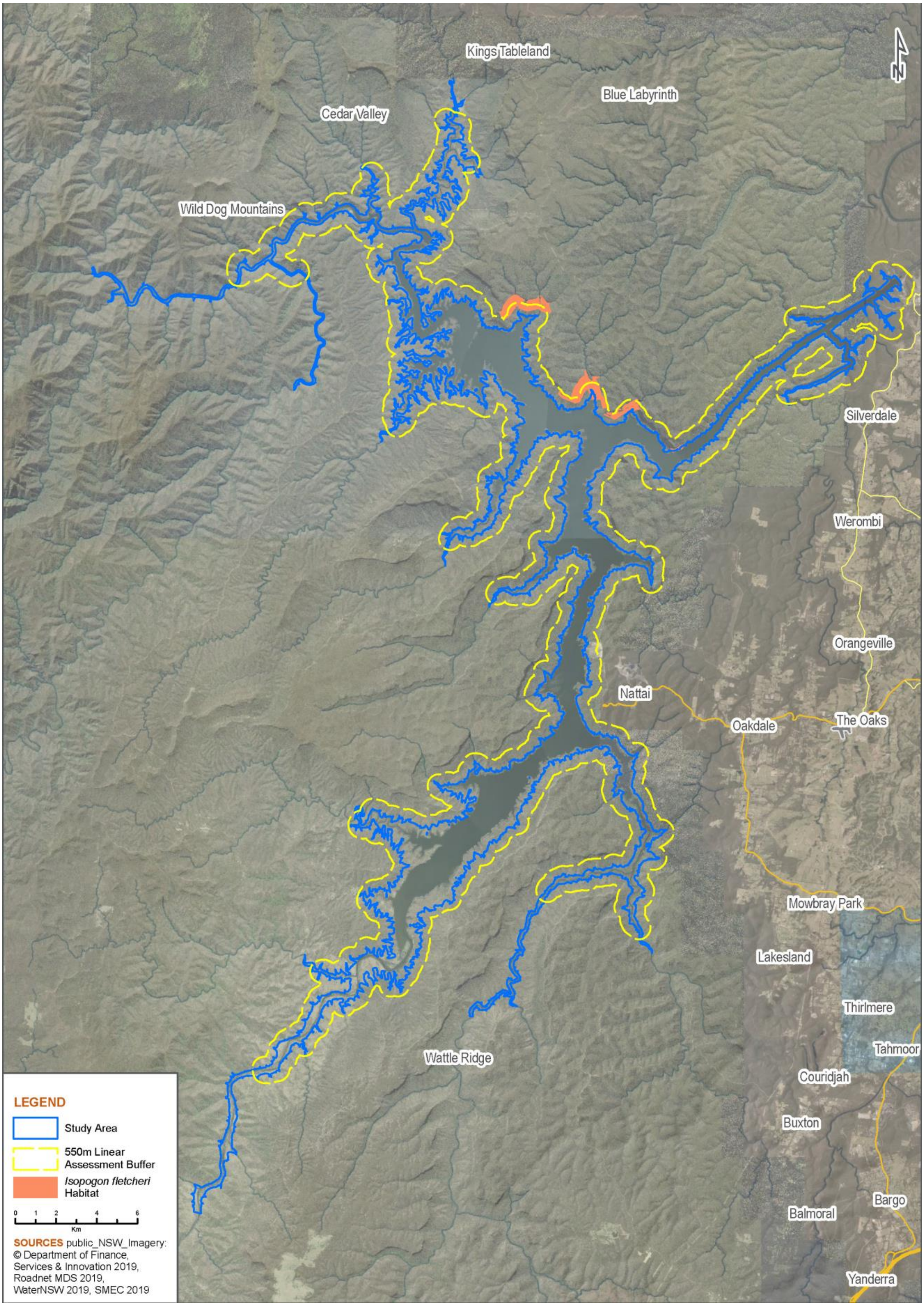
B.38 *Hygrocybe anomala var. iathinomarginata* species polygon



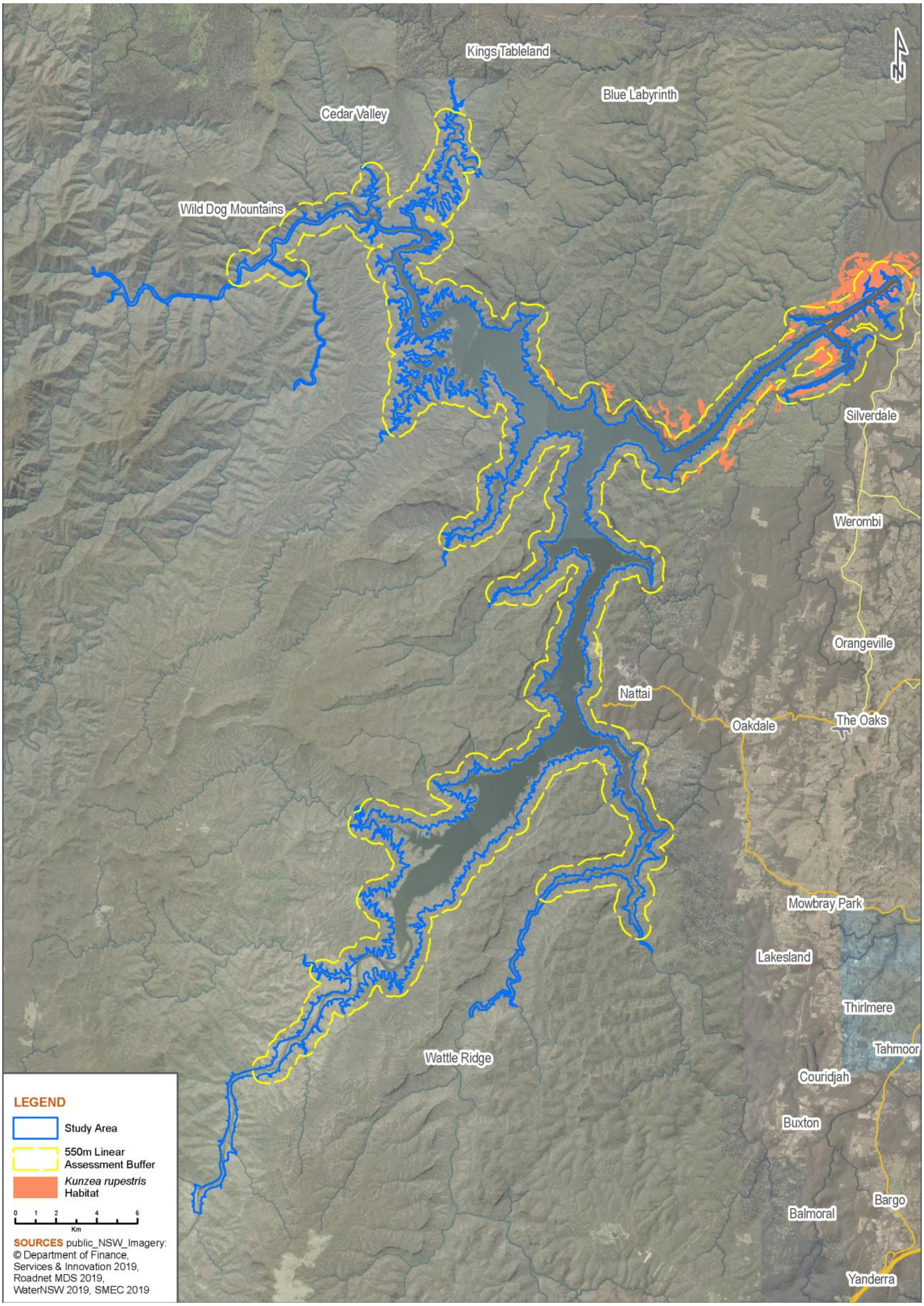
B.39 *Hygrocybe aurantipes and Hygrocybe reesiae* species polygon



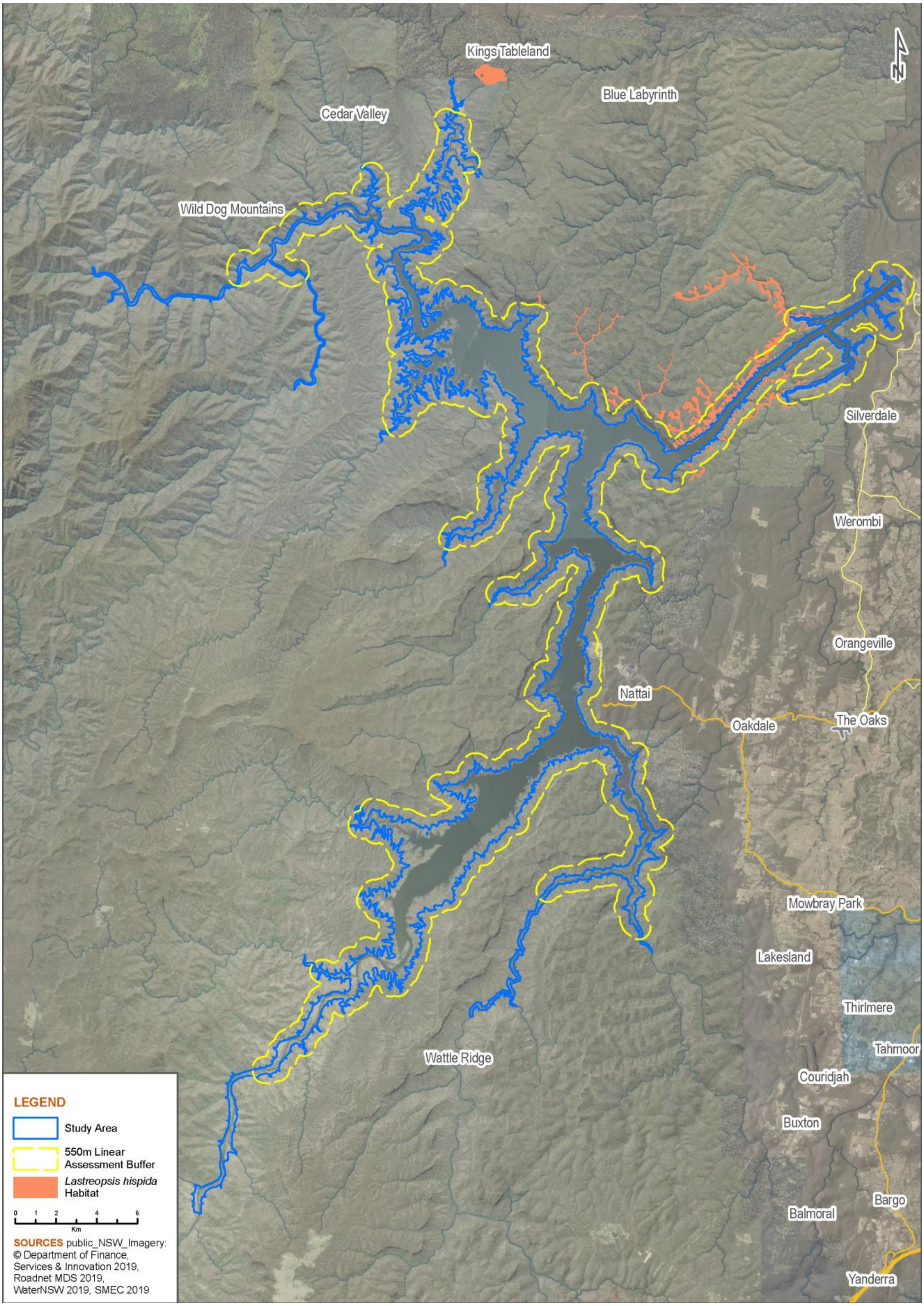
B.40 *Isopogon fletcheri* species polygon



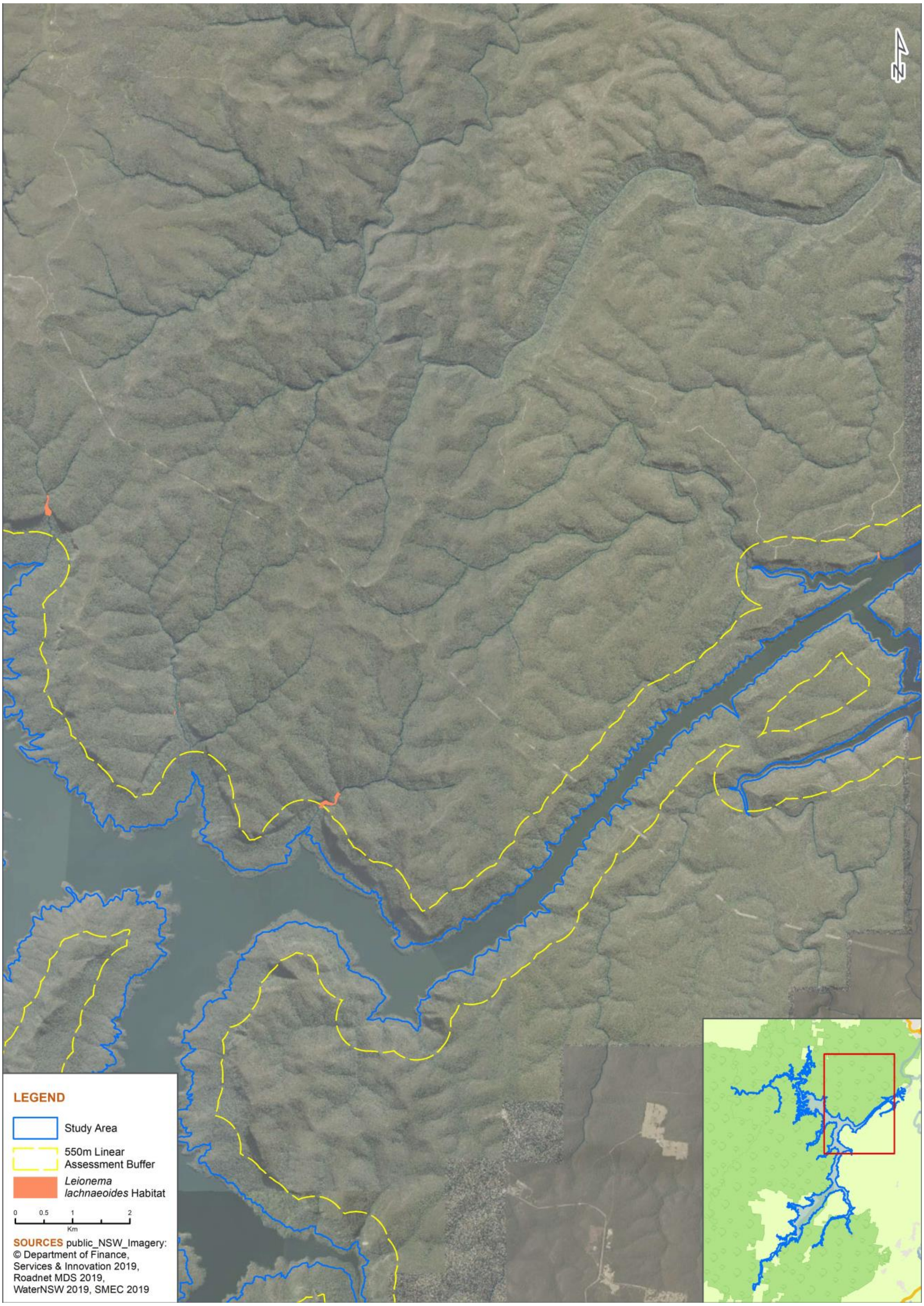
B.41 *Kunzea rupestris* species polygon



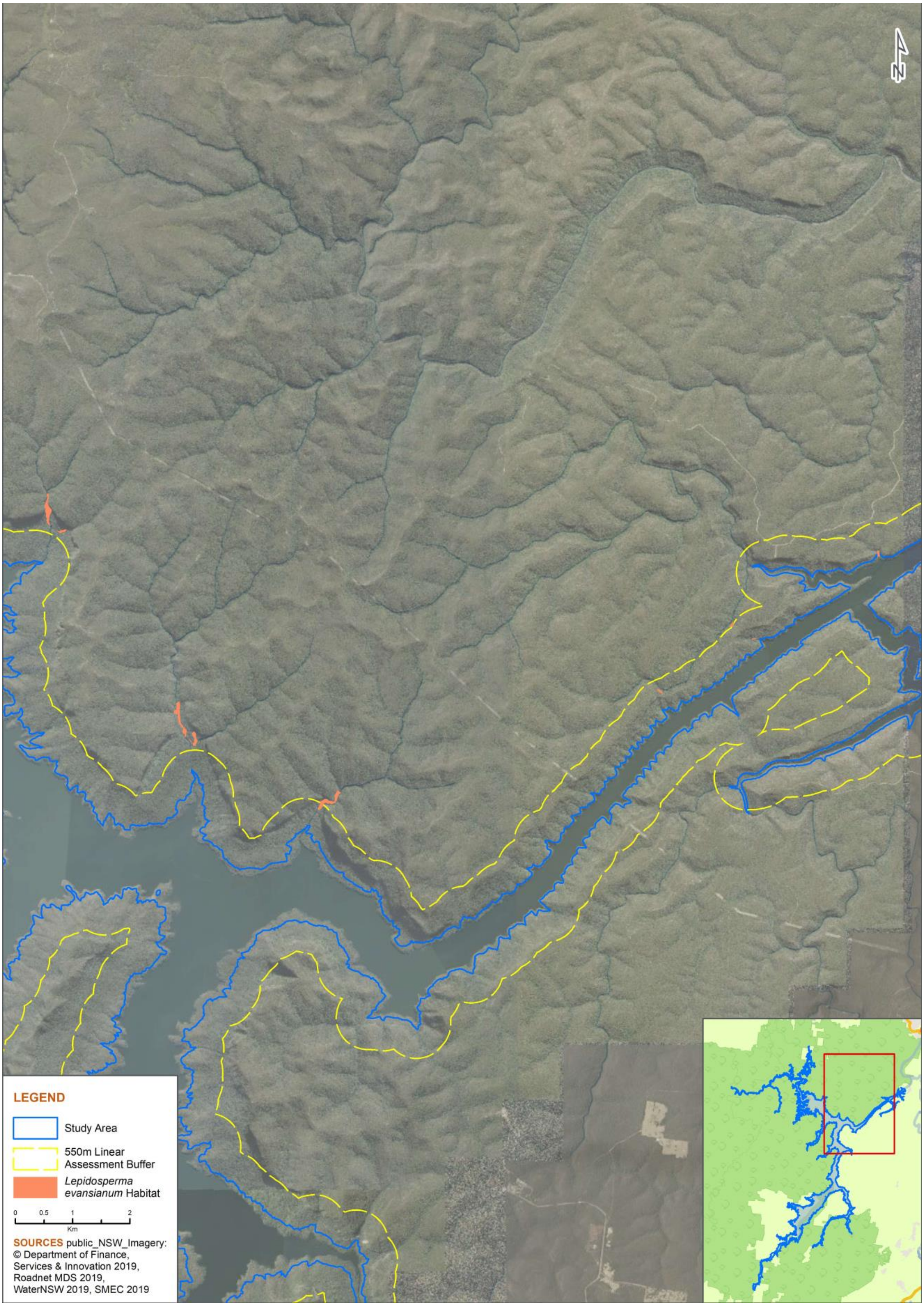
B.42 *Lastreopsis hispida* species polygon



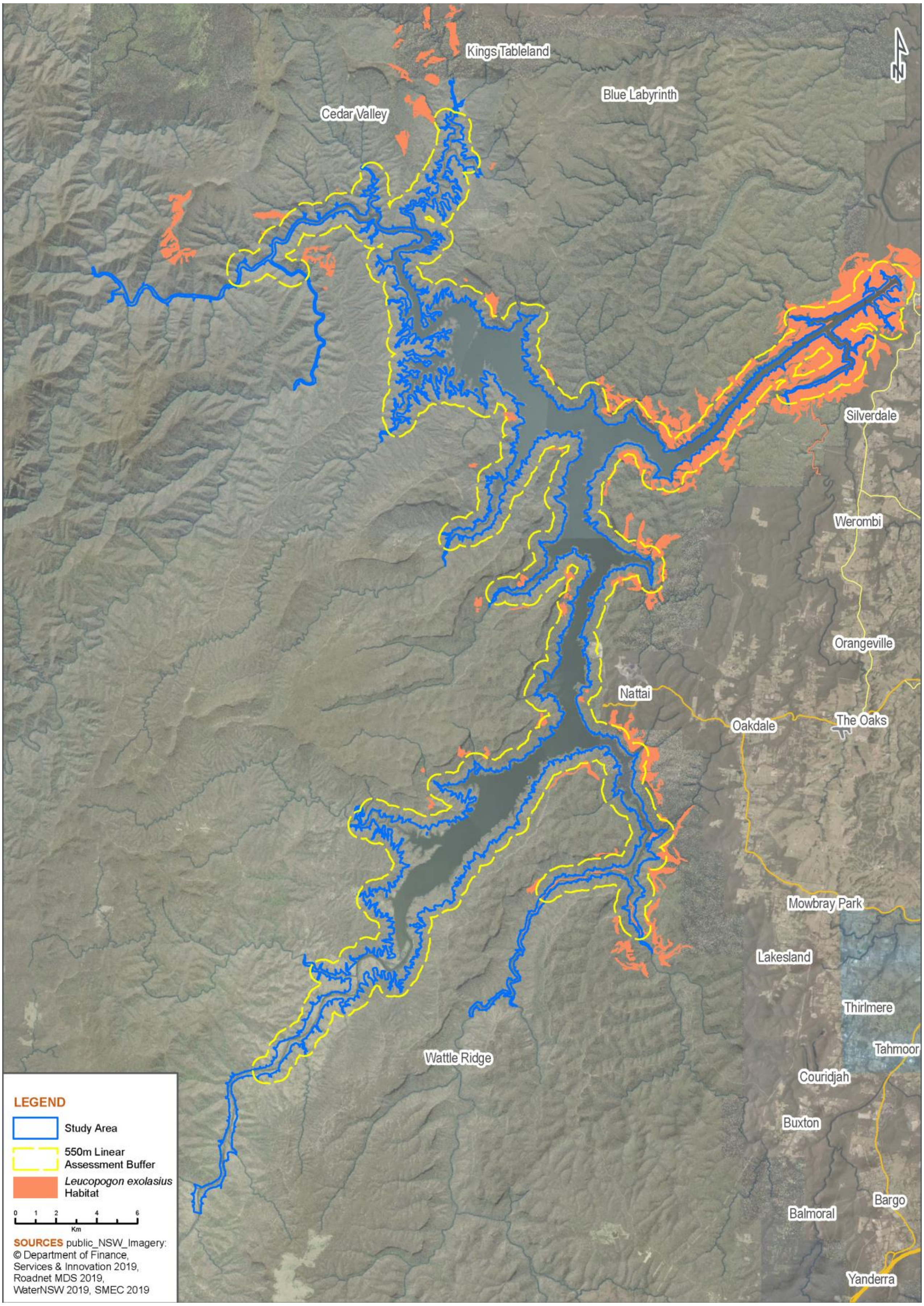
B.43 *Leionema lachnaeoides* species polygon



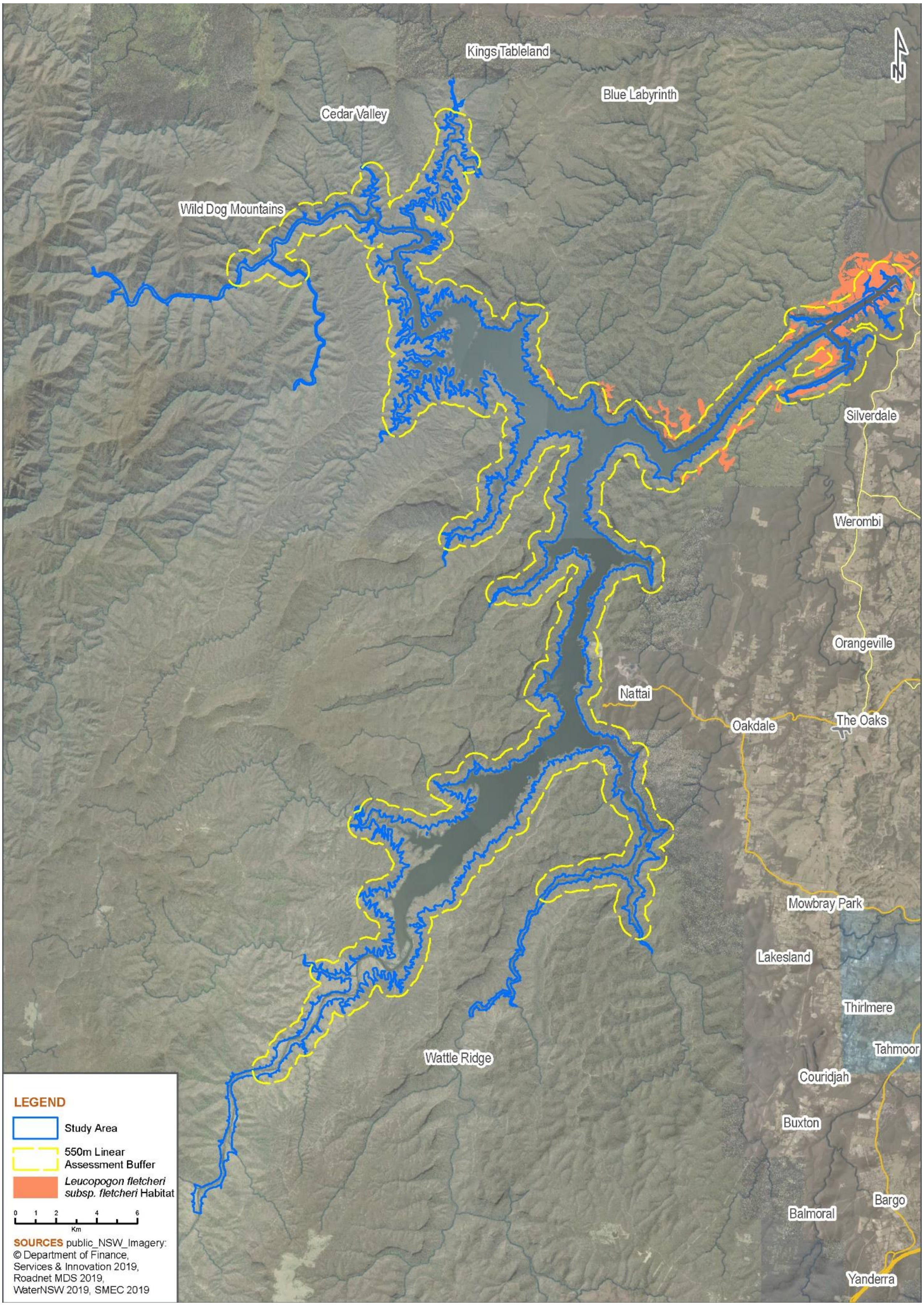
B.44 *Lepidosperma evansianum* species polygon



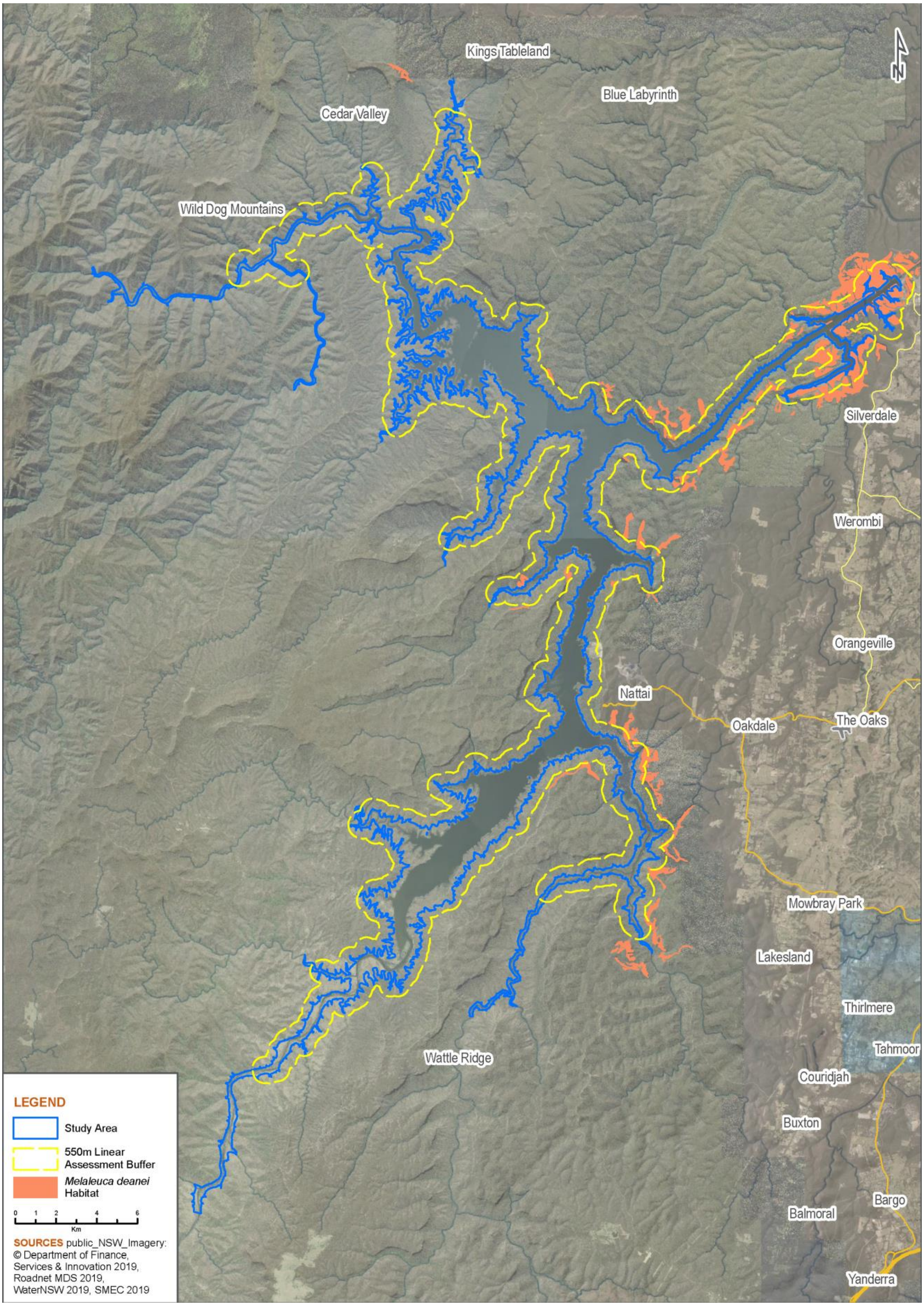
B.45 *Leucopogon exolasius* species polygon



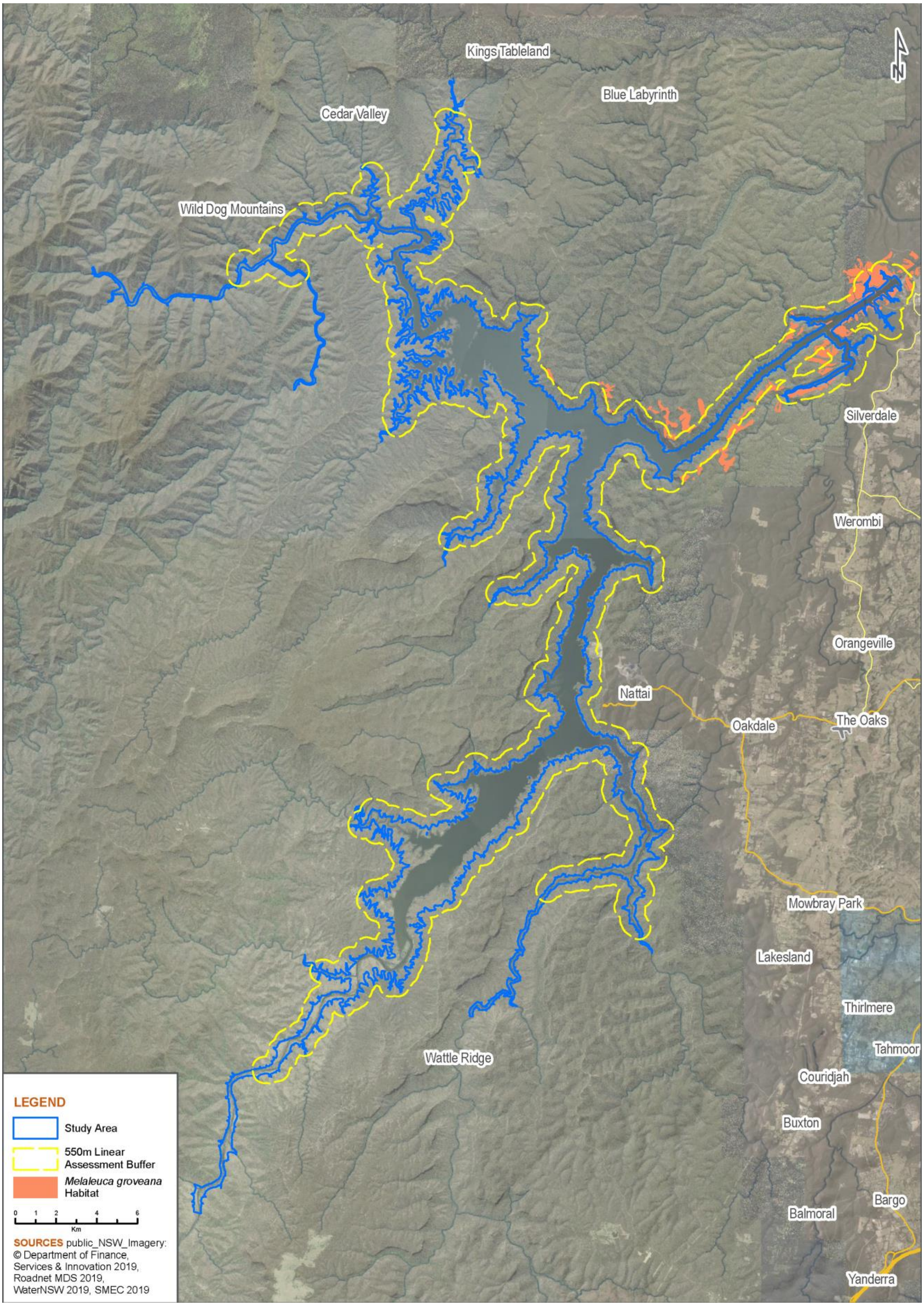
B.46 *Leucopogon fletcheri subsp. fletcheri* species polygon



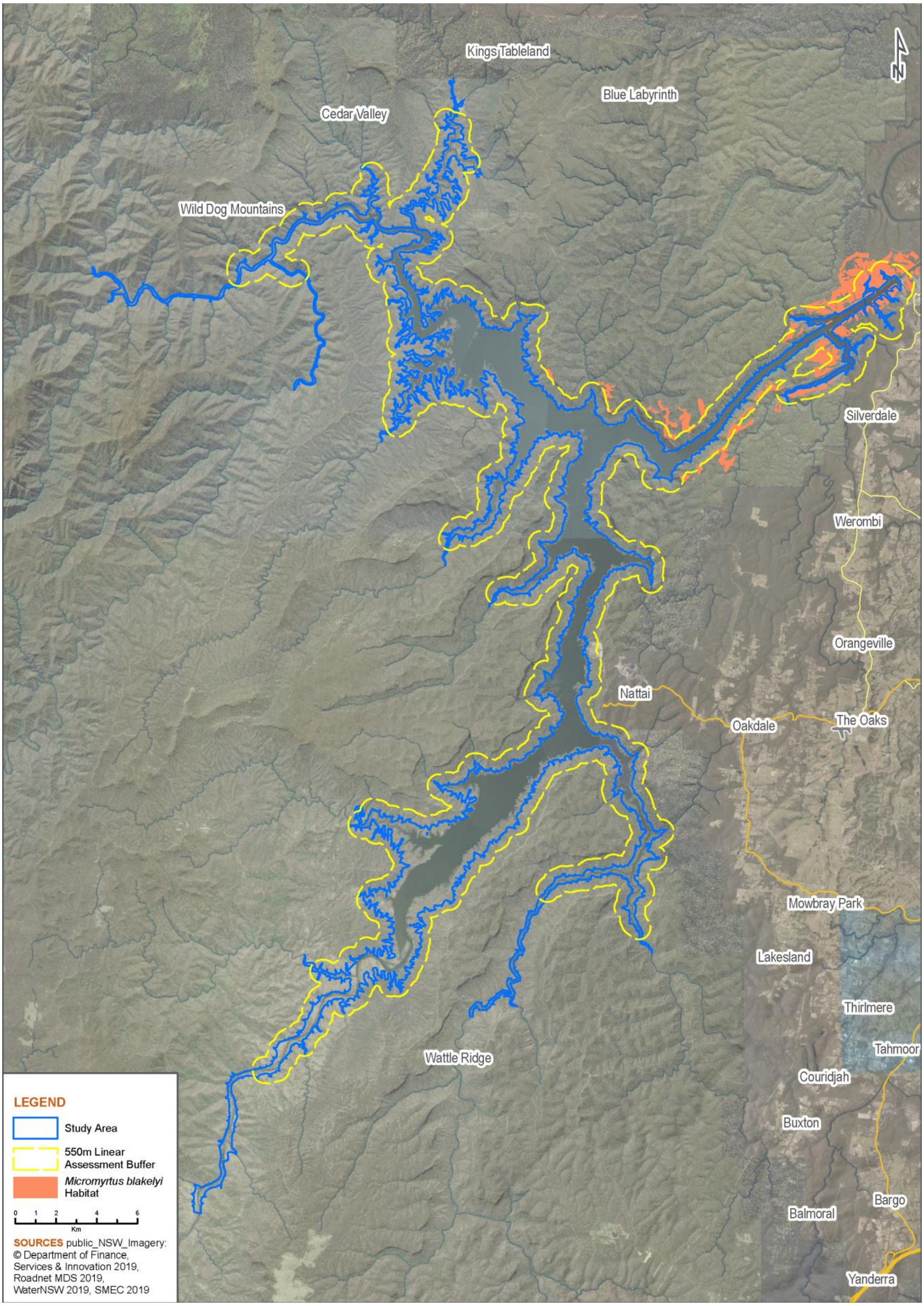
B.47 *Melaleuca deanei* species polygon



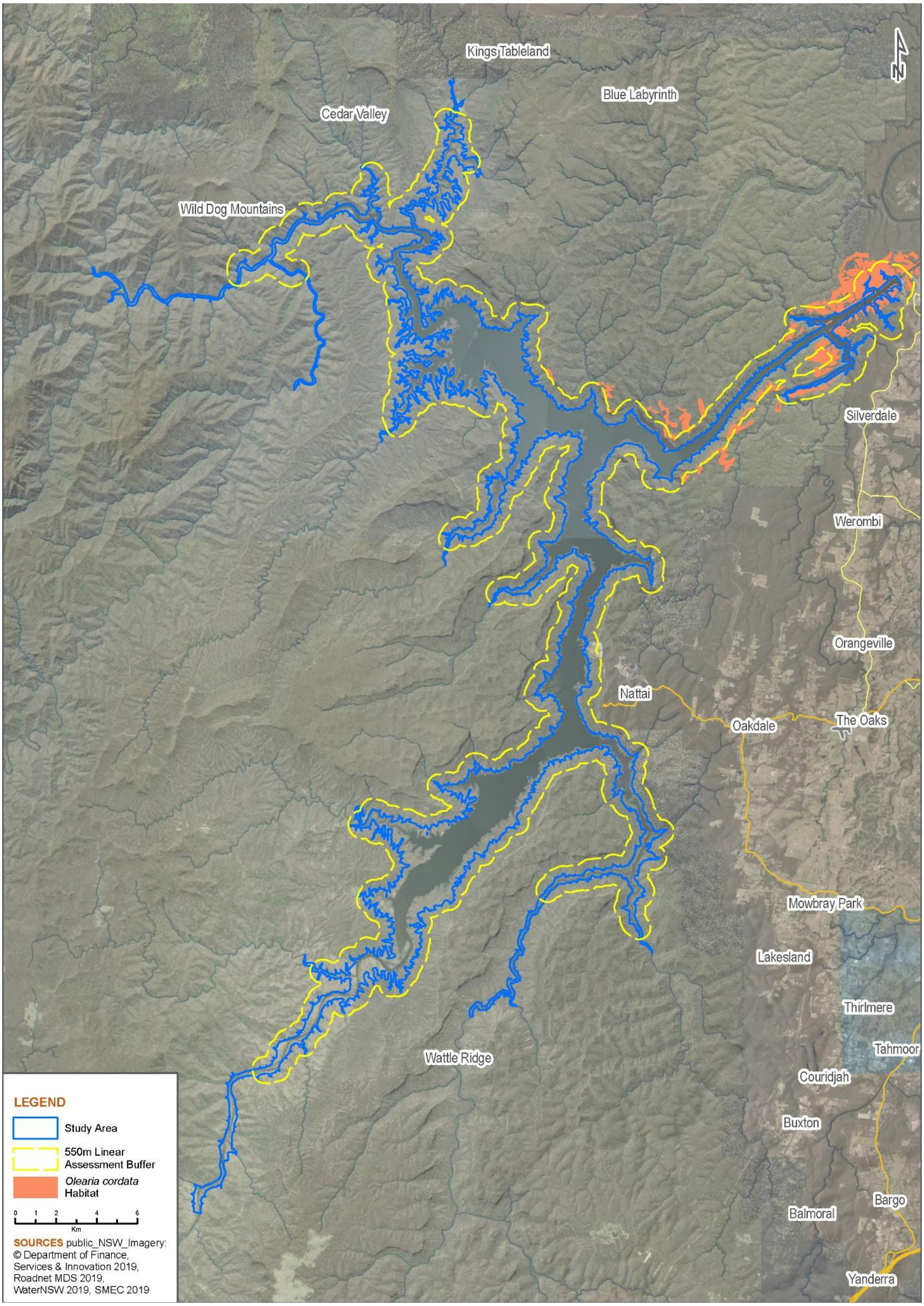
B.48 *Melaleuca groveana* species polygon



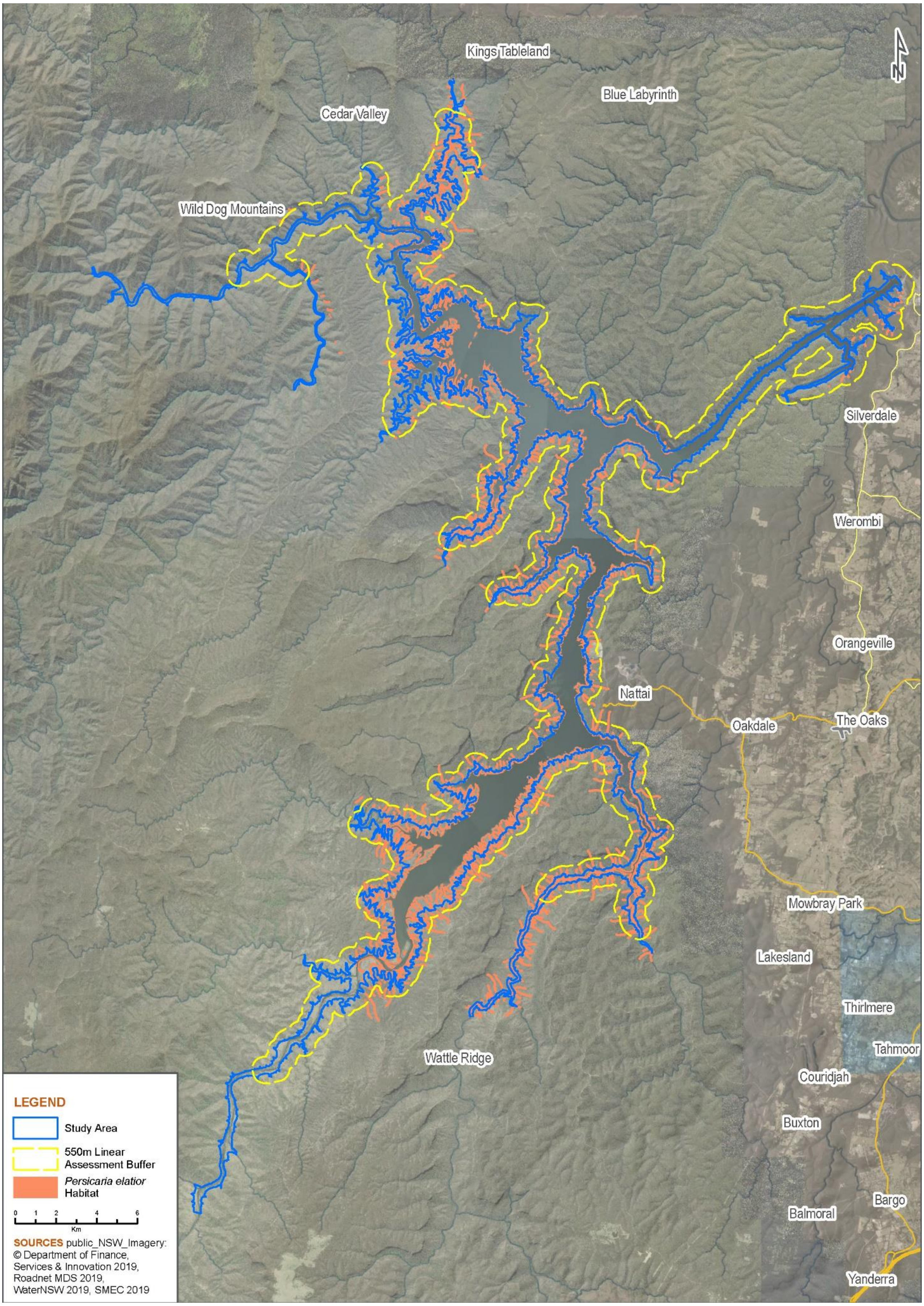
B.49 *Micromyrtus blakelyi* species polygon



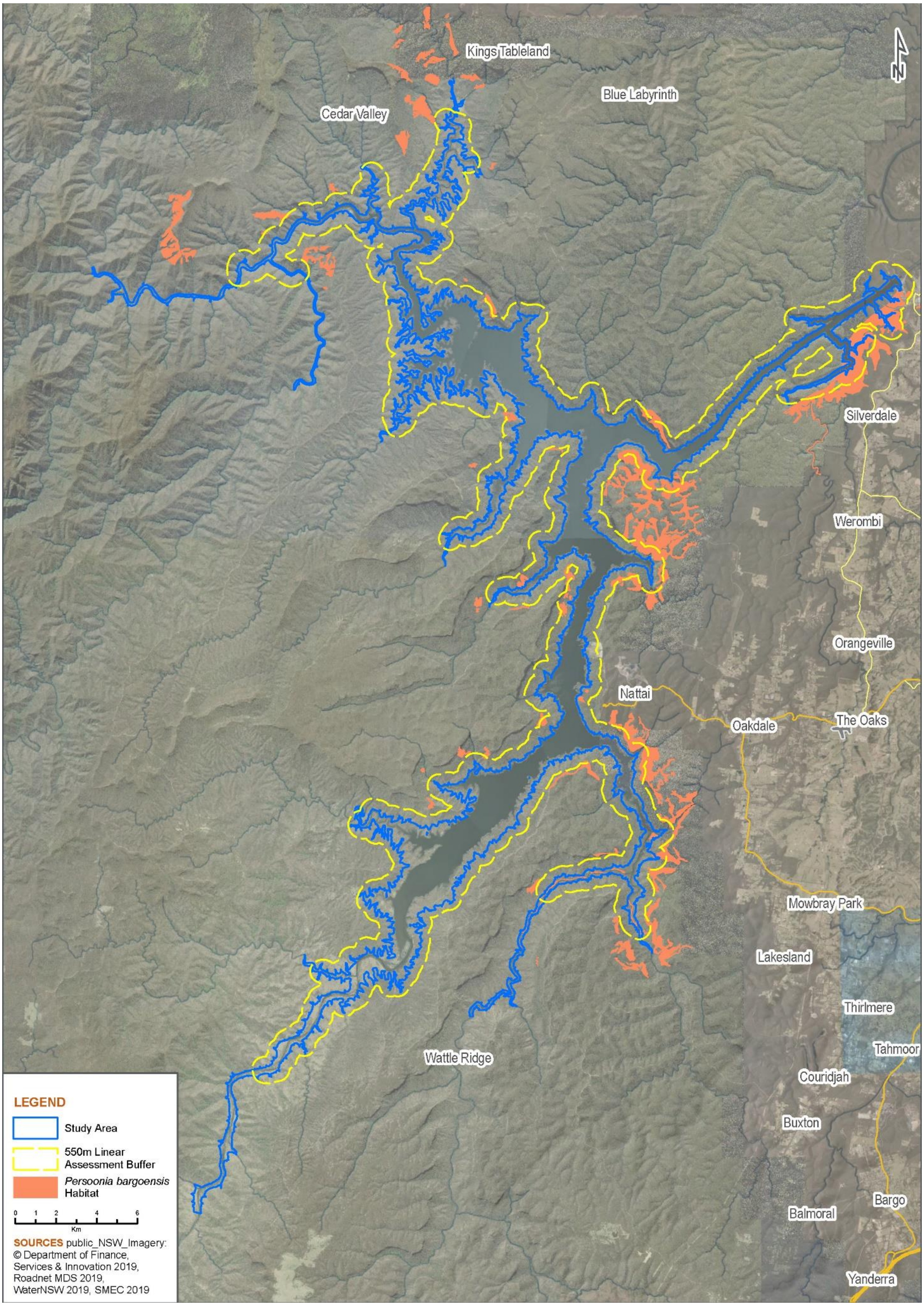
B.50 *Olearia cordata* species polygon



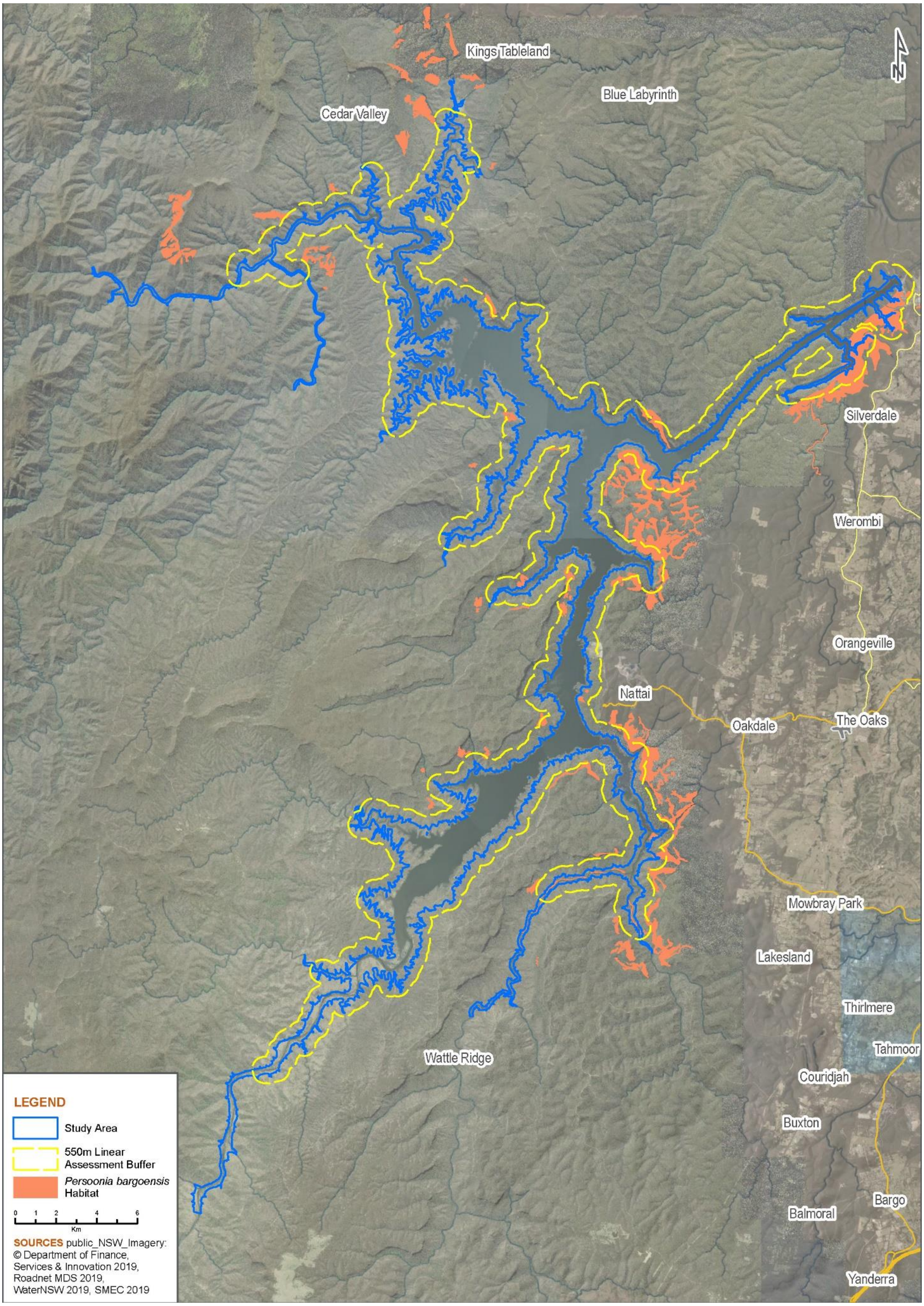
B.51 *Persicaria elatior* species polygon



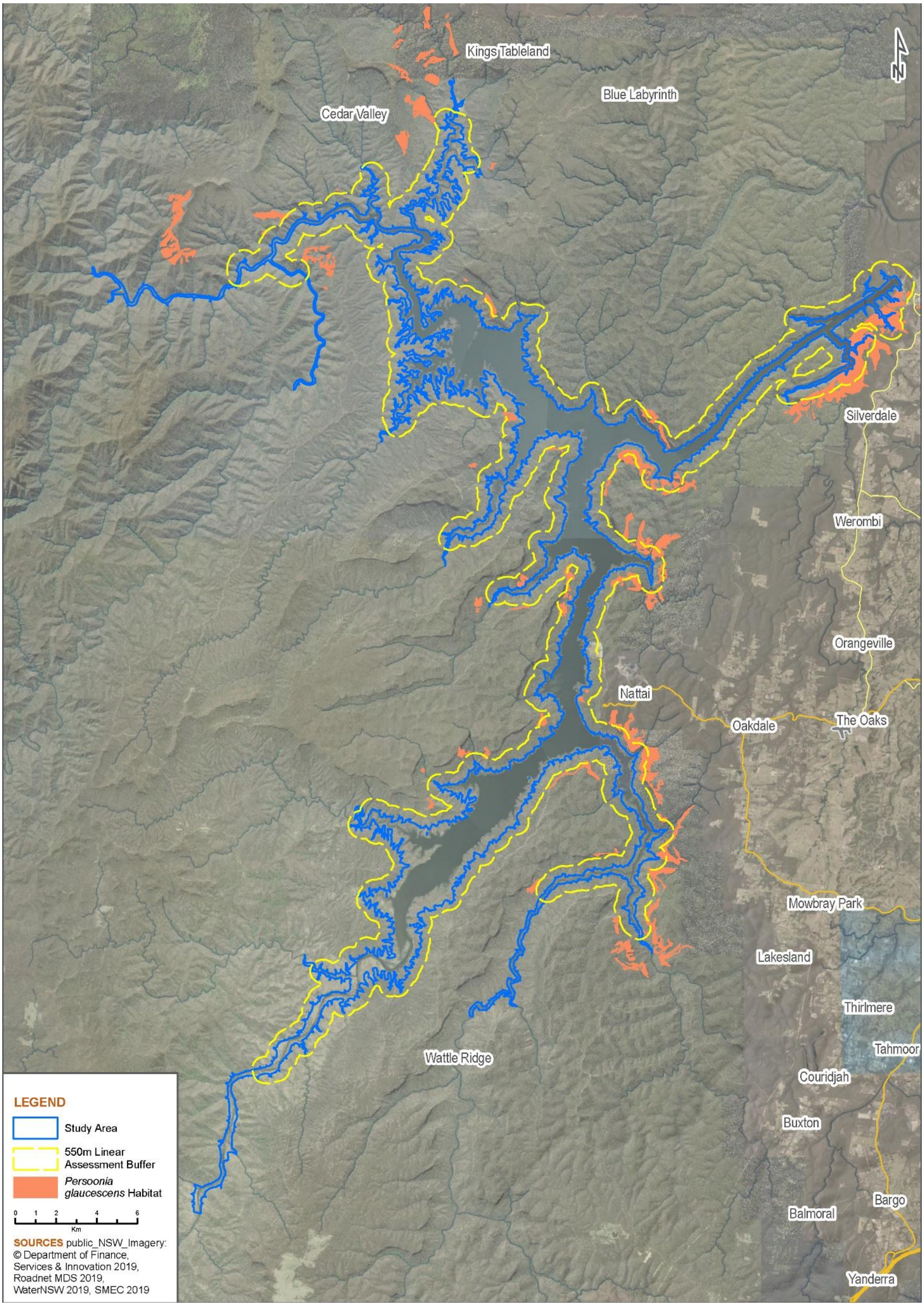
B.52 *Persoonia acerosa* species polygon



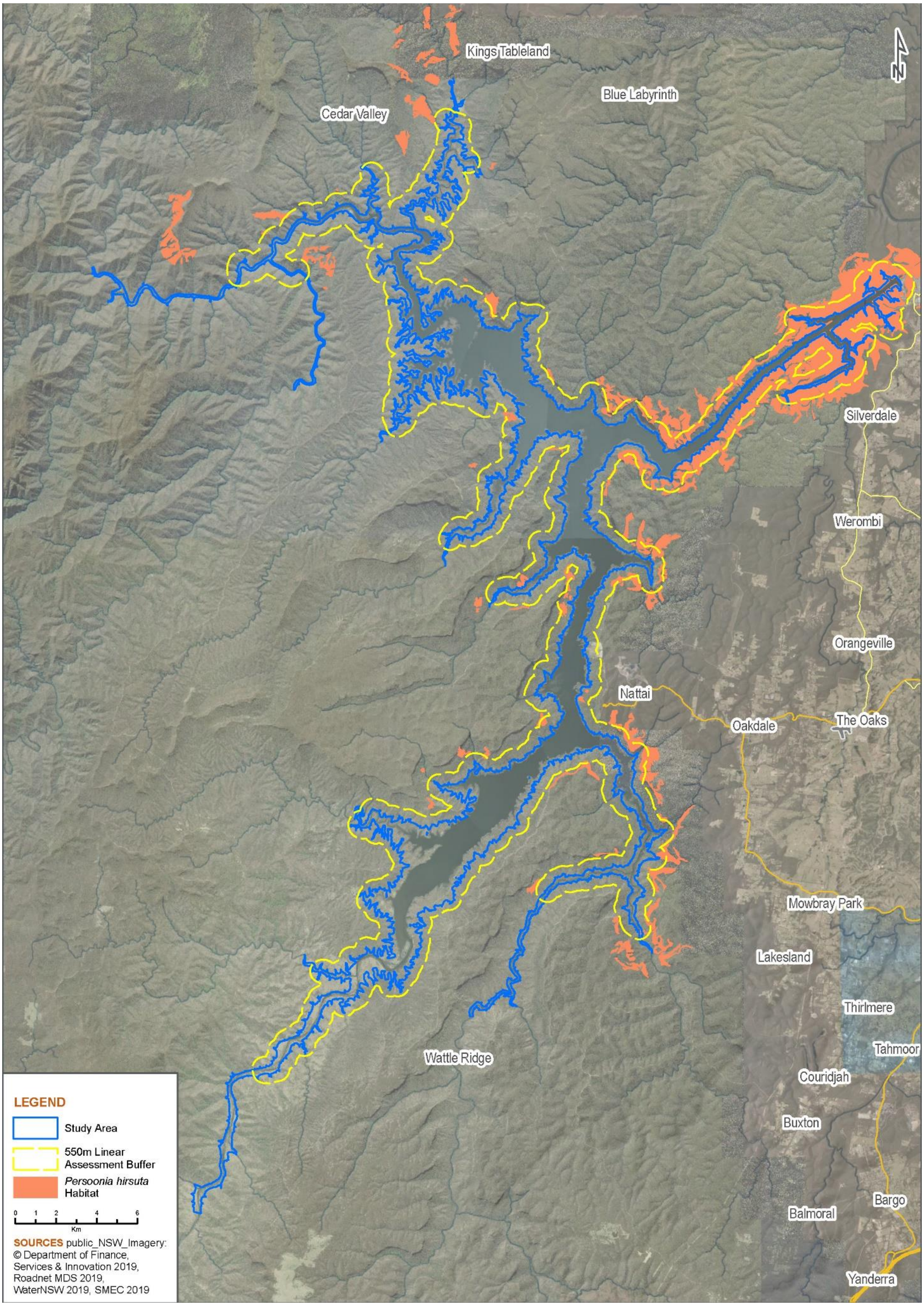
B.53 *Persoonia bargoensis* species polygon



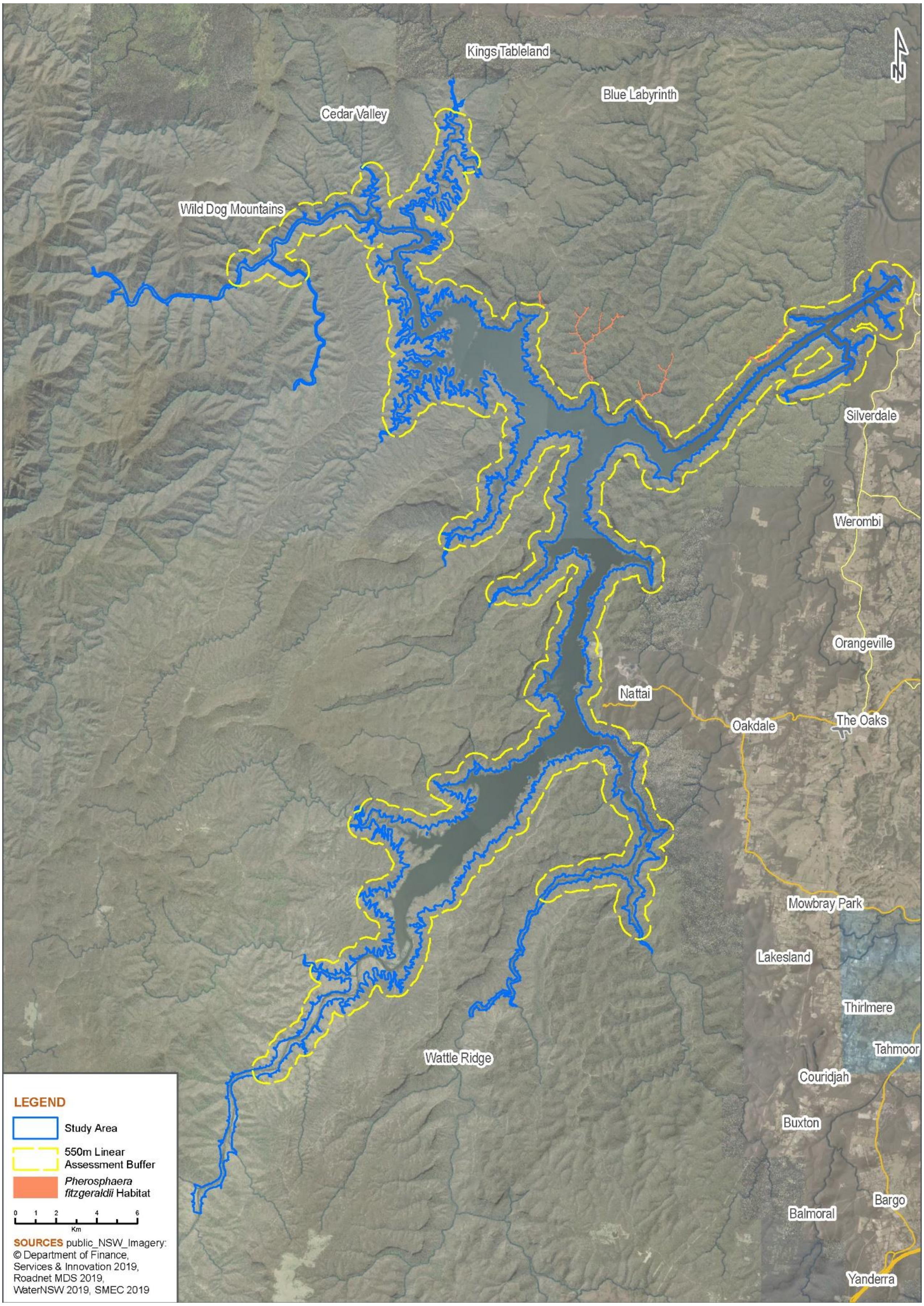
B.54 *Persoonia glaucescens* species polygon



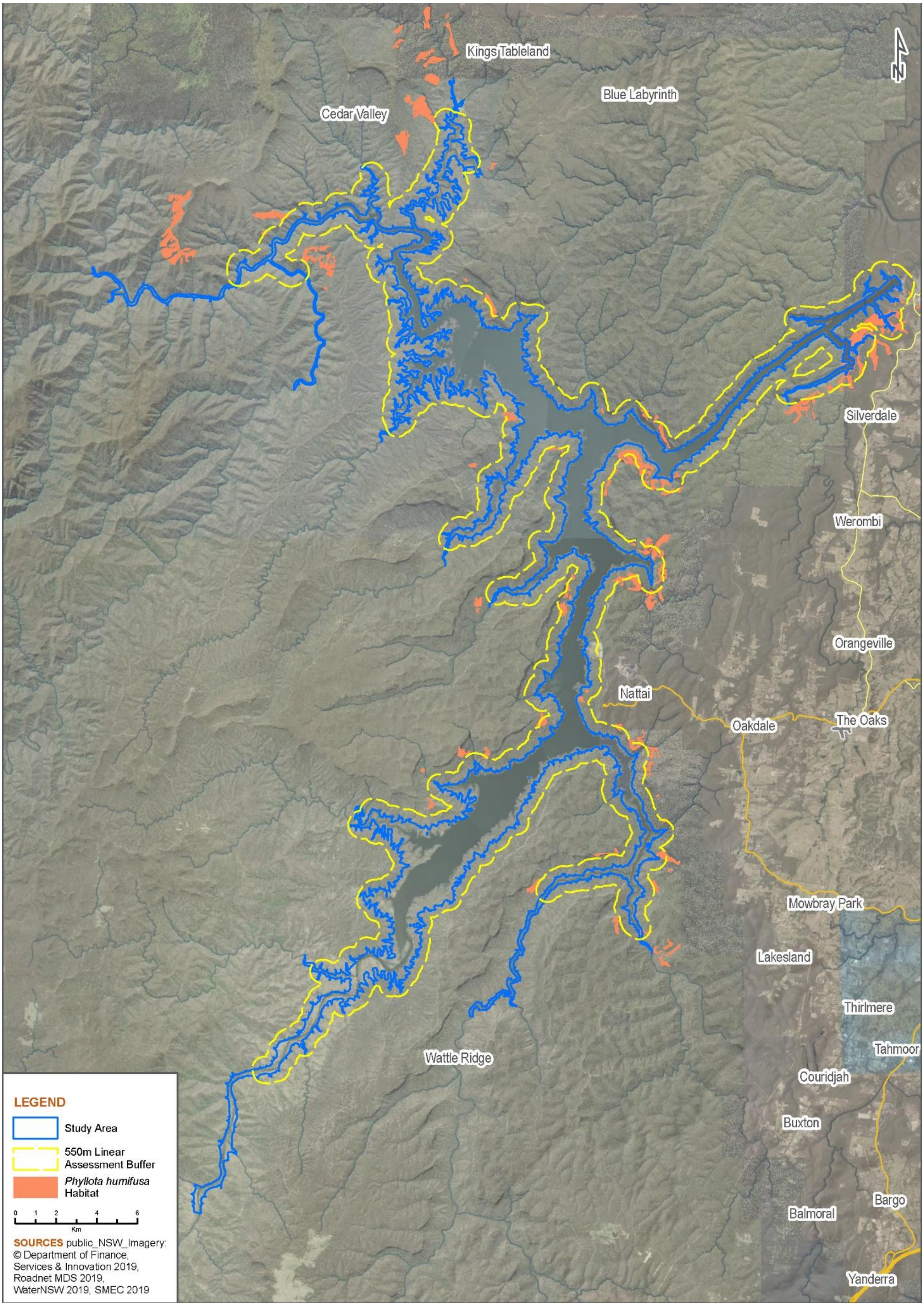
B.55 *Persoonia hirsuta* species polygon



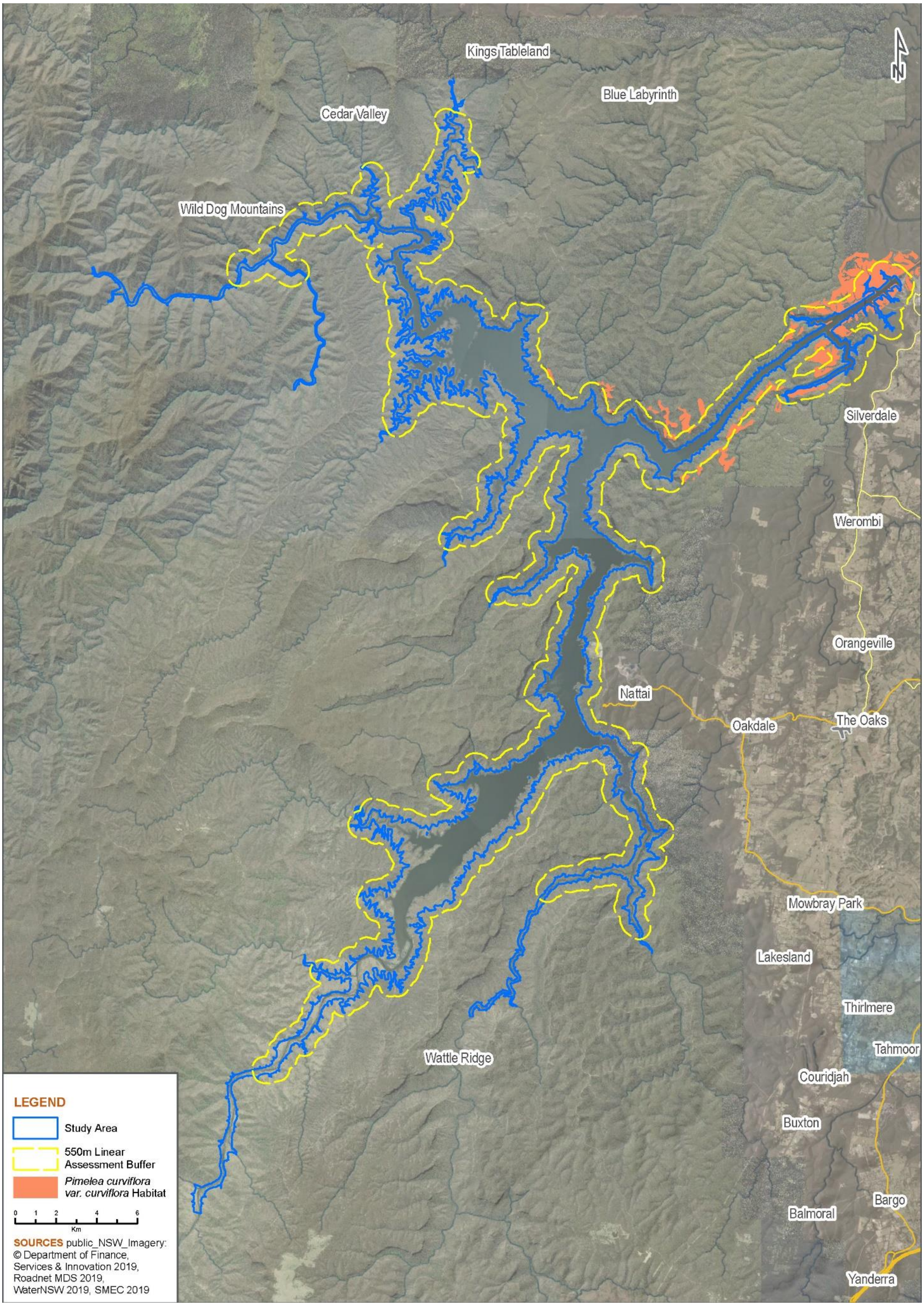
B.56 *Pherophaera fitzgeraldii* species polygon



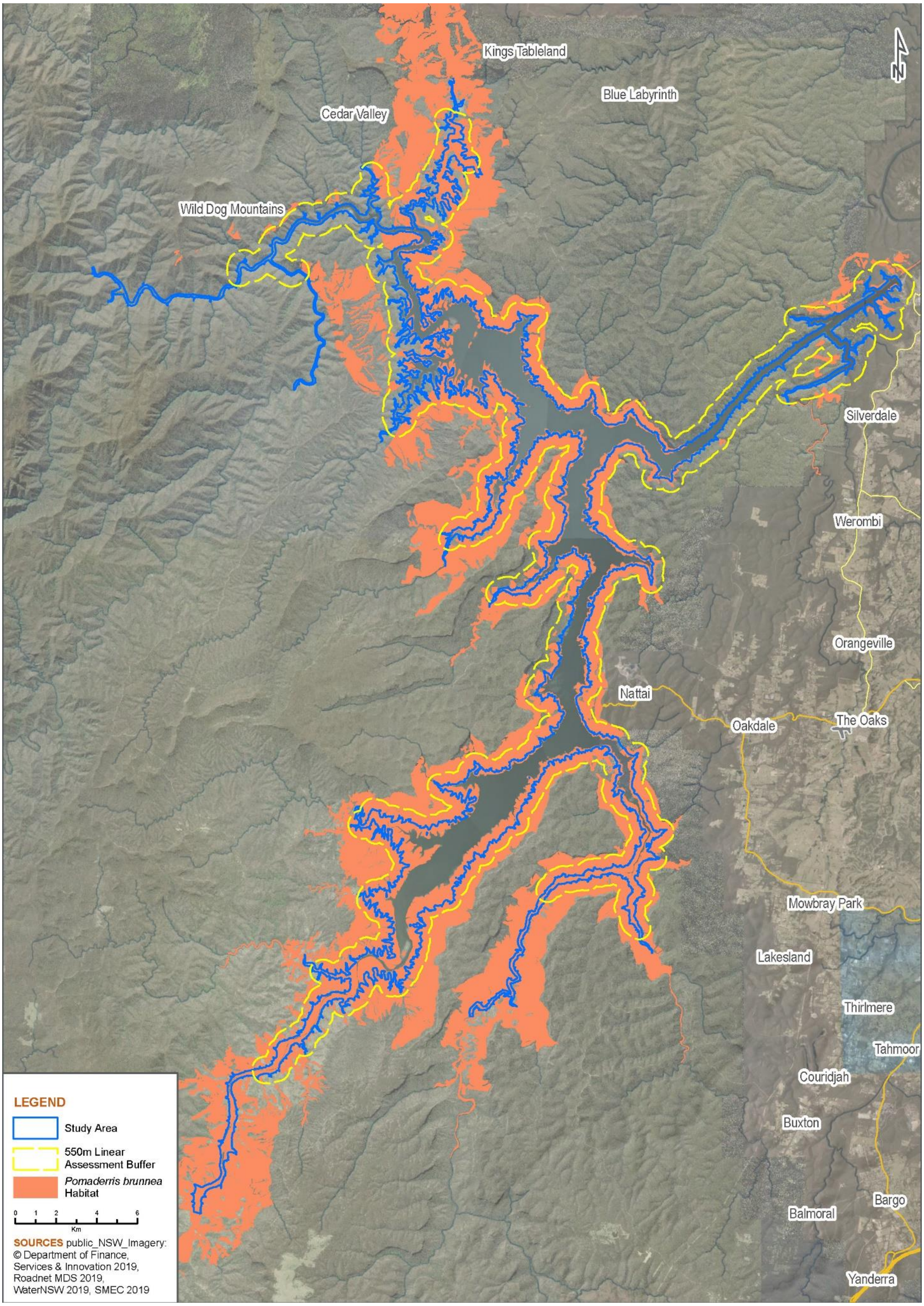
B.57 *Phyllota humifusa* species polygon



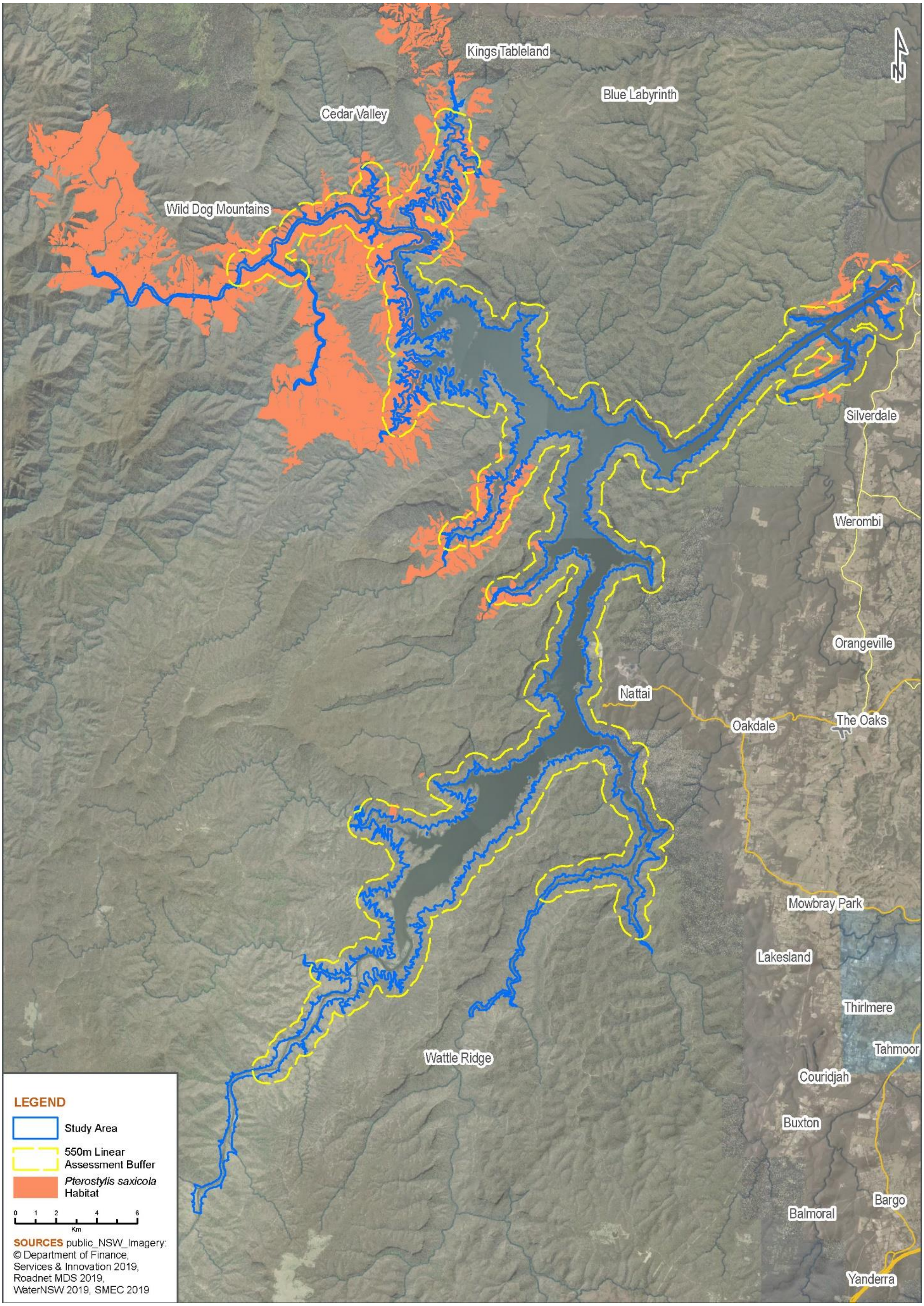
B.58 *Pimelea curviflora var. curviflora* species polygon



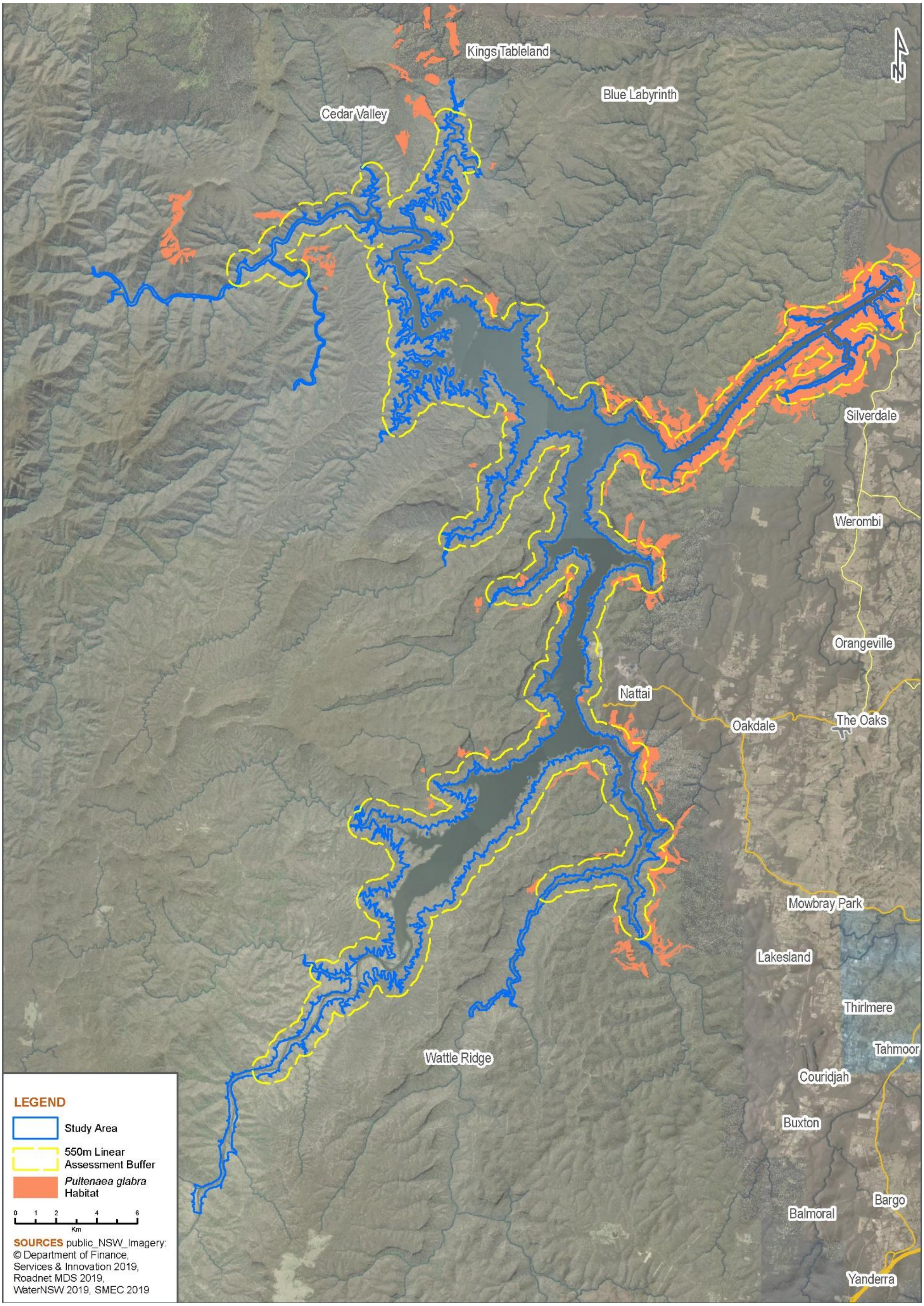
B.59 *Pomaderris brunnea* species polygon



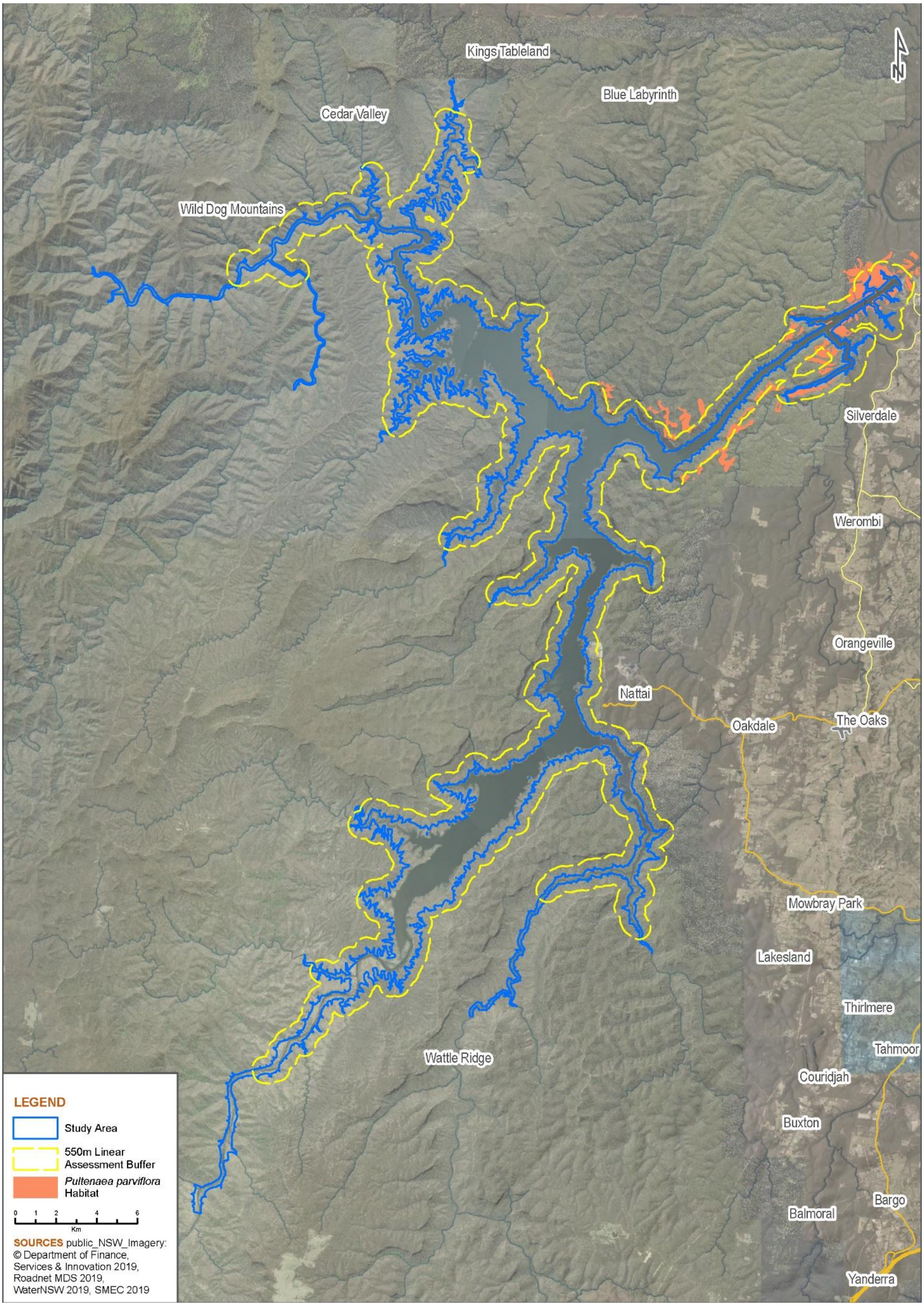
B.60 *Pterostylis saxicola* species polygon



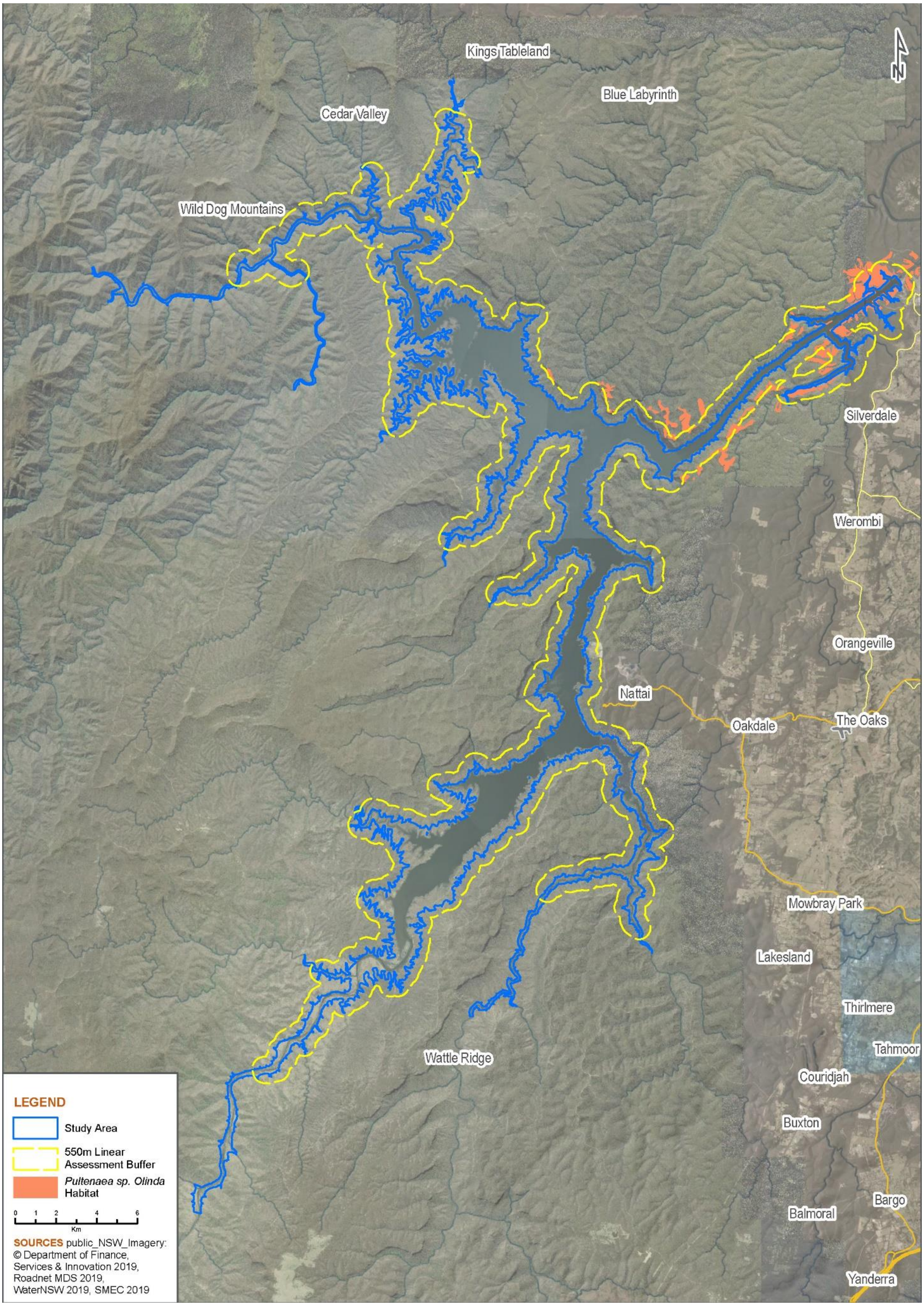
B.61 *Pultanaea glabra* species polygon



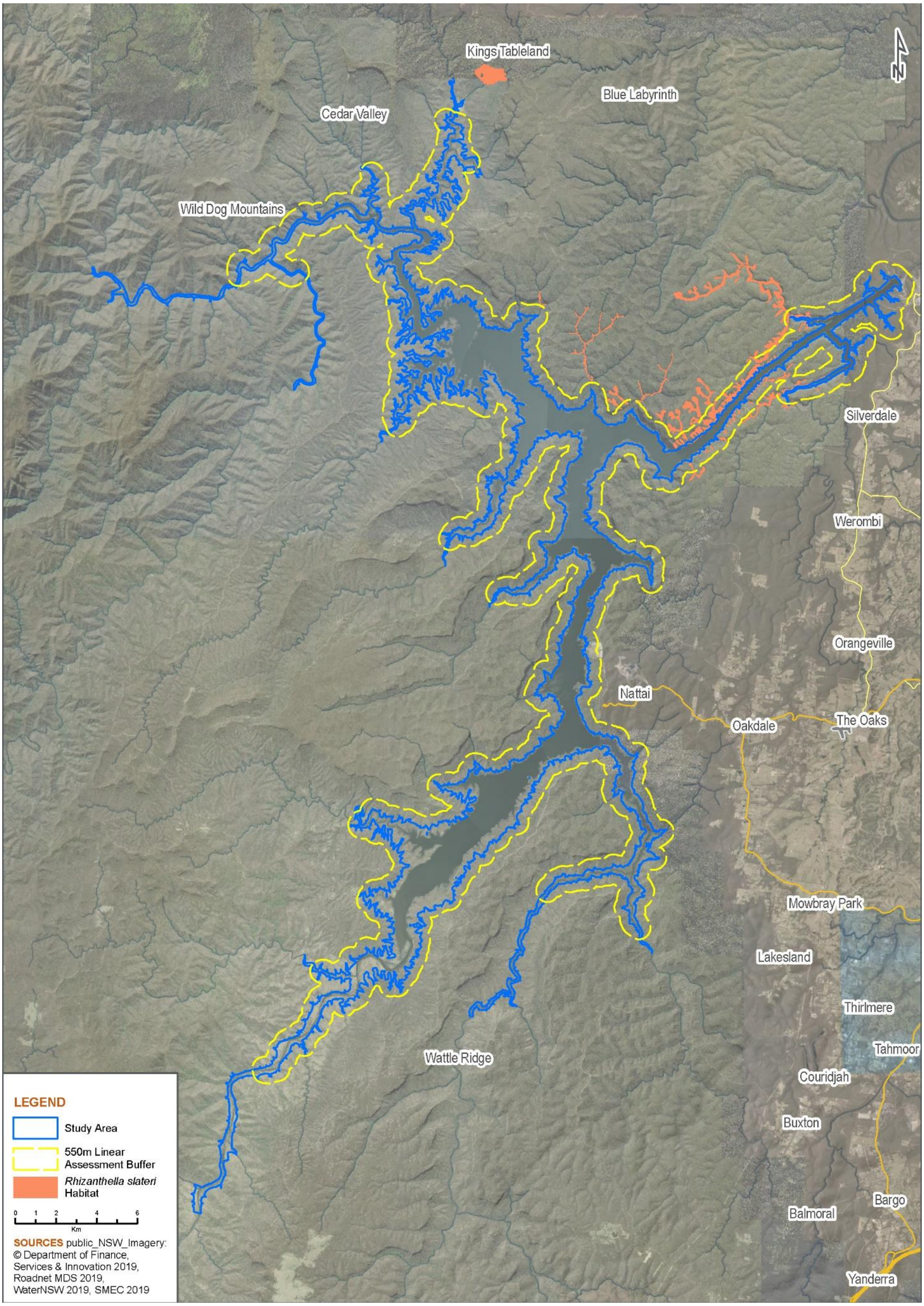
B.62 *Pultenaea parviflora* species polygon



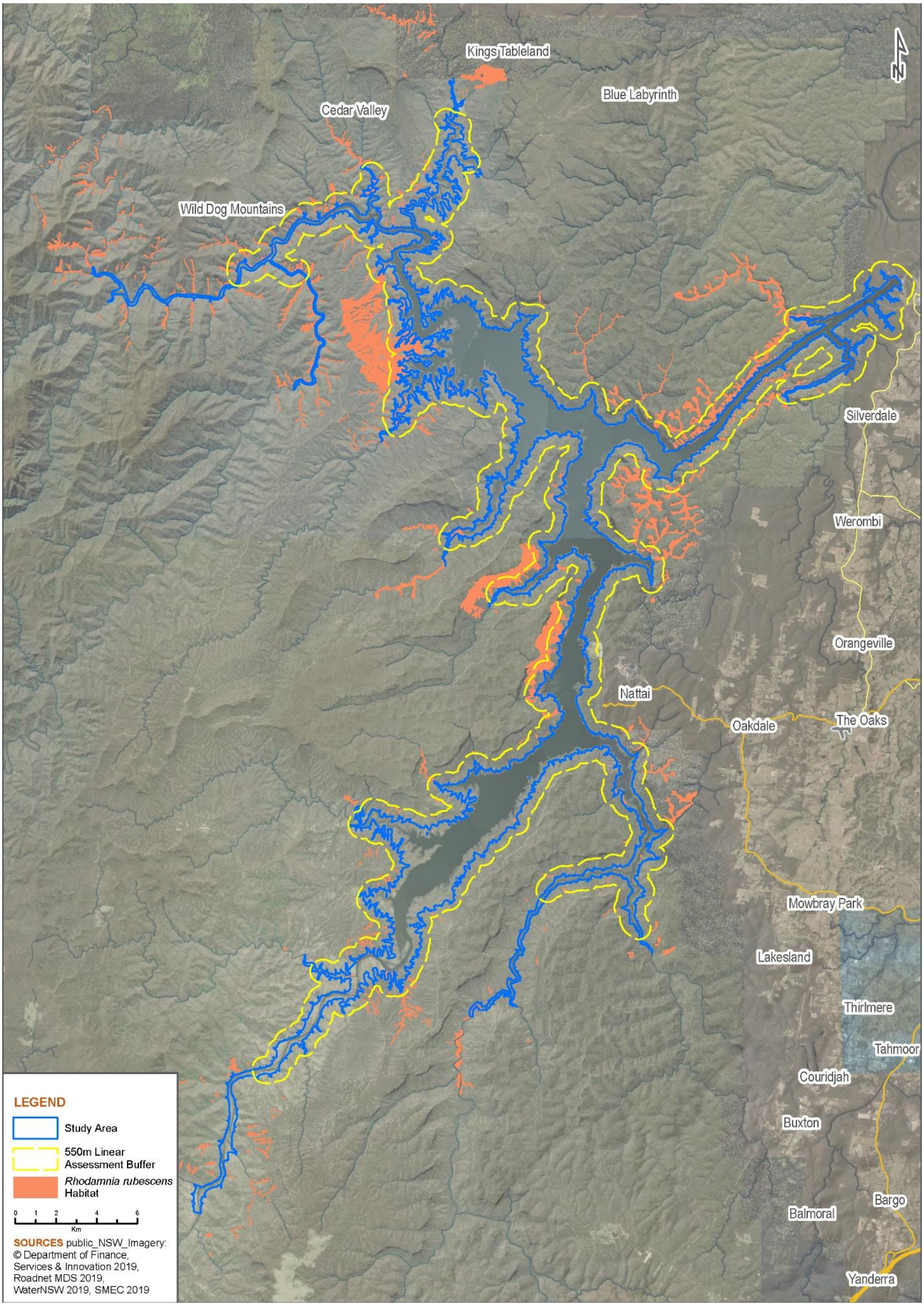
B.63 *Pultenaea sp. Olinda* species polygon



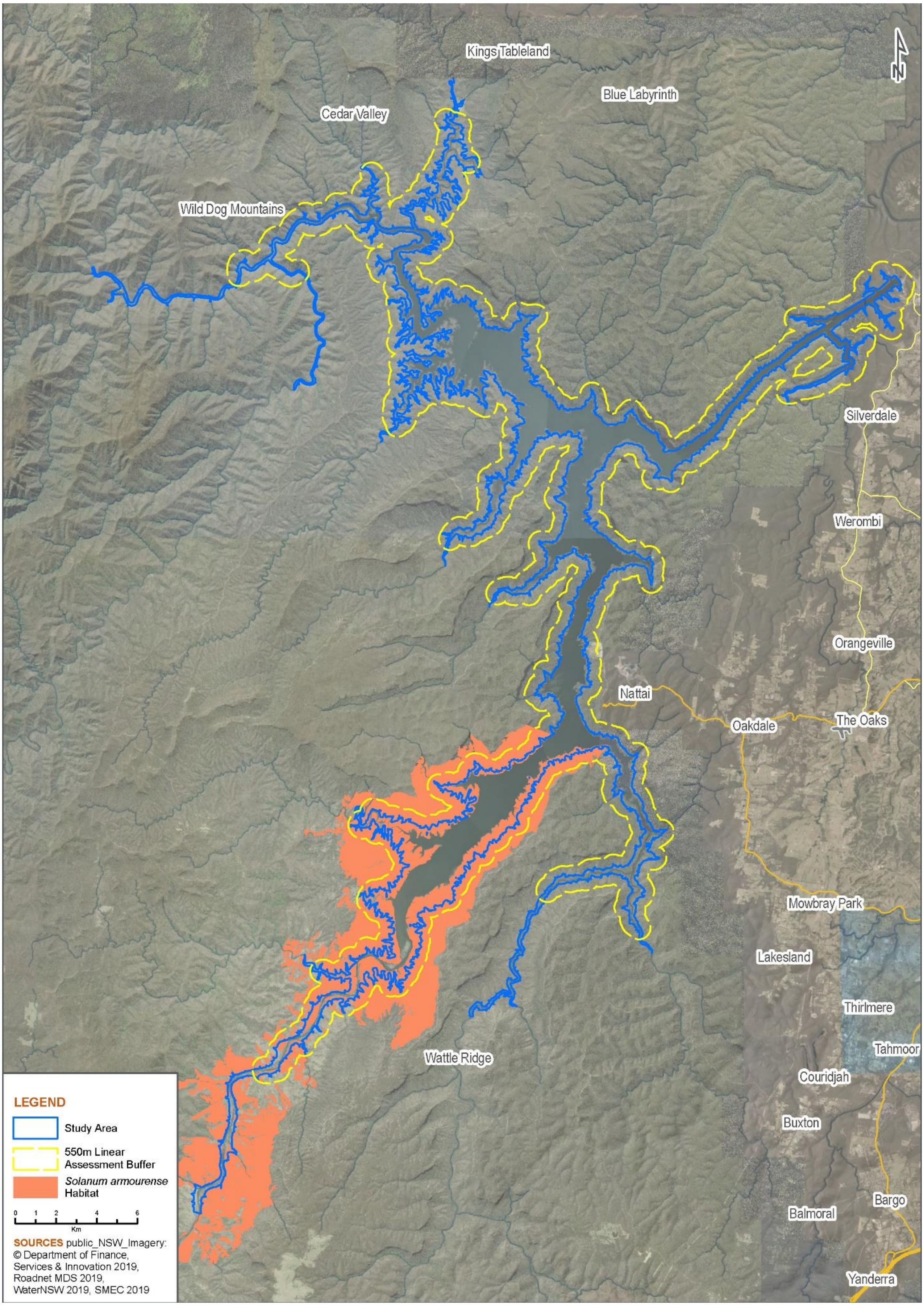
B.64 *Rhizanthella slateri* species polygon



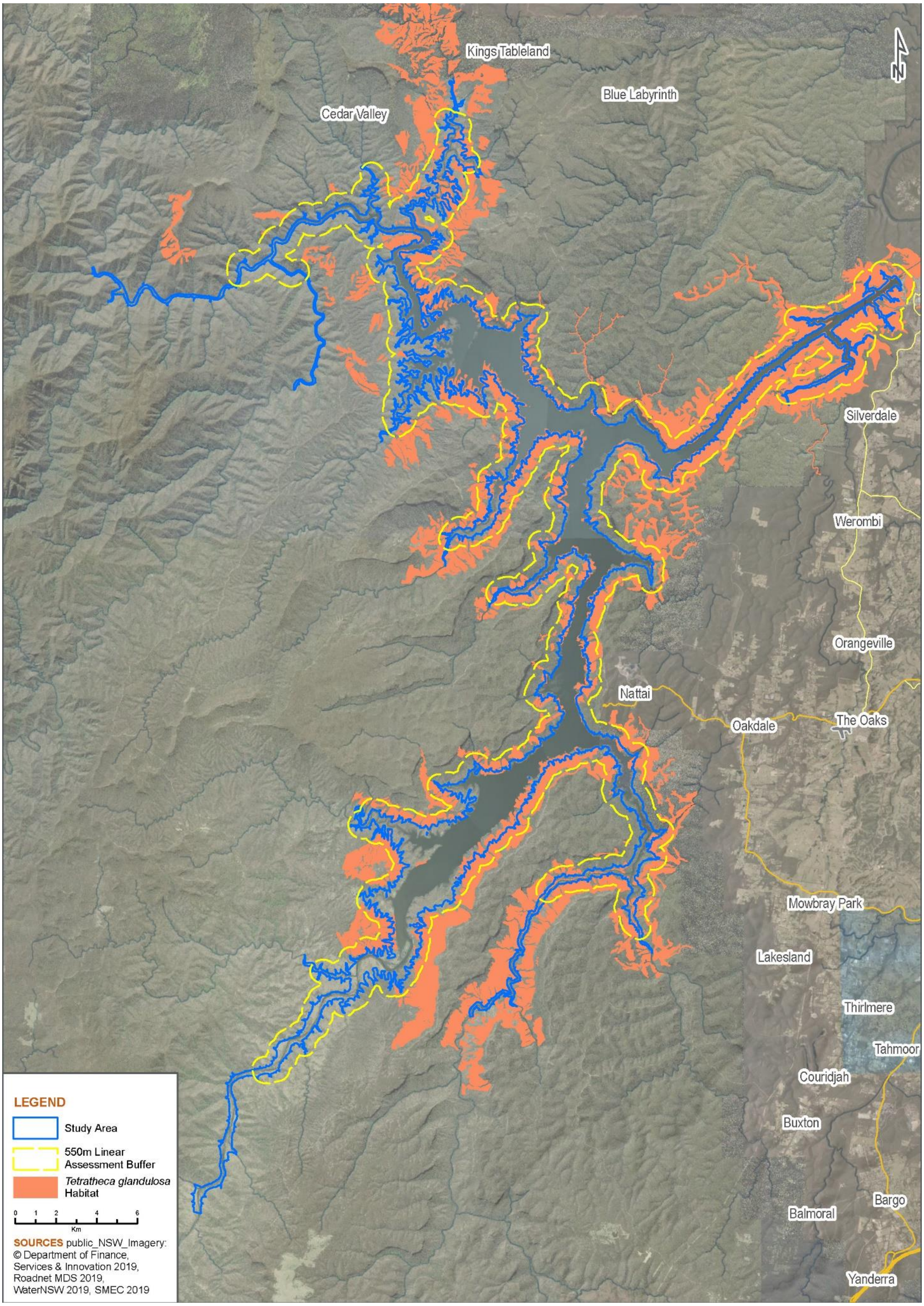
B.65 *Rhodamnia rubescens* species polygon



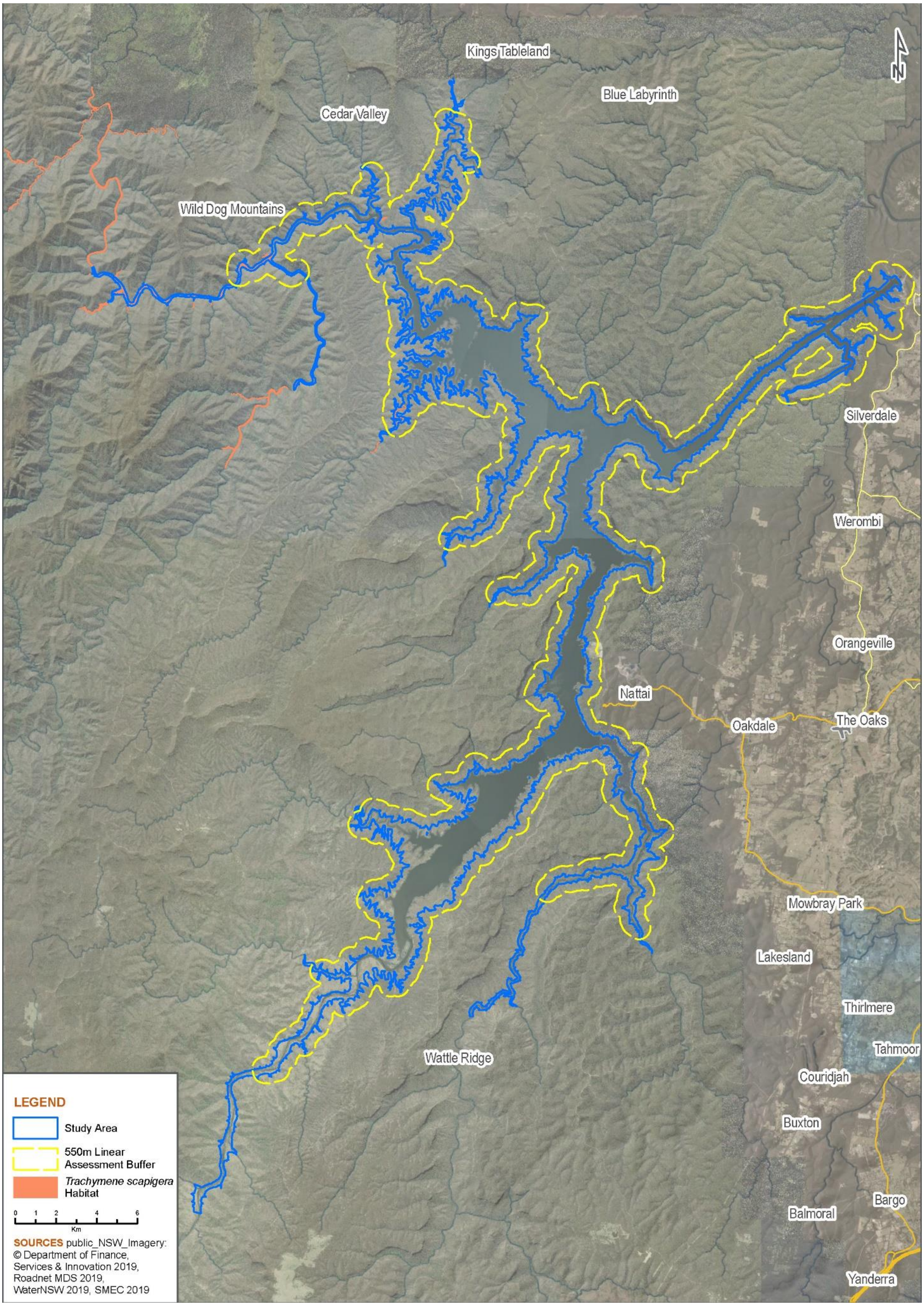
B.66 *Solanum armourense* species polygon



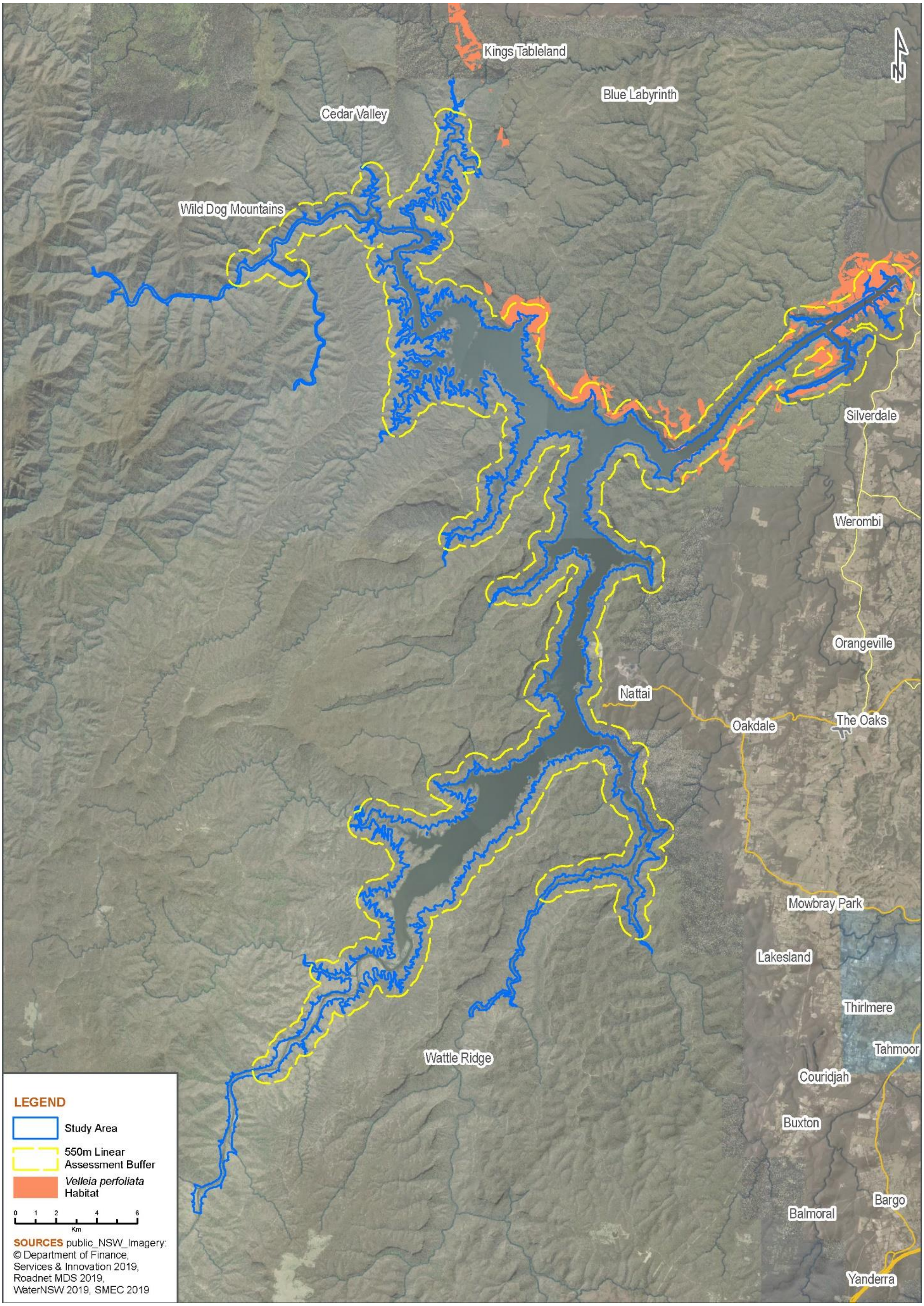
B.67 *Tetratheca glandulosa* species polygon



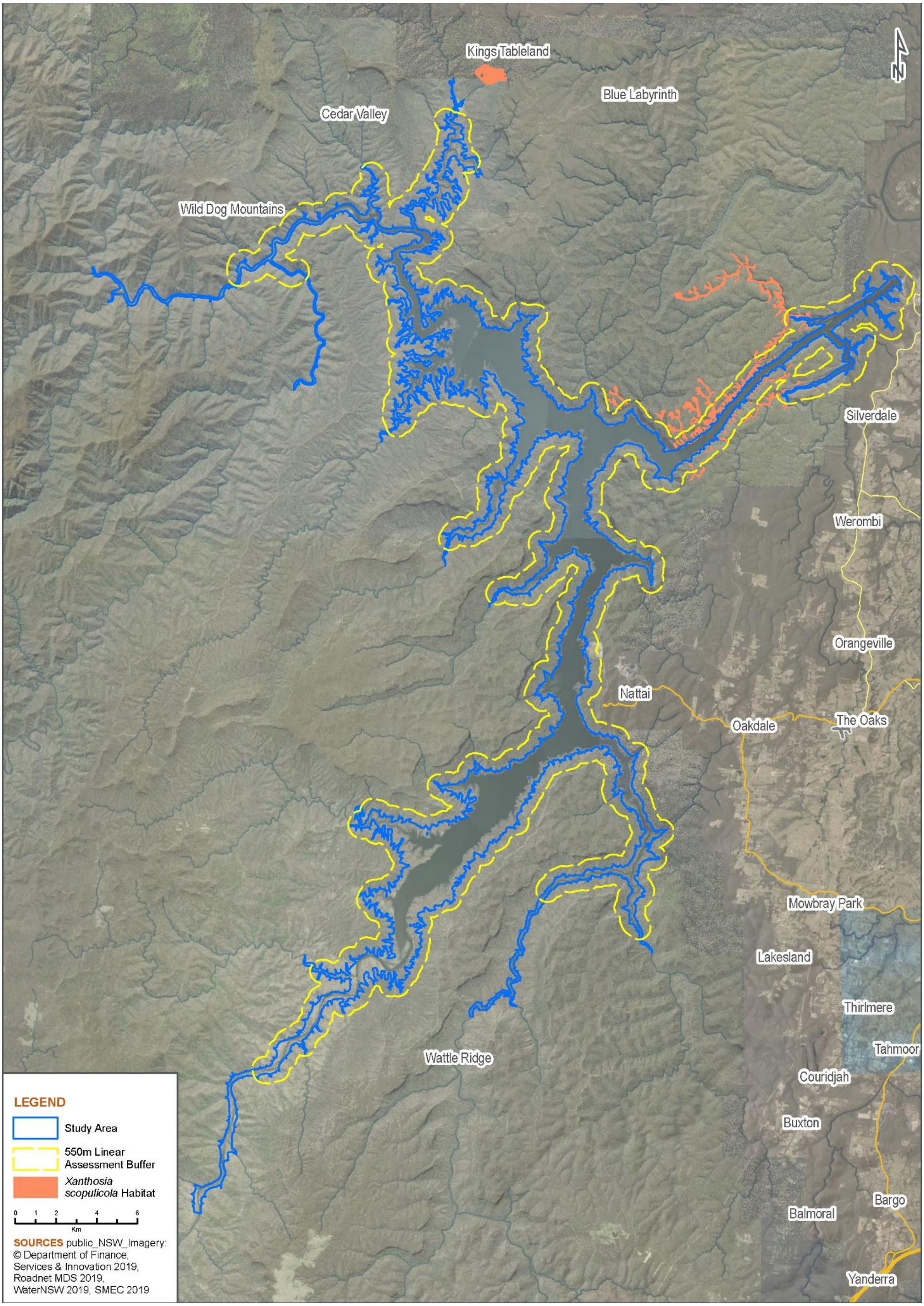
B.68 *Trachymene scapigera* species polygon



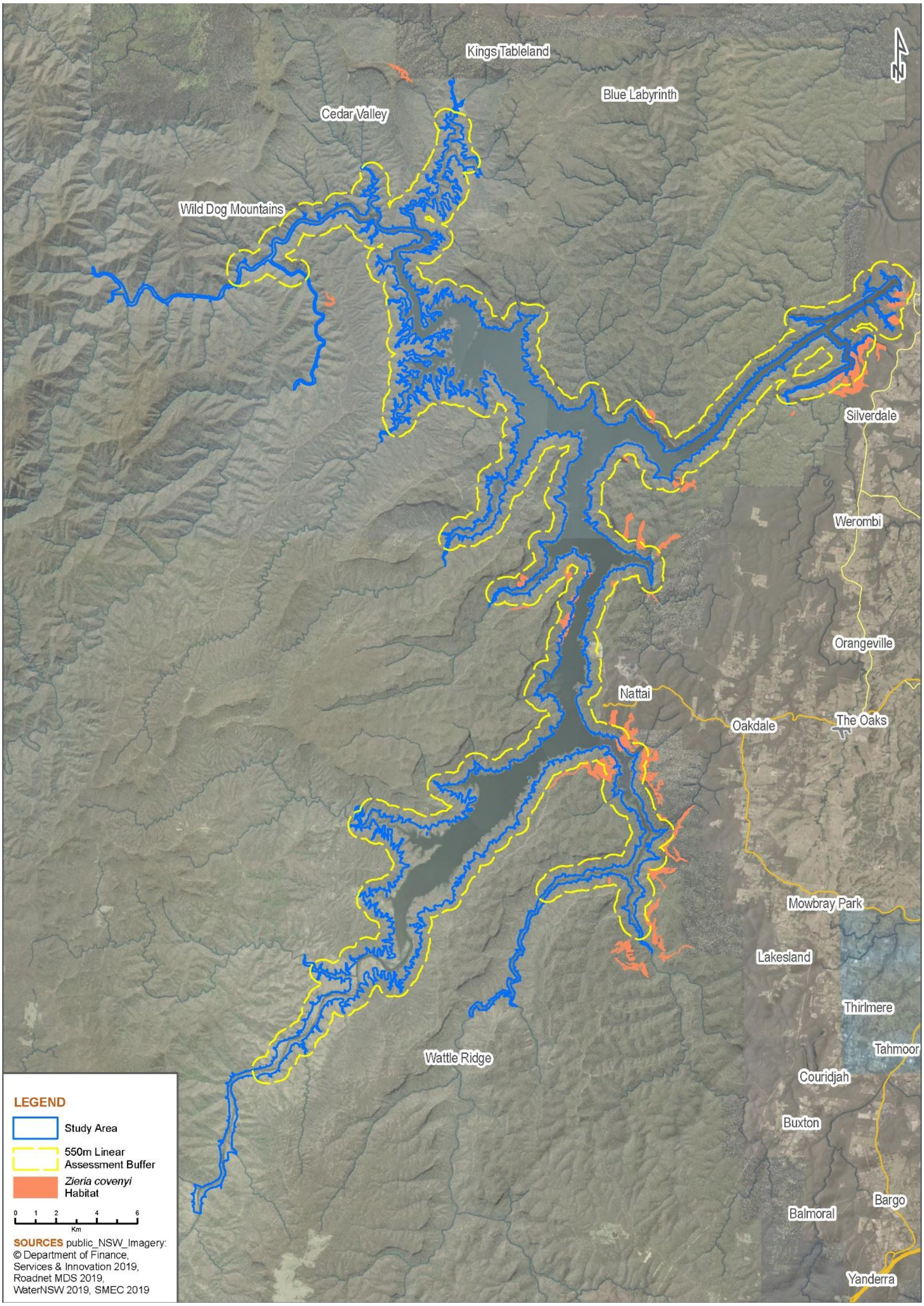
B.69 *Velleia perfoliata* species polygon



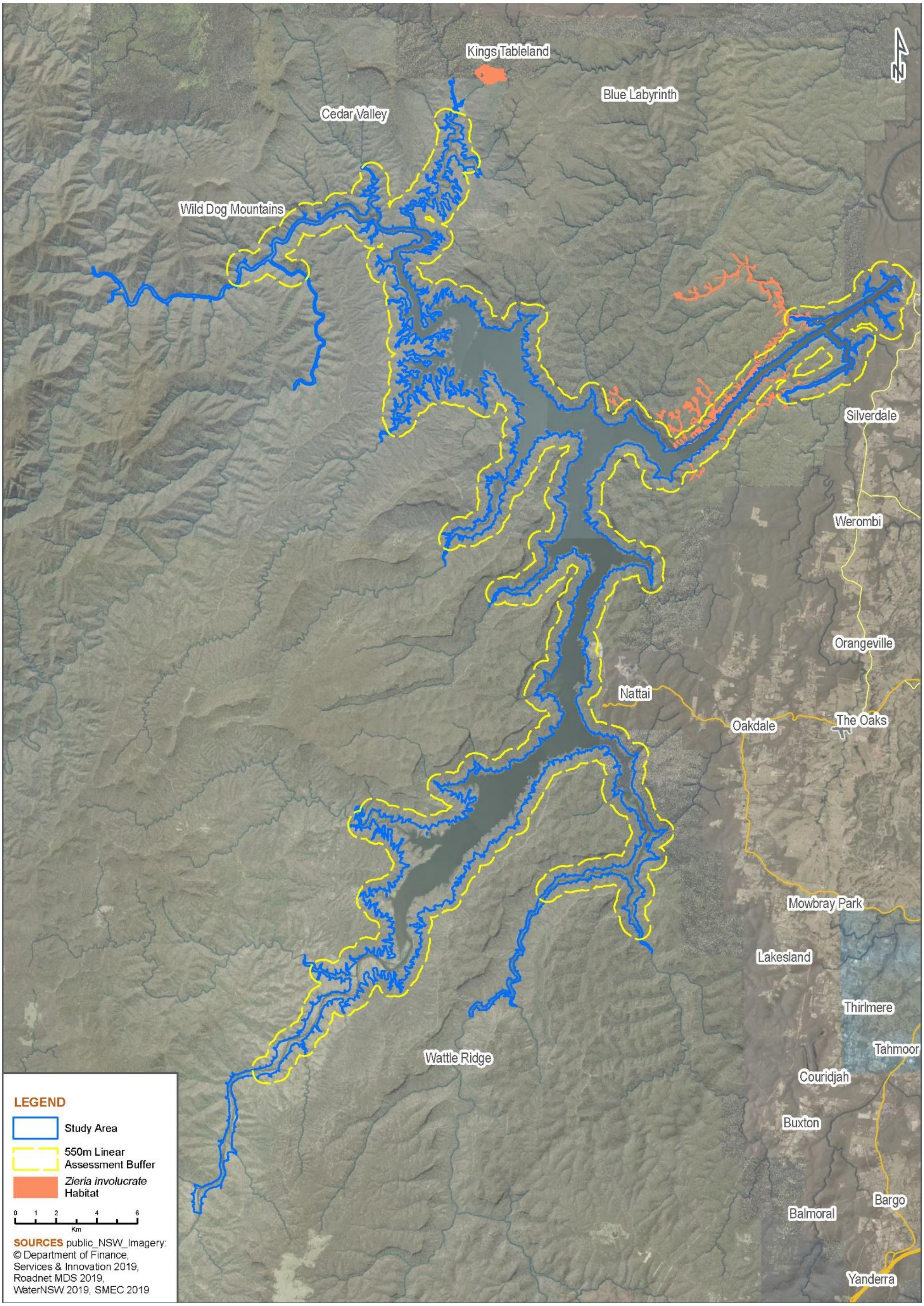
B.70 *Xanthosia scopulicola* species polygon



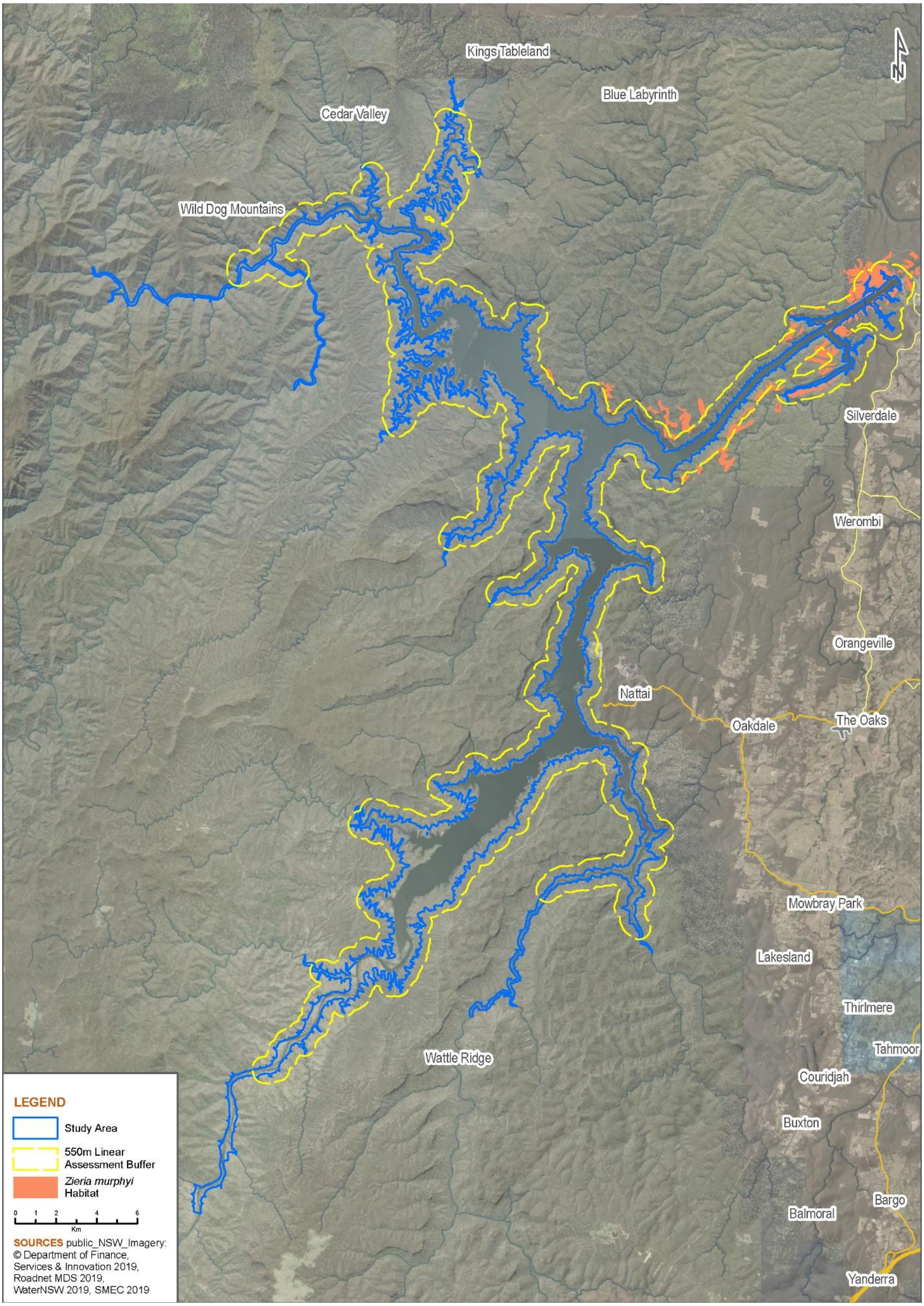
B.71 *Zieria covenyi* species polygon



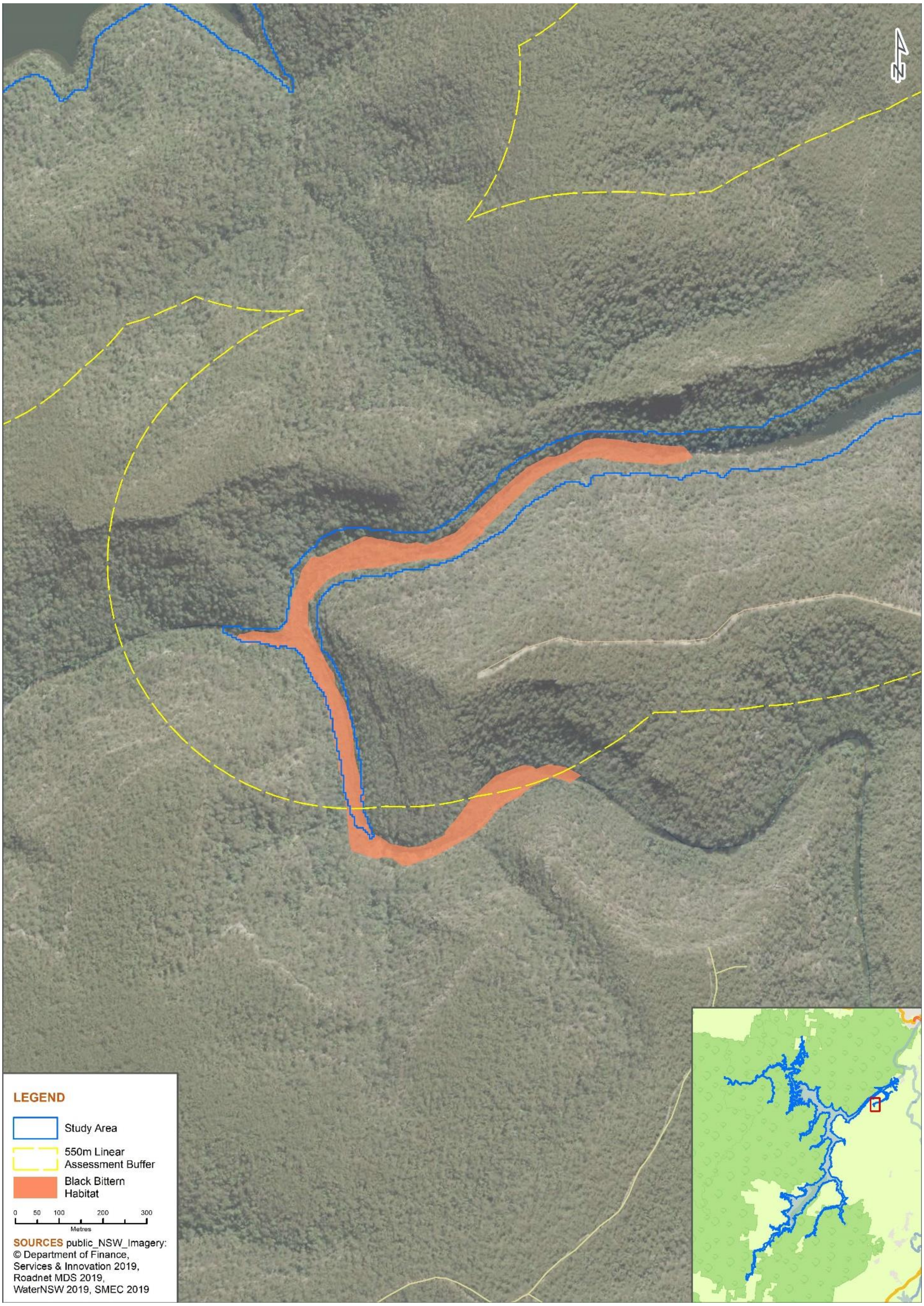
B.72 *Zieria involucrata* species polygon



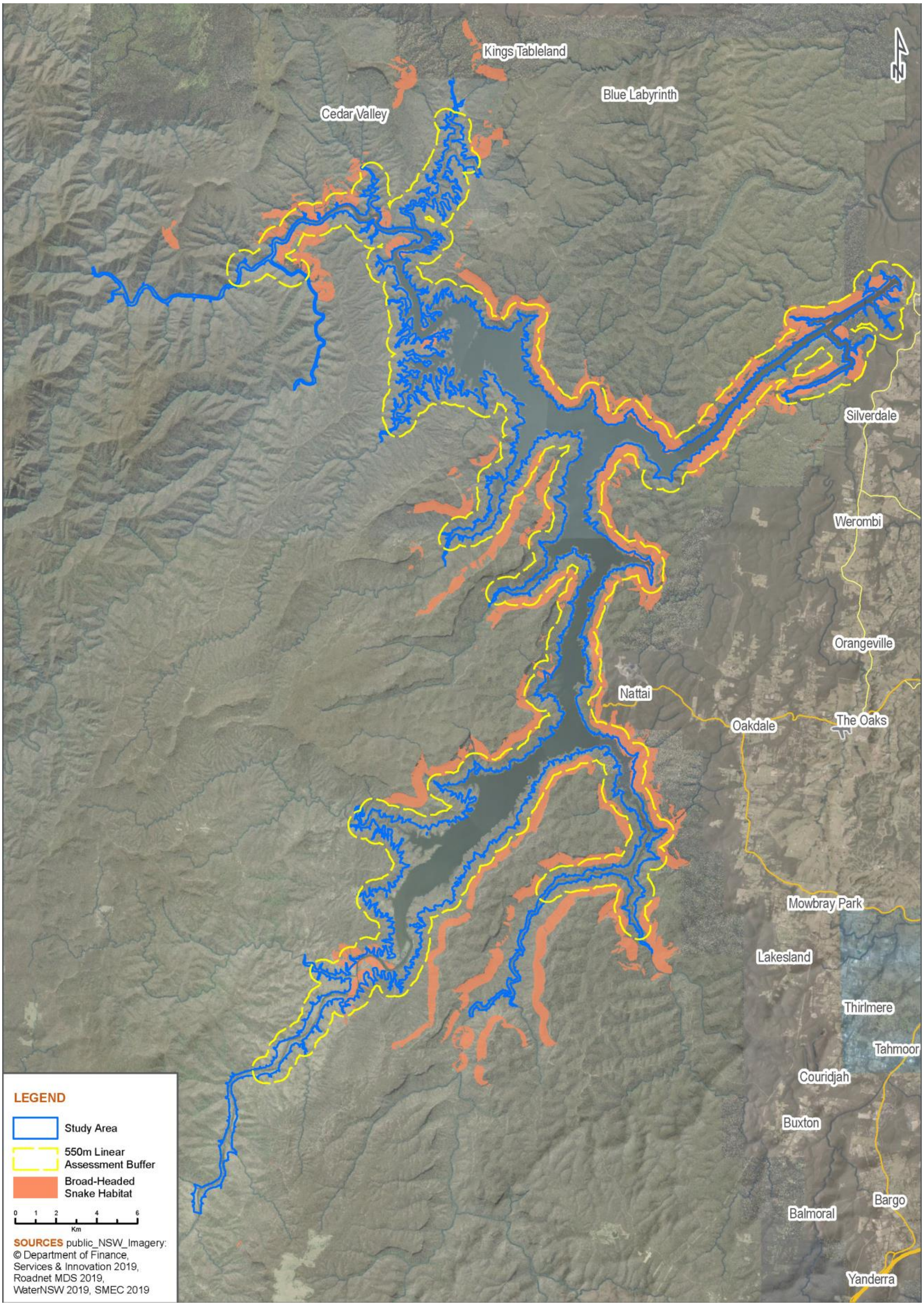
B.73 *Zieria murphyi* species polygon



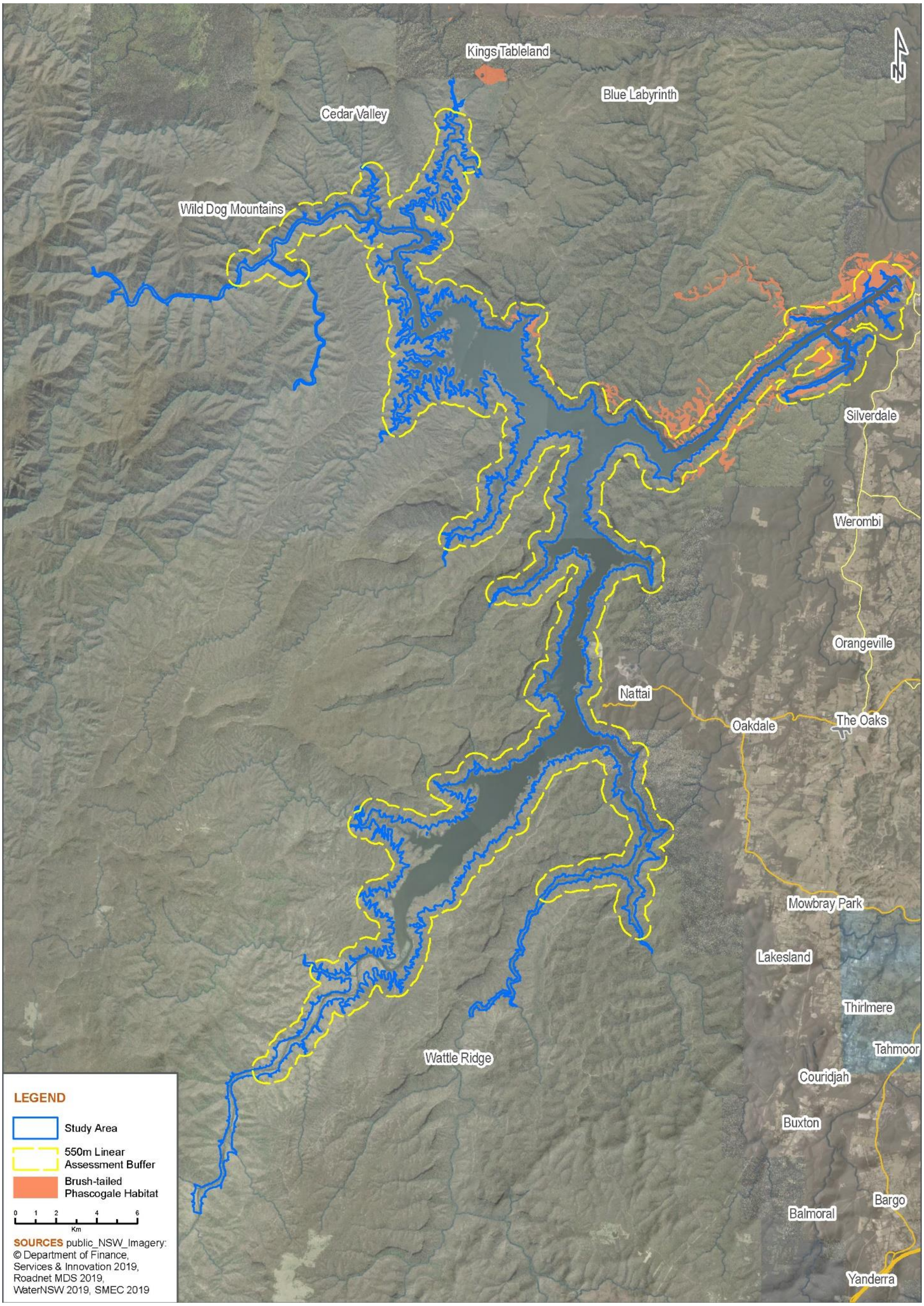
B.74 Black Bittern species polygon



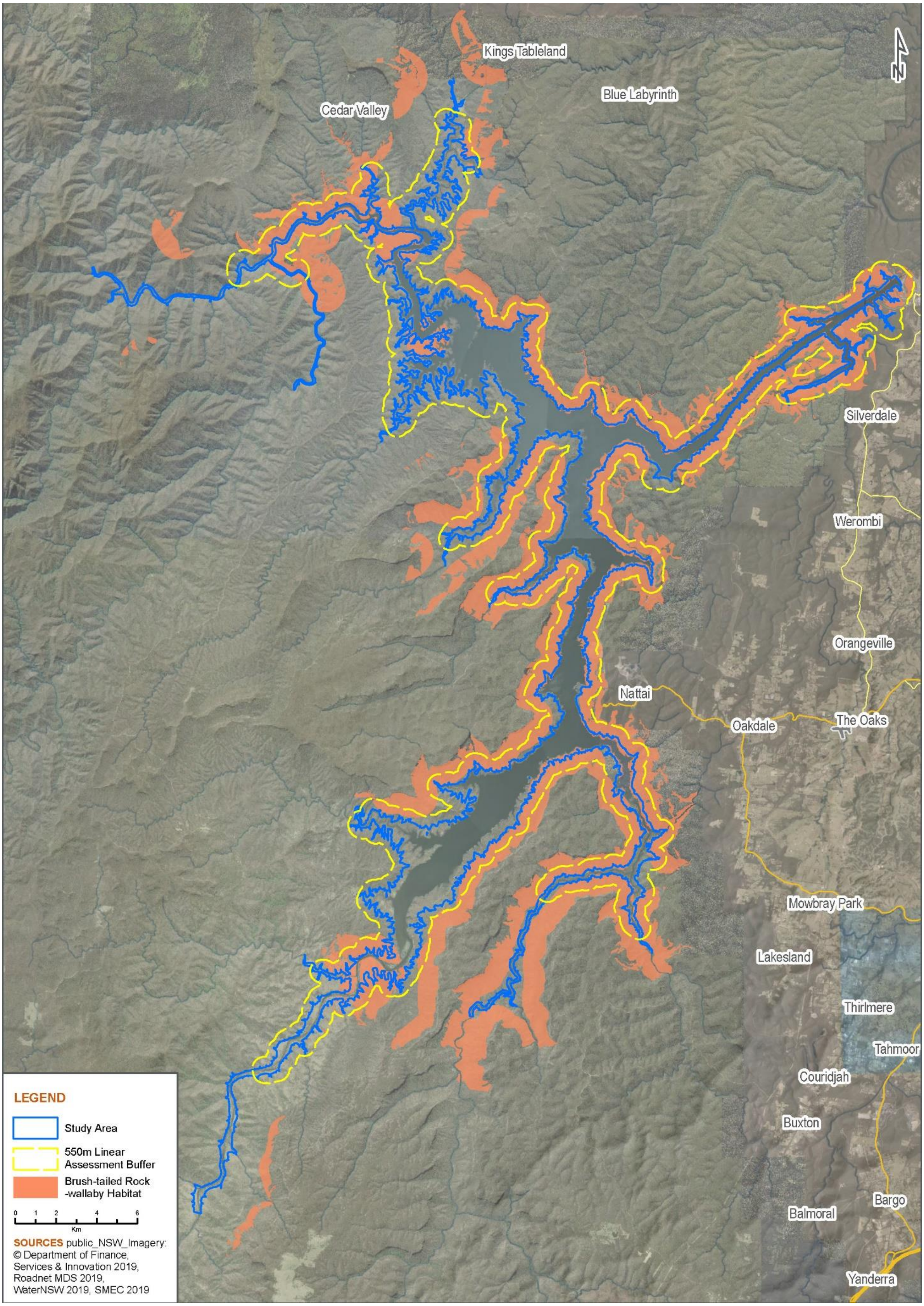
B.75 Broad-headed Snake species polygon



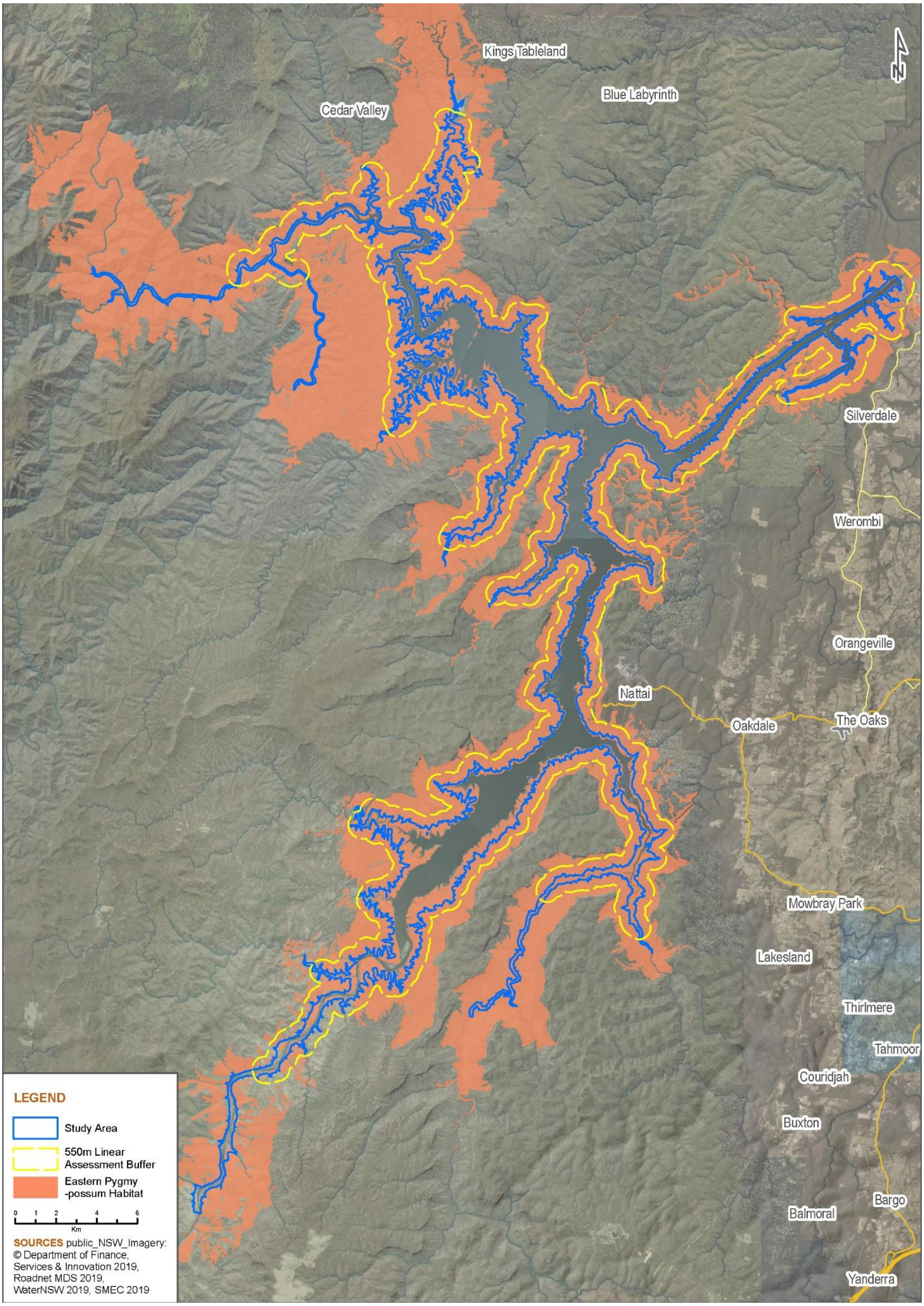
B.76 Brush-tail Phascogale species polygon



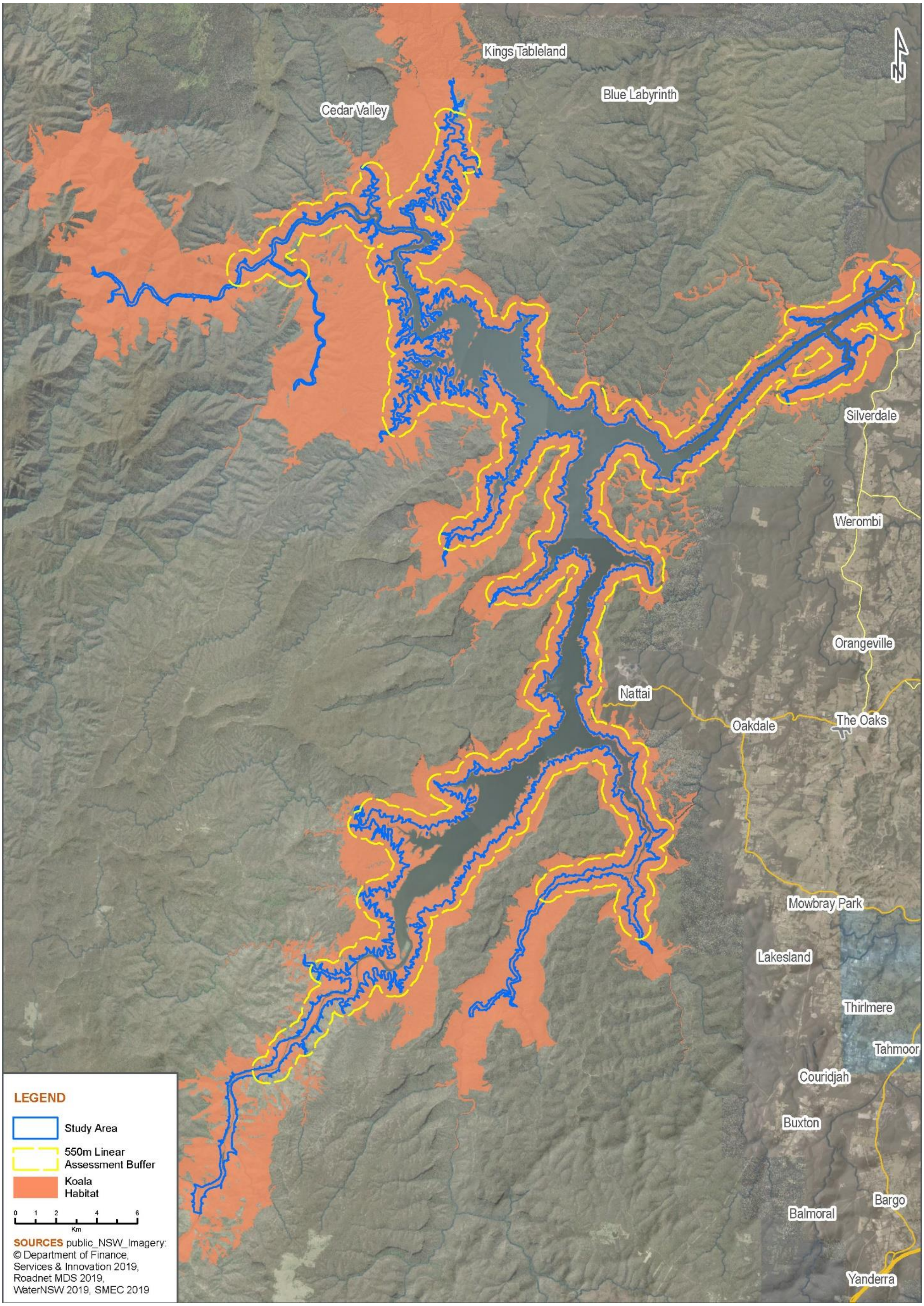
B.77 Brush-tail rock-wallaby species polygon



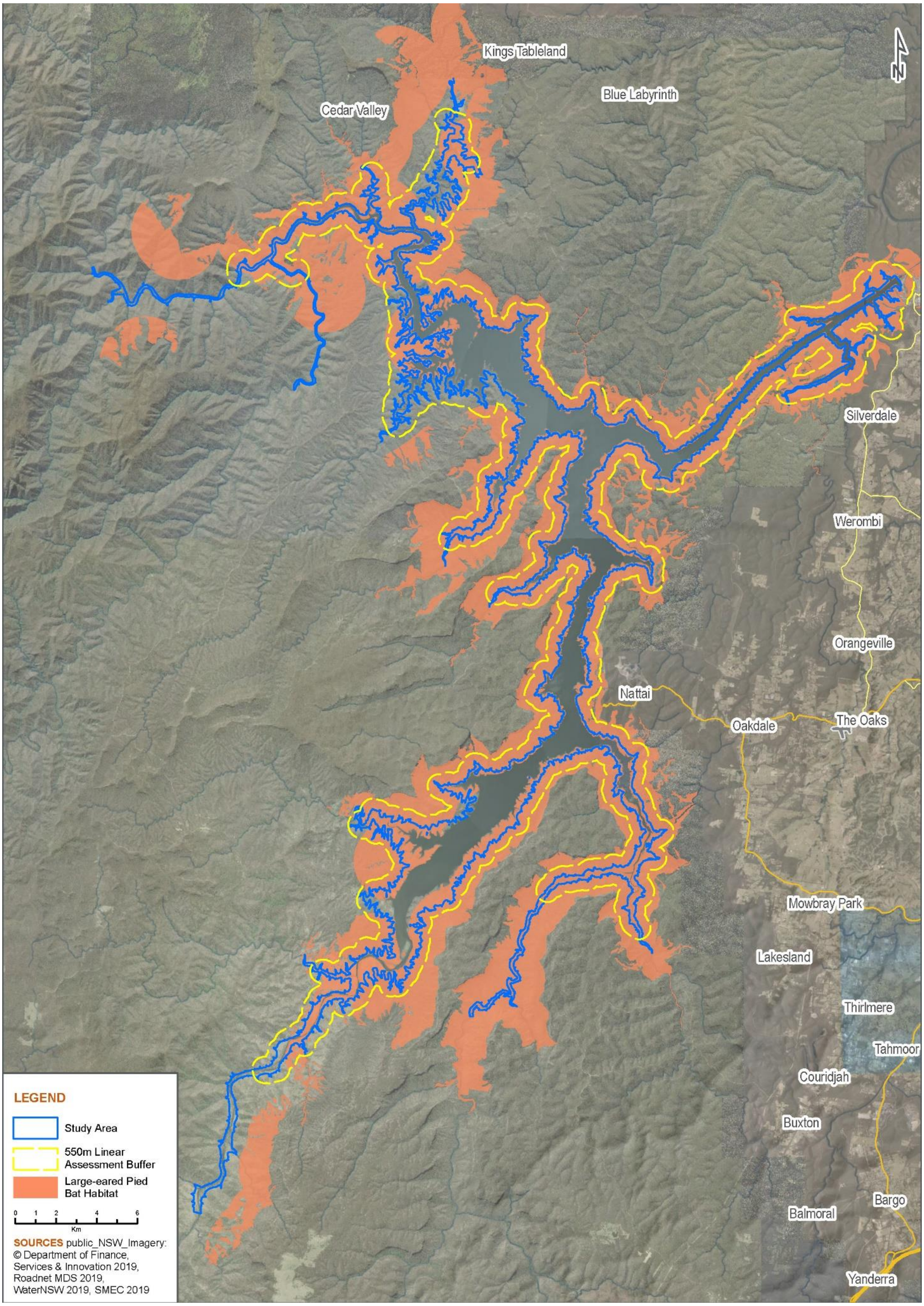
B.78 Eastern Pygmy-possum species polygon



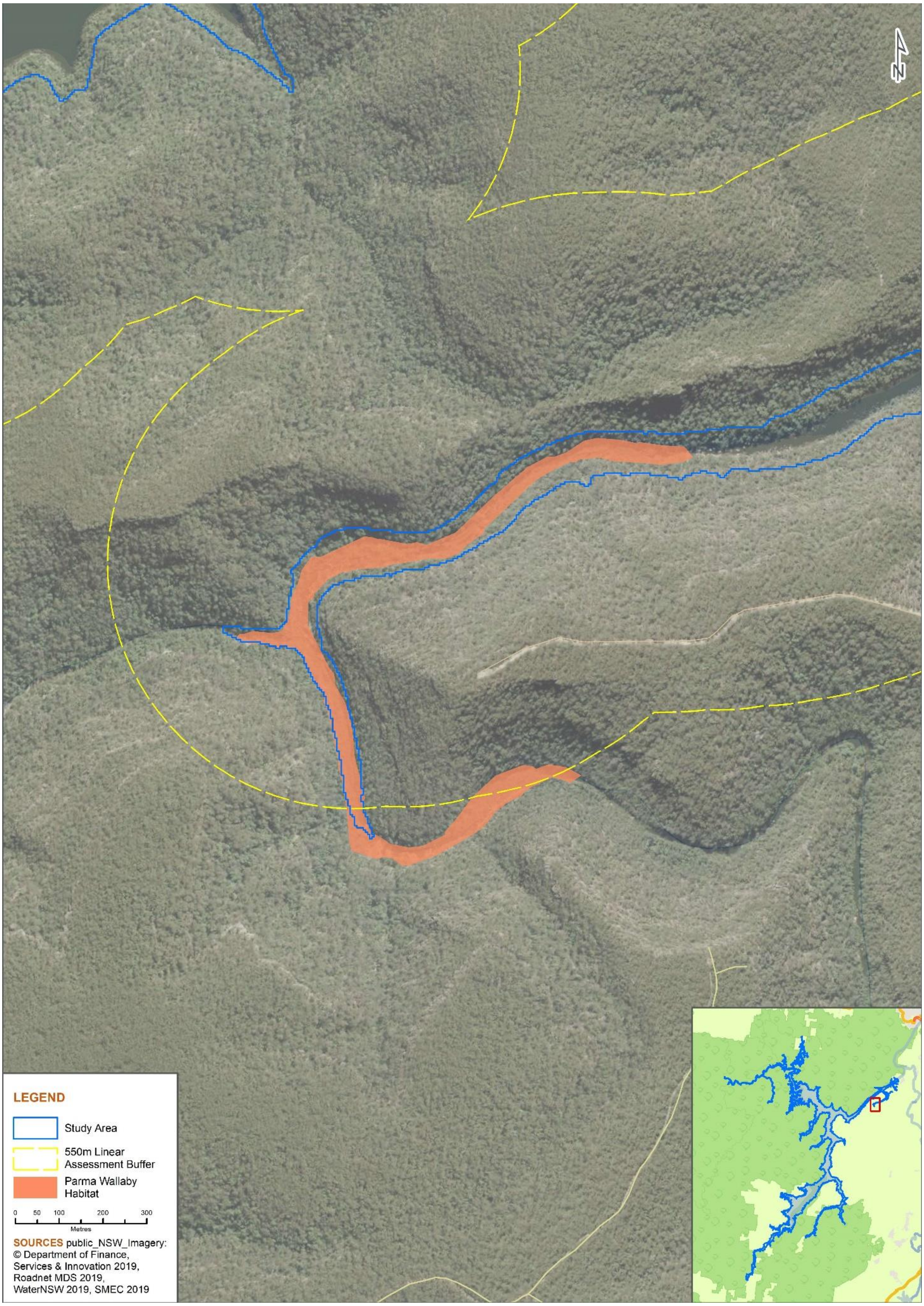
B.79 Koala species polygon



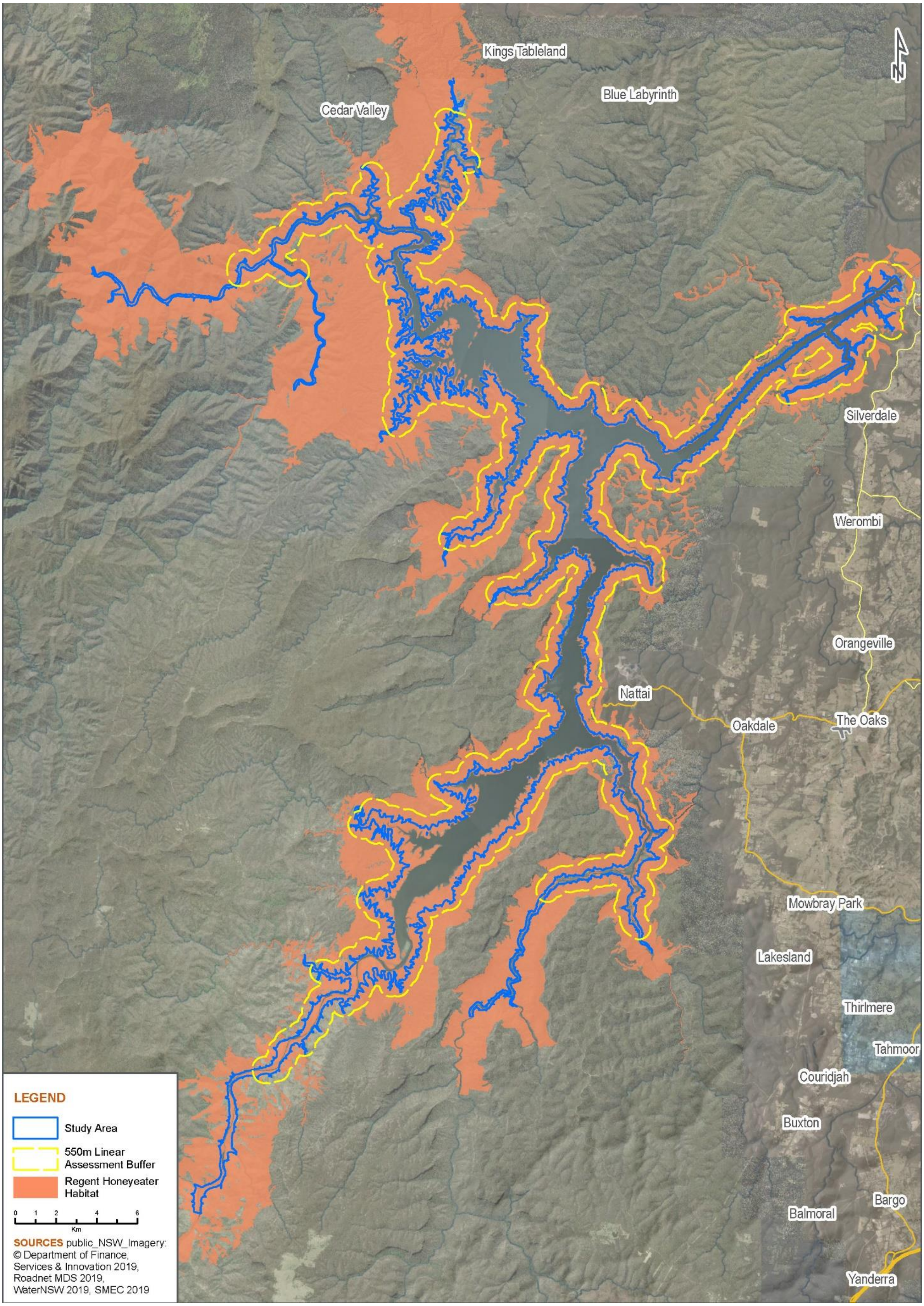
B.80 Large-eared Pied Bat species polygon



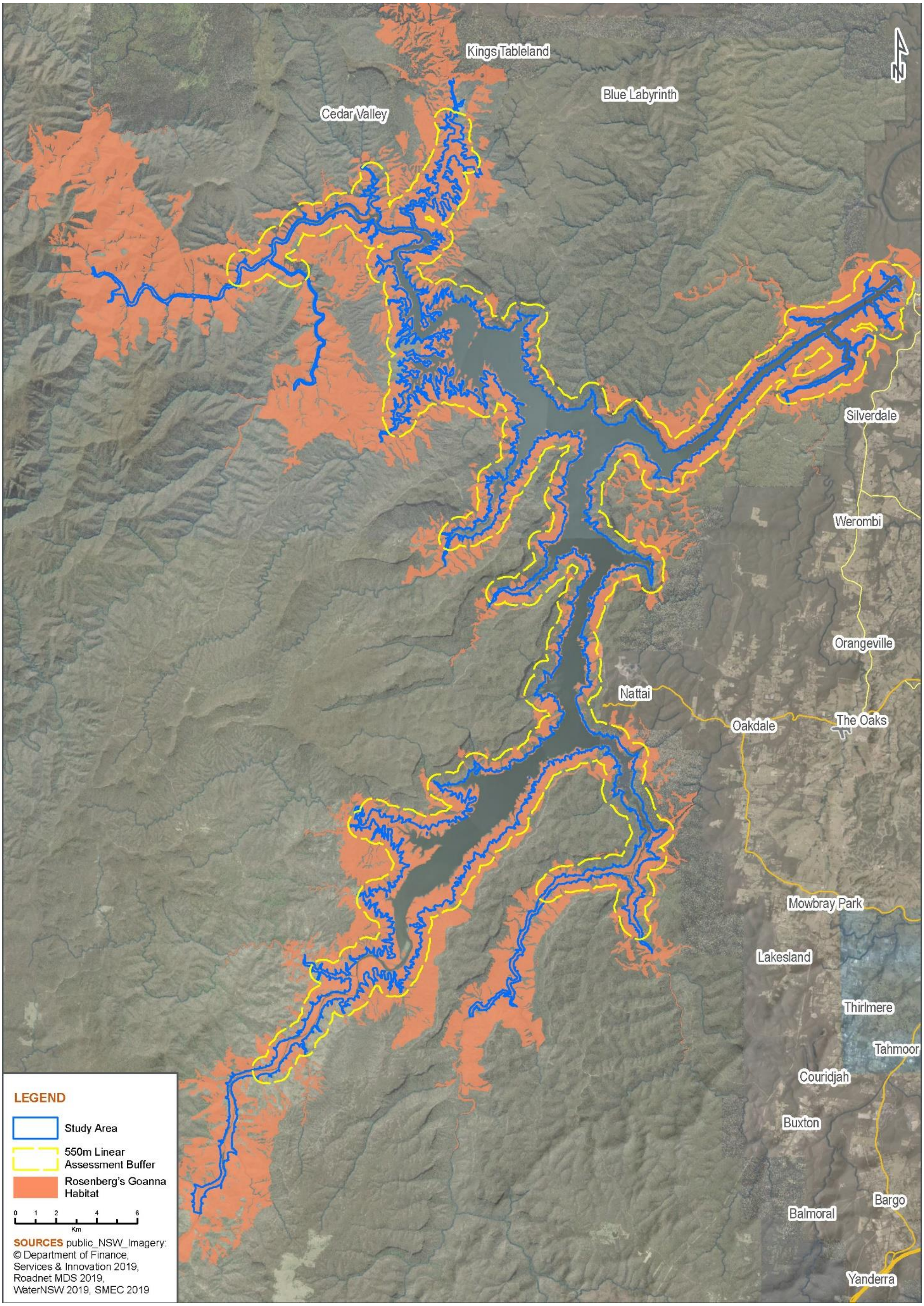
B.81 Parma Wallaby species polygon



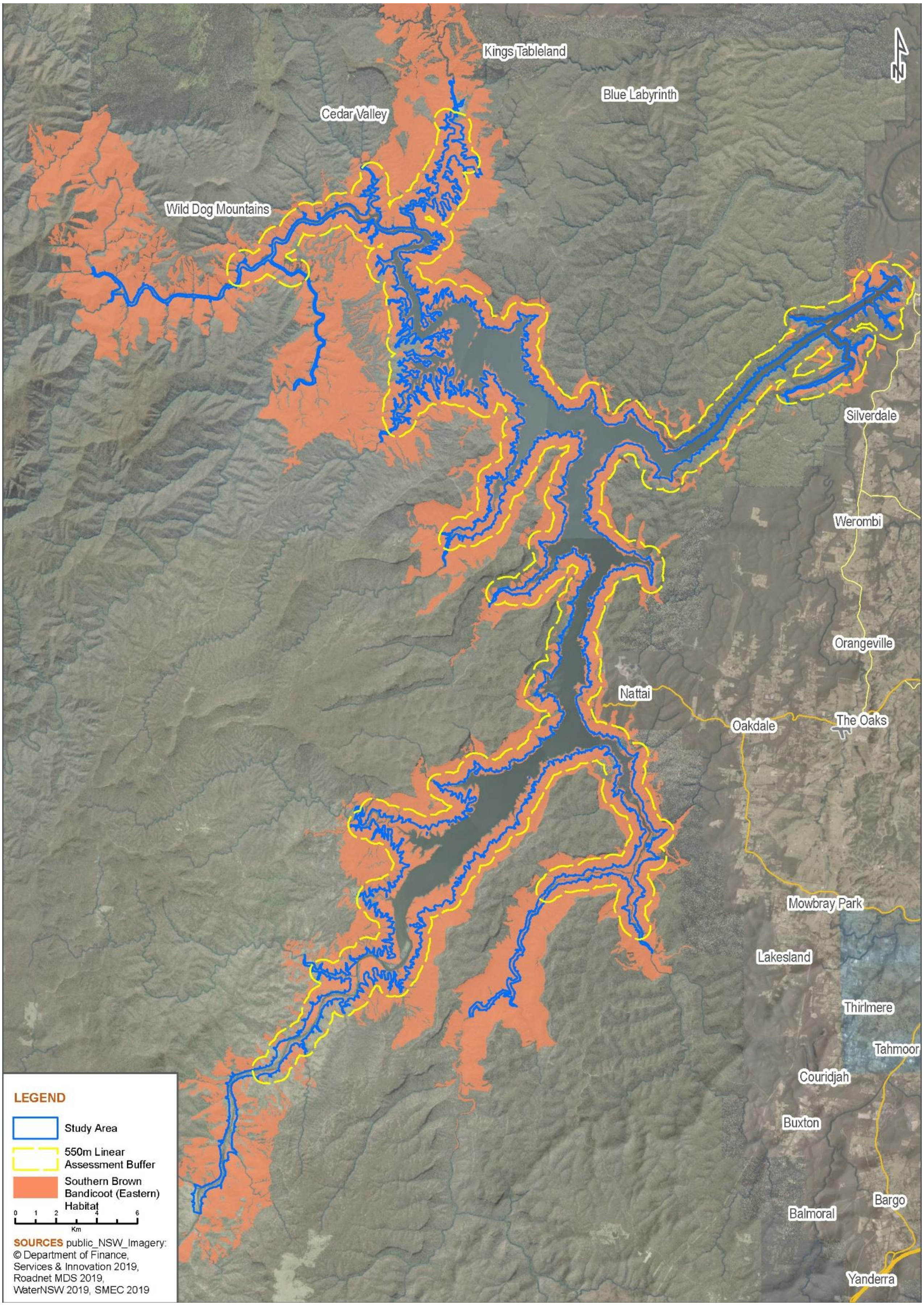
B.82 Regent Honeyeater species polygon



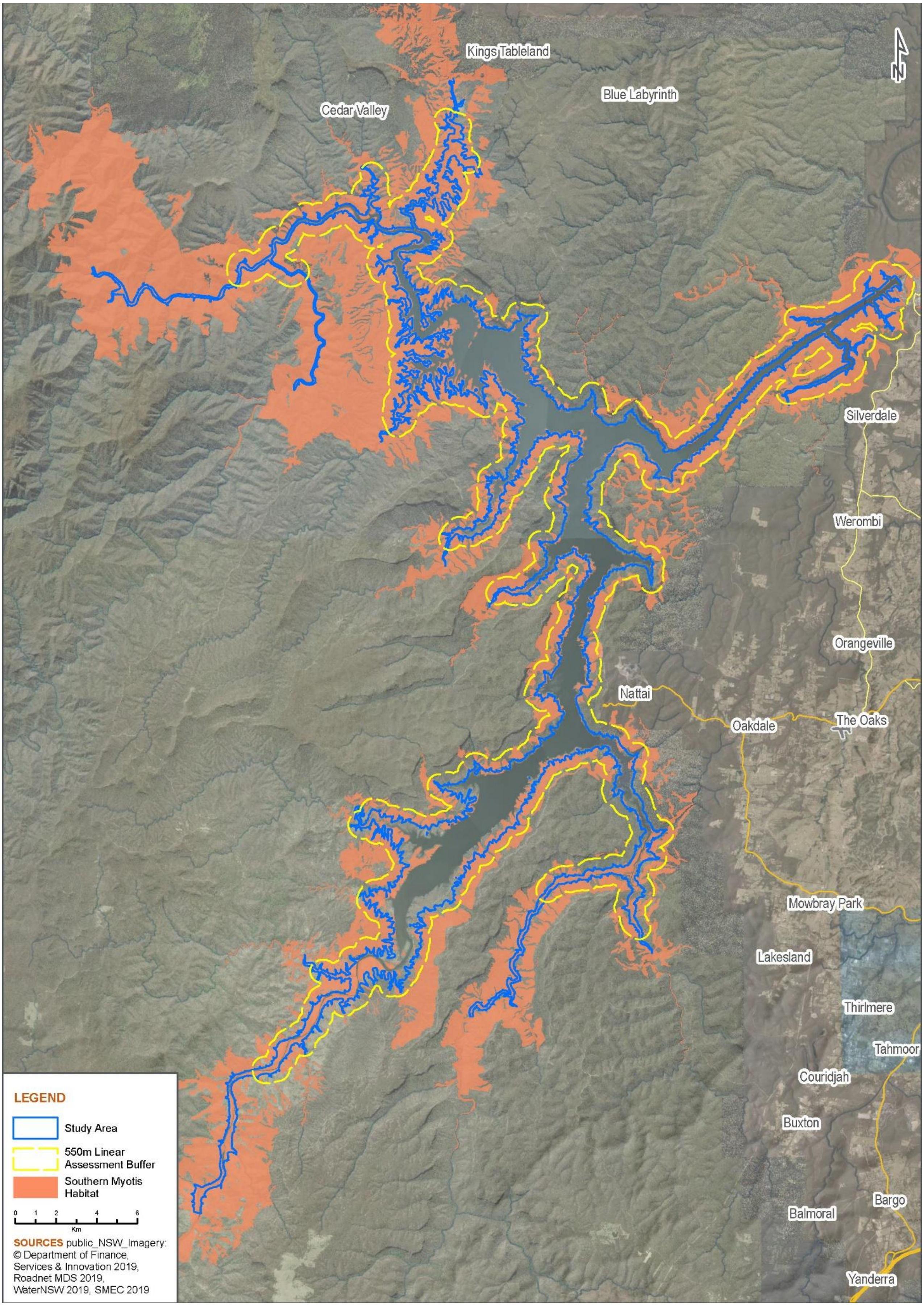
B.83 Rosenberg's Goanna species polygon



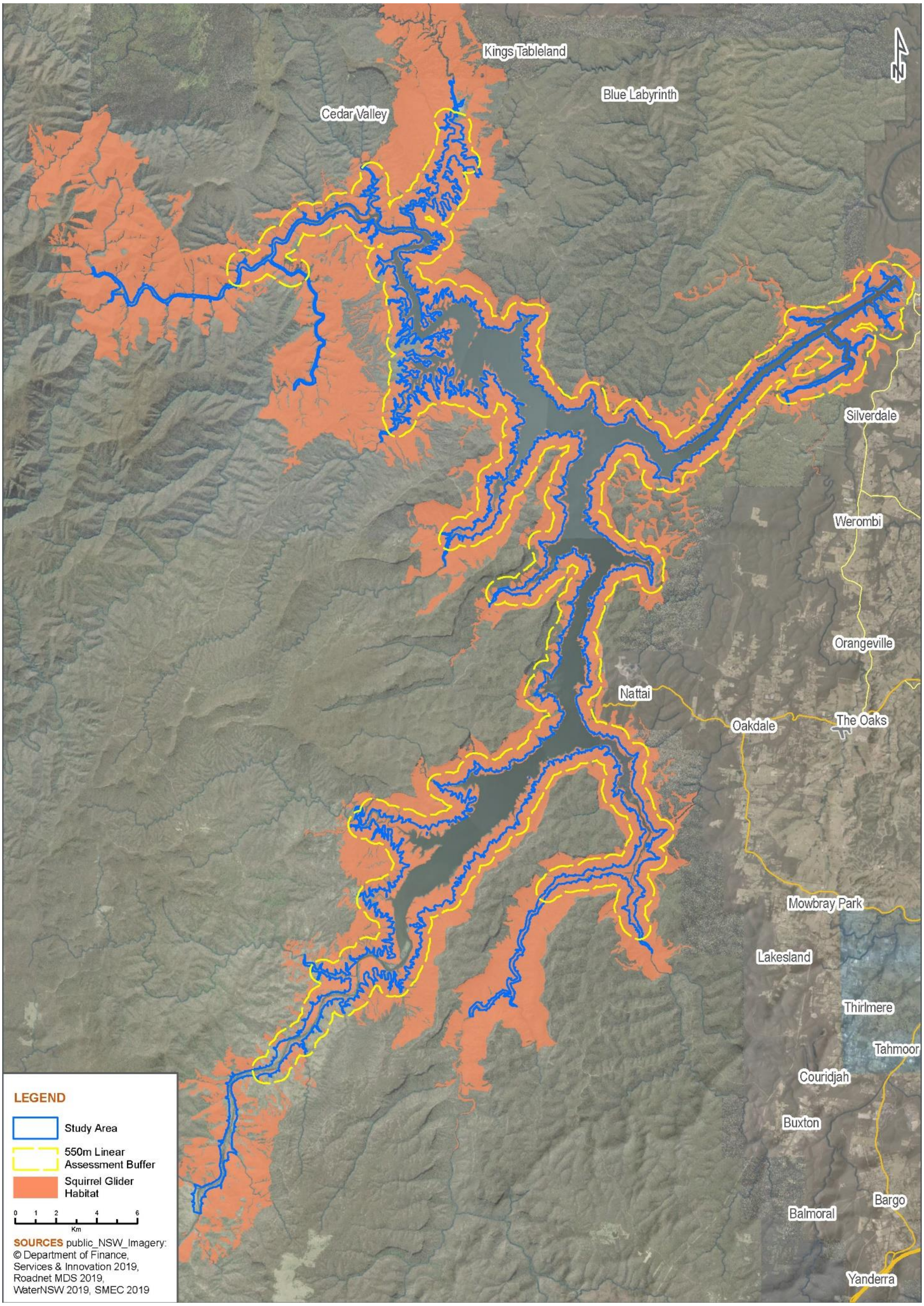
B.84 Southern Brown Bandicoot species polygon



B.85 Southern Myotis species polygon



B.86 Squirrel Glider species polygon



Appendix C
Plot and transect data

VEG ZONE	PLOT	DATE	RECORDERS	PCT_CONDITION	NO. NATIVE SPECIES	NATIVE OVERSTOREY COVER %	NATIVE MIDSTOREY COVER %	NATIVE GROUND COVER (GRASSES) %	NATIVE GROUND COVER (SHRUBS) %	NATIVE GROUND COVER (OTHER) %	EXOTIC PLANT COVER %	NO. TREES WITH HOLLOWS	REGENE-RATION	TOTAL LENGTH OF FALLEN LOGS (M)	SITE VALUE SCORE	BEARING (°)	EASTINGS	NORTHINGS	ZONE
1	US2	9/07/2018	RM & JT	HN564_Moderate/good	44	49	0	42	46	32	0	0	1	165	60.63	86	277209	6248696	56
	US7	12/12/2017	LL & RM		27	38.5	0	6	2	8	0	4	1	17		94	277533	6247901	56
	US11	13/12/2017	LL & RM		28	43	0	0	80	28	0	4	1	67		45	274878	6246639	56
	US12	13/12/2017	LL & RM		43	44	16	2	56	18	0	9	1	42		228	274805	6246660	56
2	US1	9/07/2018	RM & JT	HN566_Moderate/good	40	24	0	20	42	24	0.66667	5	1	48	77.08	328	277117	6248580	56
	US6	17/10/2018	RM & MA		37	44	0	8	8	12	0	0	1	29		334	277447	6248461	56
	US8	10/07/2018	RM & JT		41	28	5	6	34	14	0	3	1	53		58	277348	6247340	56
	US10	12/12/2017	LL & RM		44	22	0	2	70	30	0	2	1	26		153	276545	6247022	56
3	US9	12/12/2017	LL & RM	HN568_Moderate/good	30	39	9	0	26	12	0	0	1	20	91.06	250	277058	6247536	56
	S1	-	-		34	27.5	30	1	5.7	10.1	0	1	1	1		-	-	-	-
	S2	-	-		35	29	33	3	7.5	11	0	2	1	2		-	-	-	-
	S3	-	-		36	30.3	35.2	5	8.5	12	0	3	1	3		-	-	-	-
	S4	-	-		37	32.5	40	10	9.7	14.1	0	4	1	4		-	-	-	-
6	US27	18/1/2018	LL & JC	HN553_Moderate/good	23	55.5	7	2	42	36	0	3	1	64	68.12	82	255563	6252860	56
	US28	2/3/2018	RM & LH		32	53	39	2	82	68	0	2	1	38		356	255551	6252859	56
	US31	6/3/2018	LL & JC		25	49	27	30	26	56	0	6	1	84		213	255020	6253224	56
	US32	6/3/2018	RM & LH		30	77	10	42	0	84	0	0	1	28		192	255521	6254399	56
	US34	6/3/2018	RM & LH		29	38.5	22	10	0	82	0	0	1	10		171	255711	6254608	56
	US41	5/4/2018	LL & MA		40	47	15	60	0	46	2.66667	1	1	39		316	245610	6248766	56
	US90	26/10/2017	RM, LL & JC		36	21	42.5	24	8	90	0	2	1	73		282	265484	6219779	56
7	US24	17/1/2018	LL & JC	HN538_Moderate/good	22	75	0	2	0	26	0	6	1	45	84.44	346	254986	6250167	56
	US38	19/3/2018	LL & JC		32	84	0	0	0	24	13.3333	1	1	27		4	246074	6248789	56
	US39	12/2/2018	LL & JC		39	61	7	22	2	84	0	11	1	44		210	245500	6249022	56
	US44	13/2/2018	LL & JC		42	62.5	5	2	12	60	0	3	1	17		9	248722	6248384	56
	US79	25/10/2017	RM, LL & JC		49	26	20	30	18	46	0	0	1	18		345	263985	6219298	56
	US85	2/11/2017	RM & JC		21	19	85.5	4	0	0	0	2	1	79		35	263518	6218984	56
8	US36	7/3/2018	LL & JC	HN537_Moderate/good	43	17	70	10	6	22	0	3	1	38	100.00	62	251952	6252879	56
	S8	-	-		27	33	35.5	0	0	17.6	0	1	1	1		-	-	-	-
	S9	-	-		28	53	60.5	5	5	25.6	0	2	1	2		-	-	-	-
9	US16	15/12/2017	JC & LL	HN536_Moderate/good	37	33	38	0	4	76	0	2	1	53	77.95	72	266746	6239727	56
	US17	6/11/2018	RM & JC		47	54.5	1	2	26	46	0	2	1	76		293	266746	6241385	56
	US21	17/1/2018	LL & JC		49	26	21	0	32	32	0	3	1	37		93	255442	6247366	56
	US78	14/3/2018	RM & LL		18	47	10.2	52	30	40	0	0	1	6		215	264606	6219654	56
	US82	14/3/2018	RM & LL		7	29.5	6.5	16	66	22	0.66667	0	1	0		79	262657	6219131	56
	US91	25/10/2017	LL, RM & JC		47	44	13.5	0	20	68	0	1	1	13		293	265770	6219680	56
	US92	26/10/2017	RM, LL & JC		18	61	4	0	4	82	0	5	1	77		114	265725	6219762	56

VEG ZONE	PLOT	DATE	RECORDERS	PCT_CONDITION	NO. NATIVE SPECIES	NATIVE OVERSTOREY COVER %	NATIVE MIDSTOREY COVER %	NATIVE GROUND COVER (GRASSES) %	NATIVE GROUND COVER (SHRUBS) %	NATIVE GROUND COVER (OTHER) %	EXOTIC PLANT COVER %	NO. TREES WITH HOLLOWS	REGENE-RATION	TOTAL LENGTH OF FALLEN LOGS (M)	SITE VALUE SCORE	BEARING (°)	EASTINGS	NORTHINGS	ZONE
	US93	26/10/2017	RM, LL & JC		13	52.5	31.5	4	32	6	0	1	1	38		154	265381	6220046	56
	US95	1/11/2018	RM & LK		24	32	15.5	0	42	68	0	1	1	88		156	264106	6224954	56
10	US35	6/12/2018	RM & AW	HN535_Moderate/good	42	19.5	26	20	6	28	0	1	1	72	100.00	329	252129	6250833	56
	US46	14/11/2018	LL & JT		51	33	56	34	2	8	0	0	1	40		43	252804	6249536	56
	US49	5/11/2018	RM & JC		43	18.5	5	30	14	32	0	3	1	34		126	255234	6245083	56
	US50	9/11/2018	RM & JC		53	16	11.5	26	20	21	0	3	1	56		126	255084	6245086	56
	S7	-	-		36	24	19	22.5	5	22.5	0	1	1	1		-	-	-	-
11	US18	7/12/2018	RM & AW	HN533_Moderate/good	29	17	20.5	14	26	14	0	0	1	73	75.36	200	259259	6245804	56
	US20	16/1/2018	LL & JC		34	26	2	0	30	58	0	2	1	33		174	255666	6247105	56
	US22	20/11/2018	LL & RC		49	24	6.5	4	16	70	0	4	1	38		13	255308	6247180	56
	US26	2/3/2018	RM & LH		32	56	3	6	8	36	0	0	1	39		179	256518	6252365	56
	US33	6/3/2018	RM & LH		34	41.5	12	0	2	72	0	0	1	24		204	255728	6254433	56
12	US19	16/1/2018	LL & JC	HN532_Moderate/good	39	37.5	0	6	28	20	0	0	1	20	59.42	236	255731	6246945	56
	US23	17/1/2018	LL & JC		27	16.5	18	2	40	44	0	3	1	75		134	254910	6250134	56
	US29	6/3/2018	LL & JC		30	36.5	1.5	6	26	78	0	3	1	78		302	255208	6252924	56
	US30	6/3/2018	LL & JC		35	26	1	2	4	74	0	1	1	19		224	254939	6252956	56
	US75	21/11/2017	RM, DM, JC & AW		28	31.5	6	18	10	6	0	0	1	40		21	253907	6215369	56
	US84	15/3/2018	RM & LL		26	40	0	12	18	20	0	0	1	30		272	261752	6218639	56
	US87	2/11/2017	RM & JC		33	33.5	2.5	10	2	16	0	2	1	25		270	264619	6216473	56
13	US55	29/11/2017	LL & AW	HN527_Moderate/good	34	32	14.5	64	16	36	0.66667	0	1	7	72.22	184	253526	6218852	56
	US56	30/11/2017	LL & AW		43	18	22	46	18	76	0	4	1	10		137	252111	6217707	56
	US57	12/12/2018	RM & JC		43	19.5	0	38	0	10	0	0	1	4		9	250854	6213812	56
	US60	6/6/2018	LL & JC		24	34.5	0	34	0	12	0	1	1	21		196	250909	6213486	56
	US61	6/6/2018	LL & JC		20	23	0	46	0	14	0	3	1	75		191	248852	6211835	56
	US66	4/6/2018	LL & JC		22	24	0	54	0	4	0	2	1	12		356	251283	6213985	56
	US68	23/11/2017	RM & JC		50	28	0.5	28	4	20	0	0	1	39		109	251291	6214410	56
	US71	23/11/2017	RM & DM		40	26	0	78	0	40	4	3	1	42		23	251695	6214384	56
14	US58	12/12/2018	RM & JC	HN527_Moderate/good DNG	27	0	0	56	0	16	6	0	1	0	53.38	87	250934	6213730	56
	US59	12/12/2018	RM & JC		27	0	0	28	0	28	4.66667	0	1	0		37	250870	6213569	56
	US62	12/12/2018	RM & JC		14	0	0	74	0	24	0	0	1	0		210	247502	5210659	56
	US69	12/12/2018	RM & JC		21	0	0	46	0	8	0	0	1	0		225	251400	6214456	56
	US70	23/11/2017	AW & DM		27	0	0	88	0	48	0	0	1	0		19	251362	6214522	56
	S10	-	-		35	21	20	13.1	5	13.1	0	1	1	1		-	-	-	-
15	US37	7/3/2018	LL & JC	HN525_Moderate/good	45	28	22	18	30	26	0	2	1	82	76.09	270	251850	6252884	56
	US40	4/4/2018	LL & MA		40	29	11	30	2	20	0	0	1	23		275	243754	6247222	56
	US43	5/4/2018	LL & MA		58	37	39	22	2	64	0	3	1	57		234	246580	6249039	56

VEG ZONE	PLOT	DATE	RECORDERS	PCT_CONDITION	NO. NATIVE SPECIES	NATIVE OVERSTOREY COVER %	NATIVE MIDSTOREY COVER %	NATIVE GROUND COVER (GRASSES) %	NATIVE GROUND COVER (SHRUBS) %	NATIVE GROUND COVER (OTHER) %	EXOTIC PLANT COVER %	NO. TREES WITH HOLLOWS	REGENE-RATION	TOTAL LENGTH OF FALLEN LOGS (M)	SITE VALUE SCORE	BEARING (°)	EASTINGS	NORTHINGS	ZONE
	US47	5/6/2018	LL & JC		40	22	0	8	28	38	0	0	1	72		67	252633	6249042	56
	US48	5/6/2018	LL & JC		32	31.5	1.5	50	10	2	0	3	1	59		76	252743	6248900	56
	US51	5/11/2018	RM & JC		34	24.5	19.5	26	6	10	0	1	1	36		273	255129	6244689	56
	US52	5/6/2018	LL & JC		24	23	14	26	14	4	0	2	1	30		298	254116	6244313	56
16	US13	4/7/2018	LL & JC	HN517_Moderate/good	32	75	10	0	28	56	0	2	1	42	78.26	72	274560	6246486	56
17	US65	23/11/2017	RM, DM, AW & JC	HN557_Moderate/good	26	19	23	46	2	42	0	2	1	57	73.44	196	251264	6213658	56
	US72	23/11/2017	RM, DM, AW & JC		21	10	18	40	0	52	0.66667	1	1	32		184	252262	6214203	56
	US73	21/11/2017	RM & AW		38	21.5	24	86	14	48	0	0	1	105		12	253286	6214280	56
	US74	21/11/2017	RM, DM, JC & AW		33	23.5	9.5	38	38	38	4	0	1	73		22	253705	6214989	56
	US76	21/11/2017	DM & JC		26	34.5	0	38	10	6	0	0	1	63		7	253745	6216260	56
	US77	21/11/2017	RM & AW		37	52	4	26	46	24	0	0	1	69		29	253878	6216847	56
	US86	3/11/2017	LL & JC		30	29	13	12	6	6	0	1	1	59		342	264506	6216845	56
18	US80	31/5/2018	LL & JC	HN607_Moderate/good	28	39	10	0	38	10	0	1	1	104	64.98	97	263732	6219229	56
	US81	13/12/2018	RM & JC		57	0	15	18	28	18	0	0	1	77		100	262796	6219079	56
	US83	25/5/2018	RM & JC		40	5	17	6	34	10	0	0	1	34		93	262253	6218818	56
	US88	25/5/2018	RM & JC		30	9	5	0	14	0	0	1	1	121		300	264810	6216453	56
19	US14	19/12/2017	PE & LL	HN606_Moderate/good	33	36.5	7	0	68	82	0	4	1	9	85.99	64	272719	6245050	56
	US15	15/12/2017	AW & LL		37	38.5	31.5	0	4	84	0	1	1	52		71	268077	6240584	56
	S5	-	-		32	41	31.5	0	0	45.5	0	1	1	1		-	-	-	-
	S6	-	-		33	51	46.5	15	5	53.5	0	2	1	2		-	-	-	-
20	US53	7/11/2018	RM & JC	HN598_Moderate/good	45	26.5	0	4	32	14	0	7	1	57	83.51	40	261149	6230275	56
	US96	1/11/2018	RM & LK		52	15	22.5	0	18	48	0	2	1	26		173	263879	6225319	56
	US97	1/11/2018	RM & LK		49	30.5	21	2	22	20	0	4	1	54		151	263846	6225437	56
21	US42	21/3/2018	LL & JC	HN574_Moderate/good	21	55	0	44	2	34	6	1	1	46	74.64	267	245984	6248665	56
	US54	11/12/2018	RM & JC		41	24	9	38	2	28	4.66667	0	1	19		34	252516	6221652	56
	US63	22/11/2017	AW & JC		34	68.5	9	56	6	6	8.66667	0	1	19		195	249234	6212244	56
	US64	4/6/2018	LL & JC		17	36	0	62	12	2	8.66667	0	1	39		186	251121	6213506	56
	US67	22/11/2017	RM & AW		27	60	0	100	2	22	16.6667	0	1	0		17	251199	6214384	56
	US89	31/5/2018	LL & JC		24	49	2	0	40	14	0	0	1	121		208	264647	6218973	56
	US94	26/10/2017	RM, LL & JC		31	75	23	28	10	32	2	1	1	29		21	265200	6220086	56

Appendix D
Floristic data

Status	Family	Genus species	Common Name
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet
lin	Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower
*	Alstroemeriaceae	*Alstroemeria psittacina*	Christmas lily
lin	Amaranthaceae	*Nyssanthes ?diffusa*	Barbwire Weed
lin	Amaranthaceae	*Nyssanthes diffusa*	Barbwire Weed
	Anthericaceae	*?Caesia*	
lin	Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily
lin	Anthericaceae	*Arthropodium spp.*	
lin	Anthericaceae	*Caesia parviflora*	
lin	Anthericaceae	*Laxmannia gracilis*	Slender Wire Lily
lin	Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily
lin	Anthericaceae	*Tricoryne simplex*	
lin	Aphanopetalaceae	*Aphanopetalum resinosum*	Gum Vine
*	Apiaceae	*Ammi majus*	Bishop's-weed
lin	Apiaceae	*Apiaceae sp*	
lin	Apiaceae	*Centella asiatica*	Gotu Cola
*	Apiaceae	*Conium maculatum*	Hemlock
lin	Apiaceae	*Daucus glochidiatus*	Native Carrot
lin	Apiaceae	*Platysace linearifolia*	
lin	Apiaceae	*Xanthosia pilosa*	Woolly Xanthosia
lin	Apiaceae	*Xanthosia tridentata*	Rock Xanthosia
HTW	Apocynaceae	*Araujia sericifera*	Moth Vine
*	Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush
lin	Apocynaceae	*Marsdenia flavescens*	Hairy Milk Vine
lin	Apocynaceae	*Marsdenia suaveolens*	Scented Marsdenia
lin	Apocynaceae	*Parsonsia straminea*	Common Silkpod
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora
lin	Araliaceae	*Astrotricha latifolia*	
lin	Araliaceae	*Hydrocotyle geraniifolia*	Forest Pennywort
lin	Araliaceae	*Hydrocotyle laxiflora*	Stinking Pennywort
lin	Araliaceae	*Hydrocotyle sibthorpioides*	
lin	Araliaceae	*Hydrocotyle spp.*	
lin	Araliaceae	*Polyscias sambucifolia*	Elderberry Ash
HTW	Asparagaceae	*Asparagus asparagoides*	Bridal Creeper
*	Asparagaceae	*Asparagus officinalis*	Asparagus
	Asparagaceae	*Asparagus sp*	
lin	Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern
lin	Asteraceae	"Asteraceae yellow petals"	
lin	Asteraceae	*?Calotis spp.*	
lin	Asteraceae	*?Cassinia spp.*	
lin	Asteraceae	*?Coronidium rutidolepis*	
lin	Asteraceae	*?Lagenophora stipitata*	
	Asteraceae	*?Vittadinia sp*	

Status	Family	Genus species	Common Name
lin	Asteraceae	*Ageratina adenophora*	Crofton Weed
*	Asteraceae	*Aster subulatus*	Wild Aster
lin	Asteraceae	*Asteraceae spp.*	
*	Asteraceae	*Bidens bipinnata*	Bipinnate Beggar's Ticks
*	Asteraceae	*Bidens pilosa*	Cobbler's Pegs
*	Asteraceae	*Bidens subalternans*	Greater Beggar's Ticks
lin	Asteraceae	*Brachyscome graminea*	Grass Daisy
lin	Asteraceae	*Calomeria amaranthoides*	
lin	Asteraceae	*Calotis ?dentax*	
lin	Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy
HTW	Asteraceae	*Carthamus lanatus*	Saffron Thistle
	Asteraceae	*Cassinia sp*	
lin	Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting
*	Asteraceae	*Cirsium vulgare*	Spear Thistle
*	Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane
*	Asteraceae	*Conyza spp.*	A Fleabane
lin	Asteraceae	*Coronidium ?rutidolepis*	
lin	Asteraceae	*Coronidium elatum*	
lin	Asteraceae	*Euchiton spp.*	A Cudweed
*	Asteraceae	*Gamochaeta americana*	Purple Cudweed
lin	Asteraceae	*Gamochaeta spp.*	
*	Asteraceae	*Hypochaeris glabra*	Smooth Catsear
*	Asteraceae	*Hypochaeris radicata*	Catsear
lin	Asteraceae	*Hypochaeris spp.*	
lin	Asteraceae	*Lagenophora gracilis*	Slender Lagenophora
lin	Asteraceae	*Lagenophora stipitata*	Blue Bottle-daisy
lin	Asteraceae	*Olearia microphylla*	
lin	Asteraceae	*Olearia viscidula*	Wallaby Weed
lin	Asteraceae	*Ozothamnus adnatus*	Winged Everlasting
lin	Asteraceae	*Ozothamnus diosmifolius*	White Dogwood
lin	Asteraceae	*Senecio linearifolius*	Fireweed Groundsel
*	Asteraceae	*Senecio madagascariensis*	Fireweed
lin	Asteraceae	*Senecio prenanthoides*	
lin	Asteraceae	*Senecio spp.*	Groundsel, Fireweed
lin	Asteraceae	*Sigesbeckia orientalis*	Indian Weed
*	Asteraceae	*Sonchus oleraceus*	Common Sowthistle
*	Asteraceae	*Sonchus spp.*	
*	Asteraceae	*Tagetes minuta*	Stinking Roger
lin	Asteraceae	*Triptilodiscus pygmaeus*	Common Sunray
lin	Asteraceae	*Vittadinia cuneata*	A Fuzzweed
lin	Asteraceae	*Vittadinia muelleri*	
lin	Asteraceae	*Vittadinia spp.*	Fuzzweed
lin	Asteraceae	*Vittadinia sulcata*	

Status	Family	Genus species	Common Name
*	Asteraceae	*Xanthium strumarium*	
lin	Asteraceae	*Xerochrysum bracteatum*	Golden Everlasting
lin	Atherospermataceae	*Doryphora sassafras*	Sassafras
lin	Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine
lin	Blechnaceae	*Blechnum cartilagineum*	Gristle Fern
lin	Blechnaceae	*Blechnum nudum*	Fishbone water fern
lin	Blechnaceae	*Blechnum patersonii*	Strap Water Fern
lin	Blechnaceae	*Doodia aspera*	Prickly rasp fern
lin	Blechnaceae	*Doodia caudata*	Small rasp fern
*	Boraginaceae	*Echium plantagineum*	Patterson's Curse
lin	Boraginaceae	*Ehretia acuminata*	Koda
	Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope
lin	Brassicaceae	*Brassica sp*	
*	Brassicaceae	*Brassica tournefortii*	Mediterranean Turnip
lin	Brassicaceae	*Lepidium spp.*	A Peppercress
*	Brassicaceae	*Rorippa palustris*	Marsh Watercress
*	Cactaceae	*Opunita sp*	
*	Cactaceae	*Opuntia stricta*	Common Prickly Pear
lin	Campanulaceae	*Lobelia anceps*	
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot
lin	Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell
lin	Campanulaceae	*Wahlenbergia gracilenta*	Hairy Annual Bluebell
lin	Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell
lin	Campanulaceae	*Wahlenbergia spp.*	Bluebell
lin	Campanulaceae	*Wahlenbergia stricta*	Tall Bluebell
lin	Cannabaceae	*Trema tomentosa*	Native Peach
*	Caryophyllaceae	*Paronychia brasiliana*	Chilean Whitlow Wort, Brazilian Whitlow
*	Caryophyllaceae	*Petrorhagia nanteuilii*	Proliferous Pink
lin	Caryophyllaceae	*Stellaria flaccida*	
lin	Caryophyllaceae	*Stellaria pungens*	Prickly Starwort
lin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak
lin	Casuarinaceae	*Allocasuarina torulosa*	Forest Oak
lin	Casuarinaceae	*Allocasuarina verticillata*	Drooping Sheoak
lin	Casuarinaceae	*Casuarina cunninghamiana*	River Oak
lin	Casuarinaceae	*Casuarina cunninghamiana subsp. cunninghamiana*	River Sheoak
lin	Celastraceae	*Denhamia silvestris*	Narrow-leaved Orangebark
*	Chenopodiaceae	*Atriplex prostrata*	
	Chenopodiaceae	*Atriplex spp.*	
lin	Chenopodiaceae	*Einadia hastata*	Berry Saltbush
lin	Chenopodiaceae	*Einadia nutans*	
lin	Chenopodiaceae	*Einadia spp.*	A Saltbush

Status	Family	Genus species	Common Name
lin	Commelinaceae	*Aneilema acuminatum*	
lin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew
lin	Commelinaceae	*Tradescantia fluminensis*	Wandering Jew
lin	Convolvulaceae	*Convolvulaceae*	
	Convolvulaceae	*Cuscuta spp.*	
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed
lin	Crassulaceae	*Crassula sieberiana*	Australian Stonecrop
lin	Cunoniaceae	*Callicoma serratifolia*	Black Wattle
lin	Cunoniaceae	*Ceratopetalum apetalum*	Coachwood
lin	Cunoniaceae	*Ceratopetalum gummiferum*	Christmas Bush
lin	Cupressaceae	*Callitris endlicheri*	Black Cypress Pine
lin	Cyatheaceae	*Cyathea australis*	Rough Treefern
lin	Cyperaceae	*Carex ?breviculmis*	
lin	Cyperaceae	*Carex appressa*	Tall Sedge
lin	Cyperaceae	*Carex inversa*	Knob Sedge
lin	Cyperaceae	*Carex spp.*	A Sedge
lin	Cyperaceae	*Caustis flexuosa*	Curly Wig
lin	Cyperaceae	*Cyathochaeta diandra*	
lin	Cyperaceae	*Cyperus ?gracillis*	Slender Flat-sedge
lin	Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge
lin	Cyperaceae	*Cyperus spp.*	A Sedge
lin	Cyperaceae	*Gahnia ?melanocarpa*	Black-fruit Saw-sedge
lin	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge
lin	Cyperaceae	*Gahnia erythrocarpa*	
lin	Cyperaceae	*Gahnia melanocarpa*	Black Fruit Saw-sedge
lin	Cyperaceae	*Lepidosperma ?viscidum*	
lin	Cyperaceae	*Lepidosperma gunnii*	
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge
lin	Cyperaceae	*Lepidosperma spp.*	
lin	Cyperaceae	*Lepidospermsa ?viscidium*	
lin	Cyperaceae	*Schoenus melanostachys*	Black Bog-rush
lin	Cyperaceae	*Sedge spp.*	
lin	Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern
lin	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken
lin	Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern
lin	Dilleniaceae	*Hibbertia acicularis*	
lin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower
lin	Dilleniaceae	*Hibbertia cistoidea/cistiflora*	
lin	Dilleniaceae	*Hibbertia dentata*	Trailing Guinea Flower
lin	Dilleniaceae	*Hibbertia diffusa*	Wedge Guinea Flower
lin	Dilleniaceae	*Hibbertia empetrifolia*	
lin	Dilleniaceae	*Hibbertia linearis*	
lin	Dilleniaceae	*Hibbertia obtusifolia*	Hoary Guinea Flower

Status	Family	Genus species	Common Name
lin	Dilleniaceae	*Hibbertia scandens*	Climbing Guinea Flower
lin	Dilleniaceae	*Hibbertia spp.*	
lin	Dryopteridaceae	*Lastreopsis acuminata*	Creeping Shield Fern
lin	Dryopteridaceae	*Polystichum australiense*	Harsh Shield Fern
lin	Dryopteridaceae	*Polystichum proliferum*	Mother Shield Fern
lin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash
lin	Elaeocarpaceae	*Tetratheca ericifolia*	
lin	Elaeocarpaceae	*Tetratheca thymifolia*	Black-eyed Susan
lin	Ericaceae (Epacridoideae)	*?Leucopogon spp.*	
lin	Ericaceae (Epacridoideae)	*?Styphelia laeta*	Five-corners
lin	Ericaceae (Epacridoideae)	*Acrotriche divaricata*	
lin	Ericaceae (Epacridoideae)	*Acrotriche serrulata*	
lin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry
lin	Ericaceae (Epacridoideae)	*Brachyloma daphnoides*	Daphne Heath
lin	Ericaceae (Epacridoideae)	*Dracophyllum secundum*	
lin	Ericaceae (Epacridoideae)	*Epacris pulchella*	Wallum Heath
lin	Ericaceae (Epacridoideae)	*Ericaceae, Epacridoideae*	
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath
lin	Ericaceae (Epacridoideae)	*Leucopogon lanceolatus*	
lin	Ericaceae (Epacridoideae)	*Leucopogon muticus*	Blunt Beard-heath
lin	Ericaceae (Epacridoideae)	*Leucopogon virgatus*	
lin	Ericaceae (Epacridoideae)	*Lissanthe sapida*	Native Cranberry
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa subsp. subulata*	Peach Heath
lin	Ericaceae (Epacridoideae)	*Melichrus procumbens*	Jam Tarts
lin	Ericaceae (Epacridoideae)	*Monotoca ledifolia*	
lin	Ericaceae (Epacridoideae)	*Monotoca scoparia*	
lin	Ericaceae (Epacridoideae)	*Styphelia triflora*	Pink Five-Corners

Status	Family	Genus species	Common Name
lin	Euphorbiaceae	*Claoxylon australe*	Brittlewood
*	Euphorbiaceae	*Euphorbia peplus*	Petty Spurge
lin	Euphorbiaceae	*Euphorbia spp.*	
lin	Euphorbiaceae	*Euphorbia spp. 2*	
lin	Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart
lin	Eupomatiaceae	*Eupomatia laurina*	Bolwarra
lin	Fabaceae (Caesalpinioideae)	*Senna sp "yellow"*	
lin	Fabaceae (Faboideae)	*?Pultenaea sp* presume NGS	
lin	Fabaceae (Faboideae)	*?Pultenea*	
lin	Fabaceae (Faboideae)	*Bossiaea ?rhombifolia*	
lin	Fabaceae (Faboideae)	*Bossiaea buxifolia*	
lin	Fabaceae (Faboideae)	*Bossiaea heterophylla*	Variable Bossiaea
lin	Fabaceae (Faboideae)	*Bossiaea obcordata*	Spiny Bossiaea
lin	Fabaceae (Faboideae)	*Bossiaea oligosperma*	
lin	Fabaceae (Faboideae)	*Bossiaea rhombifolia*	
lin	Fabaceae (Faboideae)	*Bossiaea sp*	
lin	Fabaceae (Faboideae)	*Chorizema parviflorum*	Eastern Flame Pea
lin	Fabaceae (Faboideae)	*Daviesia ulicifolia*	Gorse Bitter Pea
lin	Fabaceae (Faboideae)	*Daviesia ulicifolia subsp. stenophylla*	
lin	Fabaceae (Faboideae)	*Desmodium ?varians*	
lin	Fabaceae (Faboideae)	*Desmodium brachypodum*	Large Tick-trefoil
lin	Fabaceae (Faboideae)	*Desmodium rhytidophyllum*	
lin	Fabaceae (Faboideae)	*Desmodium spp.*	Tick-trefoil
lin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil
lin	Fabaceae (Faboideae)	*Dillwynia retorta*	
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine
lin	Fabaceae (Faboideae)	*Glycine microphylla*	Small-leaf Glycine

Status	Family	Genus species	Common Name
lin	Fabaceae (Faboideae)	*Glycine spp.*	A Glycine
lin	Fabaceae (Faboideae)	*Glycine tabacina*	Variable Glycine
lin	Fabaceae (Faboideae)	*Gompholobium ?minus*	
lin	Fabaceae (Faboideae)	*Gompholobium glabratum*	Dainty Wedge Pea
lin	Fabaceae (Faboideae)	*Gompholobium grandiflorum*	Large Wedge Pea
lin	Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla
lin	Fabaceae (Faboideae)	*Hovea linearis*	
lin	Fabaceae (Faboideae)	*Hovea purpurea*	
lin	Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo
lin	Fabaceae (Faboideae)	*Jacksonia scoparia*	Dogwood
lin	Fabaceae (Faboideae)	*Kennedia rubicunda*	Dusky Coral Pea
lin	Fabaceae (Faboideae)	*Podolobium ilicifolium*	Prickly Shaggy Pea
lin	Fabaceae (Faboideae)	*Podolobium scandens*	Netted Shaggy Pea
lin	Fabaceae (Faboideae)	*Pultenaea daphnoides*	Large-leaf Bush-pea
lin	Fabaceae (Faboideae)	*Pultenaea flexilis*	Graceful Bush-pea
lin	Fabaceae (Faboideae)	*Pultenaea linophylla*	
lin	Fabaceae (Faboideae)	*Pultenaea retusa*	Notched Bush-pea
lin	Fabaceae (Faboideae)	*Pultenaea scabra*	Rough Bush-pea
*	Fabaceae (Faboideae)	*Trifolium sp*	
lin	Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia
lin	Fabaceae (Mimosoideae)	*Acacia ?penninervis*	
lin	Fabaceae (Mimosoideae)	*Acacia binervata*	Two-veined Hickory
lin	Fabaceae (Mimosoideae)	*Acacia binervia*	Coast Myall
lin	Fabaceae (Mimosoideae)	*Acacia clunies-rossiae*	Kowmung wattle

Status	Family	Genus species	Common Name
lin	Fabaceae (Mimosoideae)	*Acacia dealbata*	Silver Wattle
lin	Fabaceae (Mimosoideae)	*Acacia decurrens*	Black Wattle
lin	Fabaceae (Mimosoideae)	*Acacia echinula*	Hedgehog Wattle
lin	Fabaceae (Mimosoideae)	*Acacia elata*	Cedar Wattle
lin	Fabaceae (Mimosoideae)	*Acacia falcata*	
lin	Fabaceae (Mimosoideae)	*Acacia falciformis*	Broad-leaved Hickory
lin	Fabaceae (Mimosoideae)	*Acacia fimbriata*	Fringed Wattle
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle
lin	Fabaceae (Mimosoideae)	*Acacia irrorata*	Green Wattle
lin	Fabaceae (Mimosoideae)	*Acacia linearifolia*	Narrow-leaved Wattle
lin	Fabaceae (Mimosoideae)	*Acacia linifolia*	White Wattle
lin	Fabaceae (Mimosoideae)	*Acacia longifolia*	
lin	Fabaceae (Mimosoideae)	*Acacia longissima*	Long-leaf Wattle
lin	Fabaceae (Mimosoideae)	*Acacia paradoxa*	Kangaroo Thorn
lin	Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle
lin	Fabaceae (Mimosoideae)	*Acacia parvipinnula*	Silver-stemmed Wattle
lin	Fabaceae (Mimosoideae)	*Acacia penninervis*	Mountain Hickory
lin	Fabaceae (Mimosoideae)	*Acacia prominens*	Golden Rain Wattle
lin	Fabaceae (Mimosoideae)	*Acacia sp A. clunie-rossiae* or *A. fimbriata?*	
lin	Fabaceae (Mimosoideae)	*Acacia spp.*	
lin	Fabaceae (Mimosoideae)	*Acacia terminalis*	Sunshine Wattle
lin	Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses
lin	Fabaceae (Mimosoideae)	*Acacia uncinata*	Gold-dust Wattle
*	Gentianaceae	*Centaurium erythraea*	Common Centaury

Status	Family	Genus species	Common Name
*	Gentianaceae	*Centaurium tenuiflorum*	Branched Centaury, Slender centaury
lin	Gentianaceae	*Cicendia spp.*	
lin	Geraniaceae	*Geranium homeanum*	
lin	Geraniaceae	*Geranium sp*	
lin	Gleicheniaceae	*Sticherus flabellatus*	Umbrella Fern
lin	Goodeniaceae	*Dampiera purpurea*	
lin	Goodeniaceae	*Goodenia bellidifolia*	
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia
lin	Goodeniaceae	*Goodenia ovata*	Hop Goodenia
lin	Goodeniaceae	*Scaevola ramosissima*	Purple Fan-flower
lin	Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort
lin	Haloragaceae	*Gonocarpus teucrioides*	Germander Raspwort
lin	Hymenophyllaceae	*Hymenophyllum cupressiforme*	Common Filmy Fern
lin	Hypericaceae	*Hypericum ?japonica*	
lin	Hypericaceae	*Hypericum gramineum*	Small St John's Wort
lin	Hypericaceae	*Hypericum japonicum*	
lin	Hypoxidaceae	*?Hypoxis sp*	
lin	Hypoxidaceae	*Hypoxis hygrometrica*	Golden Weather-grass
lin	Iridaceae	*Libertia paniculata*	Branching Grass-flag
lin	Iridaceae	*Patersonia glabrata*	Leafy Purple-flag
lin	Iridaceae	*Patersonia sericea*	Silky Purple-Flag
lin	Iridaceae	*Patersonia spp.*	
HTW	Iridaceae	*Romulea rosea*	Onion Grass
lin	Juncaceae	*Juncus usitatus*	
lin	Lamiaceae	*Ajuga australis*	Austral Bugle
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum
*	Lamiaceae	*Marrubium vulgare*	White Horehound
lin	Lamiaceae	*Plectranthus parviflorus*	Cockspur Flower
lin	Lamiaceae	*Prostanthera spp.*	Mint Bushes
lin	Lauraceae	*Cassytha glabella*	
lin	Lauraceae	*Cassytha pubescens*	
lin	Lauraceae	*Cryptocarya glaucescens*	Jackwood
lin	Linaceae	*Linum ?marginale*	Native Flax
lin	Linaceae	*Linum spp.*	
lin	Lindsaeaceae	*Lindsaea linearis*	Screw Fern
lin	Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge Fern
lin	Loganiaceae	*Logania albiflora*	
lin	Loganiaceae	*Mitrasacme pilosa*	
lin	Loganiaceae	*Mitrasacme polymorpha*	
lin	Lomandraceae	*Lomandra bracteata*	Mat-rush
lin	Lomandraceae	*Lomandra brevis*	Tufted Mat-rush
lin	Lomandraceae	*Lomandra confertifolia*	Matrush

Status	Family	Genus species	Common Name
lin	Lomandraceae	*Lomandra confertifolia subsp. rubiginosa*	
lin	Lomandraceae	*Lomandra cylindrica*	
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush
lin	Lomandraceae	*Lomandra filiformis subsp. coriacea*	Wattle Matt-rush
lin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush
lin	Lomandraceae	*Lomandra gracilis*	
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush
lin	Lomandraceae	*Lomandra micrantha subsp. Tuberculata*	Small-flowered Mat-rush
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush
lin	Lomandraceae	*Lomandra multiflora subsp. multiflora*	Many-flowered Mat-rush
lin	Lomandraceae	*Lomandra obliqua*	
lin	Lomandraceae	*Lomandra spp.*	
lin	Loranthaceae	*Amyema cambagei*	
lin	Loranthaceae	*Amyema pendula*	
lin	Loranthaceae	*Dendrophthoe vitellina*	
lin	Loranthaceae	*Muellerina eucalyptoides*	
lin	Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily
lin	Malvaceae	*Brachychiton populneus*	Kurrajong
lin	Malvaceae	*Commersonia dasyphylla*	
lin	Malvaceae	*Lasiopetalum ferrugineum*	
*	Malvaceae	*Modiola caroliniana*	Red-flowered Mallow
lin	Malvaceae	*Sida ?corrugata*	Variable Sida
lin	Malvaceae	*Sida corrugata*	Corrugated Sida
*	Malvaceae	*Sida rhombifolia*	Paddy's Lucerne
lin	Meliaceae	*Melia azedarach*	White Cedar
lin	Meliaceae	*Toona ciliata*	Red Cedar
lin	Menispermaceae	*Legnephora moorei*	Round-leaf Vine
lin	Menispermaceae	*Sarcopetalum harveyanum*	Pearl Vine
lin	Menispermaceae	*Stephania japonica*	Snake vine
lin	Moraceae	*Ficus coronata*	Sandpaper Fig
lin	Moraceae	*Ficus rubiginosa*	Port Jackson Fig
lin	Moraceae	*Maclura cochinchinensis*	Cockspur Thorn
lin	Myrtaceae	*Acmena smithii*	Lilly Pilly
lin	Myrtaceae	*Angophora bakeri*	Narrow-leaved Apple
lin	Myrtaceae	*Angophora costata*	Sydney Red Gum
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle
lin	Myrtaceae	*Callistemon ?linearifolius*	
lin	Myrtaceae	*Callistemon linearifolius*	
lin	Myrtaceae	*Calytrix tetragona*	Common Fringe-myrtle

Status	Family	Genus species	Common Name
lin	Myrtaceae	*Corymbia eximia*	Yellow Bloodwood
lin	Myrtaceae	*Corymbia gummifera*	Red Bloodwood
lin	Myrtaceae	*Eucalyptus ?resinifera*	Mahogany
lin	Myrtaceae	*Eucalyptus agglomerata*	Blue-leaved Stringybark
lin	Myrtaceae	*Eucalyptus albens*	White Box
lin	Myrtaceae	*Eucalyptus benthamii*	Camden White Gum
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark
lin	Myrtaceae	*Eucalyptus deanei*	Mountain Blue Gum
lin	Myrtaceae	*Eucalyptus elata*	River Peppermint
lin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark
lin	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark
lin	Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum
lin	Myrtaceae	*Eucalyptus globoidea*	White Stringybark
lin	Myrtaceae	*Eucalyptus melliodora*	Yellow Box
lin	Myrtaceae	*Eucalyptus moluccana*	
lin	Myrtaceae	*Eucalyptus pilularis*	Blackbutt
lin	Myrtaceae	*Eucalyptus piperita*	Sydney Peppermint
lin	Myrtaceae	*Eucalyptus punctata*	Grey Gum
lin	Myrtaceae	*Eucalyptus resinifera*	Red Mahogany
lin	Myrtaceae	*Eucalyptus sclerophylla*	Hard-leaved Scribbly Gum
lin	Myrtaceae	*Eucalyptus sideroxylon*	
lin	Myrtaceae	*Eucalyptus signata*	Scribbly Gum
lin	Myrtaceae	*Eucalyptus sparsifolia*	Narrow-leaved Stringybark
lin	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum
lin	Myrtaceae	*Eucalyptus tereticornis-glaucina*	
lin	Myrtaceae	*Kunzea ambigua*	Tick Bush
lin	Myrtaceae	*Kunzea parvifolia*	Violet Kunzea
lin	Myrtaceae	*Leptospermum ?polygalifolium*	Jelly Bush
lin	Myrtaceae	*Leptospermum ?trinervium*	
lin	Myrtaceae	*Leptospermum morrisonii*	
lin	Myrtaceae	*Leptospermum parviflorum*	
lin	Myrtaceae	*Leptospermum polyanthum*	
lin	Myrtaceae	*Leptospermum polygalifolium*	Tantoon
lin	Myrtaceae	*Leptospermum spp.*	
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree
lin	Myrtaceae	*Melaleuca erubescens*	Pink Honeymyrtle
lin	Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark
lin	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree
lin	Myrtaceae	*Myrtaceae spp.*	
lin	Myrtaceae	*Sannantha pluriflora*	
lin	Myrtaceae	*Syncarpia glomulifera*	Turpentine
lin	Myrtaceae	*Tristaniopsis laurina*	Water Gum
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive

Status	Family	Genus species	Common Name
lin	Oleaceae	*Notelaea spp.*	
lin	Oleaceae	*Notelaea venosa*	Veined Mock-olive
lin	Orchidaceae	*Acianthus fornicatus*	Pixie Caps
lin	Orchidaceae	*Chiloglottis diphylla*	
lin	Orchidaceae	*Cymbidium suave*	Snake Orchid
lin	Orchidaceae	*Dendrobium linguiforme*	Tongue Orchid
lin	Orchidaceae	*Dendrobium speciosum*	Sydney rock orchid
lin	Orchidaceae	*Dendrobium striolatum*	Streaked Rock Orchid
lin	Orchidaceae	*Plectorrhiza tridentata*	Tangle Orchid
lin	Orchidaceae	*Sarcochilus hillii*	
lin	Orchidaceae	*Sarcochilus spp.*	
lin	Osmundaceae	*Todea barbara*	King Fern
lin	Oxalidaceae	*Oxalis perennans*	Oxalis
lin	Oxalidaceae	*Oxalis spp.*	
*	Papaveraceae	*Fumaria muralis*	Wall Fumitory
*	Passifloraceae	*Passiflora caerulea*	Blue Passionflower
lin	Passifloraceae	*Passiflora herbertiana*	Native Passionfruit
*	Passifloraceae	*Passiflora subpeltata*	White Passionflower
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily
lin	Phormiaceae	*Dianella caerulea var. producta*	
lin	Phormiaceae	*Dianella longifolia*	Blue Flax-Lily
lin	Phormiaceae	*Dianella revoluta*	Blueberry Lily
lin	Phormiaceae	*Stypandra glauca*	Nodding Blue Lily
lin	Phyllanthaceae	*?Phyllanthus*	Leafflower
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush
lin	Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree
lin	Phyllanthaceae	*Phyllanthus gunnii*	Scrubby Spurge
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge
*	Phyllanthaceae	*Phyllanthus tenellus*	Hen and Chicken
lin	Phyllanthaceae	*Phyllanthus virgatus*	Wiry Spurge
lin	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera
lin	Picrodendraceae	*Micrantheum ericoides*	
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry
lin	Pittosporaceae	*Bursaria longisepala*	
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn
lin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum
lin	Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum
lin	Pittosporaceae	*Rhytidosporum spp.*	
lin	Plantaginaceae	*Plantago debilis*	Shade Plantain
*	Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell
lin	Plantaginaceae	*Veronica lithophila*	
	Poaceae	*?Rytidosperma sp*	

Status	Family	Genus species	Common Name
lin	Poaceae	*Anisopogon avenaceus*	Oat Speargrass
lin	Poaceae	*Aristida ramosa*	Purple Wiregrass
lin	Poaceae	*Aristida spp.*	A Wiregrass
lin	Poaceae	*Aristida vagans*	Threeawn Speargrass
lin	Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass
lin	Poaceae	*Bothriochloa macra*	Red Grass
lin	Poaceae	*Bothriochloa spp.*	Redgrass, Bluegrass
*	Poaceae	*Briza minor*	Shivery Grass
lin	Poaceae	*Chloris ventricosa*	Tall Chloris
lin	Poaceae	*Cymbopogon refractus*	Barbed Wire Grass
lin	Poaceae	*Cymbopogon spp.*	
lin	Poaceae	*Cynodon dactylon*	Common Couch
lin	Poaceae	*Dichelachne spp.*	A Plumegrass
lin	Poaceae	*Digitaria spp.*	
lin	Poaceae	*Echinopogon caespitosus*	Bushy Hedgehog-grass
lin	Poaceae	*Echinopogon spp.*	A Hedgehog Grass
lin	Poaceae	*Ehrharta erecta*	Panic Veldtgrass
lin	Poaceae	*Elymus scaber*	Wheatgrass, Common Wheatgrass
lin	Poaceae	*Entolasia marginata*	Bordered Panic
lin	Poaceae	*Entolasia stricta*	Wiry Panic
lin	Poaceae	*Eragrostis brownii*	Brown's Lovegrass
lin	Poaceae	*Eragrostis spp.*	A Lovegrass
lin	Poaceae	*Imperata cylindrica*	Blady Grass
lin	Poaceae	*Microlaena stipoides*	Weeping Grass
lin	Poaceae	*Microleana spp.*	
lin	Poaceae	*Oplismenus aemulus*	Australian Basket Grass
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass
lin	Poaceae	*Oplismenus spp.*	
lin	Poaceae	*Panicum ?simile*	Two-colour Panic
lin	Poaceae	*Panicum effusum*	Hairy Panic
lin	Poaceae	*Panicum simile*	Two-colour Panic
lin	Poaceae	*Poaceae spp.*	
lin	Poaceae	*Rytidosperma spp.*	Wallaby Grass
lin	Poaceae	*Rytidosperma tenuius*	A Wallaby Grass
*	Poaceae	*Setaria spp.*	
lin	Poaceae	*Themeda australis*	
lin	Poaceae	*Themeda triandra*	
*	Poaceae	*Vulpia spp.*	Rat's-tail Fescue
lin	Podocarpaceae	*Podocarpus spinulosus*	Spiny-leaf Podocarp
HTW	Polygonaceae	*Acetosella vulgaris*	Sheep Sorrel
lin	Polygonaceae	*Muehlenbeckia rhyticarya*	Wrinkle-nut Lignum
lin	Polygonaceae	*Rumex brownii*	Swamp Dock
lin	Polygonaceae	*Rumex sp.* (Assume NGO)	

Status	Family	Genus species	Common Name
lin	Polypodiaceae	*Platycerium bifurcatum*	Elkhorn Fern
lin	Polypodiaceae	*Pyrrosia rupestris*	Rock Felt Fern
*	Primulaceae	*Anagallis arvensis*	Scarlet Pimpernel
*	Primulaceae	*Lysimachia arvensis*	Scarlet Pimpernel
lin	Primulaceae	*Myrsine howittiana*	Brush muttonwood
lin	Primulaceae	*Myrsine variabilis*	
lin	Proteaceae	*Banksia serrata*	Old-man Banksia
lin	Proteaceae	*Banksia spinulosa*	Hairpin Banksia
lin	Proteaceae	*Grevillea acanthifolia*	
lin	Proteaceae	*Grevillea arenaria*	
lin	Proteaceae	*Grevillea buxifolia*	Grey Spider Flower
lin	Proteaceae	*Grevillea mucronulata*	
lin	Proteaceae	*Grevillea parviflora subsp. Parviflora*	Small-flower Grevillea
lin	Proteaceae	*Grevillea ramosissima*	
lin	Proteaceae	*Grevillea robusta*	
lin	Proteaceae	*Grevillea spp.*	
lin	Proteaceae	*Grevillea sphacelata*	Grey Spider Flower
lin	Proteaceae	*Hakea dactyloides*	Finger Hakea
lin	Proteaceae	*Hakea sericea*	Needlebush
lin	Proteaceae	*Lambertia formosa*	Mountain Devil
lin	Proteaceae	*Lomatia silaifolia*	Crinkle Bush
lin	Proteaceae	*Lomatia spp.*	Crinkle Bush
lin	Proteaceae	*Persoonia laurina*	Laurel Geebung
lin	Proteaceae	*Persoonia levis*	Broad-leaved Geebung
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung
lin	Proteaceae	*Persoonia mollis*	Soft Geebung
lin	Proteaceae	*Persoonia mollis subsp. revoluta*	
lin	Proteaceae	*Persoonia pinifolia*	Pine-leaved Geebung
lin	Proteaceae	*Petrophile pedunculata*	Conesticks
lin	Proteaceae	*Stenocarpus salignus*	Scrub Beefwood
lin	Proteaceae	*Xylomelum pyriforme*	Native Pear
lin	Pteridaceae	*Adiantum ?aethiopicum*	Maidenhair
lin	Pteridaceae	*Adiantum aethiopicum*	Common Maidenhair
lin	Pteridaceae	*Adiantum atroviride*	
lin	Pteridaceae	*Adiantum formosum*	Giant Maidenhair
lin	Pteridaceae	*Adiantum hispidulum*	Rough Maidenhair Fern
lin	Pteridaceae	*Adiantum spp.*	
lin	Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern
lin	Pteridaceae	*Pellaea falcata*	Sickle Fern
lin	Pteridaceae	*Pellaea nana*	Dwarf Sickle Fern
lin	Pteridaceae	*Pteris tremula*	Tender Brakefern
lin	Ranunculaceae	*Clematis aristata*	Old Man's Beard

Status	Family	Genus species	Common Name
lin	Ranunculaceae	*Clematis glycinoides*	Headache Vine
lin	Ranunculaceae	*Clematis spp.*	
lin	Rhamnaceae	*Alphitonia excelsa*	Red Ash
lin	Rhamnaceae	*Pomaderris ?ferruginea*	Rusty Pomaderris
lin	Rhamnaceae	*Pomaderris andromedifolia*	
lin	Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris
lin	Rhamnaceae	*Pomaderris brunnea*	Rufous Pomaderris
lin	Rhamnaceae	*Pomaderris spp.*	
lin	Rhamnaceae	*Spyridium burragorang*	
lin	Rosaceae	*Acaena echinata*	Sheep's Burr
lin	Rosaceae	*Acaena novae-zelandiae*	Bidgee-widgee
*	Rosaceae	*Rosa spp.*	
*	Rosaceae	*Rubus fruticosus*	Blackberry
lin	Rosaceae	*Rubus moluccanus*	Molucca Bramble
lin	Rosaceae	*Rubus nebulosus*	Green-leaved Bramble
lin	Rosaceae	*Rubus parvifolius*	Native Raspberry
lin	Rosaceae	*Rubus rosifolius*	Native Raspberry
lin	Rousseaceae	*Abrophyllum ornans*	Native Hydrangea
lin	Rubiaceae	*Asperula conferta*	Common Woodruff
lin	Rubiaceae	*Galium ?leiocarpum*	
lin	Rubiaceae	*Galium spp.*	
lin	Rubiaceae	*Gynochthodes jasminoides*	Sweet Morinda
lin	Rubiaceae	*Opercularia aspera*	Coarse Stinkweed
lin	Rubiaceae	*Opercularia diphylla*	
lin	Rubiaceae	*Opercularia spp.*	
lin	Rubiaceae	*Opercularia varia*	Variable Stinkweed
lin	Rubiaceae	*Pomax umbellata*	Pomax
lin	Rubiaceae	*Richardia spp.*	
*	Rubiaceae	*Richardia spp.*	
*	Rubiaceae	*Richardia stellaris*	
lin	Rutaceae	*Asterolasia correifolia*	
lin	Rutaceae	*Boronia ledifolia*	Showy Boronia
lin	Rutaceae	*Boronia polygalifolia*	Dwarf Boronia
lin	Rutaceae	*Correa reflexa*	Native Fuschia
lin	Rutaceae	*Eriostemon australasius*	Pink Wax Flower
lin	Rutaceae	*Zieria spp.*	
lin	Santalaceae	*Choretrum pauciflorum*	Dwarf Sour Bush
lin	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart
lin	Santalaceae	*Exocarpos strictus*	Dwarf Cherry
lin	Santalaceae	*Leptomeria acida*	Sour Currant Bush
lin	Sapindaceae	*Alectryon subcinereus*	Native quince
lin	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush
lin	Sapindaceae	*Dodonaea truncatiales*	Angular Hop-bush

Status	Family	Genus species	Common Name
lin	Sapindaceae	*Dodonaea viscosa*	Sticky Hop-bush
lin	Scrophulariaceae	*Myoporum acuminatum*	Boobialla
lin	Scrophulariaceae	*Myoporum insulare*	Common Boobialla
lin	Scrophulariaceae	*Myoporum montanum*	Western Boobialla
lin	Scrophulariaceae	*Verbascum spp.*	Mulleins
*	Scrophulariaceae	*Verbascum thapsus*	Great Mullein
*	Scrophulariaceae	*Verbascum virgatum*	Twiggy Mullein
lin	Smilacaceae	*Smilax australis*	Barbwire Vine
lin	Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla
lin	Solanaceae	*Duboisia myoporoides*	Poison Corkwood
*	Solanaceae	*Physalis spp.*	
lin	Solanaceae	*Solanum ?pungetium*	Eastern Nightshade
lin	Solanaceae	*Solanum americanum*	Glossy Nightshade
lin	Solanaceae	*Solanum brownii*	Violet Nightshade
*	Solanaceae	*Solanum chenopodioides*	Whitetip Nightshade
lin	Solanaceae	*Solanum prinophyllum*	Forest Nightshade
lin	Solanaceae	*Solanum pungetium*	Eastern Nightshade
lin	Solanaceae	*Solanum spp.*	
lin	Solanaceae	*Solanum stelligerum*	Devil's Needles
lin	Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia
lin	Stylidiaceae	*Stylidium graminifolium*	Grass Trigger-plant
lin	Stylidiaceae	*Stylidium laricifolium*	Giant Trigger-plant
lin	Stylidiaceae	*Stylidium productum*	
lin	Thymelaeaceae	*?Pimelea latifolia subsp. Hirsuta*	
lin	Thymelaeaceae	*Pimelea curviflora*	Rice Flower
lin	Thymelaeaceae	*Pimelea latifolia*	
lin	Thymelaeaceae	*Pimelea linifolia*	Slender Rice Flower
lin	Urticaceae	*Urtica incisa*	Stinging Nettle
lin	Uvulariaceae	*Schelhammera undulata*	
*	Verbenaceae	*Verbena bonariensis*	Purpletop
lin	Verbenaceae	*Verbena littoralis*	
lin	Verbenaceae	*Verbena spp.*	Verbenas
lin	Violaceae	*Hybanthus monopetalus*	Slender Violet-bush
lin	Violaceae	*Melicytus dentatus*	Tree Violet
lin	Violaceae	*Melicytus dentatus*	Tree Violet
lin	Violaceae	*Viola hederacea*	Ivy-leaved Violet
lin	Violaceae	*Viola silicestris*	Sandstone Violet
lin	Vitaceae	*Cayratia clematidea*	Native Grape
lin	Vitaceae	*Cissus antarctica*	Kangaroo Vine
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine
lin	Xanthorrhoeaceae	*Xanthorrhoea arborea*	Grass Tree
lin	Xanthorrhoeaceae	*Xanthorrhoea media*	Grass Tree
lin	Xanthorrhoeaceae	*Xanthorrhoea resinosa*	Grass Tree

Status	Family	Genus species	Common Name
lin	Xanthorrhoeaceae	*Xanthorrhoea spp.*	Grass trees
lin		*Aristata spp.*	
lin		Unknown species	

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW)

Status	Family	Genus species	Common Name	US2 C	US2 A	US7 C	US7 A	US11 C	US11 A	US12 C	US12 A
lin	Apiaceae	*Platysace linearifolia*								0.01	5
lin	Apiaceae	*Xanthosia pilosa*	Woolly Xanthosia	0.1	2					0.01	10
lin	Araliaceae	*Astrotricha latifolia*						1	200	0.05	1
lin	Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine					0.1	2		
lin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak	5	22						
lin	Casuarinaceae	*Allocasuarina torulosa*	Forest Oak					2	150	1	10
lin	Cyperaceae	*Cyathochaeta diandra*		10	100	0.1	25				
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge			0.1	100	0.1	30		
lin	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken	1	5						
lin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash					1	10		
lin	Ericaceae (Epacridoideae)	*?Styphelia laeta*	Five-corners					0.1	1		
lin	Ericaceae (Epacridoideae)	*Epacris pulchella*	Wallum Heath	0.1	2						
lin	Ericaceae (Epacridoideae)	*Leucopogon lanceolatus*		0.1	1			0.1	5		
lin	Ericaceae (Epacridoideae)	*Lissanthe sapida*	Native Cranberry	0.1	1						
lin	Ericaceae (Epacridoideae)	*Monotoca scoparia*								0.5	1
lin	Fabaceae (Faboideae)	*Bossiaea rhombifolia*				0	10			2	75
lin	Fabaceae (Faboideae)	*Dillwynia retorta*								1	50
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine	0.5	50						
lin	Fabaceae (Faboideae)	*Gompholobium grandiflorum*	Large Wedge Pea	0.1	1						
lin	Fabaceae (Faboideae)	*Pultenaea linophylla*						3	250		
lin	Fabaceae (Faboideae)	*Pultenaea retusa*	Notched Bush-pea							0.2	30
lin	Fabaceae (Faboideae)	*Pultenaea scabra*	Rough Bush-pea							0.5	10
lin	Fabaceae (Mimosoideae)	*Acacia linearifolia*	Narrow-leaved Wattle							0.1	20
lin	Fabaceae (Mimosoideae)	*Acacia linifolia*	White Wattle			1	1				
lin	Fabaceae (Mimosoideae)	*Acacia prominens*	Golden Rain Wattle			0.01	1				
lin	Fabaceae (Mimosoideae)	*Acacia sp A. clunie-rossiae or A. fimbriata?*						12	25		
lin	Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses	0.1	3	0.1	10			0.5	10
lin	Goodeniaceae	*Dampiera purpurea*		0.1	20						
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia							0.01	1
lin	Goodeniaceae	*Scaevola ramosissima*	Purple Fan-flower							0.01	1
lin	Iridaceae	*Patersonia glabrata*	Leafy Purple-flag							x	x
lin	Lauraceae	*Cassytha pubescens*								0.1	1
lin	Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge Fern	0.1	8			0.1	30		
lin	Lomandraceae	*Lomandra confertifolia subsp. rubiginosa*		0.1	40						
lin	Lomandraceae	*Lomandra cylindrica*				0.5	50				
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	5	30			0.1	2		
lin	Lomandraceae	*Lomandra micrantha subsp. Tuberculata*	Small-flowered Mat-rush			0.5	50				
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush					0.1	15		
lin	Lomandraceae	*Lomandra obliqua*		5	50					0.1	20
lin	Loranthaceae	*Dendrophthoe vitellina*				0.01	1				
lin	Myrtaceae	*Angophora costata*	Sydney Red Gum	20	2			2	20	10	4
lin	Myrtaceae	*Corymbia eximia*	Yellow Bloodwood			15	5				

Status	Family	Genus species	Common Name	US2 C	US2 A	US7 C	US7 A	US11 C	US11 A	US12 C	US12 A
lin	Myrtaceae	*Corymbia gummifera*	Red Bloodwood	20	2	15	5	5	40	15	20
lin	Myrtaceae	*Eucalyptus ?resinifera*	Mahogany	1	2						
lin	Myrtaceae	*Eucalyptus agglomerata*	Blue-leaved Stringybark					12	25		
lin	Myrtaceae	*Eucalyptus pilularis*	Blackbutt			20	4				
lin	Myrtaceae	*Eucalyptus piperita*	Sydney Peppermint					5	10	5	10
lin	Myrtaceae	*Eucalyptus punctata*	Grey Gum							5	3
lin	Myrtaceae	*Eucalyptus sparsifolia*	Narrow-leaved Stringybark	0.5	1						
lin	Myrtaceae	*Kunzea ambigua*	Tick Bush	0.1	3						
lin	Myrtaceae	*Leptospermum ?polygalifolium*	Jelly Bush	0.1	3						
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree	10	7	1	5			0.5	20
lin	Myrtaceae	*Syncarpia glomulifera*	Turpentine	15	6	1	1	15	50	15	9
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily	5	25			1	50		
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge	0.1	40	0.5	50	1	500	0.05	75
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry	1	50			0.1	80	0.1	40
lin	Poaceae	*Cymbopogon refractus*	Barbed Wire Grass			0.5	50				
lin	Poaceae	*Entolasia marginata*	Bordered Panic	0.5	50						
lin	Poaceae	*Entolasia stricta*	Wiry Panic	1	100	0.1	100	1	300	0.01	5
lin	Poaceae	*Imperata cylindrica*	Blady Grass	1	100						
lin	Poaceae	*Microlaena stipoides*	Weeping Grass	0.5	50	0.01	3				
lin	Poaceae	*Panicum simile*	Two-colour Panic	0.1	1						
lin	Proteaceae	*Banksia spinulosa*	Hairpin Banksia	5	30	1	6			0.5	7
lin	Proteaceae	*Grevillea mucronulata*		20	100	0.1	10	0.1	1	0.5	15
lin	Proteaceae	*Grevillea parviflora subsp. Parviflora*	Small-flower Grevillea	1	30						
lin	Proteaceae	*Hakea dactyloides*	Finger Hakea	0.5	3						
lin	Proteaceae	*Hakea sericea*	Needlebush	0.1	1						
lin	Proteaceae	*Lomatia silaifolia*	Crinkle Bush	0.1	3					0.01	2
lin	Proteaceae	*Persoonia levis*	Broad-leaved Geebung	2	6	0.01	1			0.1	2
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung			1	5	1	40	0.1	2
lin	Proteaceae	*Persoonia mollis subsp. revoluta*		0.1	1						
lin	Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris					1	25		
lin	Rhamnaceae	*Pomaderris sp.*						25	500		
lin	Rubiaceae	*Pomax umbellata*	Pomax			0.5	100			0.01	30
lin	Rutaceae	*Boronia ledifolia*	Showy Boronia							0.5	10
lin	Rutaceae	*Correa reflexa*	Native Fuschia	0.1	4					0.1	10
lin	Rutaceae	*Eriostemon australasius*	Pink Wax Flower							0.1	7
lin	Santalaceae	*Exocarpos strictus*	Dwarf Cherry					0.1	1	0.01	2
lin	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush	0.1	1	0.1	10	5	500	1	15
lin	Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla	0.01	1					0.01	1
lin	Stylidiaceae	*Stylidium productum*								0.05	1
lin	Xanthorrhoeaceae	*Xanthorrhoea arborea*						5	30		
lin	Xanthorrhoeaceae	*Xanthorrhoea media*	Grass Tree			0.01	5			1	3

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US1 C	US1 A	US6 C	US6 A	US8 C	US8 A	US10 C	US10 A
Iin	Apiaceae	*Platysace linearifolia*						<1	2	0.01	20
Iin	Apiaceae	*Xanthosia pilosa*	Woolly Xanthosia	1	200			<1	1	0.01	2
Iin	Apiaceae	*Xanthosia tridentata*	Rock Xanthosia			1	20				
Iin	Araliaceae	*Astrotricha ledifolia*								0.5	20
Iin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak			1	2	7	70		
Iin	Cyperaceae	*Caustis flexuosa*	Curly Wig	<1	25			<1	50	0.5	20
Iin	Cyperaceae	*Cyathochaeta diandra*		10	700			1	300		
Iin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge			2	250	<1	50	2	100
Iin	Cyperaceae	*Lepidosperma sp.*						<1	1		
Iin	Cyperaceae	*Sedge sp.*								0.01	2
Iin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower					<1	1		
Iin	Dilleniaceae	*Hibbertia empetrifolia*		<1	1						
Iin	Ericaceae (Epacridoideae)	*?Leucopogon sp.*								0.01	2
Iin	Ericaceae (Epacridoideae)	*?Styphelia laeta*								0.01	2
Iin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath	2	20	1	2	<1	2		
Iin	Fabaceae (Faboideae)	*Bossiaea ?rhombifolia*								20	100
Iin	Fabaceae (Faboideae)	*Bossiaea buxifolia*						3	50		
Iin	Fabaceae (Faboideae)	*Bossiaea heterophylla*	Variable Bossiaea	1	15	1	20				
Iin	Fabaceae (Faboideae)	*Bossiaea obcordata*	Spiny Bossiaea	2	35			<1	50		
Iin	Fabaceae (Faboideae)	*Chorizema parviflorum*	Eastern Flame Pea	<1	5			<1	2		
Iin	Fabaceae (Faboideae)	*Dillwynia retorta*		2	500			<1	20	0.5	100
Iin	Fabaceae (Faboideae)	*Glycine microphylla*	Small-leaf Glycine			0.1	10				
Iin	Fabaceae (Faboideae)	*Gompholobium glabratum*	Dainty Wedge Pea	10	100						
Iin	Fabaceae (Faboideae)	*Pultenaea flexilis*	Graceful Bush-pea							5	20
Iin	Fabaceae (Mimosoideae)	*Acacia fimbriata*	Fringed Wattle			1	25				
Iin	Fabaceae (Mimosoideae)	*Acacia linifolia*	White Wattle	10	100	1	10	<1	20	2	20
Iin	Fabaceae (Mimosoideae)	*Acacia prominens*	Golden Rain Wattle			1	1				
Iin	Fabaceae (Mimosoideae)	*Acacia terminalis*	Sunshine Wattle							0.1	10
Iin	Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses	<1	1	1	10				
Iin	Goodeniaceae	*Dampiera purpurea*		<1	50	1	5				
Iin	Goodeniaceae	*Scaevola ramosissima*	Purple Fan-flower	<1	50	1	1				
Iin	Iridaceae	*Patersonia spp.*						<1	1		
Iin	Lindsaeaceae	*Lindsaea linearis*	Screw Fern					<1	50		
Iin	Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge Fern							0.01	5
Iin	Loganiaceae	*Logania albiflora*								0.5	40
Iin	Lomandraceae	*Lomandra confertifolia*	Matrush	<1	1000						
Iin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush			1	250				
Iin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			1	20				
Iin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush	<1	100					0.01	5

Status	Family	Genus species	Common Name	US1 C	US1 A	US6 C	US6 A	US8 C	US8 A	US10 C	US10 A
Iin	Lomandraceae	*Lomandra obliqua*		<1	1000	1	500	1	300		
Iin	Lomandraceae	*Lomandra sp.*								0.1	1
Iin	Lomandraceae	*Lomandra sp. 2*								0.01	1
Iin	Myrtaceae	*Angophora costata*	Sydney Red Gum	11	2	1	1	<1	5	5	3
Iin	Myrtaceae	*Corymbia eximia*	Yellow Bloodwood			1	2	5	46	5	3
Iin	Myrtaceae	*Corymbia gummifera*	Red Bloodwood	40	28			30	10	15	5
Iin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark	12	9						
Iin	Myrtaceae	*Eucalyptus globoidea*	White Stringybark					1	1		
Iin	Myrtaceae	*Eucalyptus pilularis*	Blackbutt			30	6	3	2	20	12
Iin	Myrtaceae	*Eucalyptus punctata*	Grey Gum			1	1				
Iin	Myrtaceae	*Eucalyptus resinifera*	Red Mahogany	2	2						
Iin	Myrtaceae	*Eucalyptus sparsifolia*	Narrow-leaved Stringybark	14	2						
Iin	Myrtaceae	*Leptospermum polygalifolium*	Tantoon			1	17				
Iin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree	10	60	1	10	<1	25	2	15
Iin	Myrtaceae	*Syncarpia glomulifera*	Turpentine	2	10	2	1	82	5	5	3
Iin	Orchidaceae	*Acianthus fornicatus*	Pixie Caps					<1	50		
Iin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily					<1	2	0.01	2
Iin	Phormiaceae	*Dianella revoluta*	Blueberry Lily			1	25				
Iin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge	1	500	1	50	<1	50		
Iin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry	<1	100			1	20		
Iin	Poaceae	*Anisopogon avenaceus*	Oat Speargrass	<1	20	1	25				
Iin	Poaceae	*Aristida vagans*	Threeawn Speargrass			1	100				
Iin	Poaceae	*Entolasia marginata*	Bordered Panic	2	1600			<1	800		
Iin	Poaceae	*Entolasia stricta*	Wiry Panic	3	600	1	500	<1	800	0.01	40
Iin	Poaceae	*Eragrostis brownii*	Brown's Lovegrass			1	1				
Iin	Poaceae	*Imperata cylindrica*	Blady Grass			1	300				
Iin	Poaceae	*Microlaena stipoides*	Weeping Grass			1	175				
Iin	Poaceae	*Panicum simile*	Two-colour Panic	<1	100						
Iin	Poaceae	*Themeda triandra*				1	25				
Iin	Proteaceae	*Banksia serrata*	Old-man Banksia	<1	1						
Iin	Proteaceae	*Banksia spinulosa*	Hairpin Banksia	3	15	1	3	<1	14	2	20
Iin	Proteaceae	*Grevillea buxifolia*	Grey Spider Flower							1	20
Iin	Proteaceae	*Grevillea mucronulata*		10	70	1	20	<1	2		
Iin	Proteaceae	*Grevillea parviflora subsp. Parviflora*	Small-flower Grevillea	13	3			<1	1		
Iin	Proteaceae	*Grevillea sphacelata*	Grey Spider Flower					<1	1		
Iin	Proteaceae	*Hakea dactyloides*	Finger Hakea					<1	2	1	5
Iin	Proteaceae	*Lambertia formosa*	Mountain Devil					<1	4	1	5
Iin	Proteaceae	*Lomatia silaifolia*	Crinkle Bush							0.01	2
Iin	Proteaceae	*Persoonia levis*	Broad-leaved Geebung	<1	1			<1	2		
Iin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	2	30	1	10			0.5	30
Iin	Proteaceae	*Persoonia mollis*	Soft Geebung	<1	1						
Iin	Proteaceae	*Persoonia mollis subsp. revoluta*				1	1				

Status	Family	Genus species	Common Name	US1 C	US1 A	US6 C	US6 A	US8 C	US8 A	US10 C	US10 A
Iin	Proteaceae	*Petrophile pedunculata*	Conesticks					<1	7	0.01	2
Iin	Proteaceae	*Xylomelum pyriforme*	Native Pear					<1	1	0.1	5
Iin	Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris							0.01	6
Iin	Rubiaceae	*Pomax umbellata*	Pomax	<1	100	1	20				
Iin	Rutaceae	*Boronia ledifolia*	Showy Boronia							0.01	5
Iin	Rutaceae	*Eriostemon australasius*	Pink Wax Flower	2	40						
Iin	Stylidiaceae	*Stylidium productum*								0.01	1
Iin	Thymelaeaceae	*Pimelea latifolia*				1	2	<1	2		
Iin	Xanthorrhoeaceae	*Xanthorrhoea arborea*								2	9
Iin	Xanthorrhoeaceae	*Xanthorrhoea media*						<1	3		
Iin	Xanthorrhoeaceae	*Xanthorrhoea spp.*		<1	1						

Notes: Status (Native, Iin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US13 C	US13 A
lin	Apiaceae	*Platysace linearifolia*		1	40
lin	Apiaceae	*Xanthosia pilosa*	Woolly Xanthosia	0.01	20
lin	Araliaceae	*Astrotricha ledifolia*		1	10
lin	Cyperaceae	*Caustis flexuosa*	Curly Wig	0.01	20
lin	Cyperaceae	*Cyathochaeta diandra*		1	40
lin	Ericaceae (Epacridoideae)	*?Styphelia laeta*	Five-corners	0.01	1
lin	Fabaceae (Faboideae)	*Bossiaea obcordata*	Spiny Bossiaea	1	10
lin	Fabaceae (Faboideae)	*Dillwynia retorta*		0.01	2
lin	Iridaceae	*Patersonia glabrata*	Leafy Purple-flag	0.01	40
lin	Loganiaceae	*Logania albiflora*		0.01	4
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush	0.01	5
lin	Myrtaceae	*Corymbia eximia*	Yellow Bloodwood	40	10
lin	Myrtaceae	*Corymbia gummifera*	Red Bloodwood	10	5
lin	Myrtaceae	*Eucalyptus agglomerata*	Blue-leaved Stringybark	5	1
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree	15	40
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge	0.05	50
lin	Picrodendraceae	*Micrantheum ericoides*		0.01	4
lin	Poaceae	*Entolasia stricta*	Wiry Panic	0.01	100
lin	Proteaceae	*Banksia spinulosa*	Hairpin Banksia	10	15
lin	Proteaceae	*Grevillea buxifolia*	Grey Spider Flower	0.1	15
lin	Proteaceae	*Lambertia formosa*	Mountain Devil	15	25
lin	Proteaceae	*Persoonia levis*	Broad-leaved Geebung	2	7
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	0.5	10
lin	Proteaceae	*Xylomelum pyriforme*	Native Pear	0.01	3
lin	Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris	0.01	4
lin	Rutaceae	*Boronia ledifolia*	Showy Boronia	0.01	3
lin	Rutaceae	*Eriostemon australasius*	Pink Wax Flower	0.01	4
lin	Xanthorrhoeaceae	*Xanthorrhoea arborea*		0.1	15

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

				US27	US27	US28	US28	US31	US31	US32	US32	US34	US34	US41	US41	US90	US90
Status	**Family**	**Genus species**	**Common Name**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet					0.01	200			0.1	25				
lin	Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower					0.01	200								
lin	Amaranthaceae	*Nyssanthes ?diffusa*	Barbwire Weed											0.1	200		
HTW	Apocynaceae	*Araujia sericifera*	Moth Vine											0.001	200		
lin	Apocynaceae	*Parsonsia straminea*	Common Silkpod							1	1						
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora													0.1	100
lin	Araliaceae	*Hydrocotyle laxiflora*	Stinking Pennywort					0.1	100	0.1	500	0.1	100				
lin	Araliaceae	*Hydrocotyle sibthorpioides*														0.1	40
lin	Araliaceae	*Polyscias sambucifolia*	Elderberry Ash			0.1	2										
lin	Asteraceae	*Ageratina adenophora*	Crofton Weed													0.1	10
*	Asteraceae	*Bidens bipinnata*	Bipinnate Beggar's Ticks											0.01	500		
*	Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane													0.1	10
lin	Asteraceae	*Senecio linearifolius*	Fireweed Groundsel			0.01	1									0.5	50
lin	Asteraceae	*Sigesbeckia orientalis*	Indian Weed											0.5	200		
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot			0.5	50	0.01	1000	0.1	500	0.2	200	4	1600	0.01	1
lin	Cannabaceae	*Trema tomentosa*	Native Peach	0.01	1									0.5	4	2	6
lin	Caryophyllaceae	*Stellaria flaccida*														0.1	20
lin	Casuarinaceae	*Casuarina cunninghamiana*	River Oak							40	17			0.5	1	10	2
lin	Celastraceae	*Denhamia silvestris*	Narrow-leaved Orangebark									0.1	5				
lin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew							0.01	25						
lin	Commelinaceae	*Tradescantia fluminensis*	Wandering Jew											0.01	100	0.1	10
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed			0.1	100	0.1	100	0.1	1000	2	500	20	5000	0.4	400
lin	Cyperaceae	*Carex ?breviculmis*						5	2000								
lin	Cyperaceae	*Carex appressa*	Tall Sedge							0.1	5	1	50				
lin	Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge											0.5	500		
lin	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge	0.001	1			2	2000								
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	2	600	1	500	0.01	1	2	10	0.1	5			0.1	2
lin	Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern													5	100
lin	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken	20	500	2	50	2	200	10	150	5	500	10	1000	5	200
lin	Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern													5	20
lin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower	0.5	20	1	25										
lin	Dilleniaceae	*Hibbertia obtusifolia*	Hoary Guinea Flower	0.01	2												
lin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash							0.1	1						
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath	0.5	20									0.01	10	0.1	4
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath			1	25										
lin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil					0.1	50					0.01	200		
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine			0.5	100	0.5	100	1	1000	3	1000			0.01	2
lin	Fabaceae (Faboideae)	*Glycine microphylla*	Small-leaf Glycine					0.1	50								
lin	Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo			1	5										

				US27	US27	US28	US28	US31	US31	US32	US32	US34	US34	US41	US41	US90	US90
Status	Family	Genus species	Common Name	C	A	C	A	C	A	C	A	C	A	C	A	C	A
lin	Fabaceae (Mimosoideae)	*Acacia dealbata*	Silver Wattle							2	5	3	15				
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally													5	5
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle											5	6		
lin	Fabaceae (Mimosoideae)	*Acacia parvipinnula*	Silver-stemmed Wattle	10	15	1	15	5	8								
lin	Geraniaceae	*Geranium homeanum*						0.5	100			0.01	10	1	1600		
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia			0.5	150										
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum													0.5	8
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush			0.1	50					0.5	25				
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	1	200	3	100			2	8	3	20			1	102
lin	Malvaceae	*Sida corrugata*	Corrugated Sida											0.001	20		
lin	Menispermaceae	*Stephania japonica*	Snake vine	5	100	0.5	50	2	2000	4	300	10	500	3	2000	0.5	100
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple	10	6	20	5							40	9		
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle							0.1	2						
lin	Myrtaceae	*Eucalyptus benthamii*	Camden White Gum	30	6	25	2	35	3	2	2	55	8				
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	5	5	5	5							2	3		
lin	Myrtaceae	*Eucalyptus deanei*	Mountain Blue Gum					40	4			5	1			10	2
lin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark	10	2	10	1										
lin	Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum											15	6		
lin	Myrtaceae	*Leptospermum polygalifolium*	Tantoon							1	3						
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree							1	3	0.1	1				
lin	Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark							1	4						
lin	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree					2	2	1	1					1	4
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive	1	2									1	50		
lin	Oxalidaceae	*Oxalis perennans*	Oxalis			0.5	150	1	1000	0.5	500	2	100	5	4000	1	400
*	Passifloraceae	*Passiflora caerulea*	Blue Passionflower											0.01	20		
lin	Passifloraceae	*Passiflora herbertiana*	Native Passionfruit									0.1	1	0.01	200	0.1	5
lin	Phormiaceae	*Dianella revoluta*	Blueberry Lily	0.01	20	1	5					0.1	25				
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush			0.01	1			0.5	1	0.1	5	1	100		
lin	Phyllanthaceae	*Phyllanthus gunnii*	Scrubby Spurge													0.5	20
lin	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera							0.1	100					0.5	200
lin	Pittosporaceae	*Bursaria longisepala*				0.5	10							0.001	10		
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	0.4	2	1	25			0.1	1	0.1	1	2	1		
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell					1	5000			0.2	200	1	500		
lin	Poaceae	*Ehrharta erecta*	Panic Veldtgrass							0.1	50						
lin	Poaceae	*Entolasia marginata*	Bordered Panic					1	5000	0.01	50	0.5	100	1	400	0.1	30
lin	Poaceae	*Entolasia stricta*	Wiry Panic			0.1	50										

Status	Family	Genus species	Common Name	US27 C	US27 A	US28 C	US28 A	US31 C	US31 A	US32 C	US32 A	US34 C	US34 A	US41 C	US41 A	US90 C	US90 A
lin	Poaceae	*Imperata cylindrica*	Blady Grass							0.01	50	0.1	50				
lin	Poaceae	*Microlaena stipoides*	Weeping Grass			0.1	50			0.2	2000	0.5	100	40	10000	1	400
lin	Poaceae	*Oplismenus aemulus*	Australian Basket Grass			0.1	50	5	10000					15	8000	0.5	50
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass					1	5000	0.1	500	0.5	100				
lin	Poaceae	*Panicum simile*	Two-colour Panic	0.01	3												
lin	Poaceae	*Rytidosperma spp.*	Wallaby Grass	0.001	1												
*	Poaceae	*Setaria sp.*								0.01	1						
lin	Podocarpaceae	*Podocarpus spinulosus*	Spiny-leaf Podocarp	20	500	55	200	20	200			0.1	3				
lin	Polygonaceae	*Rumex brownii*	Swamp Dock											0.1	500		
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern			0.1	25							0.001	50	0.1	100
lin	Pteridaceae	*Pellaea falcata*	Sickle Fern											0.1	200	1	50
lin	Pteridaceae	*Pteris tremula*	Tender Brakefern													1	1
lin	Ranunculaceae	*Clematis aristata*	Old Man's Beard			0.01	1			1	1			0.1	400		
lin	Rhamnaceae	*Alphitonia excelsa*	Red Ash											0.01	1		
lin	Rosaceae	*Rubus parvifolius*	Native Raspberry									0.5	30				
lin	Rosaceae	*Rubus rosifolius*	Native Raspberry													0.5	50
lin	Rubiaceae	*Gynochthodes jasminoides*	Sweet Morinda													0.5	50
lin	Rubiaceae	*Pomax umbellata*	Pomax			0.1	50										
lin	Solanaceae	*Duboisia myoporoides*	Poison Corkwood	5	20	2	5									2	2
*	Solanaceae	*Physalis sp.*												0.01	40		
lin	Solanaceae	*Solanum americanum*	Glossy Nightshade											0.01	20		
lin	Solanaceae	*Solanum pungetium*	Eastern Nightshade					0.01	3					0.1	100		
lin	Urticaceae	*Urtica incisa*	Stinging Nettle											1	1600	0.5	40
lin	Violaceae	*Melicytus dentatus*	Tree Violet	1	1									0.1	3		
lin	Vitaceae	*Cayratia clematidea*	Native Grape	0.01	3					1	2			1	1600	0.5	100
lin	Vitaceae	*Cissus antarctica*	Kangaroo Vine											1	100		
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine													10	30

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US24 C	US24 A	US38 C	US38 A	US39 C	US39 A	US44 C	US44 A	US79 C	US79 A	US85 C	US85 A
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet									1	50		
lin	Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily			0.001	1								
lin	Anthericaceae	*Caesia parviflora*		0.001	10										
lin	Aphanopetalaceae	*Aphanopetalum resinosum*	Gum Vine			2	10			10	5				
lin	Apocynaceae	*Marsdenia flavescens*	Hairy Milk Vine					1	100	1	100				
lin	Apocynaceae	*Parsonsia straminea*	Common Silkpod	0.001	25			0.01	2						
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora					1	30						
lin	Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern							0.001	20				
lin	Asteraceae	*Senecio linearifolius*	Fireweed Groundsel									1	1		
lin	Asteraceae	*Senecio prenanthoides*								0.001	1				
lin	Asteraceae	*Sigesbeckia orientalis*	Indian Weed			0.1	50								
lin	Atherospermataceae	*Doryphora sassafras*	Sassafras							5	2				
lin	Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	0.001	1	0.1	25	2	4	1	100			1	2
lin	Blechnaceae	*Doodia aspera*	Prickly rasp fern			0.1	50	0.5	100	10	500	1	100		
lin	Blechnaceae	*Doodia caudata*	Small rasp fern	0.001	2										
lin	Boraginaceae	*Ehretia acuminata*	Koda					x	x	20	30				
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot									2	500		
lin	Caryophyllaceae	*Stellaria flaccida*						0.01	2	0.001	20				
lin	Casuarinaceae	*Casuarina cunninghamiana*	River Oak			2	1								
lin	Commelinaceae	*Aneilema acuminatum*						0.1	200						
lin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew			0.001	10			0.5	200				
lin	Commelinaceae	*Tradescantia fluminensis*	Wandering Jew			5	4000								
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed			0.1	100	0.01	50			10	100		
lin	Cyperaceae	*Cyperus sp.*						1	10						
lin	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge									1	1	1	10
lin	Cyperaceae	*Gahnia melanocarpa*	Black Fruit Saw-sedge	0.001	4										
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	3	150					1	20	1	1		
lin	Cyperaceae	*Schoenus melanostachys*	Black Bog-rush											0.1	1
lin	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken			0.1	500	0.01	300	2	1000				
lin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower	0.001	1							1	1		
lin	Dryopteridaceae	*Polystichum proliferum*	Mother Shield Fern							1	10				
lin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash									1	2		
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath	0.1	20							5	50		
lin	Euphorbiaceae	*Claoxylon australe*	Brittlewood							5	20				
lin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil							0.05	20	1	50		
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine									1	100		
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally									15	100		
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle	0.001	1					5	5				
lin	Geraniaceae	*Geranium homeanum*				0.01	100								
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia									1	50		
lin	Iridaceae	*Libertia paniculata*	Branching Grass-flag					0.01	10						
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum									1	2		

Status	Family	Genus species	Common Name	US24 C	US24 A	US38 C	US38 A	US39 C	US39 A	US44 C	US44 A	US79 C	US79 A	US85 C	US85 A
lin	Lamiaceae	*Plectranthus parviflorus*	Cockspur Flower			0.01	50								
lin	Lamiaceae	*Prostanthera sp.*	Mint Bushes											1	5
lin	Lauraceae	*Cassytha pubescens*										1	25		
lin	Lomandraceae	*Lomandra filiformis subsp. coriacea*	Wattle Matt-rush							0.01	100				
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush					0.5	1			1	5		
lin	Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry					0.1	20	0.1	20	1	10		
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily	0.001	1	0.1	20	0.1	20	0.5	20	1	2	1	2
lin	Meliaceae	*Toona ciliata*	Red Cedar							20	10				
lin	Menispermaceae	*Stephania japonica*	Snake vine			2	100	0.1	20	5	20				
lin	Moraceae	*Ficus coronata*	Sandpaper Fig			2	30	30	6	40	30				
lin	Myrtaceae	*Angophora bakeri*	Narrow-leaved Apple									1	5		
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple			10	2								
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle	90	87	90	49	80	30	60	4			85	50
lin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark									5	2		
lin	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark									10	1		
lin	Myrtaceae	*Eucalyptus punctata*	Grey Gum									15	8	40	2
lin	Myrtaceae	*Eucalyptus sclerophylla*	Hard-leaved Scribbly Gum									1	1		
lin	Myrtaceae	*Leptospermum polygalifolium*	Tantoon									1	25		
lin	Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark									5	25		
lin	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree	2	3							50	50	10	1
lin	Myrtaceae	*Tristaniopsis laurina*	Water Gum					5	1						
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive	0.1	10			1	20			1	2	2	5
lin	Oleaceae	*Notelaea sp.*				1	10								
lin	Orchidaceae	*Dendrobium linguiforme*	Tongue Orchid			0.001	1								
lin	Orchidaceae	*Plectorrhiza tridentata*	Tangle Orchid					0.001	20						
lin	Orchidaceae	*Sarcochilus hillii*								0.001	1				
lin	Orchidaceae	*Sarcochilus sp.*												0.1	1
lin	Oxalidaceae	*Oxalis perennans*	Oxalis									1	50		
lin	Passifloraceae	*Passiflora herbertiana*	Native Passionfruit			0.001	25			0.01	20	1	2		
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily	0.001	2					0.001	1	1	1	0.1	1
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	0.1	20	0.1	1					1	25		
lin	Phyllanthaceae	*Phyllanthus gunnii*	Scrubby Spurge			0.001	20	2	30						
lin	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera									1	50	1	3
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry									1	50		
lin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum					0.1	2			2	25	2	20
lin	Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum					10	2						
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell	0.001	1										
lin	Poaceae	*Entolasia marginata*	Bordered Panic	0.001	20					0.005	200	1	50		
lin	Poaceae	*Entolasia stricta*	Wiry Panic											1	20
lin	Poaceae	*Microlaena stipoides*	Weeping Grass									2	100	1	20
lin	Poaceae	*Oplismenus aemulus*	Australian Basket Grass					2	300	0.5	100				
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass	0.001	20	1	800			0.001	10	2	100	1	20

Status	Family	Genus species	Common Name	US24 C	US24 A	US38 C	US38 A	US39 C	US39 A	US44 C	US44 A	US79 C	US79 A	US85 C	US85 A
lin	Poaceae	*Panicum ?simile*	Two-colour Panic							0.1	8				
lin	Poaceae	*Poaceae spp.*						0.001	3						
lin	Polypodiaceae	*Pyrrosia rupestris*	Rock Felt Fern			0.1	50	1	50						
lin	Primulaceae	*Myrsine howittiana*	Brush muttonwood					0.5	5	10	20				
lin	Primulaceae	*Myrsine variabilis*										2	10		
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung									1	1		
lin	Pteridaceae	*Adiantum aethiopicum*	Common Maidenhair	0.001	12	5	1600	10	200			10	100	0.1	1
lin	Pteridaceae	*Adiantum atroviride*								5	100				
lin	Pteridaceae	*Adiantum formosum*	Giant Maidenhair							5	5				
lin	Pteridaceae	*Adiantum hispidulum*	Rough Maidenhair Fern					30	300					0.01	3
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern									1	500		
lin	Pteridaceae	*Pellaea falcata*	Sickle Fern			5	1600	1	100	5	50				
lin	Pteridaceae	*Pellaea nana*	Dwarf Sickle Fern			0.01	100			0.01	5				
lin	Pteridaceae	*Pteris tremula*	Tender Brakefern					0.1	5						
lin	Ranunculaceae	*Clematis aristata*	Old Man's Beard			0.1	800	0.1	20			1	25		
lin	Ranunculaceae	*Clematis glycinoides*	Headache Vine											1	2
lin	Rhamnaceae	*Alphitonia excelsa*	Red Ash					0.01	1						
lin	Rosaceae	*Rubus rosifolius*	Native Raspberry	0.001	2					1	40	1	1		
lin	Rubiaceae	*Galium ?leiocarpum*										1	1		
lin	Rubiaceae	*Gynochthodes jasminoides*	Sweet Morinda	0.001	20			0.1	200	5	200			1	1
lin	Sapindaceae	*Alectryon subcinereus*	Native quince					1	10	20	30				
lin	Solanaceae	*Solanum prinophyllum*	Forest Nightshade									1	25		
lin	Solanaceae	*Solanum pungetium*	Eastern Nightshade			0.01	20								
lin	Solanaceae	*Solanum sp.*				0.001	1								
lin	Solanaceae	*Solanum stelligerum*	Devil's Needles							0.1	2				
lin	Violaceae	*Melicytus dentatus*	Tree Violet					5	3	5	20				
lin	Violaceae	*Viola silicestris*	Sandstone Violet	0.001	1										
lin	Vitaceae	*Cayratia clematidea*	Native Grape			1	10	0.001	2	0.001	20				
lin	Vitaceae	*Cissus antarctica*	Kangaroo Vine					1	5			1	1		
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine							40	10	1	25	1	1

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US13 C	US13 A
lin	Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower	0.01	2
lin	Apocynaceae	*Parsonsia straminea*	Common Silkpod	2	30
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora	0.01	2
lin	Araliaceae	*Hydrocotyle sibthorpioides*		0.01	1
lin	Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	0.1	40
lin	Blechnaceae	*Blechnum nudum*	Fishbone water fern	0.1	10
lin	Blechnaceae	*Doodia aspera*	Prickly rasp fern	0.1	30
lin	Casuarinaceae	*Casuarina cunninghamiana*	River Oak	25	9
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed	0.01	20
lin	Cunoniaceae	*Ceratopetalum apetalum*	Coachwood	3	60
lin	Cyperaceae	*Carex sp*	A Sedge	0.01	20
lin	Cyperaceae	*Lepidosperma viscidum*		0.1	40
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle	0.5	1
lin	Iridaceae	*Libertia paniculata*	Branching Grass-flag	0.01	10
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	0.01	1
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily	0.1	100
lin	Menispermaceae	*Legnephora moorei*	Round-leaf Vine	0.1	3
lin	Menispermaceae	*Stephania japonica*	Snake vine	0.5	50
lin	Myrtaceae	*Acmena smithii*	Lilly Pilly	10	8
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple	5	2
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle	35	16
lin	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree	1	2
lin	Myrtaceae	*Tristaniopsis laurina*	Water Gum	25	30
lin	Oxalidaceae	*Oxalis perennans*	Oxalis	0.01	1
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily	0.01	2
lin	Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree	15	25
lin	Phyllanthaceae	*Phyllanthus gunnii*	Scrubby Spurge	1	30
lin	Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	2	30
lin	Poaceae	*Entolasia marginata*	Bordered Panic	0.01	200
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass	0.01	400

Status	Family	Genus species	Common Name	US13 C	US13 A
lin	Primulaceae	*Myrsine variabilis*		1	40
lin	Proteaceae	*Stenocarpus salignus*	Scrub Beefwood	2	30
lin	Pteridaceae	*Pellaea falcata*	Sickle Fern	0.1	10
lin	Ranunculaceae	*Clematis spp.*		0.1	400
lin	Rubiaceae	*Gynochthodes jasminoides*	Sweet Morinda	0.1	400
lin	Rutaceae	*Zieria sp.*		0.01	2
lin	Sapindaceae	*Alectryon subcinereus*	Native quince	1	40
lin	Smilacaceae	*Smilax australis*	Barbwire Vine	0.1	20
lin	Uvulariaceae	*Schelhammera undulata*		0.01	20
lin	Violaceae	*Melicytus dentatus*	Tree Violet	0.1	5
lin	Violaceae	*Viola silicestris*	Sandstone Violet	0.01	1
lin	Vitaceae	*Cissus antarctica*	Kangaroo Vine	1	20
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine	4	20

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

				US16	US16	US17	US17	US21	US21	US78	US78	US82	US82	US91	US91	US92	US92	US93	US93	US95	US95
Status	Family	*Genus species*	Common Name	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet					1	20	0.01	400										
lin	Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower	0.5	1000																
lin	Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily			1	150	0.001	1												
lin	Anthericaceae	*Caesia parviflora*																		1	1000
lin	Apiaceae	*Platysace linearifolia*										0.01	50								
lin	Apocynaceae	*Marsdenia suaveolens*	Scented Marsdenia					0.01	2									1	1		
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora	0.1	20	1	3000							0.1	20	0.1	10			1	800
lin	Araliaceae	*Astrotricha latifolia*								0.5	5			1	12	0.5	10				
lin	Araliaceae	*Hydrocotyle geraniifolia*	Forest Pennywort	0.1	50																
lin	Araliaceae	*Hydrocotyle sibthorpioides*								0.1	400			0.01	1					1	3000
lin	Araliaceae	*Polyscias sambucifolia*	Elderberry Ash			1	10														
lin	Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern	1	400																
lin	Asteraceae	*Brachyscome graminea*	Grass Daisy			1	20														
lin	Asteraceae	*Brachyscome graminea*	Grass Daisy							0.001	200	0.5	100								
lin	Asteraceae	*Lagenophora stipitata*	Blue Bottle-daisy							0.001	10	0.01	100								
lin	Asteraceae	*Olearia microphylla*										0.01	2								
lin	Asteraceae	*Olearia viscidula*	Wallaby Weed	2	40					2	30			2	30			1	10		
lin	Asteraceae	*Ozothamnus diosmifolius*	White Dogwood							0.01	1							1	30		
lin	Asteraceae	*Senecio linearifolius*	Fireweed Groundsel							0.01	50			1	50	0.1	10				
lin	Asteraceae	*Sigesbeckia orientalis*	Indian Weed													0.1	10				
lin	Asteraceae	*Xerochrysum bracteatum*	Golden Everlasting							0.001	10										
lin	Atherospermataceae	*Doryphora sassafras*	Sassafras													1	1				
lin	Blechnaceae	*Blechnum cartilagineum*	Gristle Fern													0.1	20				
lin	Blechnaceae	*Doodia aspera*	Prickly rasp fern	50	5000	5	1200			0.5	20			1	500	0.5	70				
lin	Blechnaceae	*Doodia caudata*	Small rasp fern											4	50						
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot			1	4000			0.05	400							1	50	1	3000
lin	Caryophyllaceae	*Stellaria flaccida*														0.1	50				
lin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak			2	300			1	1	0.05	2					1	1		
lin	Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	25	25			10	120					10	20	5	1			10	30
lin	Casuarinaceae	*Casuarina cunninghamiana*	River Oak							0.001	1										
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed	0.01	25	1	4000	1	100	0.5	4000			1	400	1	1000	1	30	1	3000
lin	Crassulaceae	*Crassula sieberiana*	Australian Stonecrop											1	40						
lin	Cunoniaceae	*Callicoma serratifolia*	Black Wattle													0.1	1				
lin	Cunoniaceae	*Ceratopetalum apetalum*	Coachwood													5	1				
lin	Cyperaceae	*Cyathochaeta diandra*										0.001	2								
lin	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge	0.01	1													0.1	1		
lin	Cyperaceae	*Gahnia melanocarpa*	Black Fruit Saw-sedge					0.01	3					0.1	3						
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge					0.5	50	2	3	0.1	2	0.1	8	0.05	2	30	60	30	5200
lin	Cyperaceae	*Lepidosperma sp.*																1	1		
lin	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken	0.1	10									1	20	5	200			0.5	50
lin	Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern													40	1000				
lin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower											0.1	5			20	40		

Status	Family	*Genus* species	Common Name	US16 C	US16 A	US17 C	US17 A	US21 C	US21 A	US78 C	US78 A	US82 C	US82 A	US91 C	US91 A	US92 C	US92 A	US93 C	US93 A	US95 C	US95 A
lin	Dilleniaceae	*Hibbertia dentata*	Trailing Guinea Flower													0.1	10				
lin	Dilleniaceae	*Hibbertia diffusa*	Wedge Guinea Flower											0.1	10						
lin	Dilleniaceae	*Hibbertia empetrifolia*										0.5	2								
lin	Dilleniaceae	*Hibbertia obtusifolia*	Hoary Guinea Flower					1	10									20	40		
lin	Dilleniaceae	*Hibbertia scandens*	Climbing Guinea Flower	1	25																
lin	Dryopteridaceae	*Lastreopsis acuminata*	Creeping Shield Fern							0.01	1										
lin	Dryopteridaceae	*Polystichum australiense*	Harsh Shield Fern	1	40																
lin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash											0.1	1	0.2	1				
lin	Ericaceae (Epacridoideae)	*Acrotriche divaricata*						0.01	2												
lin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry					0.1	5									1	1		
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath			1	5	0.01	1	1	30							2	50	0.5	2
lin	Ericaceae (Epacridoideae)	*Leucopogon lanceolatus*																		0.5	1
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath					0.5	15									2	50		
lin	Ericaceae (Epacridoideae)	*Monotoca ledifolia*						0.01	2												
lin	Ericaceae (Epacridoideae)	*Styphelia triflora*	Pink Five-Corners															1	1		
lin	Fabaceae (Faboideae)	*?Pultenea*																5	20		
lin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	0.01	1					0.05	20			0.1	10					0.5	3000
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine	0.01	25	1	200	0.01	1									1	20	0.5	4000
lin	Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla									0.001	1								
lin	Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo	1	50																
lin	Fabaceae (Faboideae)	*Podolobium ilicifolium*	Prickly Shaggy Pea									2	50								
lin	Fabaceae (Faboideae)	*Pultenaea daphnoides*	Large-leaf Bush-pea			1	200														
lin	Fabaceae (Faboideae)	*Pultenaea flexilis*	Graceful Bush-pea			1	20														
lin	Fabaceae (Mimosoideae)	*Acacia clunies-rossiae*	Kowmung wattle					0.01	2												
lin	Fabaceae (Mimosoideae)	*Acacia decurrens*	Black Wattle	20	50					1	1			2	5			1	4	0.5	5
lin	Fabaceae (Mimosoideae)	*Acacia falcata*				1	5					0.01	1								
lin	Fabaceae (Mimosoideae)	*Acacia falciformis*	Broad-leaved Hickory	0.1	3																
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally	5	20	1	10			3	30	0.5	4	2	25	1	3	1	10	0.5	20
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle					0.1	30									1	1		
lin	Fabaceae (Mimosoideae)	*Acacia longifolia*				1	1														
lin	Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle					0.1	10												
lin	Geraniaceae	*Geranium homeanum*												0.2	5						
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia									0.01	10					1	45		
lin	Hypericaceae	*Hypericum gramineum*	Small St John's Wort							0.05	20										
lin	Hypericaceae	*Hypericum japonicum*						0.1	40												
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum	0.1	20	1	25							1	30	0.5	5			0.5	30
lin	Lamiaceae	*Plectranthus parviflorus*	Cockspur flower			1	1														
lin	Lauraceae	*Cassytha pubescens*																1	2		
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush									0.01	30							0.5	500
lin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush															1	10		
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			1	5	0.5	1			0.5	1	0.1	4	0.1	7			0.5	50
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush					0.01	4									1	5		

				US16	US16	US17	US17	US21	US21	US78	US78	US82	US82	US91	US91	US92	US92	US93	US93	US95	US95
Status	**Family**	***Genus* species**	**Common Name**	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
lin	Lomandraceae	*Lomandra obliqua*																1	5		
lin	Lomandraceae	*Lomandra sp.*						0.01	40												
lin	Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	1	200	1	500													0.5	1
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily	1	15	1	1000							0.1	10	0.1	10			0.5	50
lin	Menispermaceae	*Stephania japonica*	Snake vine	1	30	1	50			1	500			1	50	0.5	20			0.5	1
lin	Moraceae	*Ficus coronata*	Sandpaper Fig							0.5	1										
lin	Myrtaceae	*Angophora bakeri*	Narrow-leaved Apple					0.01	2			3	1								
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple	15	7	1	2							45	2	20	2	5	3	25	4
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle									0.5	1			0.5	2				
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark					0.01	1												
lin	Myrtaceae	*Eucalyptus deanei*	Mountain Blue Gum	15	8	20	6			45	10			5	10	40	3			15	1
lin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark			10	1											6	6		
lin	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark					30	6									2	10		
lin	Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum							5	1										
lin	Myrtaceae	*Eucalyptus pilularis*	Blackbutt					0.5	1												
lin	Myrtaceae	*Eucalyptus piperita*	Sydney Peppermint									30	7							5	2
lin	Myrtaceae	*Eucalyptus punctata*	Grey Gum					10	3	5	1	30	8	15	2					5	1
lin	Myrtaceae	*Eucalyptus sparsifolia*	Narrow-leaved Stringybark							5	10	5	1								
lin	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum					5	2												
lin	Myrtaceae	*Kunzea ambigua*	Tick Bush							2	2							1	10		
lin	Myrtaceae	*Leptospermum polygalifolium*	Tantoon							1	15							1	10		
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree									2	40					10	30	0.5	5
lin	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree			1	20	0.5	5	5	17										
lin	Myrtaceae	*Syncarpia glomulifera*	Turpentine			10	40	2	4												
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive			1	3	0.5	6	0.5	1									0.5	1
lin	Orchidaceae	*Chiloglottis diphylla*										0.0001	30								
lin	Orchidaceae	*Cymbidium suave*	Snake Orchid					0.01	1							0.01	2				
lin	Oxalidaceae	*Oxalis perennans*	Oxalis							0.01	1500			0.01	1					0.5	200
lin	Passifloraceae	*Passiflora herbertiana*	Native Passionfruit	0.1	15					0.001	1			0.1	2	0.01	1			0.5	2
*	Passifloraceae	*Passiflora subpeltata*	White Passionflower			1	200														
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily	0.01	10	1	200					0.01	20	1	15			1	10	1	40
lin	Phormiaceae	*Dianella caerulea var. producta*				1	50														
lin	Phormiaceae	*Dianella longifolia*	Blue Flax-Lily			1	25														
lin	Phormiaceae	*Dianella revoluta*	Blueberry Lily					0.01	5			0.001	12					1	10		
lin	Phormiaceae	*Stypandra glauca*	Nodding Blue Lily							1	5	0.5	20								
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush			2	4000	0.1	10	1	40			1	10			1	1	2	25
lin	Phyllanthaceae	*Phyllanthus gunnii*	Scrubby Spurge	1	10	1	400	0.01	10												
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge					0.1	20			0.05	80								
lin	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera													0.1	20				
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry			1	300	0.01	3									1	100	0.5	1500
lin	Pittosporaceae	*Bursaria longisepala*						1	40			0.5	7								
lin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum																	0.5	1

Status	Family	*Genus* species	Common Name	US16	US16	US17	US17	US21	US21	US78	US78	US82	US82	US91	US91	US92	US92	US93	US93	US95	US95
				C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
Iin	Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	5	25	1	50	0.01	1	1	3			0.1	2	0.5	3				
Iin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell							0.1	800			0.1	7						
Iin	Poaceae	*Entolasia marginata*	Bordered Panic	0.01	50	1	400	0.01	4	2	2000			0.1	100			1	40	0.5	500
Iin	Poaceae	*Entolasia stricta*	Wiry Panic					0.01	1			0.5	400					1	40		
Iin	Poaceae	*Microlaena stipoides*	Weeping Grass			2	1200			3	40000			1	100			2	100	1	1500
Iin	Poaceae	*Oplismenus aemulus*	Australian Basket Grass							1	20000										
Iin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass	0.01	40			0.01	20					0.1	20	0.1	50			1	1500
Iin	Primulaceae	*Myrsine variabilis*				1	1							1	20						
Iin	Proteaceae	*Banksia spinulosa*	Hairpin Banksia					0.01	1			0.5	2								
Iin	Proteaceae	*Lomatia silaifolia*	Crinkle Bush									0.05	12							0.5	15
Iin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung			1	20	1	30	0.01	1	0.5	6					1	25	0.5	2
Iin	Proteaceae	*Persoonia pinifolia*	Pine-leaved Geebung											1	15						
Iin	Proteaceae	*Xylomelum pyriforme*	Native Pear																	15	5
Iin	Pteridaceae	*Adiantum aethiopicum*	Common Maidenhair	15	5000	2	4000	0.01	1	0.5	20										
Iin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern					0.01	1	1	5000			4	20			1	50	0.5	25
Iin	Pteridaceae	*Pellaea falcata*	Sickle Fern	1	5									2	100	1	20				
Iin	Ranunculaceae	*Clematis aristata*	Old Man's Beard					0.01	1	0.5	500										
Iin	Ranunculaceae	*Clematis glycinoides*	Headache Vine	0.1	10	1	100							0.1	20						
Iin	Ranunculaceae	*Clematis spp.*																		0.5	200
Iin	Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris			1	1														
Iin	Rosaceae	*Rubus parvifolius*	Native Raspberry			1	150													0.5	500
Iin	Rosaceae	*Rubus rosifolius*	Native Raspberry							0.05	3			0.1	20						
Iin	Rubiaceae	*Gynochthodes jasminoides*	Sweet Morinda	0.01	5									1	30	0.5	50			0.5	25
Iin	Rubiaceae	*Opercularia diphylla*										0.001	1								
Iin	Rubiaceae	*Pomax umbellata*	Pomax									0.01	50					1	25		
Iin	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart							1	1	1	1					5	1		
Iin	Santalaceae	*Exocarpos strictus*	Dwarf Cherry					2	30			1	10	0.1	1						
Iin	Santalaceae	*Leptomeria acida*	Sour Currant Bush			1	5														
Iin	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush			5	300													0.5	15
Iin	Smilacaceae	*Smilax australis*	Barbwire Vine	0.1	20	1	2									0.1	10				
Iin	Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla													0.1	40				
Iin	Solanaceae	*Solanum prinophyllum*	Forest Nightshade											0.1	2			1	1	0.5	1
Iin	Thymelaeaceae	*Pimelea linifolia*	Slender Rice Flower															2	50	0.5	40
Iin	Uvulariaceae	*Schelhammera undulata*				1	500									0.01	1			0.5	500
Iin	Violaceae	*Melicytus dentatus*	Tree Violet							2	3							1	1		
Iin	Vitaceae	*Cayratia clematidea*	Native Grape											0.1	10	0.1	10				
Iin	Vitaceae	*Cissus antarctica*	Kangaroo Vine																	0.5	1
Iin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine	1	1									30	20	60	40			2	25
Iin	Xanthorrhoeaceae	*Xanthorrhoea media*	Grass Tree					0.25	1												
		Unidentified monocotyledon																1	10		

Notes: Status (Native, Iin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US35 C	US35 A	US46 C	US46 A	US49 C	US49 A	US50 C	US50 A
Iin	Acanthaceae	*Brunoniella australis*	Blue Trumpet							0.5	4000
Iin	Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower			0.01	200				
Iin	Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair			0.01	100				
Iin	Pteridaceae	*Pellaea falcata*	Sickle Fern	0.5	10						
Iin	Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily	0.5	25	0.01	400	1	1200	1	4000
Iin	Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily					0.5	120	0.5	1500
Iin	Araliaceae	*Hydrocotyle geraniifolia*	Forest Pennywort			0.01	1				
Iin	Araliaceae	*Hydrocotyle sibthorpioides*						0.5	150	0.5	200
Iin	Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern	0.5	50	0.01	100				
Iin	Asteraceae	*?Cassinia sp*		2	20						
Iin	Asteraceae	*Brachyscome graminea*	Grass Daisy					0.5	800	0.5	50
Iin	Asteraceae	*Calotis ?dentax*		0.5	30						
Iin	Asteraceae	*Olearia viscidula*	Wallaby Weed			0.5	2				
Iin	Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	0.5	45	0.1	400				
Iin	Blechnaceae	*Doodia aspera*	Prickly rasp fern			0.1	100				
Iin	Campanulaceae	*Lobelia purpurascens*	Whiteroot	0.5	25	0.01	50	0.5	2000	0.5	4000
Iin	Campanulaceae	*Wahlenbergia spp.*	Bluebell	0.5	25						
Iin	Campanulaceae	*Wahlenbergia stricta*	Tall Bluebell			0.01	2				
Iin	Caryophyllaceae	*Stellaria flaccida*				0.01	10				
Iin	Caryophyllaceae	*Stellaria pungens*	Prickly Starwort			0.01	2				
Iin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak					1	8	1	25
Iin	Casuarinaceae	*Allocasuarina torulosa*	Forest Oak			5	7				
Iin	Chenopodiaceae	*Einadia hastata*	Berry Saltbush	0.5	1						
Iin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew	0.5	25	0.01	100				
Iin	Cunoniaceae	*Ceratopetalum gummiferum*	Christmas Bush			1	10				
Iin	Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	10	15						
Iin	Cyperaceae	*Cyperus sp.*								0.5	100
Iin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	0.5	50			2	600	1	2000
Iin	Dilleniaceae	*Hibbertia obtusifolia*	Hoary Guinea Flower					1	20	0.5	10
Iin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash	0.5	10	5	40				
Iin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry					1	10	0.5	2
Iin	Ericaceae (Epacridoideae)	*Leucopogon lanceolatus*				0.1	4				
Iin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath	0.5	1			5	400	0.5	50
Iin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil			0.01	20			1	200
Iin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine							0.5	200
Iin	Fabaceae (Faboideae)	*Glycine microphylla*	Small-leaf Glycine							1	400
Iin	Fabaceae (Faboideae)	*Glycine tabacina*	Variable Glycine					0.5	5		
Iin	Fabaceae (Faboideae)	*Jacksonia scoparia*	Dogwood							0.5	1
Iin	Fabaceae (Mimosoideae)	*Acacia binervata*	Two-veined Hickory	0.5	1						

Status	Family	Genus species	Common Name	US35 C	US35 A	US46 C	US46 A	US49 C	US49 A	US50 C	US50 A
lin	Fabaceae (Mimosoideae)	*Acacia binervia*	Coast Myall					5	15		
lin	Fabaceae (Mimosoideae)	*Acacia clunies-rossiae*	Kowmung wattle	10	7			0.5	1	0.5	3
lin	Fabaceae (Mimosoideae)	*Acacia decurrens*	Black Wattle					1	25	1	3
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally							0.5	5
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle							0.5	2
lin	Fabaceae (Mimosoideae)	*Acacia longissima*	Long-leaf Wattle							0.5	10
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia							0.5	500
lin	Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort					0.5	50		
lin	Haloragaceae	*Gonocarpus teucrioides*	Germander Raspwort	0.5	25						
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum					0.5	5	0.5	1
lin	Lamiaceae	*Plectranthus parviflorus*	Cockspur flower	0.5	300	0.01	50				
lin	Lauraceae	*Cassytha glabella*						0.5	5		
lin	Lomandraceae	*Lomandra brevis*	Tufted Mat-rush							0.5	200
lin	Lomandraceae	*Lomandra confertifolia*	Matrush					1	300		
lin	Lomandraceae	*Lomandra cylindrica*						0.5	150		
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush	0.5	100					0.5	150
lin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush					0.5	50	0.5	1500
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	0.5	10	0.01	1	2	40	5	400
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush							0.5	500
lin	Loranthaceae	*Dendrophthoe vitellina*				0.01	1				
lin	Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry			0.01	20				
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily			0.01	50				
lin	Myrtaceae	*Angophora costata*	Sydney Red Gum			10	1				
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple			0.1	1	2	5		
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle	50	100	10	4			3	25
lin	Myrtaceae	*Calytrix tetragona*	Common Fringe-myrtle							10	40
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark					10	3	15	4
lin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark					10	5		
lin	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark					1	1		
lin	Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum							1	1
lin	Myrtaceae	*Eucalyptus punctata*	Grey Gum	30	5	40	2	10	5	10	3
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree	0.5	2						
lin	Myrtaceae	*Syncarpia glomulifera*	Turpentine			5	1				
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive	0.5	15	0.1	1			0.5	20
lin	Orchidaceae	*Cymbidium suave*	Snake Orchid			0.01	1				
lin	Orchidaceae	*Dendrobium speciosum*	Rock Lily	0.5	1						
lin	Oxalidaceae	*Oxalis perennans*	Oxalis	0.5	50			0.5	1200	0.5	100
lin	Passifloraceae	*Passiflora herbertiana*	Native Passionfruit			0.1	400	0.5	10	0.5	25
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily	0.5	1	0.01	2			0.5	50
lin	Phormiaceae	*Dianella revoluta*	Blueberry Lily	0.5	1					1	500
lin	Phormiaceae	*Stypandra glauca*	Nodding Blue Lily	0.5	10	0.01	100	0.5	25		
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	0.5	2			2	90	1	100

Status	Family	Genus species	Common Name	US35 C	US35 A	US46 C	US46 A	US49 C	US49 A	US50 C	US50 A
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge			0.01	10	0.5	1200	0.5	100
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry							0.5	5
lin	Pittosporaceae	*Bursaria longisepala*				0.01	1				
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	0.5	25			1	40	0.5	5
lin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum			0.01	4				
lin	Poaceae	*Aristida vagans*	Threeawn Speargrass					0.5	150	0.5	150
lin	Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass	0.5	200						
lin	Poaceae	*Entolasia marginata*	Bordered Panic	0.5	400			0.5	400	0.5	4000
lin	Poaceae	*Eragrostis brownii*	Brown's Lovegrass					0.5	150	0.5	400
lin	Poaceae	*Microlaena stipoides*	Weeping Grass	0.5	400	0.01	400	1	1200	0.1	4000
lin	Poaceae	*Oplismenus aemulus*	Australian Basket Grass	0.5	400	0.01	400				
lin	Poaceae	*Poaceae sp.*		0.5	50	0.01	10				
lin	Poaceae	*Poaceae sp. 2*				0.01	10				
lin	Polypodiaceae	*Pyrrosia rupestris*	Rock Felt Fern	0.5	100	0.1	20				
lin	Primulaceae	*Myrsine variabilis*				1	10				
lin	Proteaceae	*Banksia spinulosa*	Hairpin Banksia			0.01	1				
lin	Proteaceae	*Grevillea arenaria*		0.5	5					0.5	2
lin	Proteaceae	*Lomatia silaifolia*	Crinkle Bush			0.01	1				
lin	Proteaceae	*Persoonia laurina*	Laurel Geebung			0.01	2				
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	0.5	2			1	25	0.5	30
lin	Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	0.5	100						
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern	0.5	100			1	1200	1	3000
lin	Ranunculaceae	*Clematis glycinoides*	Headache Vine			0.01	200				
lin	Rubiaceae	*Opercularia varia*	Variable Stinkweed					0.5	400	0.5	250
lin	Rubiaceae	*Pomax umbellata*	Pomax					0.5	1200	0.5	500
lin	Rutaceae	*Boronia polygalifolia*	Dwarf Boronia					0.5	1	0.5	200
lin	Santalaceae	*Exocarpos strictus*	Dwarf Cherry			0.5	1				
lin	Santalaceae	*Leptomeria acida*	Sour Currant Bush							0.5	1
lin	Sapindaceae	*Dodonaea viscosa*	Sticky Hop-bush					0.5	1		
lin	Plantaginaceae	*Veronica lithophila*				0.01	1				
lin	Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla			0.1	40				
lin	Thymelaeaceae	*Pimelea linifolia*	Slender Rice Flower					1	800		
lin	Violaceae	*Hybanthus monopetalus*	Slender Violet-bush			0.01	1				
lin	Vitaceae	*Cayratia clematidea*	Native Grape	0.5	25						
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine			20	10				

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US18	US18	US20	US20	US22	US22	US26	US26	US33	US33
				C	A	C	A	C	A	C	A	C	A
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet					0.01	50	0.5	25	0.1	25
lin	Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily	0.5	1	0.01	5	0.01	1				
lin	Apiaceae	*Platysace linearifolia*						0.01	1				
lin	Apocynaceae	*Marsdenia suaveolens*	Scented Marsdenia			0.01	1						
lin	Apocynaceae	*Parsonsia straminea*	Common Silkpod									0.01	1
lin	Asteraceae	*Asteraceae ?*						0.001	1				
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot							0.1	25	0.5	100
lin	Campanulaceae	*Wahlenbergia sp.*								0.01	1		
lin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak	2	100								
lin	Cyperaceae	*Cyathochaeta diandra*		0.5	100	20	70	10	1600	5	50	2	100
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	1	150			0.01	200	2	50	10	200
lin	Dilleniaceae	*Hibbertia acicularis*										1	20
lin	Dilleniaceae	*Hibbertia obtusifolia*	Hoary Guinea Flower			0.01	1						
lin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash					0.5	10				
lin	Elaeocarpaceae	*Tetratheca ericifolia*						0.001	1				
lin	Ericaceae (Epacridoideae)	*Acrotriche divaricata*						0.5	2				
lin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry					0.01	5				
lin	Ericaceae (Epacridoideae)	*Brachyloma daphnoides*	Daphne Heath					0.1	400				
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath							0.1	10		
lin	Ericaceae (Epacridoideae)	*Leucopogon lanceolatus*						1	20				
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath			2	100			2	20	0.1	5
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa subsp. subulata*	Peach Heath					3	1600				
lin	Fabaceae (Faboideae)	*Bossiaea obcordata*	Spiny Bossiaea			1	50	0.5	10				
lin	Fabaceae (Faboideae)	*Daviesia ulicifolia*	Gorse Bitter Pea			0.1	20						
lin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil									0.1	100
lin	Fabaceae (Faboideae)	*Dillwynia retorta*		2	40	1	40	0.01	100				
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine							0.2	100	0.1	100
lin	Fabaceae (Faboideae)	*Gompholobium grandiflorum*	Large Wedge Pea					0.01	5				
lin	Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla					0.01	1			0.1	10
lin	Fabaceae (Faboideae)	*Hovea linearis*		0.5	25			0.01	1				
lin	Fabaceae (Faboideae)	*Jacksonia scoparia*	Dogwood	1	40								
lin	Fabaceae (Mimosoideae)	*Acacia binervia*	Coast Myall			5	1						
lin	Fabaceae (Mimosoideae)	*Acacia clunies-rossiae*	Kowmung wattle			0.01	3	5	400			1	5
lin	Fabaceae (Mimosoideae)	*Acacia falcata*								0.1	10		
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle							0.5	25		
lin	Fabaceae (Mimosoideae)	*Acacia paradoxa*	Kangaroo Thorn					0.01	2				
lin	Fabaceae (Mimosoideae)	*Acacia terminalis*	Sunshine Wattle	0.5	2								

Status	Family	Genus species	Common Name	US18 C	US18 A	US20 C	US20 A	US22 C	US22 A	US26 C	US26 A	US33 C	US33 A
lin	Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses	1	5								
lin	Goodeniaceae	*Goodenia bellidifolia*						0.01	400				
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia	0.5	10					0.1	25	0.1	100
lin	Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort					0.01	12				
lin	Hypericaceae	*Hypericum gramineum*	Small St John's Wort					0.001	20				
lin	Hypoxidaceae	*?Hypoxis sp*										0.01	1
lin	Iridaceae	*Patersonia sericea*	Silky Purple-Flag					0.01	200				
lin	Iridaceae	*Patersonia sp.*										0.5	50
lin	Lauraceae	*Cassytha glabella*				0.01	1	0.01	20				
lin	Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge Fern			5	1	0.01	40				
lin	Loganiaceae	*Mitrasacme polymorpha*						0.1	100				
lin	Lomandraceae	*Lomandra confertifolia*	Matrush									0.1	50
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush	2	150								
lin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush							0.1	10		
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush							2	20	3	50
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush			1	50					0.1	25
lin	Lomandraceae	*Lomandra obliqua*		1	200	0.01	20	0.01	1600				
lin	Loranthaceae	*Dendrophthoe vitellina*		0.5	5								
lin	Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry					0.01	1				
lin	Myrtaceae	*Angophora bakeri*	Narrow-leaved Apple	10	10	30	40	20	50	3	2	5	4
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark									3	4
lin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark	2	1					20	10	2	1
lin	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark							5	2		
lin	Myrtaceae	*Eucalyptus piperita*	Sydney Peppermint	5	3								
lin	Myrtaceae	*Eucalyptus punctata*	Grey Gum	10	8					10	3		
lin	Myrtaceae	*Eucalyptus sclerophylla*	Hard-leaved Scribbly Gum	5	1								
lin	Myrtaceae	*Eucalyptus signata*	Scribbly Gum			25	5	20	30	10	5	50	15
lin	Myrtaceae	*Leptospermum polygalifolium*	Tantoon									0.1	2
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree	3	40	1	20	20	200			3	20
lin	Myrtaceae	*Myrtaceae sp*								0.01	1	0.1	1
lin	Myrtaceae	*Syncarpia glomulifera*	Turpentine	2	1								
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive			0.01	7	0.1	50				
lin	Orchidaceae	*Cymbidium suave*	Snake Orchid			0.01	1						
lin	Phormiaceae	*Dianella revoluta*	Blueberry Lily			0.1	40	0.01	200	10	50		
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush			0.1	4	0.01	10	0.01	1		
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge	0.5	100	0.1	100	0.01	200				
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry			0.01	1						
lin	Pittosporaceae	*Bursaria longisepala*						0.01	20	0.01	1		
lin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum					0.01	1				
lin	Poaceae	*Aristida vagans*	Threeawn Speargrass							0.01	10		
lin	Poaceae	*Entolasia marginata*	Bordered Panic	0.5	400	0.1	50					1	100
lin	Poaceae	*Entolasia stricta*	Wiry Panic	0.5	50	x	x	0.01	400	0.1	25	0.5	200

Status	Family	Genus species	Common Name	US18 C	US18 A	US20 C	US20 A	US22 C	US22 A	US26 C	US26 A	US33 C	US33 A
lin	Poaceae	*Eragrostis brownii*	Brown's Lovegrass			0.1	100						
lin	Poaceae	*Imperata cylindrica*	Blady Grass							2	150	1	200
lin	Poaceae	*Microlaena stipoides*	Weeping Grass			0.1	1	0.01	200	0.01	50	0.5	500
lin	Poaceae	*Rytidosperma sp.*				0.1	50						
lin	Proteaceae	*Banksia spinulosa*	Hairpin Banksia	2	10	5	30	5	25	0.5	4	0.1	1
lin	Proteaceae	*Grevillea arenaria*										0.5	1
lin	Proteaceae	*Hakea sericea*	Needlebush							0.01	1		
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	1	5	1	6	2	100	0.1	5		
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern							0.1	50	0.5	100
lin	Rubiaceae	*Opercularia varia*	Variable Stinkweed	0.5	1								
lin	Rubiaceae	*Pomax umbellata*	Pomax	0.5	20			0.01	50	0.1	100	0.5	75
lin	Santalaceae	*Leptomeria acida*	Sour Currant Bush					1	20				
lin	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush	0.5	5	1	10						
lin	Smilacaceae	*Smilax australis*	Lawyer Vine					0.01	1				
lin	Thymelaeaceae	*Pimelea linifolia*	Slender Rice Flower			0.1	10	0.01	1				
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine					0.1	1				
lin	Xanthorrhoeaceae	*Xanthorrhoea media*		10	80	2	13					1	50
lin	Xanthorrhoeaceae	*Xanthorrhoea resinosa*						10	400				
lin		*"Large bract sample"*				0.01	10						
lin		*Unknown species*								0.01	1		

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US19	US19	US23	US23	US25	US25	US29	US29	US30	US30	US75	US75	US84	US84	US87	US87
				C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet							0.1	100	0.5	400					1	25
lin	Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily											0.1	5				
lin	Anthericaceae	*Tricoryne simplex*								0.01	40								
lin	Apocynaceae	*Parsonsia straminea*	Common Silkpod									0.1	1						
lin	Asteraceae	*Olearia viscidula*	Wallaby Weed															0.1	1
lin	Asteraceae	*Ozothamnus adnatus*	Winged Everlasting	0.5	11														
lin	Asteraceae	*Ozothamnus diosmifolius*	White Dogwood	0.5	3														
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot									0.5	20000	0.1	5				
lin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak	0.1	7					0.5	1			10	40			20	22
lin	Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	0.1	5														
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed															0.1	25
lin	Cyperaceae	*"small sedge" 1*		0.1	500														
lin	Cyperaceae	*"small sedge" 2*		0.01	20														
lin	Cyperaceae	*Cyathochaeta diandra*		1	30														
lin	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge							0.5	100								
lin	Cyperaceae	*Gahnia melanocarpa*	Black Fruit Saw-sedge			0.01	5												
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	0.1	40	1	40			5	100	5	200			1	20	1	100
lin	Cyperaceae	*Lepidospermsa ?viscidium*						10	2000										
lin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower							2	50							1	11
lin	Dilleniaceae	*Hibbertia cistoidea/cistiflora*						0.01	50										
lin	Dilleniaceae	*Hibbertia obtusifolia*	Hoary Guinea Flower			0.01	5			1	50								
lin	Elaeocarpaceae	*Tetratheca thymifolia*	Black-eyed Susan									0.5	10						
lin	Ericaceae (Epacridoideae)	*?Leucopogon sp*																1	5
lin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry											0.1	1				
lin	Ericaceae (Epacridoideae)	*Ericaceae, Epacridoideae*																0.1	2
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath							1	20								
lin	Ericaceae (Epacridoideae)	*Leucopogon muticus*	Blunt Beard-heath	1	14	1	5	1	45										
lin	Ericaceae (Epacridoideae)	*Leucopogon virgatus*						0.1	200										
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath	4	100	0.5	30			2	20	1	50	5	50	5	30		
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa subsp. subulata*	Peach Heath															1	10
lin	Ericaceae (Epacridoideae)	*Melichrus procumbens*	Jam Tarts	0.01	1														
lin	Fabaceae (Faboideae)	*Bossiaea buxifolia*												0.1	2			0.1	5
lin	Fabaceae (Faboideae)	*Daviesia ulicifolia*	Gorse Bitter Pea	0.5	4														
lin	Fabaceae (Faboideae)	*Daviesia ulicifolia subsp. stenophylla*																1	10
lin	Fabaceae (Faboideae)	*Dillwynia retorta*		2	100											0.01	1		
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine					0.01	20	0.1	20	0.5	50	0.5	20	0.01	100	0.1	150
lin	Fabaceae (Faboideae)	*Glycine tabicina*																0.1	100
lin	Fabaceae (Faboideae)	*Gompholobium ?minus*		0.01	2														
lin	Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla													0.01	1	0.1	3
lin	Fabaceae (Faboideae)	*Jacksonia scoparia*	Dogwood											1	5	1	12		
lin	Fabaceae (Mimosoideae)	*Acacia binervia*	Coast Myall			35	50												
lin	Fabaceae (Mimosoideae)	*Acacia clunies-rossiae*	Kowmung wattle	0.1	6			0.01	5										

Status	Family	Genus species	Common Name	US19	US19	US23	US23	US25	US25	US29	US29	US30	US30	US75	US75	US84	US84	US87	US87
				C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
lin	Fabaceae (Mimosoideae)	*Acacia echinula*	Hedgehog Wattle													0.01	2		
lin	Fabaceae (Mimosoideae)	*Acacia falcata*		0.1	30											0.1	20		
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally											1	2				
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle	1	3							0.01	1						
lin	Fabaceae (Mimosoideae)	*Acacia paradoxa*	Kangaroo Thorn											2	20				
lin	Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle													0.5	1		
lin	Fabaceae (Mimosoideae)	*Acacia parvipinnula*	Silver-stemmed Wattle							1	12	1	4						
lin	Fabaceae (Mimosoideae)	*Acacia penninervis*	Mountain Hickory															5	34
lin	Fabaceae (Mimosoideae)	*Acacia spp.*						0.01	2	0.01	1			5	30				
lin	Fabaceae (Mimosoideae)	*Acacia uncinata*	Gold-dust Wattle													0.5	30		
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia							0.1	200	0.01	400			0.1	800	1	500
lin	Haloragaceae	*Gonocarpus teucrioides*	Germander Raspwort													0.01	1		
lin	Hypoxidaceae	*Hypoxis hygrometrica*	Golden Weather-grass									0.01	100						
lin	Iridaceae	*Patersonia sp.*		0.01	2														
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum			0.1	1												
lin	Lauraceae	*Cassytha glabella*				0.5	1												
lin	Loganiaceae	*Logania albiflora*				0.01	1												
lin	Loganiaceae	*Mitrasacme pilosa*						0.01	40										
lin	Lomandraceae	*Lomandra "small..."*		1	500														
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush											0.1	5				
lin	Lomandraceae	*Lomandra filiformis subsp. coriacea*	Wattle Matt-rush													0.1	100		
lin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush									0.01	1					1	100
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			0.1	5			10	200	10	200						
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush	0.1	30													1	50
lin	Lomandraceae	*Lomandra obliqua*										0.01	1						
lin	Lomandraceae	*Lomandra sp.*		0.01	30	0.01	1	0.01	50										
lin	Malvaceae	*Brachychiton populneus*	Kurrajong									0.01	1						
lin	Malvaceae	*Lasiopetalum ferrugineum*										0.5	2						
lin	Myrtaceae	*Angophora bakeri*	Narrow-leaved Apple	1	6											2	2		
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	15	5	25	30	1	6	30	7	15	8	30	6				
lin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark			5	1			10	13	10	12					5	1
lin	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark	25	11							30	12			50	25	30	6
lin	Myrtaceae	*Eucalyptus moluccana*	Grey Box															10	2
lin	Myrtaceae	*Eucalyptus punctata*	Grey Gum	1	14			1	1	10	15	5	2						
lin	Myrtaceae	*Eucalyptus sparsifolia*	Narrow-leaved Stringybark	3	5														
lin	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum			5	1									3	2		
lin	Myrtaceae	*Kunzea parvifolia*	Violet Kunzea					1	300										
lin	Myrtaceae	*Leptospermum ?trinervium*		1	14														
lin	Myrtaceae	*Leptospermum parviflorum*						50	2000										
lin	Myrtaceae	*Leptospermum polygalifolium*	Tantoon							1	5								
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree													15	26		
lin	Myrtaceae	*Melaleuca erubescens*	Pink Honeymyrtle					30	500										

Status	Family	Genus species	Common Name	US19	US19	US23	US23	US25	US25	US29	US29	US30	US30	US75	US75	US84	US84	US87	US87
				C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
Iin	Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark													0.5	1		
Iin	Myrtaceae	*Syncarpia glomulifera*	Turpentine			1	1												
Iin	Oleaceae	*Notelaea longifolia*	Large Mock-olive	0.1	6	1	5	0.5	5			1	7					0.1	1
Iin	Oxalidaceae	*Oxalis perennans*	Oxalis											1	50				
Iin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily													0.001	1	0.1	3
Iin	Phormiaceae	*Dianella revoluta*	Blueberry Lily	0.1	40			0.01	40	0.1	50	1	50	0.1	5			0.1	3
Iin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush			2	50							2	20				
Iin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge	0.01	6							0.1	400					5	500
Iin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry			0.1	10							1	10				
Iin	Pittosporaceae	*Bursaria longisepala*						0.1	50	2	10	1	20			0.1	10		
Iin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	1	3	2	40			0.5	1			0.1	1				
Iin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum			0.1	1												
Iin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell											1	50				
Iin	Poaceae	*Aristida sp.*								0.1	20								
Iin	Poaceae	*Austrostipa ramosissima*				0.5	10												
Iin	Poaceae	*Entolasia marginata*	Bordered Panic							1	1000	0.5	2000	1	10	0.05	200		
Iin	Poaceae	*Entolasia stricta*	Wiry Panic	0.01	200							0.5	1600	1	50	0.1	400	1	500
Iin	Poaceae	*Eragrostis brownii*	Brown's Lovegrass					0.01	100										
Iin	Poaceae	*Eragrostis sp.*		0.01	50														
Iin	Poaceae	*Imperata cylindrica*	Blady Grass									0.1	50						
Iin	Poaceae	*Microlaena stipoides*	Weeping Grass							5	5000	0.5	5000	15	1000	0.1	1600	0.5	150
Iin	Poaceae	*Oplismenus sp.*																1	200
Iin	Poaceae	*Poaceae sp.*														0.01	50		
Iin	Podocarpaceae	*Podocarpus spinulosus*	Spiny-leaf Podocarp							2	100	2	20						
Iin	Proteaceae	*Grevillea arenaria*						2	100	2	4	2	3						
Iin	Proteaceae	*Grevillea sp*												0.1	1				
Iin	Proteaceae	*Hakea dactyloides*	Finger Hakea															0.1	1
Iin	Proteaceae	*Hakea sericea*	Needlebush							0.5	1								
Iin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	1	6	2	10	0.1	5	1	13	1	20	2	10			0.1	1
Iin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern			0.1	1			0.1	500	0.5	1600	0.5	100	1	200	1	25
Iin	Ranunculaceae	*Clematis glycinoides*	Headache Vine			0.01	1												
Iin	Ranunculaceae	*Clematis sp*												0.1	1				
Iin	Rhamnaceae	*Alphitonia excelsa*	Red Ash			1	2												
Iin	Rubiaceae	*Gynochthodes jasminoides*	Sweet Morinda			0.1	10												
Iin	Rubiaceae	*Pomax umbellata*	Pomax							0.01	1	0.5	1200	1	10	0.01	50	1	500
Iin	Rutaceae	*Correa reflexa*	Native Fuschia									0.5	1						
Iin	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart	1	1														
Iin	Santalaceae	*Exocarpos strictus*	Dwarf Cherry	3	50														
Iin	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush	1	30													0.1	1
Iin	Sapindaceae	*Dodonaea truncatiales*	Angular Hop-bush	0.5	7														
Iin	Sapindaceae	*Dodonaea viscosa*	Sticky Hop-bush											1	1				
Iin	Scrophulariaceae	*Myoporum acuminatum*	Boobialla			0.01	1												

				US19	US19	US23	US23	US25	US25	US29	US29	US30	US30	US75	US75	US84	US84	US87	US87
Status	**Family**	**Genus species**	**Common Name**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**
lin	Thymelaeaceae	*Pimelea linifolia*	Slender Rice Flower									0.1	20						
lin	Xanthorrhoeaceae	*Xanthorrhoea media*	Grass Tree	0.5	2														

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	*Genus species*	Common Name	US55 C	US55 A	US56 C	US56 A	US57 C	US57 A	US60 C	US60 A	US61 C	US61 A	US66 C	US66 A	US68 C	US68 A	US71 C	US71 A
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet			0.01	1	3	1200	1	4000			1	200	0.1	25		
lin	Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily			0.01	1	1	1										
lin	Anthericaceae	*Arthropodium spp.*																0.5	1
lin	Anthericaceae	*Laxmannia gracilis*	Slender Wire Lily			0.5	5												
lin	Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily	0.01	100	1	1000	1	800							0.1	50	0.5	500
lin	Apiaceae	*Daucus glochidiatus*	Native Carrot															0.5	50
lin	Apiaceae	*Hydrocotyle sibthorpioides*		0.1	300														
lin	Apiaceae	*Hydrocotyle spp.*																1	500
HTW	Apocynaceae	*Araujia sericifera*	Moth Vine					1	1							1	1		
HTW	Asparagaceae	*Asparagus asparagoides*	Bridal Creeper					1	5	0.1	400			0.1	200				
*	Asparagaceae	*Asparagus officinalis*	Asparagus															0.01	5
lin	Asteraceae	*"Asteraceae yellow petals"*														1	10		
lin	Asteraceae	*Asteraceae sp. 1*						1	1										
lin	Asteraceae	*Asteraceae sp. 2*						1	50										
lin	Asteraceae	*Asteraceae sp. 3*						1	50										
lin	Asteraceae	*Asteraceae sp. 4*						1	25										
*	Asteraceae	*Bidens pilosa*	Cobbler's Pegs													0.01	10		
*	Asteraceae	*Bidens subalternans*	Greater Beggar's Ticks					1	400										
lin	Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy							0.01	10	0.5	3200	2	1600	2	50		
lin	Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting	0.1	50	0.1	300							1	400			0.5	100
*	Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane															0.2	50
*	Asteraceae	*Conyza spp.*	A Fleabane	0.0001	1	0.1	10												
lin	Asteraceae	*Euchiton spp.*	A Cudweed			0.1	100									0.5	25		
*	Asteraceae	*Hypochaeris radicata*	Catsear															0.5	200
lin	Asteraceae	*Olearia viscidula*	Wallaby Weed					1	1										
lin	Asteraceae	*Senecio spp.*	Groundsel, Fireweed															0.2	50
lin	Asteraceae	*Vittadinia cuneata*	A Fuzzweed			0.1	100												
lin	Asteraceae	*Vittadinia spp.*	Fuzzweed									0.5	400						
lin	Asteraceae	*Vittadinia sulcata*						1	10	0.1	400			1	800				
lin	Brassicaceae	*Lepidium sp.*										0.1	400						
*	Cactaceae	*Opunita sp*				0.1	1												
*	Cactaceae	*Opuntia stricta*	Common Prickly Pear															0.01	1
lin	Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell					1	400			0.01	1						
lin	Campanulaceae	*Wahlenbergia spp. 2*	Bluebell													0.2	100		
lin	Campanulaceae	*Wahlenbergia spp.*	Bluebell			0.01	10									0.1	100	0.5	500
lin	Campanulaceae	*Wahlenbergia stricta*	Tall Bluebell			0.1	300												
*	Caryophyllaceae	*Paronychia brasiliana*	Chilean Whitlow Wort															0.5	50
*	Caryophyllaceae	*Petrorhagia nanteuilii*	Proliferous Pink															0.5	100
lin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak	5	11	1	32												
lin	Casuarinaceae	*Allocasuarina verticillata*	Drooping Sheoak			2	12												
lin	Casuarinaceae	*Casuarina cunninghamiana*	River Oak	0.1	3														

Status	Family	*Genus species*	Common Name	US55 C	US55 A	US56 C	US56 A	US57 C	US57 A	US60 C	US60 A	US61 C	US61 A	US66 C	US66 A	US68 C	US68 A	US71 C	US71 A
*	Chenopodiaceae	*Atriplex prostrata*																0.01	10
lin	Chenopodiaceae	*Einadia hastata*	Berry Saltbush	0.01	1			1	50	1	4000	0.5	800	0.2	200	0.01	5		
lin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew	0.01	300			1	50			0.1	400			0.01	10		
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed					10	4000	0.1	400	1	800	0.1	50	5	500	0.1	100
lin	Cyperaceae	*Carex inversa*	Knob Sedge															1	100
lin	Cyperaceae	*Carex sp*	A Sedge															1	100
lin	Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge					1	100	1	800	1	2000	0.1	200	0.2	20		
lin	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge			20	500	1	1										
lin	Cyperaceae	*Gahnia erythrocarpa*								0.5	30								
lin	Cyperaceae	*Lepidosperma sp*																1	100
lin	Dilleniaceae	*Hibbertia linearis*		0.01	7														
lin	Dilleniaceae	*Hibbertia sp.*				5	100									2	20		
lin	Ericaceae	*Leucopogon juniperinus*	Prickly Beard-heath	0.5	20														
lin	Ericaceae	*Lissanthe strigosa*	Peach Heath	0.1	50	1	5	1	25							1	10		
lin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry			1	30			0.01	2			0.01	7			1	5
lin	Fabaceae (Caesalpinioideae)	*Senna sp "yellow"*																0.1	1
lin	Fabaceae (Faboideae)	*Desmodium brachypodum*	Large Tick-trefoil							0.01	1			0.01	50				
lin	Fabaceae (Faboideae)	*Desmodium spp.*	Tick-trefoil															0.1	10
lin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	0.01	20			1	400							1	50		
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine	0.01	10											1	50	0.5	200
lin	Fabaceae (Faboideae)	*Glycine tabacina*	Variable Glycine							0.01	50	0.1	100	0.01	200				
lin	Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia			0.1	30												
lin	Fabaceae (Mimosoideae)	*Acacia falciformis*	Broad-leaved Hickory											0.1	1	2	10		
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally					1	1									0.5	1
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle	1	36	0.1	4	1	1	0.5	7							0.5	1
lin	Fabaceae (Mimosoideae)	*Acacia parvipinnula*	Silver-stemmed Wattle	10	100	5	200												
lin	Fabaceae (Mimosoideae)	*Acacia sp*														0.01	1		
lin	Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses			0.1	50												
*	Gentianaceae	*Centaurium erythraea*	Common Centaury															0.2	50
lin	Geraniaceae	*Geranium homeanum*						1	25									3	100
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia			0.1	200									0.5	100		

Status	Family	Genus species	Common Name	US55 C	US55 A	US56 C	US56 A	US57 C	US57 A	US60 C	US60 A	US61 C	US61 A	US66 C	US66 A	US68 C	US68 A	US71 C	US71 A
lin	Juncaceae	*Juncus usitatus*												0.01	10				
lin	Lamiaceae	*Ajuga australis*	Austral Bugle											0.1	200	1	50		
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum	0.1	10														
*	Lamiaceae	*Marrubium vulgare*	White Horehound							0.01	2								
lin	Lobeliaceae	*Pratia purpurascens*	Whiteroot	2	1000			1	500							0.5	70	0.5	500
lin	Lomandraceae	*Lomandra bracteata*	Mat-rush	0.01	40	0.1	50											2	200
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush	0.01	20											0.5	50		
lin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush					1	50							0.5	50		
lin	Lomandraceae	*Lomandra longiflolia*	Spiny-headed Mat-rush			0.1	1												
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush			0.5	5												
lin	Lomandraceae	*Lomandra multiflora subsp. multiflora*	Many-flowered Mat-rush					1	25										
lin	Loranthaceae	*Amyema pendula*		1	20														
lin	Loranthaceae	*Muellerina eucalyptoides*		0.1	1														
lin	Malvaceae	*Brachychiton populneus*	Kurrajong	0.01	24	2	11	1	5	0.1	7			0.1	5	0.5	2	0.5	2
lin	Malvaceae	*Sida corrugata*	Corrugated Sida									0.5	200	1	200	0.5	100	0.5	10
*	Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	0.01	50			1	50	0.1	1000	0.1	400						
lin	Myoporaceae	*Myoporum montanum*	Western Boobialla							0.5	3								
lin	Myrtaceae	*Eucalyptus albens*	White Box															0.5	1
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark											2	12	25	9		
lin	Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum											0.01	1				
lin	Myrtaceae	*Eucalyptus melliodora*	Yellow Box	50	27	1	12											20	10
lin	Myrtaceae	*Eucalyptus moluccana*	Grey Box	5	1					60	86	45	1	40	18	15	3		
lin	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum			20	9									40	20	10	10
lin	Myrtaceae	*Eucalyptus tereticornis-glaucina*						40	22										
lin	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree	0.5	1														
lin	Oxalidaceae	*Oxalis perennans*				0.1	200	1	400			0.1	100					0.1	100
lin	Oxalidaceae	*Oxalis spp.*														0.1	30		
lin	Passifloraceae	*Passiflora herbertiana*		0.1	20														
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily															0.5	5
lin	Phormiaceae	*Dianella revoluta*	Blueberry Lily													0.1	10		
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	5	200	2	30	1	1									1	1
*	Phyllanthaceae	*Phyllanthus tenellus*	Hen and Chicken													0.5	25		
lin	Phyllanthaceae	*Phyllanthus virgatus*	Wiry Spurge							0.01	20			0.01	20				
lin	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera													0.5	100		
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry	0.01	1														
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn													2	15		
*	Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	0.01	30	0.1	100												
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell					1	100			0.5	400	0.1	50	0.5	500		
lin	Poaceae	*Aristida ramosa*	Purple Wiregrass			6	1000											0.1	20

Status	Family	*Genus species*	Common Name	US55 C	US55 A	US56 C	US56 A	US57 C	US57 A	US60 C	US60 A	US61 C	US61 A	US66 C	US66 A	US68 C	US68 A	US71 C	US71 A
lin	Poaceae	*Aristida spp.*	A Wiregrass					10	400										
lin	Poaceae	*Aristida vagans*	Threeawn Speargrass											3	1000				
lin	Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass	0.01	5			2	25	0.1	400	2	50			1	5	1	50
lin	Poaceae	*Bothriochloa spp.*	Redgrass, Bluegrass					10	200			0.01	20						
*	Poaceae	*Briza minor*	Shivery Grass															0.5	500
lin	Poaceae	*Chloris ventricosa*	Tall Chloris							0.01	100								
lin	Poaceae	*Cymbopogon refractus*	Barbed Wire Grass															1	500
lin	Poaceae	*Cymbopogon sp*				0.01	20												
lin	Poaceae	*Dichelachne spp.*	A Plumegrass					1	25	5	40000	0.5	8000	5	4000	0.5	200		
lin	Poaceae	*Digitaria spp.*						1	25							0.2	20		
lin	Poaceae	*Echinopogon spp.*	A Hedgehog Grass	0.1	200			1	100										
lin	Poaceae	*Elymus scaber*	Wheatgrass															1	50
lin	Poaceae	*Entolasia stricta*	Wiry Panic													1	30		
lin	Poaceae	*Eragrostis spp.*	A Lovegrass															1	5
lin	Poaceae	*Microlaena stipoides*	Weeping Grass	2	500			10	1000	0.1	400	0.1	200	1	500	0.5	5000	20	100
lin	Poaceae	*Microleana sp*				1	500												
lin	Poaceae	*Poacea spp.*						1	100										
lin	Poaceae	*Rytidosperma spp.*						10	100										
lin	Poaceae	*Rytidosperma tenuius*	A Wallaby Grass			2	1000												
lin	Poaceae	*Themeda triandra*						10	200	0.1	200							2	200
HTW	Polygonaceae	*Acetosella vulgaris*	Sheep Sorrel									0.1	200					0.2	50
lin	Polygonaceae	*Rumex brownii*	Swamp Dock															0.1	50
*	Primulaceae	*Anagallis arvensis*	Scarlet Pimpernel																
lin	Proteaceae	*Grevillea arenaria*				3	12									2	10		
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	0.1	1	0.5	1												
lin	Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern					1	200	1	1000	1	1600			1	200		
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern	0.02	200	1	5000	1	200	0.1	100	0.1	200	0.1	1600	1	200	1	500
lin	Ranunculaceae	*Clematis sp*														1	1		
lin	Rhamnaceae	*Spyridium burragorang*				8	40												
lin	Rosaceae	*Acaena echinata*	Sheep's Burr			0.1	20												
lin	Rubiaceae	*Asperula conferta*	Common Woodruff					1	1200										
lin	Rubiaceae	*Galium spp.*																0.1	10
lin	Rubiaceae	*Pomax umbellata*	Pomax			0.1	200									0.5	100		
*	Rubiaceae	*Richardia stellaris*																0.5	500
lin	Rubiaceae	*Richarida sp*				0.1	10												
lin	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart			1	3									1	5		
lin	Santalaceae	*Exocarpos strictus*	Dwarf Cherry			30	40	1	1										
lin	Sapindaceae	*Dodonaea viscosa*	Sticky Hop-bush			0.25	20	1	1										
lin	Solanaceae	*Solanum prinophyllum*	Forest Nightshade																
lin	Thymelaeaceae	*Pimelea curviflora*	Rice Flower			5	2500												
lin	Ulmaceae	*Trema tomentosa*	Native Peach	2	4														
lin		*"Sample 2"*														1	50		

Status	Family	*Genus species*	Common Name	US55 C	US55 A	US56 C	US56 A	US57 C	US57 A	US60 C	US60 A	US61 C	US61 A	US66 C	US66 A	US68 C	US68 A	US71 C	US71 A
lin		*"Sample 3"*														1	70		
lin		*"Sample 4"*														1	70		
lin		*"Sample 5"*														1	50		
lin		*"Sample 7"*														1	50		
lin		*Sample on iPhone*														0.5	25		

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	*Genus species*	Common Name	US58 C	US58 A	US59 C	US59 A	US62 C	US62 A	US69 C	US69 A	US70 C	US70 A
lin	Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily					1	50	1	400	0.1	200
lin	Apiaceae	*Apiaceae sp*		1	150								
lin	Asteraceae	*?Calotis sp.*								1	150		
lin	Asteraceae	*Asteraceae sp.*		1	100	5	800	1	30	1	50		
lin	Asteraceae	*Asteraceae sp. 2*		1	300					1	150		
*	Asteraceae	*Bidens subalternans*	Greater Beggar's Ticks	1	400			1	25				
lin	Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy									0.01	5
HTW	Asteraceae	*Carthamus lanatus*	Saffron Thistle	1	1			0.01	1				
lin	Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting									0.1	15
*	Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	1	50								
*	Asteraceae	*Gamochaeta americana*	Purple Cudweed									0.01	50
*	Asteraceae	*Hypochaeris radicata*	Catsear									0.1	200
lin	Asteraceae	*Hypochaeris sp.*		1	4000			1	10			0.01	10
*	Asteraceae	*Senecio madagascariensis*	Fireweed									0.01	2
lin	Asteraceae	*Senecio spp.*	Groundsel, Fireweed	1	50	0.5	1						
lin	Asteraceae	*Triptilodiscus pygmaeus*	Common Sunray			20	1200					0.1	200
lin	Asteraceae	*Vittadinia cuneata*	A Fuzzweed									0.01	20
lin	Asteraceae	*Vittadinia muelleri*										0.1	50
*	Boraginaceae	*Echium plantagineum*	Patterson's Curse									0.1	1
lin	Brassicaceae	*Brassica sp*						1	200				
lin	Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell	1	3000	1	50	1	50	1	400		
lin	Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell	1	1200	1	25			1	50		
lin	Campanulaceae	*Wahlenbergia spp.*	Bluebell			1	25						
lin	Campanulaceae	*Wahlenbergia stricta*	Tall Bluebell									0.1	500
lin	Chenopodiaceae	*Einadia spp.*	A Saltbush			1	25						
lin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew			1	25	1	10				
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed	1	400	1	200			1	100		
lin	Cyperaceae	*Cyperus sp.*	A Sedge					10	20000				
lin	Cyperaceae	*Sedge sample*	A Sedge	1	800								
lin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry			1	1			0.5	1	0.1	1
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath									0.1	2
*	Euphorbiaceae	*Euphorbia peplus*	Petty Spurge					1	50	1	100		
lin	Euphorbiaceae	*Euphorbia spp. 2*										0.01	5
lin	Euphorbiaceae	*Euphorbia spp.*		1	800							0.1	500
lin	Fabaceae (Faboideae)	*Daviesia ulicifolia*	Gorse Bitter Pea							1	20		
lin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	1	30	0.5	50	1	200	1	400	0.01	1
lin	Fabaceae (Faboideae)	*Podolobium scandens*	Netted Shaggy Pea									0.1	50
lin	Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia	1	50	0.5	25			1	400		
*	Gentianaceae	*Centaurium erythraea*	Common Centaury									0.01	2
*	Gentianaceae	*Centaurium tenuiflorum*	Branched Centaury, Slender centaury							1	50		

Status	Family	*Genus species*	Common Name	US58	US58	US59	US59	US62	US62	US69	US69	US70	US70
				C	A	C	A	C	A	C	A	C	A
lin	Gentianaceae	*Cicendia spp.*										0.1	500
lin	Geraniaceae	*Geranium homeanum*		1	150			1	50				
lin	Geraniaceae	*Geranium sp*		1	100								
lin	Hypericaceae	*Hypericum ?japonica*										0.1	500
lin	Linaceae	*Linum sp.*				1	100						
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush									0.01	5
*	Malvaceae	*Modiola caroliniana*	Red-flowered Mallow					1	25				
lin	Malvaceae	*Sida corrugata*	Corrugated Sida	1	800	1	400			1	50		
*	Malvaceae	*Sida rhombifolia*	Paddy's Lucerne			1	2						
lin	Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum							1	4		
lin	Myrtaceae	*Eucalyptus melliodora*	Yellow Box			0.5	1						
lin	Myrtaceae	*Eucalyptus moluccana*	Grey Box									3	8
lin	Oxalidaceae	*Oxalis perennans*	Oxalis	1	1000	1	200			1	400	0.01	10
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn							1	18	0.1	1
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell	1	50			1	50				
lin	Poaceae	*Aristida ramosa*	Purple Wiregrass									10	500
lin	Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass					1	100				
lin	Poaceae	*Bothriochloa macra*	Red Grass									3	1000
lin	Poaceae	*Bothriochloa spp.*	Redgrass, Bluegrass	10	1000	2	4000	1	50				
*	Poaceae	*Briza minor*	Shivery Grass	2	1500								
lin	Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	2	1500							0.01	1
lin	Poaceae	*Cynodon dactylon*	Common Couch					10	10000				
lin	Poaceae	*Digitaria spp.*	A Finger Grass	10	1000					20	80		
lin	Poaceae	*Entolasia stricta*	Wiry Panic									0.1	50
lin	Poaceae	*Microlaena stipoides*	Weeping Grass	5	1000	2	800	40	20000	2	150	0.1	50
lin	Poaceae	*Panicum effusum*	Hairy Panic									0.1	100
lin	Poaceae	*Poaceae sp.*								50	1200		
lin	Poaceae	*Rytidosperma sp.*				2	2000					1	500
lin	Poaceae	*Themeda australis*										1	1000
lin	Poaceae	*Themeda triandra*								5	100		
*	Poaceae	*Vulpia spp.*	Rat's-tail Fescue	5	100								
lin	Polygonaceae	*Rumex sp. (Assume NGO)*						1	50				
*	Primulaceae	*Anagallis arvensis*	Scarlet Pimpernel	1	800			1	100			1	400
lin	Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	1	200	0.5	100						
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern	1	100	0.5	100			1	150	1	1000
lin	Rosaceae	*Acaena novae-zelandiae*	Bidgee-widgee	1	2								
*	Rosaceae	*Rosa spp.*		1	1								
*	Rubiaceae	*Richardia spp.*		1	150	1	100			1	200		
lin	Scrophulariaceae	*Verbascum sp.*	Mulleins					1	10				
lin	Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia							1	5		
*	Verbenaceae	*Verbena bonariensis*	Purpletop	1	150								
lin	Verbenaceae	*Verbena littoralis*		1	50								

Status	Family	*Genus* species	Common Name	US58 C	US58 A	US59 C	US59 A	US62 C	US62 A	US69 C	US69 A	US70 C	US70 A
lin		*Unidentified sp. 1*		1	4000	2	2000						
lin		*Unidentified sp. 2*		50	4000	1	1000						
lin		*Unidentified sp. 3*		50	4000	1	1000						
lin		*Unidentified sp. 4*		1	4000	1	1000						
lin		*Unidentified sp. 5*				0.5	30						
lin		*Unidentified sp. 6*				0.5	100						

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

				US37	US37	US40	US40	US43	US43	US47	US47	US48	US48	US51	US51	US52	US52
Status	**Family**	***Genus* species**	**Common Name**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet					0.1	800			0.01	100			0.1	400
lin	Amaranthaceae	*Nyssanthes diffusa*	Barbwire Weed							2	100	0.5	50				
lin	Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily	1	50							0.0001	1	0.5	50	0.1	100
lin	Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily											0.5	25		
lin	Apocynaceae	*Marsdenia flavescens*	Hairy Milk Vine							0.1	10						
lin	Apocynaceae	*Parsonsia straminea*	Common Silkpod							0.1	10			1	25		
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora	1	2												
lin	Araliaceae	*Hydrocotyle laxiflora*	Stinking Pennywort									0.01	1				
lin	Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern							0.01	10						
lin	Asteraceae	*?Coronidium rutidolepis*												0.5	1		
lin	Asteraceae	*?Lagenophora stipitata*		0.1	10												
lin	Asteraceae	*Brachyscome graminea*	Grass Daisy											1	1		
lin	Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy									0.01	100				
lin	Asteraceae	*Coronidium ?rutidolepis*				1	400										
lin	Asteraceae	*Euchiton spp.*	A Cudweed	0.01	1												
lin	Asteraceae	*Lagenophora gracilis*	Slender Lagenophora							0.1	200	0.01	200				
lin	Asteraceae	*Olearia viscidula*	Wallaby Weed			0.1	1	1	40	1	5	0.5	3			1	30
lin	Asteraceae	*Senecio linearifolius*	Fireweed Groundsel			0.5	50										
lin	Asteraceae	*Sigesbeckia orientalis*	Indian Weed					0.001	200	1	5000						
*	Asteraceae	*Tagetes minuta*	Stinking Roger			0.01	20										
lin	Asteraceae	*Vittadinia cuneata*	Fuzzweed	2	1600												
lin	Asteraceae	*Vittadinia sp.*						0.01	50								
lin	Asteraceae	*Vittadinia sulcata*														0.1	50
lin	Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine			0.5	100	0.01	200	0.01	10						
lin	Brassicaceae	*Lepidium spp.*	A Peppercress					0.001	2								
*	Cactaceae	*Opuntia stricta*	Common Prickly Pear									0.01	1				
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot					1	200	0.1	400	0.01	400	1	1600		
lin	Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell							0.01	1						
lin	Campanulaceae	*Wahlenbergia sp.*				0.01	30	0.0001	1								
lin	Cannabaceae	*Trema tomentosa*	Native Peach					0.01	3	2	5						
lin	Caryophyllaceae	*Stellaria flaccida*								1	20						
lin	Caryophyllaceae	*Stellaria pungens*	Prickly Starwort					0.01	50								
lin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak	5	30									1	15	2	20
lin	Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	2	4												
lin	Chenopodiaceae	*Einadia hastata*	Berry Saltbush	0.01	50	2	400			0.01	1	0.1	400				

				US37	US37	US40	US40	US43	US43	US47	US47	US48	US48	US51	US51	US52	US52
Status	Family	*Genus* species	Common Name	C	A	C	A	C	A	C	A	C	A	C	A	C	A
lin	Chenopodiaceae	*Einadia sp.*	A Saltbush					0.1	400								
lin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew	0.1	400	1	200					0.01	20				
lin	Convolvulaceae	*Convolvulaceae*						0.01	1								
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed	0.01	100	0.5	100	2	800	0.5	5000					0.1	1400
lin	Cyperaceae	*Cyperus ?gracillis*	Slender Flat-sedge			1	200										
lin	Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge					0.01	800	0.1	1000	1	1600				
lin	Cyperaceae	*Cyperus sp.*	A Sedge	0.01	1	0.05	50										
lin	Cyperaceae	*Gahnia ?melanocarpa*	Black-fruit Saw-sedge					0.001	1								
lin	Cyperaceae	*Lepidosperma ?viscidum*		1	20												
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge											0.5	150		
lin	Dilleniaceae	*Hibbertia sp.*						0.1	5							0.5	30
lin	Dilleniaceae	*Hibbertia sp. "hairy, toothed edge"*		0.01	20												
lin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry											10	40	0.01	5
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath	20	100			1	11	1	20	0.5	3				
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath	2	400	0.1	2							0.5	1	0.5	10
lin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	0.01	20					0.1	200						
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine											1	400		
lin	Fabaceae (Faboideae)	*Glycine microphylla*	Small-leaf Glycine											1	1200		
lin	Fabaceae (Faboideae)	*Glycine spp.*	A Glycine			0.01	20	0.01	200								
lin	Fabaceae (Faboideae)	*Glycine tabacina*	Variable Glycine									0.1	200				
lin	Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo	0.5	10	0.5	20	0.05	4							0.5	2
lin	Fabaceae (Faboideae)	*Jacksonia scoparia*	Dogwood	15	80											1	30
lin	Fabaceae (Faboideae)	*Kennedia rubicunda*	Dusky Coral Pea	1	40												
lin	Fabaceae (Faboideae)	*Oxytes brachypoda*	Large Tick-trefoil									0.01	10				
lin	Fabaceae (Mimosoideae)	*Acacia ?penninervis*				1	20										
lin	Fabaceae (Mimosoideae)	*Acacia binervia*	Coast Myall											30	200	1	1
lin	Fabaceae (Mimosoideae)	*Acacia clunies-rossiae*	Kowmung wattle					5	25					0.5	1		

Status	Family	*Genus* species	Common Name	US37 C	US37 A	US40 C	US40 A	US43 C	US43 A	US47 C	US47 A	US48 C	US48 A	US51 C	US51 A	US52 C	US52 A
lin	Fabaceae (Mimosoideae)	*Acacia falciformis*	Broad-leaved Hickory							40	12						
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle	1	2	2	9	1	10	0.01	1	1	30			10	60
lin	Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle	1	1												
lin	Fabaceae (Mimosoideae)	*Acacia sp.*						1	1								
lin	Geraniaceae	*Geranium homeanum*								0.1	100						
lin	Haloragaceae	*Gonocarpus teucrioides*	Germander Raspwort											0.5	1		
lin	Lamiaceae	*Ajuga australis*	Austral Bugle	0.01	100			0.1	100	0.01	1					0.1	100
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum	0.01	1	0.5	30					1	30				
lin	Lamiaceae	*Plectranthus parviflorus*	Cockspur flower	0.01	50	1	10	0.001	2								
lin	Lomandraceae	*Lomandra brevis*	Tufted Mat-rush											0.5	50		
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush			0.05	1	0.5	15					0.5	200		
lin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush											0.5	50	0.1	100
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	1	10			0.01	20								
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush			0.5	5	0.01	30							0.01	1
lin	Lomandraceae	*Lomandra sp.*		10	200												
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily					0.5	17								
lin	Malvaceae	*Brachychiton populneus*	Kurrajong					0.001	1			1	5	0.5	1		
lin	Malvaceae	*Commersonia dasyphylla*										0.5	100				
lin	Malvaceae	*Sida ?corrugata*	Variable Sida			0.1	200										
lin	Malvaceae	*Sida corrugata*	Corrugated Sida					0.1	50			0.1	200				
lin	Menispermaceae	*Stephania japonica*	Snake vine			0.01	10	1	50	2	50						
lin	Moraceae	*Ficus rubiginosa*	Port Jackson Fig									2	2				
lin	Moraceae	*Maclura cochinchinensis*	Cockspur Thorn			0.1	10										
lin	Myrtaceae	*Angophora bakeri*	Narrow-leaved Apple					0.01	1								
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle					2	4								
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	40	17	40	18	40	16			50	3	10	3	60	37
lin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark	5	1			5	1								
lin	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark											10	1		
lin	Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum	10	3							10	0	15	1	2	7
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive	0.05	1			2	3								
lin	Orchidaceae	*Sarcochilus hillii*								0.01	1						
lin	Oxalidaceae	*Oxalis perennans*	Oxalis	0.01	20	4	1600			0.01	1000			1	800		

Status	Family	*Genus species*	Common Name	US37 C	US37 A	US40 C	US40 A	US43 C	US43 A	US47 C	US47 A	US48 C	US48 A	US51 C	US51 A	US52 C	US52 A
lin	Passifloraceae	*Passiflora herbertiana*	Native Passionfruit			0.01	5	0.01	50	2	50	0.1	200				
lin	Phormiaceae	*Dianella revoluta*	Blueberry Lily	0.1	100	0.1	5	0.1	20							0.1	1
lin	Phyllanthaceae	*?Phyllanthus*	Leafflower					0.001	1								
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	1	800	0.5	50	1	120	2	20	0.5	16	1	50	1	20
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge	0.01	1												
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry											1	25		
lin	Pittosporaceae	*Bursaria longisepala*		1	100			1	40	0.01	10						
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	5	20	3	30			10	15	0.5	7				
lin	Plantaginaceae	*Plantago debilis*	Shade Plantain			0.01	1										
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell					0.01	50								
lin	Poaceae	*Aristida vagans*	Threeawn Speargrass											1	150		
lin	Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass					0.01	10								
lin	Poaceae	*Dichelachne sp. (very short, grazed)*	A Plumegrass									0.01	400				
lin	Poaceae	*Digitaria spp.*										0.01	1	0.5	1		
lin	Poaceae	*Echinopogon spp.*	A Hedgehog Grass													0.1	100
lin	Poaceae	*Entolasia marginata*	Bordered Panic											1	1200		
lin	Poaceae	*Entolasia stricta*	Wiry Panic					0.001	100								
lin	Poaceae	*Eragrostis brownii*	Brown's Lovegrass											1	50		
lin	Poaceae	*Microlaena stipoides*	Weeping Grass			1	200	0.5	200	0.1	40000	0.5	2000	1	800		
lin	Poaceae	*Oplismenus aemulus*	Australian Basket Grass	0.1	800			0.1	600								
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass							0.01	1500						
lin	Poaceae	*Poaceae spp.*										0.01	20			0.1	100
lin	Polygonaceae	*Rumex brownii*	Swamp Dock					0.1	36	0.01	100						
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	2	20			0.01	2								
lin	Pteridaceae	*Adiantum spp.*								0.1	400						
lin	Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern							0.1	500			1	400	1	1600
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern	2	400	0.05	200							1	1200		
lin	Pteridaceae	*Pellaea falcata*	Sickle Fern	0.01	1			0.5	100	0.5	5000						
lin	Ranunculaceae	*Clematis aristata*	Old Man's Beard					1	200								
lin	Ranunculaceae	*Clematis glycinoides*	Headache Vine							0.1	10	0.1	200				
lin	Rhamnaceae	*Alphitonia excelsa*	Red Ash					20	3								
lin	Rosaceae	*Acaena novae-zelandiae*	Bidgee-widgee							0.01	50						
lin	Rosaceae	*Rubus parvifolius*	Native Raspberry							1	20						
lin	Rubiaceae	*Pomax umbellata*	Pomax	0.01	50												
lin	Santalaceae	*Choretrum pauciflorum*	Dwarf Sour Bush													0.1	1
lin	Santalaceae	*Exocarpos strictus*	Dwarf Cherry	1	20	0.5	1										
lin	Santalaceae	*Leptomeria acida*	Sour Currant Bush											0.5	1		
lin	Sapindaceae	*Dodonaea truncatiales*	Angular Hop-bush			0.5	2	0.5	1								

				US37	US37	US40	US40	US43	US43	US47	US47	US48	US48	US51	US51	US52	US52
Status	**Family**	***Genus* species**	**Common Name**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**
lin	Scrophulariaceae	*Myoporum insulare*	Common Boobialla					0.01	2								
lin	Scrophulariaceae	*Myoporum montanum*	Western Boobialla			0.1	1					0.01	1				
lin	Solanaceae	*Solanum ?pungetium*	Eastern Nightshade					0.001	2								
lin	Solanaceae	*Solanum pungetium*	Eastern Nightshade							0.001	1	0.05	10				
lin	Solanaceae	*Solanum sp.*						0.001	1								
lin	Thymelaeaceae	*?Pimelea latifolia subsp. Hirsuta*												1	25		
lin	Urticaceae	*Urtica incisa*	Stinging Nettle							1	100						
lin	Violaceae	*Melicytus dentatus*	Tree Violet					3	3								
lin	Vitaceae	*Cayratia clematidea*	Native Grape			0.5	100			1	2						
lin		*"grey-leaved grass"*		0.05	200												
lin		*Aristata sp.*		0.01	20			0.001	1								
lin		*Plant sp.*						0.001	1								

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US13 C	US13 A
lin	Araliaceae	*Hydrocotyle sp*		1	50
lin	Atherospermataceae	*Doryphora sassafras*	Sassafras	2	5
lin	Blechnaceae	*Blechnum cartilagineum*	Gristle Fern	5	100
lin	Blechnaceae	*Blechnum patersonii*	Strap Water Fern	0.5	200
lin	Blechnaceae	*Doodia aspera*	Prickly rasp fern	1	100
lin	Cunoniaceae	*Callicoma serratifolia*	Black Wattle	5	5
lin	Cunoniaceae	*Ceratopetalum apetalum*	Coachwood	70	106
lin	Cyatheaceae	*Cyathea australis*	Rough Treefern	0.5	1
lin	Eupomatiaceae	*Eupomatia laurina*	Bolwarra	2	40
lin	Gleicheniaceae	*Sticherus flabellatus*	Umbrella Fern	1	20
lin	Hymenophyllaceae	*Hymenophyllum cupressiforme*	Common Filmy Fern	3	1000
lin	Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	0.1	20
lin	Menispermaceae	*Sarcopetalum harveyanum*	Pearl Vine	0.5	100
lin	Moraceae	*Ficus rubiginosa*	Port Jackson Fig	1	1
lin	Myrtaceae	*Acmena smithii*	Lilly Pilly	20	9
lin	Oleaceae	*Notelaea venosa*	Veined Mock-olive	0.5	5
lin	Orchidaceae	*Dendrobium speciosum*	Sydney rock orchid	0.1	1
lin	Orchidaceae	*Dendrobium striolatum*	Streaked Rock Orchid	1	30
lin	Osmundaceae	*Todea barbara*	King Fern	5	200
lin	Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	1	5
lin	Polypodiaceae	*Platycerium bifurcatum*	Elkhorn Fern	0.001	1
lin	Polypodiaceae	*Pyrrosia rupestris*	Rock Felt Fern	2	20
lin	Proteaceae	*Stenocarpus salignus*	Scrub Beefwood	1	8
lin	Pteridaceae	*Adiantum hispidulum*	Rough Maidenhair Fern	1	500
lin	Ranunculaceae	*Clematis aristata*	Old Man's Beard	0.1	10
lin	Rousseaceae	*Abrophyllum ornans*	Native Hydrangea	5	100
lin	Rubiaceae	*Gynochthodes jasminoides*	Sweet Morinda	1	50
lin	Smilacaceae	*Smilax australis*	Barbwire Vine	1	40
lin	Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla	1	10
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine	30	20

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US65 C	US65 A	US72 C	US72 A	US73 C	US73 A	US74 C	US74 A	US76 C	US76 A	US77 C	US77 A	US86 C	US86 A
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet											0.01	1	0.1	20
	Anthericaceae	*?Caesia*						0.01	25								
lin	Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily					x	x			0.05	10				
HTW	Apocynaceae	*Araujia sericifera*	Moth Vine					0.01	1	10	200						
*	Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush							0.1	1						
lin	Araliaceae	*Hydrocotyle laxiflora*	Stinking Pennywort							1	50						
lin	Araliaceae	*Hydrocotyle spp.*										0.1	50	0.05	70		
HTW	Asparagaceae	*Asparagus asparagoides*	Bridal Creeper							0.5	3	0.1	20				
	Asparagaceae	*Asparagus sp*						0.01	1								
	Asteraceae	*?Vittadinia sp*														0.1	1
*	Asteraceae	*Bidens pilosa*	Cobbler's Pegs	2	1000	1	200	0.01	1	0.1	1	0.1	20				
lin	Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	1	200	0.5	20										
	Asteraceae	*Cassinia sp*				0.1	1										
*	Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	0.1	10			0.01	1	0.1	1						
*	Asteraceae	*Conyza spp.*	A Fleabane									0.1	20				
*	Asteraceae	*Hypochaeris radicata*	Catsear					0.01	1								
lin	Asteraceae	*Olearia viscidula*	Wallaby Weed					1	10					0.1	1	1	40
*	Asteraceae	*Senecio madagascariensis*	Fireweed	0.5	200												
lin	Asteraceae	*Senecio spp.*	Groundsel, Fireweed	0.1	10												
*	Asteraceae	*Sonchus oleraceus*	Common Sowthistle							0.1	1						
lin	Asteraceae	*Vittadinia cuneata*	A Fuzzweed			0.1	5										
lin	Asteraceae	*Vittadinia sulcata*		1	200												
*	Asteraceae	*Xanthium strumarium*				0.01	1					0.1	50				
*	Cactaceae	*Opuntia stricta*	Common Prickly Pear	0.01	1	0.1	5										
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot			0.5	10	0.01	1	1	10			1	100	0.1	100
lin	Campanulaceae	*Wahlenbergia spp.*	Bluebell	0.1	50	0.1	50							0.1	20		
lin	Cannabaceae	*Trema tomentosa*	Native Peach							0.01	1						
lin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak					1	2					1	4	5	75
	Chenopodiaceae	*Atriplex sp*		0.1	20	1	20										
lin	Chenopodiaceae	*Einadia hastata*	Berry Saltbush	0.01	5							1	3				
lin	Chenopodiaceae	*Einadia nutans*		1	50	1	50										
lin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew	0.5	100	0.5	50					0.1	20				
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed	2	500	0.5	50			10	1000					0.1	30
lin	Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	5	30			25	13								
lin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower					0.01	1							2	35
lin	Dilleniaceae	*Hibbertia sp.*		1	200			0.01	1	0.1	1						
lin	Ericaceae (Epacridoideae)	*Acrotriche serrulata*														0.2	4
lin	Ericaceae (Epacridoideae)	*Astroloma humifusum*	Native Cranberry									3	25	0.1	1		
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*						1	10							0.5	8
lin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath					2	25	0.5	2	2	15	20	50	5	100
lin	Ericaceae (Epacridoideae)	*Monotoca scoparia*						0.01	1								
lin	Fabaceae (Faboideae)	*Bossiaea sp*												0.1	1		

Status	Family	Genus species	Common Name	US65 C	US65 A	US72 C	US72 A	US73 C	US73 A	US74 C	US74 A	US76 C	US76 A	US77 C	US77 A	US86 C	US86 A
Iin	Fabaceae (Faboideae)	*Daviesia ulicifolia*	Gorse Bitter Pea													0.1	2
Iin	Fabaceae (Faboideae)	*Desmodium ?varians*														0.1	3
Iin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil					0.1	150	1	10			0.5	30		
Iin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine	1	50	0.5	50	1	50	0.1	1	0.5	200	0.1	30		
Iin	Fabaceae (Faboideae)	*Glycine microphylla*	Small-leaf Glycine							0.1	1						
Iin	Fabaceae (Faboideae)	*Glycine tabacina*	Variable Glycine			0.01	1										
Iin	Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo											0.1	1		
Iin	Fabaceae (Faboideae)	*Jacksonia scoparia*	Dogwood											0.12			
*	Fabaceae (Faboideae)	*Trifolium sp*												0.5	70		
Iin	Fabaceae (Mimosoideae)	*Acacia binervia*	Coast Myall	60	50	60	75	5	25								
Iin	Fabaceae (Mimosoideae)	*Acacia decurrens*	Black Wattle													10	200
Iin	Fabaceae (Mimosoideae)	*Acacia falcata*												0.1	1	1	5
Iin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally							0.1	1	1	1				
Iin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle									1	2	0.5	4		
Iin	Fabaceae (Mimosoideae)	*Acacia paradoxa*	Kangaroo Thorn							20	36			2	20		
Iin	Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle					2	10								
Iin	Fabaceae (Mimosoideae)	*Acacia parvipinnula*	Silver-stemmed Wattle							2	4						
Iin	Geraniaceae	*Geranium homeanum*				0.01	1			2	500						
Iin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia													0.1	50
Iin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum							2	8						
Iin	Lauraceae	*Cassytha glabella*						0.01	1	0.01	1						
Iin	Lomandraceae	*Lomandra "toothed edges, toothed ends sample"*														0.1	10
Iin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush	0.1	10												
Iin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush											0.5	50		
Iin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush									0.01	1	2	20		
Iin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush													0.1	14
Iin	Lomandraceae	*Lomandra sp.*						0.01	2								
Iin	Malvaceae	*Brachychiton populneus*	Kurrajong							1	2						
Iin	Malvaceae	*Sida corrugata*	Corrugated Sida	1	50												
*	Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	0.5	10	0.01	5			0.01	1						
Iin	Menispermaceae	*Stephania japonica*	Snake vine					0.01	10	5	200	1	5				
Iin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple									2	5	1	1		
Iin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark			10	5	25	2					1	1		
Iin	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark											45	20		
Iin	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark													10	12
Iin	Myrtaceae	*Eucalyptus melliodora*	Yellow Box	2	3					10	3	1	3				
Iin	Myrtaceae	*Eucalyptus moluccana*														25	17
Iin	Myrtaceae	*Eucalyptus punctata*	Grey Gum													10	2
Iin	Myrtaceae	*Eucalyptus sideroxylon*														10	1
Iin	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum	1	2			10	6	35	17	40	20	10	7		
Iin	Myrtaceae	*Leptospermum sp*						2	20								
Iin	Oxalidaceae	*Oxalis perennans*	Oxalis	1	500	0.5	100	0.01	1			0.5	50				

Status	Family	Genus species	Common Name	US65 C	US65 A	US72 C	US72 A	US73 C	US73 A	US74 C	US74 A	US76 C	US76 A	US77 C	US77 A	US86 C	US86 A
lin	Passifloraceae	*Passiflora herbertiana*	Native Passionfruit	0.1	1												
lin	Phormiaceae	*Dianella caerulea var. producta*														0.1	80
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	0.1	1	1	5	1	10	3	10	15	100	1	25		
lin	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera									0.1	20	0.01	2		
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry					0.01	25	0.01	1			2	20		
lin	Pittosporaceae	*Bursaria longisepala*														3	30
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn							5	9			35	100		
lin	Plantaginaceae	*Plantago debilis*	Shade Plantain													0.1	5
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell	0.5	50							0.1	50				
	Poaceae	*?Rytidosperma sp*														0.1	20
lin	Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass	0.01	2	0.01	1	2	8								
lin	Poaceae	*Entolasia marginata*	Bordered Panic	0.5	200			1	50			0.1	50				
lin	Poaceae	*Imperata cylindrica*	Blady Grass											1	100		
lin	Poaceae	*Microlaena stipoides*	Weeping Grass	3	1000	10	500	50	1000	15	1000	15	1000	2	200	0.1	200
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass					1	50	0.5	20	1	200	0.1	25		
*	Primulaceae	*Lysimachia arvensis*	Scarlet Pimpernel							0.1	1						
lin	Proteaceae	*Grevillea acanthifolia*						0.1	2					20	40		
lin	Proteaceae	*Grevillea ramosissima*										2	20				
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung					0.01	1	0.1	1			0.5	4		
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern	2	1000	3	1000	1	150			2	500	1	100		
lin	Ranunculaceae	*Clematis spp.*						0.01	1								
lin	Rosaceae	*Acaena novae-zelandiae*	Bidgee-widgee							0.01	1						
lin	Rubiaceae	*Pomax umbellata*	Pomax					0.01	1	0.1	1			0.1	20	0.1	200
lin	Rutaceae	*Correa reflexa*	Native Fuschia					2	25								
lin	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart									2	4	1	1		
lin	Santalaceae	*Exocarpos strictus*	Dwarf Cherry					0.01	1			15	30	0.1	1	0.1	1
lin	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush											0.01	1	5	150
lin	Sapindaceae	*Dodonaea viscosa*	Sticky Hop-bush			0.5	2			1	4						
lin	Thymelaeaceae	*Pimelea curviflora*	Rice Flower							0.01	1						
lin	Violaceae	*Melicytus dentatus*	Tree Violet							0.1	1						

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US80 C	US80 A	US81 C	US81 A	US83 C	US83 A	US88 C	US88 A
lin	Acanthaceae	*Brunoniella australis*	Blue Trumpet					0.1	25		
lin	Anthericaceae	*Caesia parviflora*				1	1				
lin	Apiaceae	*Centella asiatica*	Gotu Cola			1	200				
lin	Apiaceae	*Xanthosia tridentata*	Rock Xanthosia					1	5		
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora			1	50	0.1	1		
lin	Araliaceae	*Astrotricha latifolia*						0.1	1	0.1	1
lin	Araliaceae	*Hydrocotyle sibthorpioides*				1	1500				
lin	Asteraceae	*Ageratina adenophora*	Crofton Weed					0.1	1		
*	Asteraceae	*Bidens pilosa*	Cobbler's Pegs					0.2	3		
lin	Asteraceae	*Calomeria amaranthoides*						0.1	1		
*	Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	0.1	200	1	5	0.5	50		
lin	Asteraceae	*Senecio linearifolius*	Fireweed Groundsel							0.1	1
lin	Asteraceae	*Sigesbeckia orientalis*	Indian Weed					0.5	30		
lin	Blechnaceae	*Blechnum cartilagineum*	Gristle Fern			1	50				
lin	Blechnaceae	*Doodia aspera*	Prickly rasp fern	0.01	1000	1	100	0.1	25		
*	Brassicaceae	*Rorippa palustris*	Marsh Watercress	0.001	1						
lin	Campanulaceae	*Lobelia anceps*		0.01	1						
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot	0.01	100	1	2000	0.1	30		
lin	Campanulaceae	*Wahlenbergia gracilenta*	Hairy Annual Bluebell			1	150				
lin	Cannabaceae	*Trema tomentosa*	Native Peach					0.5	10		
lin	Caryophyllaceae	*Stellaria flaccida*				1	2000				
lin	Casuarinaceae	*Casuarina cunninghamiana*	River Oak	20	200			2	25	2	5
lin	Casuarinaceae	*Casuarina cunninghamiana subsp. cunninghamiana*	River Sheoak			2	5				
lin	Commelinaceae	*Tradescantia fluminensis*	Wandering Jew					0.1	1		
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed			1	400				
lin	Cyperaceae	*Cyperus ?gracillis*	Slender Flat-sedge	0.01	20						
lin	Cyperaceae	*Cyperus spp.*	A Sedge			1	25				
lin	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge			1	30				
lin	Cyperaceae	*Lepidosperma gunnii*		1	50						
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge			1	25			1	25
lin	Cyperaceae	*Schoenus melanostachys*	Black Bog-rush			2	25				
lin	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken			1	50	1	20		
lin	Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern							1	10
lin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower							0.1	1
lin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash			1	1				
lin	Ericaceae (Epacridoideae)	*Epacris pulchella*	Wallum Heath			1	10				
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath	0.01	1						
lin	Ericaceae (Epacridoideae)	*Lissanthe sapida*	Native Cranberry	0.5	3						
lin	Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart					0.1	1		

Status	Family	Genus species	Common Name	US80	US80	US81	US81	US83	US83	US88	US88
				C	A	C	A	C	A	C	A
lin	Fabaceae (Faboideae)	*Desmodium rhytidophyllum*								0.1	3
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine			1	1000				
lin	Fabaceae (Mimosoideae)	*Acacia elata*	Cedar Wattle			1	1			0.5	20
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally	5	200	2	15	0.1	20	1	25
lin	Fabaceae (Mimosoideae)	*Acacia irrorata*	Green Wattle					0.5	10		
lin	Fabaceae (Mimosoideae)	*Acacia longifolia*								0.5	5
lin	Goodeniaceae	*Goodenia ovata*	Hop Goodenia	0.01	1					0.1	5
lin	Juncaceae	*Juncus usitatus*		0.01	20						
lin	Lamiaceae	*Plectranthus parviflorus*	Cockspur flower			1	15				
lin	Lauraceae	*Cassytha glabella*		5	250					0.1	2
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	2	300	5	50	1	50		
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily			1	50	0.1	2		
lin	Menispermaceae	*Stephania japonica*	Snake vine			1	15	0.1	5		
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle			10	30	5	25		
lin	Myrtaceae	*Callistemon linearifolius*								1	2
lin	Myrtaceae	*Eucalyptus deanei*	Mountain Blue Gum	0.01	1	1	5	0.5	1		
lin	Myrtaceae	*Eucalyptus elata*	River Peppermint					1	5		
lin	Myrtaceae	*Leptospermum morrisonii*						15	30	0.2	4
lin	Myrtaceae	*Leptospermum polyanthum*		5	100						
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree			10	25				
lin	Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark	2	30	10	25	20	50	3	6
lin	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree			2	25				
lin	Myrtaceae	*Tristaniopsis laurina*	Water Gum	50	1000	50	20				
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive	0.01	1			1	1		
lin	Oxalidaceae	*Oxalis perennans*	Oxalis			1	500			0.1	20
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily	0.01	1	1	1			0.1	5
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush			1	25	0.5	10	0.1	2
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge							1	5
lin	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera			1	2000				
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry			1	50			0.1	1
lin	Pittosporaceae	*Bursaria longisepala*				1	1				
lin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum			1	15	1	2		
lin	Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum			1	1				
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell			1	4000	1	25		
lin	Poaceae	*Echinopogon caespitosus*	Bushy Hedgehog-grass			1	1000				
lin	Poaceae	*Ehrharta erecta*	Panic Veldtgrass			1	50				
lin	Poaceae	*Entolasia marginata*	Bordered Panic	0.01	100	1	200	1	100	0.1	25
lin	Poaceae	*Microlaena stipoides*	Weeping Grass	0.01	200	1	4000	1	200		
lin	Poaceae	*Oplismenus aemulus*	Australian Basket Grass			2	1000				

Status	Family	Genus species	Common Name	US80 C	US80 A	US81 C	US81 A	US83 C	US83 A	US88 C	US88 A
lin	Polygonaceae	*Muehlenbeckia rhyticarya*	Wrinkle-nut Lignum							1	15
lin	Proteaceae	*Grevillea arenaria*				1	1			0.1	2
lin	Proteaceae	*Lomatia spp.*	Crinkle Bush			4	30				
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	0.001	1			0.1	1		
lin	Proteaceae	*Stenocarpus salignus*	Scrub Beefwood	0.5	2	5	20	15	50	2	5
lin	Pteridaceae	*Adiantum ?aethiopicum*	Maidenhair	0.01	100						
lin	Pteridaceae	*Adiantum aethiopicum*	Common Maidenhair			1	5000	5	200		
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern							1	25
lin	Ranunculaceae	*Clematis aristata*	Old Man's Beard			1	150				
lin	Rhamnaceae	*Pomaderris ?ferruginea*	Rusty Pomaderris							0.1	1
lin	Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris					1	5		
lin	Rosaceae	*Rubus nebulosus*	Green-leaved Bramble					0.1	1		
lin	Rosaceae	*Rubus parvifolius*	Native Raspberry			1	200	0.1	5		
lin	Rubiaceae	*Opercularia aspera*	Coarse Stinkweed	0.01	1						
lin	Rubiaceae	*Opercularia diphylla*		0.01	2						
lin	Rubiaceae	*Opercularia varia*	Variable Stinkweed			1	1500				
lin	Rubiaceae	*Pomax umbellata*	Pomax							0.1	1
lin	Rutaceae	*Correa reflexa*	Native Fuschia							0.1	1
lin	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush							0.5	10
lin	Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla			1	1				
lin	Solanaceae	*Solanum prinophyllum*	Forest Nightshade	0.01	1	1	5	1	5		
lin	Urticaceae	*Urtica incisa*	Stinging Nettle					0.1	1		
lin	Violaceae	*Melicytus dentatus*	Tree Violet			1	1	0.1	25		
lin	Violaceae	*Viola hederacea*	Ivy-leaved Violet	0.01	1						
lin	Violaceae	*Viola silicestris*	Sandstone Violet					1	100	0.5	25
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine			1	1	0.1	1		
lin		*unidentified plant species*								0.1	1

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US14 C	US14 A	US15 C	US15 A
lin	Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower			2	1000
lin	Aphanopetalaceae	*Aphanopetalum resinosum*	Gum Vine			5	40
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora	0.01	20		
lin	Araliaceae	*Hydrocotyle geraniifolia*	Forest Pennywort	0.01	1		
lin	Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	1	20		
lin	Blechnaceae	*Blechnum cartilagineum*	Gristle Fern	5	80	75	3000
lin	Blechnaceae	*Doodia aspera*	Prickly rasp fern	5	200	30	4000
lin	Boraginaceae	*Ehretia acuminata*	Koda			3	2
lin	Cannabaceae	*Trema tomentosa*	Native Peach			0.01	10
lin	Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	5	20		
lin	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge	0.5	5		
lin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	0.1	2		
lin	Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern			5	100
lin	Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern			5	100
lin	Dilleniaceae	*Hibbertia dentata*	Trailing Guinea Flower	0.01	10	1	5
lin	Dryopteridaceae	*Polystichum australiense*	Harsh Shield Fern			1	50
lin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash	0.5	10		
lin	Ericaceae (Epacridoideae)	*Dracophyllum secundum*		0.01	20		
lin	Eupomatiaceae	*Eupomatia laurina*	Bolwarra			3	30
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine	0.01	100	0.01	20
lin	Fabaceae (Faboideae)	*Podolobium ilicifolium*	Prickly Shaggy Pea	1	50		
lin	Fabaceae (Mimosoideae)	*Acacia falciformis*	Broad-leaved Hickory			5	2
lin	Fabaceae (Mimosoideae)	*Acacia prominens*	Golden Rain Wattle	5	50		
lin	Goodeniaceae	*Goodenia ovata*	Hop Goodenia	1	30		
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum			0.5	5
lin	Lamiaceae	*Plectranthus parviflorus*	Cockspur flower	0.5	1000		
lin	Lauraceae	*Cassytha pubescens*		0.1	3		
lin	Lauraceae	*Cryptocarya glaucescens*	Jackwood			1	1
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	1	50		
lin	Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	0.01	1	5	50
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily	0.5	30	1	20
lin	Menispermaceae	*Sarcopetalum harveyanum*	Pearl Vine	0.1	10	1	5
lin	Menispermaceae	*Stephania japonica*	Snake vine			5	1000
lin	Moraceae	*Ficus coronata*	Sandpaper Fig			5	10
lin	Myrtaceae	*Acmena smithii*	Lilly Pilly			2	1
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple	5	6	10	4
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle	0.1	1	2	3
lin	Myrtaceae	*Eucalyptus deanei*	Mountain Blue Gum	25	8	10	4
lin	Myrtaceae	*Syncarpia glomulifera*	Turpentine	30	15	60	6

Status	Family	Genus species	Common Name	US14 C	US14 A	US15 C	US15 A
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive	0.5	20		
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily	1	20		
lin	Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree			5	5
lin	Phyllanthaceae	*Phyllanthus gunnii*	Scrubby Spurge			1	20
lin	Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum			5	10
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass	0.01	100		
lin	Polypodiaceae	*Pyrrosia rupestris*	Rock Felt Fern	0.1	50		
lin	Pteridaceae	*Adiantum aethiopicum*	Common Maidenhair			4	1000
lin	Pteridaceae	*Adiantum formosum*	Giant Maidenhair			10	3000
lin	Pteridaceae	*Pellaea falcata*	Sickle Fern			1	100
lin	Rosaceae	*Rubus moluccanus*	Molucca Bramble			1	5
lin	Rutaceae	*Asterolasia correifolia*		2	200		
lin	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart	0.05	1		
lin	Smilacaceae	*Smilax australis*	Barbwire Vine	1	50	4	50
lin	Solanaceae	*Solanum brownii*	Violet Nightshade			0.1	3
lin	Uvulariaceae	*Schelhammera undulata*		0.01	500		
lin	Violaceae	*Viola hederacea*	Ivy-leaved Violet			1	10
lin	Vitaceae	*Cayratia clematidea*	Native Grape			10	50
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine			10	10

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Status	Family	Genus species	Common Name	US53 C	US53 A	US96 C	US96 A	US97 C	US97 A
Iin	Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower			0.5	4		
Iin	Anthericaceae	*Caesia parviflora*				0.5	50		
Iin	Apiaceae	*Xanthosia tridentata*	Rock Xanthosia	1	1				
Iin	Araliaceae	*Astrotricha latifolia*						0.5	30
Iin	Araliaceae	*Hydrocotyle sibthorpioides*				0.5	100		
Iin	Asteraceae	*Brachyscome ?graminea*						0.5	1
Iin	Asteraceae	*Brachyscome graminea*	Grass Daisy	1	50				
Iin	Asteraceae	*Brachyscome sp*				0.5	15		
Iin	Campanulaceae	*Lobelia purpurascens*	Whiteroot	1	400	0.5	500	0.5	500
Iin	Campanulaceae	*Wahlenbergia stricta*	Tall Bluebell	1	2				
Iin	Casuarinaceae	*Allocasuarina littoralis*	Black She-Oak	1	50				
Iin	Casuarinaceae	*Allocasuarina torulosa*	Forest Oak			10	40	25	70
Iin	Convolvulaceae	*Dichondra repens*	Kidney Weed			0.5	300		
Iin	Cyperaceae	*Cyathochaeta diandra*		1	100				
Iin	Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	1	50	0.5	50	2	350
Iin	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken			0.5	10		
Iin	Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower			0.5	30	0.5	15
Iin	Dilleniaceae	*Hibbertia sp*				0.5	20		
Iin	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash			0.5	1		
Iin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath					0.5	1
Iin	Ericaceae (Epacridoideae)	*Leucopogon lanceolatus*		1	1				
Iin	Ericaceae (Epacridoideae)	*Leucopogon muticus*	Blunt Beard-heath	1	100				
Iin	Ericaceae (Epacridoideae)	*Lissanthe strigosa*	Peach Heath			0.5	1		
Iin	Fabaceae (Faboideae)	*?Pultenaea sp presume NGS*						0.5	1
Iin	Fabaceae (Faboideae)	*Bossiaea oligosperma*						0.5	8
Iin	Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	1	50				
Iin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine	1	100	0.5	200		
Iin	Fabaceae (Faboideae)	*Glycine tabacina*	Variable Glycine					0.5	340
Iin	Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla	1	50	0.5	1	0.5	1
Iin	Fabaceae (Faboideae)	*Hovea linearis*		1	5			0.5	1
Iin	Fabaceae (Faboideae)	*Hovea purpurea*						2	150
Iin	Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo	1	3				
Iin	Fabaceae (Faboideae)	*Jacksonia scoparia*	Dogwood	1	50				
Iin	Fabaceae (Faboideae)	*Podolobium ilicifolium*	Prickly Shaggy Pea	1	100				
Iin	Fabaceae (Mimosoideae)	*Acacia decurrens*	Black Wattle			0.5	10		
Iin	Fabaceae (Mimosoideae)	*Acacia falcata*				0.5	5	0.5	1
Iin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally			0.5	25	0.5	50

Status	Family	Genus species	Common Name	US53 C	US53 A	US96 C	US96 A	US97 C	US97 A
lin	Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses					0.5	1
lin	Goodeniaceae	*Dampiera purpurea*						2	200
lin	Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia	1	800				
lin	Goodeniaceae	*Scaevola ramosissima*	Purple Fan-flower	1	1				
lin	Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort					0.5	50
lin	Lauraceae	*Cassytha glabella*				0.5	5	0.5	3
lin	Lomandraceae	*Lomandra brevis*	Tufted Mat-rush	1	150				
lin	Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush	1	200			0.5	200
lin	Lomandraceae	*Lomandra glauca*	Pale Mat-rush	1	400	0.5	25		
lin	Lomandraceae	*Lomandra gracilis*						0.5	150
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	1	25	0.5	1	0.5	1
lin	Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush	1	200	10	300	0.5	150
lin	Lomandraceae	*Lomandra obliqua*		1	400	0.5	150	0.5	500
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily			0.5	25		
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple	1	5	3	2	15	10
lin	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark			30	5		
lin	Myrtaceae	*Eucalyptus piperita*	Sydney Peppermint	30	16	10	1	15	1
lin	Myrtaceae	*Eucalyptus punctata*	Grey Gum	5	3	10	1	10	1
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree			0.5	25	15	250
lin	Orchidaceae	*Cymbidium suave*	Snake Orchid			0.5	1		
lin	Oxalidaceae	*Oxalis perennans*	Oxalis			0.5	50		
lin	Phormiaceae	*Dianella caerulea*	Blue Flax-lily	1	50	0.5	1	0.5	25
lin	Phormiaceae	*Stypandra glauca*	Nodding Blue Lily			2	30	0.5	1
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush			0.5	30	1	15
lin	Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge	1	800	0.5	150	0.5	50
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry	1	25	0.5	150	0.5	30
lin	Pittosporaceae	*Bursaria longisepala*		1	200				
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	1	100			0.5	10
lin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum			0.5	2	0.5	1
lin	Poaceae	*Entolasia marginata*	Bordered Panic	1	400			2	700
lin	Poaceae	*Entolasia stricta*	Wiry Panic	1	400	0.5	150	0.5	150
lin	Poaceae	*Microlaena stipoides*	Weeping Grass	1	800	0.5	300	0.5	500
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass					0.5	100
lin	Proteaceae	*Banksia spinulosa*	Hairpin Banksia			0.5	1	2	5
lin	Proteaceae	*Lomatia silaifolia*				0.5	25	0.5	30
lin	Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	1	40	0.5	25	10	250
lin	Proteaceae	*Xylomelum pyriforme*	Native Pear			5	10		
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern	1	25	0.5	5		
lin	Rhamnaceae	*Pomaderris andromedifolia*		1	1				

Status	Family	Genus species	Common Name	US53 C	US53 A	US96 C	US96 A	US97 C	US97 A
lin	Rubiaceae	*Opercularia sp.*		1	50				
lin	Rubiaceae	*Opercularia varia*	Variable Stinkweed	1	1200				
lin	Rubiaceae	*Pomax umbellata*	Pomax	1	400	0.5	250	0.5	400
lin	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart			0.5	1		
lin	Santalaceae	*Leptomeria acida*	Sour Currant Bush	1	75	0.5	10	15	400
lin	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush	1	500	2	200	10	300
lin	Solanaceae	*Solanum prinophyllum*	Forest Nightshade					0.5	1
lin	Stylidiaceae	*Stylidium graminifolium*	Grass Trigger-plant	1	25				
lin	Thymelaeaceae	*Pimelea linifolia*	Slender Rice Flower			0.5	70	5	150
lin	Uvulariaceae	*Schelhammera undulata*				0.5	150	0.5	240
lin	Xanthorrhoeaceae	*Xanthorrhoea media*	Grass Tree	1	25				
lin	Xanthorrhoeaceae	*Xanthorrhoea sp*	Grass trees			0.5	1		
lin		*Unknown plant presume NGS*				0.5	1	0.5	1

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

				US42	US42	US54	US54	US63	US63	US64	US64	US67	US67	US89	US89	US94	US94
Status	**Family**	**Genus species**	**Common Name**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**
*	Alstroemeriaceae	*Alstroemeria psittacina*	Christmas lily							0.1	1000						
*	Apiaceae	*Ammi majus*	Bishop's-weed					0.01	10								
lin	Apiaceae	*Centella asiatica*	Gotu Cola			1	50										
*	Apiaceae	*Conium maculatum*	Hemlock							0.01	100						
HTW	Apocynaceae	*Araujia sericifera*	Moth Vine					10	200	0.5	100	4	200			0.1	100
lin	Apocynaceae	*Tylophora barbata*	Bearded Tylophora			1	100										
lin	Araliaceae	*Astrotricha latifolia*												0.01	1		
lin	Araliaceae	*Hydrocotyle geraniifolia*	Forest Pennywort			2	2000										
lin	Araliaceae	*Hydrocotyle sibthorpioides*														0.1	20
HTW	Asparagaceae	*Asparagus asparagoides*	Bridal Creeper									0.1	1				
*	Asteraceae	*Aster subulatus*	Wild Aster			1	5										
*	Asteraceae	*Bidens pilosa*	Cobbler's Pegs	0.01	400			30	1000	0.1	1600	0.1	20				
*	Asteraceae	*Bidens subalternans*	Greater Beggar's Ticks					0.1	20								
*	Asteraceae	*Cirsium vulgare*	Spear Thistle									0.01	1				
*	Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane			1	5	0.2	20								
*	Asteraceae	*Conyza spp.*	A Fleabane							0.01	400					0.1	20
lin	Asteraceae	*Coronidium elatum*												0.01	1		
lin	Asteraceae	*Olearia viscidula*	Wallaby Weed	0.1	1											0.1	2
lin	Asteraceae	*Senecio linearifolius*	Fireweed											0.1	50	0.1	20
lin	Asteraceae	*Senecio spp.*	Groundsel, Fireweed					0.01	1								
lin	Asteraceae	*Sigesbeckia orientalis*	Indian Weed	0.5	400	1	1									0.5	50
*	Asteraceae	*Sonchus oleraceus*	Common Sowthistle									0.1	1				
*	Asteraceae	*Sonchus sp.*						0.01	5								
*	Asteraceae	*Tagetes minuta*	Stinking Roger							0.1	100						
*	Asteraceae	*Xanthium strumarium*						0.5	50	0.01	100						
lin	Asteraceae	*Xerochrysum bracteatum*	Golden Everlasting													0.1	20
lin	Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	1	400												
lin	Blechnaceae	*Doodia aspera*	Prickly rasp fern													1	40
*	Boraginaceae	*Echium plantagineum*	Patterson's Curse					0.03	3								
	Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope			2	80	3	50	0.1	50						
lin	Brassicaceae	*Brassica sp*								0.01	400						
*	Brassicaceae	*Brassica tournefortii*	Mediterranean Turnip					0.01	3			0.1	10				
lin	Campanulaceae	*Lobelia purpurascens*	Whiteroot	2	4000												
lin	Cannabaceae	*Trema tomentosa*	Native Peach							0.05	1			1	100	2	5
lin	Caryophyllaceae	*Stellaria flaccida*						0.1	12								
lin	Casuarinaceae	*Casuarina cunninghamiana*	River Oak	110	60			50	11	60	35	60	22	65	81	70	19
lin	Casuarinaceae	*Casuarina cunninghamiana subsp. cunninghamiana*	River Sheoak			30	80										
lin	Commelinaceae	*Commelina cyanea*	Native Wandering Jew									1	50				
lin	Commelinaceae	*Tradescantia fluminensis*	Wandering Jew	2	200												
	Convolvulaceae	*Cuscuta sp.*								0.01	10						
lin	Convolvulaceae	*Dichondra repens*	Kidney Weed	0.01	10	2	1000									0.5	100
lin	Cyperaceae	*Carex spp.*	A Sedge			1	5										

Status	Family	Genus species	Common Name	US42 C	US42 A	US54 C	US54 A	US63 C	US63 A	US64 C	US64 A	US67 C	US67 A	US89 C	US89 A	US94 C	US94 A
lin	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken			1	100							2	50	0.1	15
lin	Ericaceae (Epacridoideae)	*Leucopogon juniperinus*	Prickly Beard-heath													0.1	3
*	Euphorbiaceae	*Euphorbia peplus*	Petty Spurge			1	150	0.01	1								
lin	Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine			1	1000										
lin	Fabaceae (Faboideae)	*Glycine tabacina*	Variable Glycine					0.01	5								
lin	Fabaceae (Mimosoideae)	*Acacia decurrens*	Black Wattle			1	10					1	5			1	1
lin	Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally							2	20			10	60	2	10
lin	Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle	0.01	1					0.5	1						
lin	Fabaceae (Mimosoideae)	*Acacia linifolia*	White Wattle					0.1	1								
lin	Fabaceae (Mimosoideae)	*Acacia longifolia*												0.01	2		
lin	Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle					1	1					0.5	4	2	5
lin	Fabaceae (Mimosoideae)	*Acacia spp.*						0.1	1	0.5	1						
lin	Geraniaceae	*Geranium homeanum*						2	50			1	50				
lin	Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum													1	7
lin	Lamiaceae	*Plectranthus parviflorus*	Cockspur Flower	2	800												
lin	Lauraceae	*Cassytha glabella*												1	10		
lin	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	2	50	3	25			1	10	1	5				
lin	Loranthaceae	*Amyema cambagei*								1	40						
lin	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily	1	200												
lin	Malvaceae	*Brachychiton populneus*	Kurrajong			1	1					1	5				
*	Malvaceae	*Modiola caroliniana*	Red-flowered Mallow					0.01	1								
*	Malvaceae	*Sida rhombifolia*	Paddy's Lucerne					0.2	20	0.01	1600					0.01	2
lin	Meliaceae	*Melia azedarach*	White Cedar					1	5								
lin	Menispermaceae	*Stephania japonica*	Snake vine	3	200	2	400	2	50	0.5	200	2	100	1	50	0.5	50
lin	Myrtaceae	*Angophora floribunda*	Rough-barked Apple			2	3			3	1						
lin	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle	1	20	2	15										
lin	Myrtaceae	*Callistemon ?linearifolius*				1	5										
lin	Myrtaceae	*Leptospermum polyanthum*				4	70										
lin	Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree									1	20				
lin	Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark			2	25							2	18		
lin	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree			3	50			1	2						
lin	Myrtaceae	*Sannantha pluriflora*														0.1	10
lin	Oleaceae	*Notelaea longifolia*	Large Mock-olive			1	2										
lin	Orchidaceae	*Dendrobium linguiforme*	Tongue Orchid	0.001	10												
lin	Oxalidaceae	*Oxalis perennans*	Oxalis			2	800	0.1	1	0.05	400			0.5	200		
*	Papaveraceae	*Fumaria muralis*	Wall Fumitory									0.1	1				
*	Passifloraceae	*Passiflora caerulea*	Blue Passionflower													1	1
lin	Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	1	7	1	30			0.5	10	1	1				
lin	Phyllanthaceae	*Phyllanthus gunnii*	Scrubby Spurge			1	200					1	30	5	50		
lin	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera			1	400										
lin	Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry											0.01	1		
lin	Pittosporaceae	*Bursaria longisepala*										1	10				

				US42	US42	US54	US54	US63	US63	US64	US64	US67	US67	US89	US89	US94	US94
Status	Family	Genus species	Common Name	C	A	C	A	C	A	C	A	C	A	C	A	C	A
lin	Pittosporaceae	*Bursaria spinosa*	Native Blackthorn			1	10										
lin	Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum													0.1	1
lin	Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	0.5	1											0.1	3
*	Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues					0.01	4								
lin	Plantaginaceae	*Veronica plebeia*	Trailing Speedwell			1	25										
lin	Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass					0.01	1	5	200	5	50				
lin	Poaceae	*Echinopogon caespitosus*	Bushy Hedgehog-grass					0.01	1			1	1				
lin	Poaceae	*Ehrharta erecta*	Panic Veldtgrass	1	2000			20	100			1	50				
lin	Poaceae	*Entolasia marginata*	Bordered Panic			2	3000										
lin	Poaceae	*Microlaena stipoides*	Weeping Grass	40	40000	5	4000	50	1000	60	40000	95	500			0.1	100
lin	Poaceae	*Oplismenus aemulus*	Australian Basket Grass	3	1200			30	500	2	800	1	100	0.5	100	0.5	100
lin	Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass	1	400	1	1000							0.01	100		
*	Poaceae	*Setaria sp.*								0.01	1						
lin	Polygonaceae	*Rumex brownii*	Swamp Dock					0.01	1			1	1				
*	Primulaceae	*Lysimachia arvensis*	Scarlet Pimpernel			1	10										
lin	Proteaceae	*Grevillea robusta*														2	11
lin	Pteridaceae	*Adiantum aethiopicum*	Common Maidenhair			1	200									0.5	400
lin	Pteridaceae	*Cheilanthes sieberi*	Rock Fern													0.01	10
lin	Pteridaceae	*Pellaea falcata*	Sickle Fern			1	50									1	1
lin	Ranunculaceae	*Clematis aristata*	Old Man's Beard	0.001	400												
lin	Ranunculaceae	*Clematis glycinoides*	Headache Vine			1	50									0.5	25
lin	Rhamnaceae	*Pomaderris brunnea*	Rufous Pomaderris			1	2										
lin	Rhamnaceae	*Pomaderris sp.*														0.1	1
*	Rosaceae	*Rubus fruticosus*	Blackberry									1	25				
lin	Rosaceae	*Rubus parvifolius*	Native Raspberry			2	400										
lin	Rubiaceae	*Gynochthodes jasminoides*	Sweet Morinda											0.5	1		
lin	Rubiaceae	*Opercularia diphylla*												0.01	10		
lin	Scrophulariaceae	*Myoporum acuminatum*	Boobialla											0.1	12		
*	Solanaceae	*Solanum chenopodioides*	Whitetip Nightshade					0.01	1								
lin	Solanaceae	*Solanum prinophyllum*	Forest Nightshade	0.001	2									0.01	1	0.1	2
lin	Stylidiaceae	*Stylidium laricifolium*	Giant Trigger-plant											0.01	1		
lin	Thymelaeaceae	*Pimelea linifolia*	Slender Rice Flower											0.1	100		
lin	Urticaceae	*Urtica incisa*	Stinging Nettle			1	1										
lin	Violaceae	*Melicytus dentatus*	Tree Violet							2	20					5	20
lin	Violaceae	*Melicytus dentatus*	Tree Violet					0.01	3			5	30				
lin	Vitaceae	*Cayratia clematidea*	Native Grape			1	40			1	50	1	50				
lin	Vitaceae	*Cissus antarctica*	Kangaroo Vine	0.001	1												
lin	Vitaceae	*Cissus hypoglauca*	Giant Water Vine											1	2	10	20
		Unidentified plant										0.11	1				

Notes: Status (Native, lin; Exotic, *; High Threat Weeds, HTW); Cover (C); Abundance (A)

Appendix E
Flora species list

Scientific name	Common name	NSW status	Comm status
Acacia baueri subsp. *aspera*	–	V	–
Acacia bynoeana	Bynoe's Wattle	E	V
Acacia clunies-rossiae	Kanangra Wattle	V	–
Acacia flocktoniae	Flockton Wattle	V	V
Acacia gordonii	–	E	E
Acacia pubescens	Downy Wattle	V	V
Acrophyllum australe	–	V	V
Ancistrachne maidenii	–	V	–
Asterolasia buxifolia	–	E	–
Asterolasia elegans	–	E	E
Astrotricha crassifolia	Thick-leaf Star-hair	V	V
Baloskion longipes	Dense Cord-rush	V	V
Bossiaea oligosperma	Few-seeded Bossiaea	V	V
Caesia parviflora var. *minor*	Small Pale Grass-lily	E	–
Caladenia tessellata	Thick Lip Spider Orchid	E	V
Callistemon linearifolius	–	V	–
Callistemon megalongensis	Megalong Valley Bottlebrush	CE	CE
Calomnion complanatum	–	E	-
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V
Cynanchum elegans	White-flowered Wax Plant	E	E
Darwinia biflora	–	V	V
Darwinia peduncularis	–	V	–
Dillwynia tenuifolia	–	V	–
Epacris hamiltonii	–	E	E
Epacris purpurascens var. *purpurascens*	–	V	–
Epacris sparsa	Sparse Heath	V	V
Eucalyptus benthamii	Camden White Gum	V	V
Eucalyptus glaucina	Slaty Red Gum	V	V
Eucalyptus pulverulenta	Silver-leafed Gum	V	V
Euphrasia bowdeniae	–	V	V
Genoplesium baueri	Bauer's Midge Orchid	E	E
Genoplesium superbum	Superb Midge Orchid	E	–
Grammitis stenophylla	Narrow-leaf Finger Fern	E	–
Grevillea evansiana	Evans Grevillea	V	V
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	E	–
Gyrostemon thesioides	–	E	–
Hakea dohertyi	Kowmung Hakea	E	E
Haloragodendron lucasii	Hal	V	V
Hibbertia puberula	–	E	–

Scientific name	Common name	NSW status	Comm status
Hygrocybe anomala var. *iathinomarginata*	–	V	–
Hygrocybe aurantipes	–	V	–
Hygrocybe reesiae	–	V	–
Isopogon fletcheri	Fletcher's Drumsticks	V	V
Kunzea rupestris	–	V	V
Lastreopsis hispida	Bristly Shield Fern	E	-
Leionema lachnaeoides	–	E	E
Lepidosperma evansianum	Evans Sedge	V	E
Leucopogon exolasius	Woronora Beard-heath	V	V
Leucopogon fletcheri subsp. *fletcheri*	–	E	–
Melaleuca deanei	Deane's Paperbark	V	V
Melaleuca groveana	Grove's Paperbark	V	-
Micromyrtus blakelyi	–	V	V
Olearia cordata	–	V	V
Persicaria elatior	Tall Knotweed	V	V
Persoonia acerosa	Needle Geebung	V	V
Persoonia bargoensis	Bargo Geebung	E	V
Persoonia glaucescens	Mittagong Geebung	E	V
Persoonia hirsuta	Hairy Geebung	E	E
Pherosphaera fitzgeraldii	Dwarf Mountain Pine	E	E
Phyllota humifusa	Dwarf Phyllota	V	V
Pimelea curviflora var. *curviflora*	–	V	V
Pomaderris brunnea	Brown Pomaderris	E	V
Pterostylis saxicola	Sydney Plains Greenhood	E	E
Pultenaea glabra	Smooth Bush-pea	V	V
Pultenaea parviflora	–	E	V
Pultenaea sp. Olinda	–	E	–
Pultenaea villifera – endangered population	*Pultenaea villifera* population in the Blue Mountains Local Government Area	EP	–
Rhizanthella slateri	Eastern Australian Underground Orchid	V	E
Rhodamnia rubescens	Scrub Turpentine	CE	–
Solanum armourense	–	E	–
Tetratheca glandulosa	–	V	–
Trachymene scapigera	Mountain Trachymene	E	E
Velleia perfoliata	–	V	V
Xanthosia scopulicola	–	V	–
Zieria covenyi	Coveny's Zieria	E	E
Zieria involucrata	–	E	E
Zieria murphyi	Velvet Zieria	E	V

Appendix F
Fauna species list

Species list

Common name	Scientific name	NSW status	Comm status	Confidence (bats only)
Amphibians (6)				
Common Eastern Froglet	*Crinia signifera*			
Blue Mountains Tree Frog	*Litoria citropa*			
Bleating Tree Frog	*Litoria dentata*			
Lesueur's frog	*Litoria lesueuri*			
Southern Leaf Green Tree Frog	*Litoria nudidigitus*			
Red-crowned Toadlet	*Pseudophryne australis*	V		
Birds (95)				
Striated Thornbill	*Acanthiza lineata*			
Yellow Thornbill	*Acanthiza nana*			
Brown Thornbill	*Acanthiza pusilla*			
Eastern Spinebill	*Acanthorhynchus tenuirostris*			
Brown Goshawk	*Accipiter fasciatus*			
Australian Owlet-nightjar	*Aegotheles cristatus*			
Australian King Parrot	*Alisterus scapularis*			
Pacific Black Duck	*Anas superciliosa*			
Red Wattlebird	*Anthochaera carunculata*			
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V		
Sulphur-crested Cockatoo	*Cacatua galerita*			
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			
Brush Cuckoo	*Cacomantis variolosus*			
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V		
Glossy Black-cockatoo	*Calyptorhynchus lathami*	V		
Australian Wood Duck	*Chenonetta jubata*			
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*			
Shining Bronze Cuckoo	*Chrysococcyx lucidus*			
Speckled Warbler	*Chthonicola sagittata*	V		
Brown Treecreeper	*Climacteris picumnus victoriae*	V		
Grey Shrike-thrush	*Colluricincla harmonica*			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			
White-bellied Cuckoo-shrike	*Coracina papuensis*			
Common Cicadabird	*Coracina tenuirostris*			
White-winged Chough	*Corcorax melanorhamphos*			
White-throated Treecreeper	*Cormobates leucophaea*			
Australian Raven	*Corvus coronoides*			
Australian Magpie	*Cracticus tibicen*			
Black Swan	*Cygnus atratus*			
Laughing Kookaburra	*Dacelo novaeguineae*			
Varied Sittella	*Daphoenositta chrysoptera*	V		
Mistletoebird	*Dicaeum hirundinaceum*			
Emu	*Dromaius novaehollandiae*			
Eastern Yellow Robin	*Eopsaltria australis*			
White-throated Nightjar	*Eurostopodus mystacalis*			

Common name	Scientific name	NSW status	Comm status	Confidence (bats only)
Crested Shrike-tit	*Falcunculus frontatus*			
White-throated Gerygone	*Gerygone olivacea*			
Little Lorikeet	*Glossopsitta pusilla*	V		
White-bellied Sea-eagle	*Haliaeetus leucogaster*	V		
Little Eagle	*Hieraaetus morphnoides*	V		
Welcome Swallow	*Hirundo neoxena*			
Wonga Pigeon	*Leucosarcia melanoleuca*			
Yellow-faced Honeyeater	*Lichenostomus chrysops*			
Fuscous Honeyeater	*Lichenostomus fuscus*			
Yellow-tufted Honeyeater	*Lichenostomus melanops*			
Superb Fairy-wren	*Malurus cyaneus*			
Variegated Fairy-wren	*Malurus lamberti*			
Bell Miner	*Manorina melanophrys*			
Hooded Robin	*Melanodryas cucullata*	V		
Lewin's Honeyeater	*Meliphaga lewinii*			
Black-chinned Honeyeater	*Melithreptus gularis gularis*	V		
White-naped Honeyeater	*Melithreptus lunatus*			
Superb Lyrebird	*Menura novaehollandiae*			
Rainbow Bee-eater	*Merops ornatus*			
Rainbow Bee-eater	*Merops ornatus*			
Jacky Winter	*Microeca fascinans*			
Black-faced Monarch	*Monarcha melanopsis*		M	
Satin Flycatcher	*Myiagra cyanoleuca*		M	
Restless Flycatcher	*Myiagra inquieta*			
Leaden Flycatcher	*Myiagra rubecula*			
Scarlet Honeyeater	*Myzomela sanguinolenta*			
Red-browed Finch	*Neochmia temporalis*			
Turquoise Parrot	*Neophema pulchella*	V		
Southern Boobook	*Ninox boobook*			
Barking Owl	*Ninox connivens*	V		
Powerful Owl	*Ninox strenua*	V		
Olive-backed Oriole	*Oriolus sagittatus*			
Golden Whistler	*Pachycephala pectoralis*			
Rufous Whistler	*Pachycephala rufiventris*			
Spotted Pardalote	*Pardalotus punctatus*			
Australian Pelican	*Pelecanus conspicillatus*			
Little Black Cormorant	*Phalacrocorax sulcirostris*			
Common Bronzewing	*Phaps chalcoptera*			
Brush Bronzewing	*Phaps elegans*			
Noisy Friarbird	*Philemon corniculatus*			
White-cheeked Honeyeater	*Phylidonyris niger*			
New Holland Honeyeater	*Phylidonyris novaehollandiae*			
Crimson Rosella	*Platycercus elegans*			
Eastern Whipbird	*Psophodes olivaceus*			
Satin Bowerbird	*Ptilonorhynchus violaceus*			
Grey Fantail	*Rhipidura albiscapa*			

Common name	Scientific name	NSW status	Comm status	Confidence (bats only)
Willie Wagtail	*Rhipidura leucophrys*			
Rufous Fantail	*Rhipidura rufifrons*		M	
Channel-billed Cuckoo	*Scythrops novaehollandiae*			
White-browed Scrub-wren	*Sericornis frontalis*			
Australasian Fig Bird	*Sphecotheres vieilloti*			
Pied Currawong	*Strepera graculina*			
Sacred Kingfisher	*Todiramphus sanctus*			
Rainbow Lorikeet	*Trichoglossus moluccanus*			
Painted Button-quail	*Turnix varius*			
Masked Owl	*Tyto novaehollandiae*	V		
Masked Lapwing	*Vanellus miles*			
Bassian Thrush	*Zoothera lunulata*			
Silvereye	*Zosterops lateralis*			
Insects (1)				
Monarch Butterfly	*Danaus plexippus*			
Mammals (37)				
Unidentified antechinus	*Antechinus* sp.			
Brown Antechinus	*Antechinus stuartii*			
Dog	*Canis lupus familiaris**			
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	C/Pr/Po
Gould's Wattled Bat	*Chalinolobus gouldii*			C
Chocolate Wattled Bat	*Chalinolobus morio*			C
Horse	*Equus caballus**			
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*			Pr
Cat	*Felis catus**			
Eastern Grey Kangaroo	*Macropus giganteus*			
Common Wallaroo	*Macropus robustus*			
Red-necked Wallaby	*Macropus rufogriseus*			
Little Bent-winged Bat	*Miniopterus australis*	V		Pr
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	V		C/Po
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	V		Pr
Southern Free-tailed Bat	*Mormopterus planiceps*			C
Eastern Free-tailed Bat	*Mormopterus ridei*			C
Unidentified long-eared bat	*Nyctophilus spp.*			C
Greater Glider	*Petauroides volans*	V		
Yellow-bellied Glider	*Petaurus australis*	V		
Sugar Glider	*Petaurus breviceps*			
Common Ringtail Possum	*Pseudocheirus peregrinus*			
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	
Black Rat	*Rattus rattus**			
Unidentified rodent	*Rattus* sp.			
Eastern Horseshoe-bat	*Rhinolophus megaphyllus*			C
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V		C
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		C/Pr
Eastern Broad-nosed Bat	*Scotorepens orion*			C
Common Dunnart	*Sminthopsis murina*			

Common name	Scientific name	NSW status	Comm status	Confidence (bats only)
Pig	*Sus scrofa**			
White-striped Freetail-bat	*Tadarida australis*			C
Unidentified possum	*Trichosurus* sp.			
Common Brushtail Possum	*Trichosurus vulpecula*			
Large Forest Bat	*Vespadelus darlingtoni*			C
Southern Forest Bat	*Vespadelus regulus*			C
Little Forest Bat	*Vespadelus vulturnus*			C
Common Wombat	*Vombatus ursinus*			
Fox	*Vulpes vulpes**			
Swamp Wallaby	*Wallabia bicolor*			
Reptiles (6)				
Unidentified turtle	*Chelodina* sp.			
Eastern Water Dragon	*Intellagama lesueurii*			
Red-bellied Black Snake	*Pseudechis porphyriacus*			
Eastern Brown Snake	*Pseudonaja textilis*			
Rosenberg's Goanna	*Varanus rosenbergi*	V		
Lace Monitor	*Varanus varius*			

Appendix G
Likelihood of occurrence table

Likelihood of occurrence table

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Fauna												
Amphibians												
Heleioporus australiacus	Giant Burrowing Frog	V	V	✓	✓	✓	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN553 HN557 HN564 HN566 HN568 HN598 HN606 HN607	Distributed through the Sydney Basin sandstone country in woodland, open woodland and heath vegetation. Breeding habitat is comprised of soaks or pools within first or second order streams, but also 'hanging swamp' seepage lines and where small pools form from collected water. Spends the majority of time in non-breeding habitat up to 300 m away and burrows in soil surface or leaf litter.	8	29/2/2016	Moderate. Habitat is present in study area, including breeding habitat.
Litoria aurea	Green and Golden Bell Frog	E	V	✓	✓	✓	✓	HN553 HN574 HN607	Large populations in NSW are located around coastal and near coastal areas of the metropolitan areas of Sydney, Shoalhaven and the Mid North Coast. The species inhabits marshes, dams and stream-sides with emergent vegetation, particularly those containing bulrushes (*Typha* spp.) or spike rushes (*Eleocharis* spp.)	1	28/8/1999	Low. Greater than 10 km from the coast. Small dams and side streams are present in the study area; however, this area would not be considered coastal or near-coastal.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Litoria booroolongensis	Booroolong Frog	E	E	-	✓	-	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN607	The Booroolong Frog is restricted to NSW and north-eastern Victoria, predominantly along the western-flowing streams of the Great Dividing Range. Lives along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Shelter under rocks or amongst vegetation near the ground on the stream edge. Adults occur on or near cobble banks and other rock structures within stream margins.	-	-	Low. This species has a distribution that is further west than the study area.
Litoria littlejohni	Littlejohn's Tree Frog	V	V	✓	✓	✓	✓	HN517 HN566 HN606 HN607	Restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks, leaf litter and low vegetation in heath-based forests and woodland. It is not known from coastal habitats.	3	20/3/2013	Low. Sandstone woodland and heath occur in the study area however at a lower elevation to where this species has been previously recorded.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Mixophyes balbus	Stuttering Frog	E	V	-	✓	✓	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN538 HN553 HN557 HN564 HN568 HN574 HN598 HN606 HN607	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Spends the majority of time in non-breeding habitat up to 300 m away and burrows in soil surface or leaf litter.	-	-	Low. Limited suitable wet, tall, open forest can be found in certain locations throughout the study area. Likely to be extinct due to Chytrid fungus.
Mixophyes iteratus	Giant Barred Frog	E	E	-	-	-	✓	HN517 HN533 HN537 HN538 HN553 HN557 HN574 HN598 HN606 HN607	Freshwater streams with permanent or semi-permanent slow flowing water at lower elevations within moist riparian habitats such as rainforest and wet sclerophyll forest with deep leaf litter and open perching sites on forest floor.	-	-	Low. No records in the area, sandstone habitat unsuitable.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Pseudophryne australis	Red-crowned Toadlet	V	-	✓	-	-	✓	HN517 HN532 HN533 HN536 HN564 HN566 HN568 HN598 HN606 HN607	Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations 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.	37	6/1/2017	Species recorded during current surveys.
Birds												
Actitis hypoleucos	Common Sandpiper	-	M, Ma	-	✓	-	-	-	Utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves.	-	-	None. Suitable habitat not present within the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Anthochaera phrygia	Regent Honeyeater	CE	CE	✓	✓	✓	✓	HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. NSW the distribution is very patchy and mainly confined to the two main breeding areas at Capertee Valley and the Bundarra-Barraba region and surrounding fragmented woodlands. Birds are also found in drier coastal woodlands and forests. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak. These habitats have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Nectar and fruit from the mistletoes are also eaten during the breeding season.	42	6/8/2017	Recorded.
Apus pacificus	Fork-tailed Swift	-	M, Ma	-	✓	-	-	-	Aerial space over a variety of habitat types; feeds on insects; breeds in Asia.	-	-	Moderate. Species may fly over the site on occasion.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. Has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests. Understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, including heath. The ground cover may consist of grasses, sedges or open ground, often with coarse woody debris	84	7/2/2019	Recorded.
Botaurus poiciloptilus	Australasian Bittern	E	E	-	✓	✓	-	HN574	Inhabits temperate freshwater wetlands and occasionally estuarine reedbeds, with a preference for permanent waterbodies with tall dense vegetation. The species prefers wetlands with dense vegetation, including sedges, rushes and reeds. Freshwater is generally preferred, although dense saltmarsh vegetation in estuaries and flooded grasslands are also used by the species.	-	-	Low. Limited habitat (freshwater wetlands) is present in the study area.
Burhinus grallarius	Bush Stone-curlew	E	-	-	-	-	✓	HN527 HN557 HN574	Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber.	-	-	Moderate. Suitable open forest and woodland habitat occurs throughout the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Calidris acuminata	Sharp-tailed Sandpiper	-	M, Ma	-	✓	-	-	-	Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.	-	-	None. Suitable habitat not present within the study area.
Calidris ferruginea	Curlew Sandpiper	E	CE, M, Ma	-	✓	-	-	-	Coastal migratory species with NSW distribution from Hastings Point to Shoalhaven Heads. Found in open, sandy beaches with exposed sand bars and rocky outcrops. Rare use of near-coastal wetlands.	-	-	Low. Only sometimes is it found in non-coastal swamps, lakes and lagoons (near-coastal wetlands).
Calidris melanotos	Pectoral Sandpiper	-	M, Ma	-	✓	-	-	-	Shallow freshwater ponds/pools with low vegetation, flooded pasture, swamp margins, sewage ponds; occasionally mudflats and saltmarsh	-	-	None. Suitable habitat not present within the study area.
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests in winter and open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas in summer. Nests in tree hollows.	136	29/7/2018	Recorded.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Calyptorhynchus lathami	Glossy Black-cockatoo	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Occupy coastal woodlands and drier forest areas, open inland woodlands or timbered watercourses where Casuarina and Allocasuarina species are present. This species is dependent on large hollow-bearing eucalypts for nesting.	261	7/2/2019	Recorded. Chewed and discarded *Allocasuarina* fruit found in the impact area.
Chthonicola sagittata	Speckled Warbler	V	-	✓	-	-	-	HN525 HN527 HN532 HN535 HN557 HN574 HN598	Lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	91	17/11/2018	High. Suitable habitat occurs throughout study area. Numerous recorded sightings.
Circus assimilis	Spotted Harrier	V	-	✓	-	-	-	HN574	Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	1	14/5/2005	Moderate. Suitable habitat occurs throughout the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	✓	-	-	-	HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN564 HN568 HN574 HN598	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	179	7/2/2019	Recorded. Incidental observation.
Cuculus optatus	Oriental Cuckoo	-	M	-	✓	-	-	-	Inhabits rainforest margins, monsoon forest, vine scrub, riverine thickets, dense eucalypt forest, paperbark swamp and mangroves.	-	-	Moderate. Suitable habitat present within the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Daphoenositta chrysoptera	Varied Sittella	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	81	18/11/2018	High. Suitable habitat present within the study area. Previously recorded in the study area.
Dasyornis brachypterus	Eastern Bristlebird	E	E	-	✓	✓	-	HN566	Habitat for central and southern populations is characterised by dense, low vegetation including heath and open woodland with a heathy understorey. In northern NSW the habitat occurs in open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone; all of these vegetation types are fire prone. Shy and cryptic and rarely flies, although can be seen scampering over the ground; when approached, may move to a lookout perch 1 m or more above the ground, then retreat into dense vegetation.	-	-	Low. This species has a distribution that does not overlap with the study area, occurring to the far south or to the far north.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	✓	-	-	-	-	Restricted to coastal and near-coastal habitat. Inhabits wetlands, floodplains and deeper permanent water bodies. Occurs in shallow, permanent freshwater terrestrial wetlands and surrounding marginal vegetation. Nest in tall, isolated paddock trees near freshwater swamps and construct large nesting platform.	1	29/12/1994	Low. Limited habitat (freshwater wetlands) is present in the study area.
Epthianura albifrons	White-fronted Chat	V	-	-	-	✓	-	-	Open damp ground, grass clumps, fence lines, heath, samphire saltmarsh, mangroves, dunes, saltbush plains.	-	-	Low. Limited damp-ground habitat occurs in the study area.
Falco subniger	Black Falcon	V	-	-	-	-	-	-	Core habitat is semi-arid and arid interior; uses tree-lined watercourses, isolated stands of trees and hunts over low vegetation of surrounding plains, grasslands, saltbush and blue-bush. Also hunts over wetlands and temporary waters or bore drains in arid regions.	-	-	Low. Inhabits semi-arid inland regions. Recorded sightings are most likely of the Brown Falcon.
Gallinago hardwickii	Latham's Snipe	-	M, Ma	-	✓	-	-	-	Latham's Snipe occurs in permanent and ephemeral wetlands up to 2,000 m above sea-level. Usually inhabit open, freshwater wetlands with low, dense vegetation (for example, swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity.	-	-	Moderate. Suitable habitat not present within the Wollondilly River area of the study area.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Glossopsitta pusilla	Little Lorikeet	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. Nest in small hollows (entrance approx. 3 cm) of Eucalyptus spp. between 2 - 15 m above the ground.	66	12/11/2017	Recorded.
Grantiella picta	Painted Honeyeater	V	V	✓	✓	✓	-	HN525 HN527 HN532 HN553 HN557 HN564 HN574	Occurs in Eucalyptus woodland and forests, with a preference for mistletoe (Amyema spp.). Can also occur along watercourses and in farmland. Nests from spring to autumn in outer canopy of eucalypts, she-oak, paperbark and mistletoe branches.	5	7/2/2019	Recorded. Species was recorded within the study area during spring of 2018.
Haliaeetus leucogaster	White-bellied Sea-eagle	V	M, Ma	✓	✓	-	-	HN553 HN566 HN574 HN607	Coastlines, estuaries, large rivers and lakes; occasionally over adjacent habitats; builds a large stick nest in a tall tree, rarely on artificial structures.	62	18/11/2018	Recorded.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Hieraaetus morphnoides	Little Eagle	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Occupies habitats rich in prey (birds, reptiles and mammals) within open eucalypt forest, woodland or open woodland. Requires tall living trees for building a large stick nest and preys on birds, reptiles and mammals and occasionally carrion.	3	19/5/2014	High. Open eucalypt forest and woodland that incorporates large trees for nesting are present in the study area.
Hirundapus caudacutus	White-throated Needletail	-	M, Ma	-	✓	-	-	-	Aerial space over a variety of habitat types but prefers to forage over treed habitats as these would provide a greater abundance of insect prey; often forage on the edge of low pressure systems and may follow these systems; breeds in Asia.	-	-	Moderate. Species may fly over the site on occasion.
Irediparra gallinacea	Comb-crested Jacana	V	-	-	-	-	-	-	Inhabit permanent freshwater wetlands, either still or slow-flowing, with a good surface cover of floating vegetation, especially water-lilies, or fringing and aquatic vegetation.	-	-	Low. Limited habitat (freshwater wetlands with high surface vegetation) is present in the study area.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Ixobrychus flavicollis	Black Bittern	V	-	✓	-	-	✓	HN553 HN574 HN607	Rarely occurs above 200 m in altitude and inhabits both terrestrial and estuarine wetlands, with a preference for permanent water bodies and dense vegetation. Roosts in trees or amongst dense reeds.	1	29/1/1995	Moderate. Suitable habitat occurs throughout the study area; however, it occurs above 200 m in altitude.
Lathamus discolor	Swift Parrot	E	CE, M, Ma	✓	✓	✓	-	HN525 HN527 HN532 HN533 HN535 HN536 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN606	In NSW mostly occurs on the coast and south west slopes, occurring in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking insects) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*). Nests in Tasmania.	16	5/8/2015	High. Suitable habitat occurs throughout the study area. Numerous recorded sightings.
Limosa limosa	Black-tailed Godwit	V	-	✓	-	-	-	-	Estuaries and lagoons with large intertidal sandflats or mudflats.	1	30/10/1982	None.
Lophochroa leadbeateri	Major Mitchell's Cockatoo	V	-	-	-	-	-	-	Inhabits a wide range of tree and treeless inland habitats, always within easy reach of water.	-	-	None.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Lophoictinia isura	Square-tailed Kite	V	-	✓	-	-	-	HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. Builds a large stick nest in a tall tree.	4	30/1/2013	High. Suitable habitat occurs throughout the study area.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	✓	-	-	-	HN525 HN527 HN557 HN568 HN574	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	63	18/11/2018	High. Suitable habitat occurs throughout the study area. Numerous recorded sightings.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	✓	-	-	-	HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN564 HN574 HN598	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees.	8	19/3/2004	High. Suitable habitat occurs throughout the study area.
Monarcha melanopsis	Black-faced Monarch	-	M, Ma	-	✓	-	-	-	Mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest.	-	-	Recorded (bird survey and opportunistic).
Monarcha trivirgatus (Symposiachrus trivirgatus)	Spectacled Monarch	-	M, Ma	-	✓	-	-	-	The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	-	-	Moderate. Suitable habitat occurs throughout the study area.
Motacilla flava	Yellow Wagtail	-	M, Ma	-	✓	-	-	-	Occurs in a variety of damp or wet habitats with low vegetation. Outside of the breeding season it is also found in cultivated areas. Typically forages in damp grassland and on relatively bare open ground at edges of waterbodies, but also feeds in dry grassland and in fields of cereal crops.	-	-	Moderate. Suitable habitat occurs throughout the study area.
Myiagra cyanoleuca	Satin Flycatcher	-	M, Ma	-	✓	-	-	-	Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	-	-	Recorded (bird survey).

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Neochimia ruficauda	Star Finch	Ex	E	-	-	-	-	-	This species is currently only found in central Queensland. It mainly occurs in grasslands and grassy woodlands that are located close to bodies of fresh water.	-	-	None.
Neophema pulchella	Turquoise Parrot	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN553 HN557 HN564 HN568 HN574 HN598 HN606 HN607	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows.	53	17/11/2018	High. Suitable habitat occurs throughout the study area. Numerous recorded sightings.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Ninox connivens	Barking Owl	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN553 HN557 HN564 HN568 HN574 HN598 HN606 HN607	Occurs throughout NSW, where it inhabits dry open sclerophyll forests and woodlands. Favours dense riparian stands of eucalypts or casuarinas that occur along watercourses or around wetlands where there are many large trees suitable for roosting or breeding. Nests in tree hollows. Consumes a variety of prey items, including smaller gliders.	6	30/10/2017	Recorded within the study area within the current surveys.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Ninox strenua	Powerful Owl	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN568 HN574 HN598 HN606 HN607	Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. They require large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. Forages mainly on medium-sized arboreal mammals (greater glider, common ringtail possum), though sometimes takes roosting birds and other prey.	84	14/6/2017	Recorded within the study area within the current surveys.
Numenius madagascariensis	Eastern Curlew	-	CE, M, Ma	-	✓	-	-	-	It generally occupies coastal lakes, inlets, bays and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats and sometimes saltmarsh of sheltered coasts. It forages in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach-cast seagrass or seaweed.	-	-	Low. The study area does not incorporate any coastal lakes, inlets or bays, and only covers the upper reaches of the Hawkesbury River.
Onychoprion fuscata	Sooty Tern	V	-	-	-	-	-	-	Large flocks can be seen soaring, skimming and dipping but seldom plunging in off shore waters. Breeds in large colonies in sand or coral scrapes on offshore islands and cays including Lord Howe and Norfolk Islands.	-	-	None. Study area not near the coast.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Oxyura australis	Blue-billed Duck	V	-	-	-	-	-	-	Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. They feed on the bottom of swamps eating seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies. Usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed.	-	-	None. Lack of suitable dense aquatic vegetation.
Pachycephala olivacea	Olive Whistler	V	-	-	-	-	-	HN517	Mostly inhabit wet forests above about 500 m. During the winter months they may move to lower altitudes.	-	-	Moderate. Suitable patches of habitat occur throughout the study area.
Pandion cristatus/ haliaetus	Eastern Osprey	V	M, Ma	-	✓	-	-	HN553	Requires clear estuarine and inshore marine waters and coastal rivers for foraging, and nests in tall (usually dead or dead-topped) trees in coastal habitats from open woodland to open forest, within 1-2 km of water.	-	-	Low. Favours coastal areas.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Petroica boodang	Scarlet Robin	V	-	✓	-	-	-	HN525 HN527 HN532 HN533 HN535 HN536 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	In NSW it occupies open forests and woodlands from the coast to the inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat.	46	29/7/2018	High. Suitable habitat found throughout study area. Numerous recorded sightings.
Petroica phoenicea	Flame Robin	V	-	✓	-	-	-	HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN574 HN598	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. In winter, birds migrate to drier more open habitats in the lowlands (that is, valleys below the ranges, and to the western slopes and plains).	7	29/4/2018	High. Suitable breeding habitat found throughout the study area.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Petroica rodinogaster	Pink Robin	V	-	-	-	-	-	-	Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies.	-	-	Moderate. Suitable habitat occurs throughout the study area; however, the species is rarely observed as far north as the study area.
Polytelis swainsonii	Superb Parrot	V	V	-	-	-	-	-	Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest.	-	-	Moderate. Predominantly observed in eastern inland NSW where its preferred habitat occurs.
Rhipidura rufifrons	Rufous Fantail	-	M, Ma	-	✓	-	-	-	In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (*Eucalyptus microcorys*), Mountain Grey Gum (*Eucalyptus cypellocarpa*), Narrow-leaved Peppermint (E. radiata), Mountain Ash (*Eucalyptus regnans*), Alpine Ash (*Eucalyptus delegatensis*), Blackbutt (*Eucalyptus pilularis*) or Red Mahogany (*Eucalyptus resinifera*); usually with a dense shrubby understorey often including ferns.	-	-	Recorded (bird survey and opportunistic).
Rostratula australis	Australian Painted Snipe	E	E, Ma	-	✓	✓	-	-	Inhabits shallow inland wetlands, either freshwater or brackish water bodies. Nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats.	-	-	Low. Study area does not fall within the usual species distribution. Limited suitable habitat.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Stagonopleura guttata	Diamond Firetail	V	-	✓	-	-	-	HN525 HN527 HN532 HN533 HN535 HN536 HN538 HN553 HN557 HN564 HN568 HN574	Found in grassy eucalypt woodlands, open forest, mallee, grassland and riparian areas.	78	17/11/2018	High. Suitable habitat occurs within the study area. Numerous recorded sightings.
Stictonetta naevosa	Freckled Duck	V	-	-	-	-	-	-	Prefers heavily vegetated wetlands; uses more open wetlands during drought in non-breeding period.	-	-	Moderate. Suitable habitat found throughout the study area that could be used during drier environmental conditions (for example, drought).

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Tyto novaehollandiae	Masked Owl	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN568 HN574 HN598 HN606 HN607	Occurs throughout NSW, roosting and nesting in heavy forest. Hunts over open woodland and farmland, with a home range of 500 – 1,000 ha. The main requirements are tall trees with suitable large hollows for nesting and roosting and adjacent areas for foraging. Feeds on small mammals.	13	13/6/2017	Recorded within the study area during the current surveys.
Tyto tenebricosa	Sooty Owl	V	-	✓	-	-	-	HN517 HN525 HN532 HN535 HN536 HN537 HN538 HN553 HN568 HN574 HN598 HN606	Inhabits subtropical and warm temperate rainforest, and moist or dry eucalypt forest with a well-developed mid-storey of trees or shrubs. Roost and nest sites for the species occur in gullies. Utilises large hollows for nesting and prey on other hollow dependent species. Roost in hollows or dense vegetation.	45	31/8/2017	Recorded within the study area during the current surveys.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Invertebrates												
Meridolum corneovirens	Cumberland Plain Land Snail	E	-	✓	-	-	-	-	Primarily inhabits Cumberland Plain Woodland. Lives under litter of bark, leaves and logs, or shelters in loose soil around grass clumps. Occasionally shelters under rubbish. Can dig several centimetres into soil to escape drought.	86	19/9/2018	Low. Suitable habitat is present in the study area; however, the species is rarely recorded outside the Cumberland Plain.
Petalura gigantea	Giant Dragonfly	E	-	✓	-	-	✓	-	Live in permanent swamps and bogs with some free water and open vegetation. Adults spend most of their time settled on low vegetation on or adjacent to the swamp. Females lay eggs into moss, under other soft ground layer vegetation, and into moist litter and humic soils, often associated with groundwater seepage areas within appropriate swamp and bog habitats. The species does not utilise areas of standing water wetland, although it may utilise suitable boggy areas adjacent to open water wetlands.	21	22/2/2008	Moderate. Limited suitable habitat found in study area.
Pommerhelix duralensis	Dural Land Snail	E	E	-	✓	✓	-	HN564 HN606	Has a strong affinity for communities in the interface region between shale-derived and sandstone-derived soils, with forested habitats that have good native cover and woody debris.	-	-	Low. Species' distribution is not known to extend into the lower Blue Mountains.
Synemon plana	Golden Sun Moth	E	CE	-	✓	-	-	-	Species known from the area between Queanbeyan, Gunning, Young and Tumut. It occurs in Natural Temperate Grasslands and grassy Box-Gum Woodlands in which ground layer is dominated by wallaby grasses *Austrodanthonia* spp. Grasslands dominated by wallaby grasses are typically low and open. Habitat may contain several wallaby grass species, which are typically associated with other grasses, particularly spear-grasses *Austrostipa* spp. or Kangaroo Grass *Themeda australis*.	-	-	Low. Suitable habitat not present within the study area.

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Mammals												
Cercartetus nanus	Eastern Pygmy-possum	V	-	✓	-	-	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN553 HN557 HN564 HN566 HN568 HN598 HN606 HN607	In New South Wales the species is found in coastal areas and at higher elevation. Inhabit shrubby vegetation in a wide variety of habitats, from open heathland or shrubland to sclerophyll or rain forest. Require flowering plants and shrubs for foraging and access to hollows/nesting vegetation.	28	22/2/2017	Moderate. Limited suitable habitat found throughout study area. Numerous recorded sightings.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	✓	✓	✓	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Roosts in disused mine shafts, caves, overhangs and disused Fairy Martin (*Petrochelidon ariel*) nests for shelter and to raise young. Also potentially roost in tree hollows. Occurs in low to mid-elevation dry open forest and woodlands, preferably with extensive cliffs, caves or gullies. Pied Bat is largely restricted to the interface of sandstone escarpment (for roost habitat) and relatively fertile valleys (for foraging habitat).	87	18/11/2018	Recorded. Suitable habitat found throughout study area. Numerous recorded sightings.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E	✓	✓	✓	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Utilises a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	46	12/9/2015	High. Suitable habitat found throughout study area. Numerous recorded sightings.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	This species occupies tall, mature, wet forest and the species have been recorded roosting in stem holes in Eucalyptus and in buildings. Prefers moist habitats, with trees taller than 20 m. Generally, roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	19	6/4/2015	High (possibly recorded). Suitable habitat found throughout study area. Numerous recorded sightings.
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E	E	✓	✓	✓	✓	HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN566	Generally, only found in heath or open forest with a heathy understorey on sandy or friable soils. Feeds on a variety of ground-dwelling invertebrates and the fruit-bodies of hypogeous (underground-fruiting) fungi. Their searches for food often create distinctive conical holes in the soil. Males have a home range of approximately 5-20 ha whilst females forage over smaller areas of about 2-3 ha. Nest during the day in a shallow depression in the ground covered by leaf litter, grass or other plant material. Nests may be located under Grass trees Xanthorrhoea spp., blackberry bushes and other shrubs, or in rabbit burrows. The upper surface of the nest may be mixed with earth to waterproof the inside of the nest.	2	14/5/1987	High. Suitable habitat found throughout study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Macropus parma	Parma Wallaby	V	-	-	-	-	✓	HN607	Occurs in moist eucalypt forest with thick, scrubby understory with nearby grassy areas such as rainforest margins or dry eucalypt forest.	-	-	Moderate.
Miniopterus australis	Little Bent-winged Bat	V	-	✓	-	-	✓	HN517 HN525 HN532 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	This species occurs in moist eucalypt forest, rainforest or dense coastal banksia scrub. Little Bent-winged Bats roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	3	30/1/2013	Recorded. Suitable foraging and roosting habitat found throughout study area.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-	✓	-	-	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. They form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. This species tends to hunt in forested areas.	106	18/11/2018	Recorded. Suitable foraging and roosting habitat found throughout study area. Numerous recorded sightings.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Habitats preference includes dry eucalypt forest and coastal woodlands but also include riparian zones in rainforest and wet sclerophyll forest. Forages above forest canopy or forest edge and requires roosts including tree hollows.	36	18/11/2018	Recorded. Suitable foraging and roosting habitat found throughout study area. Numerous recorded sightings.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Myotis macropus	Southern Myotis	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN537 HN538 HN553 HN564 HN568 HN574 HN598 HN606 HN607	This species generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. They forage over streams and pools catching insects and small fish by raking their feet across the water surface.	81	18/11/2018	High. Suitable foraging and roosting habitat found throughout study area. Numerous recorded sightings.
Petauroides volans	Greater Glider	-	V	-	✓	✓	-	-	The Greater Glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria. It is typically found in highest abundance in taller, montane, moist eucalypt forests. Requires large tree hollows for denning.	-	-	Recorded.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Petaurus australis	Yellow-bellied Glider	V	-	✓	-	-	-	HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN568 HN598 HN606 HN607	Typically occurs in tall, mature eucalypt forest in regions of high rainfall, but is also known to occur in drier areas. Preference for resource rich forests where mature trees provide nesting hollows and tree species composition with adequate food resources, including winter-flowering Eucalypts and sap-rich trees.	222	29/7/2018	Recorded.
Petaurus norfolcensis	Squirrel Glider	V	-	✓	-	-	✓	HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN568 HN598 HN606	The Squirrel Glider inhabits dry sclerophyll forest and woodland. In NSW, potential habitat includes Box-Ironbark forests and woodlands in the west, the River Red Gum forests of the Murray Valley and the eucalypt forests of the northeast. Individuals have also been recorded in a diverse range of vegetation communities, including Blackbutt, Forest Red Gum and Red Bloodwood forests, Coastal Banksia heathland and Grey Gum/Spotted Gum/Grey Ironbark dry hardwood forests of the Central NSW Coast. The Squirrel Glider is nocturnal and shelters in tree hollows. This species is capable of gliding up to 50 m.	10	25/2/2017	High. Suitable foraging and roosting habitat found throughout study area. Numerous recorded sightings.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	✓	✓	✓	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN557 HN566 HN568 HN598 HN606	This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges, isolated rock stacks and tree limbs. Preference for north-facing slopes and cliff lines. A range of vegetation types are associated with Brush-tailed Rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest.	23	30/6/2006	High. Suitable foraging and roosting habitat found throughout study area. Numerous recorded sightings.
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	-	-	-	✓	HN532 HN533 HN564 HN566 HN606	Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest.	-	-	High. Suitable habitat found in the study area. No sightings could be attributed to past surveying efforts.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Phascolarctos cinereus	Koala	V	V	✓	✓	✓	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Inhabits a range of eucalypt forest and woodland communities. Adequate floristic diversity, availability of feed trees (primarily Eucalyptus tereticornis and E. viminalis) and presence of mature trees very important. Preferred food tree species vary with locality and there are quite distinct regional preferences. They are able to persist in fragmented habitats, and even survive in isolated trees across a predominantly agricultural landscape.	49	17/2/2019	High. Suitable habitat found throughout study area. Numerous recorded sightings.
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	-	✓	-	-	HN525 HN527 HN532 HN535 HN536 HN537 HN553 HN557 HN566 HN568 HN606	Inhabits coastal heaths and dry and wet sclerophyll forests, with sandy loam soils. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. Require dense vegetation for shelter and access to fungi. It is mainly nocturnal, hiding by day in dense vegetation - however, during the winter months animals may forage during daylight hours.	-	-	Moderate. Suitable habitat present within the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Pseudomys novaehollandiae	New Holland Mouse	-	V	-	✓	-	-	HN564 HN566 HN568 HN598	Inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. Nest in burrows and have a preference for deeper top soils and softer substrates to aid digging. Spends considerable time foraging above-ground for food in areas of high floristic diversity.	-	-	Moderate. Suitable habitat present within the study area.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	✓	✓	✓	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are commonly found in gullies, close to water, in vegetation with a dense canopy. They travel up to 50 km to forage, on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.	93	12/11/2017	Recorded (heard; incidental).

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Inhabits eucalypt rainforest, sclerophyll forest and open woodland vegetation. Availability of tree hollows is important for access to roosting sites.	2	1/7/2013	Recorded. Suitable roosting and foraging habitat found in study area. Limited recorded sightings could be attributed to previous survey effort.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	✓	-	-	-	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN538 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Occurs in a variety of habitats including rainforest, dry and wet sclerophyll forest and eucalypt woodland. Large hollow bearing trees required for roosting.	42	30/10/2017	Recorded. Suitable foraging and roosting habitat found throughout study area. Numerous recorded sightings.
Vespadelus troughtoni	Eastern Cave Bat	V	-	✓	-	-	-	HN598	A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals.	1	13/10/2011	Moderate. Suitable roosting and foraging habitat is present in the study area however the species' distribution is described as being north of Sydney.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Reptiles												
Aprasia parapulchella	Pink-tailed Worm-lizard	V	V	-	✓	✓	-	-	The Pink-tailed Legless Lizard is only known from the Central and Southern Tablelands, and the South Western Slopes. Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (Themeda australis). Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks and appear to spend considerable time in burrows below these rocks; the burrows have been constructed by and are often still inhabited by small black ants and termites.	-	-	Low. Although potential habitat present, it is unlikely to occur because its known distribution does not overlap with the study area.
Delma impar	Striped Legless Lizard	V	V	-	✓	-	-	-	Found mainly in Natural Temperate Grassland but also grasslands that have a high exotic component. Also found in secondary grassland near Natural Temperate Grassland and occasionally in open Box-Gum Woodland. Habitat is where grassland is dominated by perennial, tussock-forming grasses such as Kangaroo Grass, spear-grasses and poa tussocks, and occasionally wallaby grasses. Sometimes present in modified grasslands with a significant content of exotic grasses and grasslands with significant amounts of surface rocks, which are used for shelter.	-	-	Low. Study area is outside the known distribution of the species.
Eulamprus leuraensis	Blue Mountains Water Skink	E	E	✓	✓	-	-	-	Occurs at high elevations (between 560 and 1,060 m) while being restricted to an isolated and naturally fragmented habitat of sedge and shrub swamps that have boggy soils and appear to be permanently wet. This swamp vegetation typically takes the form of a sedgeland interspersed with shrubs but may occur as a dense shrub thicket.	17	9/2/2010	Low. High elevation shrub and sedge swamp is not known to occur in the study area. Records suggest, however, that the species' habitat preferences could be more flexible.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Hoplocephalus bungaroides	Broad-headed Snake	E	V	✓	✓	✓	✓	HN517 HN525 HN527 HN532 HN533 HN535 HN536 HN537 HN553 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Confined to the Sydney basin within a radius of approximately 200 km. A preferred habitat of sandstone outcrops with woodland, open woodland and/or heath vegetation. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges and tree hollows.	3	12/1/2019	High. Habitat that includes sandstone cliffs, rock crevices, flat sandstone rocks and tree hollows occurs throughout the study area, but generally at a height above the flood line.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Varanus rosenbergi	Rosenberg's Goanna	V	-	✓	-	-	✓	HN525 HN527 HN532 HN533 HN535 HN536 HN553 HN557 HN564 HN566 HN568 HN574 HN598 HN606 HN607	Utilise sandstone outcrops and crevices as an important winter sheltering habitat. Occurs in sandstone woodlands, heath and upland swamps. Also shelters in hollows, burrows and logs.	3	15/3/2004	Recorded. Sandstone woodland and heath occur in the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Flora												
Ecological Communities												
Agnes Banks Woodland in the Sydney Basin Bioregion		E	-	✓	✓	-	-	-	A low woodland community with *Eucalyptus sclerophylla*, *Angophora bakeri* and *Banksia serrata* as the dominant canopy species. Understorey shrubs include *Banksia aemula*, *Banksia oblongifolia*, *Conospermum taxifolium*, *Ricinocarpos pinifolius*, *Dillwynia sericea* and *Persoonia nutans*. Occurring in Western Sydney mostly near Agnes Banks near the Hawkesbury River. Occurs on areas of wind-blown sand which overlay Tertiary Alluvium deposits. Depending on the drainage conditions there is great variation within the community.	-	-	None. This community is restricted to the Penrith LGA occurring along the banks of the Hawkesbury River.
Bangalay Sand Forest of the Sydney Basin and South East Corner Bioregions		E	-	✓	-	-	-	-	Has a dense to open tree canopy. The most common tree species include *Eucalyptus botryoides* and *Banksia integrifolia* subsp. *integrifolia*, while *E. pilularis* and *Acmena smithii* may occur in sheltered locations. *Casuarina glauca* may occur on dunes exposed to salt-bearing sea breezes. The open stratum may be dominated by sclerophyllous species such as *Banksia serrata*, *Leptospermum laevigatum* and *Monotoca elliptica* and/ or mesophyllous species such as *Breynia oblongifolia* and *Pittosporum undulatum*. The ground cover is sparse compared to the canopy and can be dominated by *Dianella* spp., *Lepidosperma concavum*, *Lomandra longifolia* and the grasses *Imperata cylindrica*, *Microlaena stipoides* var. *stipoides* and *Themeda australis*. Bangalay Sand Forest is associated with coastal sand plains of marine or aeolian origin. It occurs on deep, freely draining to damp sandy soils on flat to moderate slopes within a few km of the sea and at altitudes below 100 m.	-	-	Low. Community typically associated with coastal sand plains below 100 m in altitude.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Blue Gum High Forest in the Sydney Basin Bioregion		CE	CE	-	✓	-	-	-	A moist, tall open forest community with dominant canopy trees of *Eucalyptus saligna* and *E. pilularis*. *Allocasuarina torulosa* and *Angophora costata* also occur. Species adapted to moist habitat such as *Acmena smithii*, *Ficus coronata*, *Calochlaena dubia* and *Adiantum aethiopicum*. Originally restricted to the ridgelines in Sydney's north from Crows Nest to Hornsby and extending west along the ridges between Castle Hill and Eastwood. Occurs only in areas where rainfall is high (above 1,100 mm/year) and the soils are relatively fertile and derived from Wianamatta shale.	-	-	None. Neither the original nor current restricted distribution occur in the study area.
Blue Mountains Basalt Forest in the Sydney Basin Bioregion		E	E	-	✓	-	-	-	Usually a tall eucalypt forest with a dense shrub or small tree layer often including tree ferns and a moist herbaceous ground cover. Canopy is usually dominated by one or more of the species *Eucalyptus fastigata*, *Eucalyptus blaxlandii*, *Eucalyptus cypellocarpa* or *Eucalyptus radiata* subsp. *radiata*. The major area of distribution is the Blue Mountains occurring mostly between 750 and 1,050 m altitude in areas with rainfall between 950 and 1, 350 mm per year. Found on highly fertile soils derived from basalt on rolling hills or gently to steep slopes.	-	-	Low. The study area is high enough and gets enough annual rainfall however large sections of basalt-derived soils are required.
Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion		E	CE	-	✓	-	-	-	Characteristic tree species include *Eucalyptus deanei*, *E. cypellocarpa* and *Syncarpia glomulifera*. Other tree species include *Angophora costata*, *A. floribunda*, *E. notabilis*, *E. piperita* and *E. punctata*. Can vary based on topography and rainfall. Known from the LGAs of Hawksbury, Blue Mountains and Wollondilly. Is found on deep fertile soils formed on the Wianamatta Shale, on moist sheltered sites at lower to middle altitudes.	-	-	Moderate. Suitable habitat occurs in the study area. It is known to occur in both the Blue Mountains and Hawkesbury LGAs.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Blue Mountains Swamps in the Sydney Basin Bioregion		V	E	-	✓	-	-	-	Characterised by a dense mixture of shrubs and sclerophyllous sedges. There is considerable local variation within the swamps in terms of species composition and vegetation structure. Common shrub species include *Baeckea linifolia*, *Leptospermum juniperinum* and *Hakea teretifolia*. Also present are *Leptospermum grandifolium*, *Grevillea acanthifolia* subsp. *acanthifolia*, *Leptospermum polygalifolium* and *Banksia spinulosa*. Sedges include *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Lepyrodia scariosa* and *Ptilothrix deusta*. Associated with poorly drained headwaters of streams on the permanent sandstone plateau of the Blue Mountains. Spans an altitudinal range between 500 and 950 m.	-	-	Low. Suitable poorly drained habitat occurs in the study area however it is too low and does not occur on any plateaux.
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion		CE	E	✓	✓	-	-	-	Dominated by *Eucalyptus parramattensis* subsp. *parramattensis*, *E. sclerophylla* and *Angophora bakeri*. A small tree stratum of *Melaleuca decora* is sometimes present in areas of poor drainage. It has a well-developed sub-stratum of *Banksia spinulosa* var. *spinulosa*, *Melaleuca decora*, *Hakea sericea* and *Hakea dactyloides*. The groundcover includes forbs such as *Themeda australis*, *Entolasia stricta*, *Dianella revoluta* subsp. *revoluta* and *Platysace ericoides*. Occurs almost exclusively on soils derived from Tertiary alluvium or on sites adjoining shale or Holocene alluvium.	-	-	Low. Known to be restricted to the Cumberland Plain, an area that is not part of the study area. Some of the species that comprise this community do not occur in the study area.
Castlereagh Swamp Woodland Community		E	-	✓	-	-	-	-	A low woodland often having dense stands of *Melaleuca decora* along with other trees such as *Eucalyptus parramattensis* subsp. *parramattensis*. Shrub layer is not well developed. Ground layer is made up of *Centella asiatica*, *Juncus usitatus* and *Goodenia paniculata*. Contains many more species. Occurs in western Sydney in the Castlereagh and Holsworthy areas, on deposits from ancient river systems that are now intermittent creeks in poorly drained depressions. Is highly adapted to seasonal fluctuations of wet and dry and is known to intergrade into Ironbark and Scribbly gum woodland. This community may occur as remnant trees.	-	-	Low. Known distribution does not overlap with the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	V	-	✓	-	-	-	Occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the ocean. Is frequently found as a zone on the landward side of mangrove stands. Characteristic plants include *Baumea juncea*, *Juncus kraussii* subsp. *australiensis*, *Sarcocornia quinqueflora* subsp. *quinqueflora*, *Sporobolus virginicus* and *Triglochin striata*.	-	-	None. Distribution is restricted to habitat along the intertidal zone or waterways that are at least intermittently connected to the ocean.
Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland		E	E	✓	-	-	-	-	The Coastal Swamp Oak Forest ecological community is characterised by the dominance of *Casuarina glauca* in the canopy, with an understorey of rushes, sedges, forbs and grasses. Coastal Swamp Oak Forest is typically found on loose or alluvial soil on coastal flats, floodplains, drainage lines, lake margins, wetlands and estuarine fringes where soils are at least occasionally saturated, water-logged or inundated. Sometimes the ecological community can intergrade with mangroves or saltmarsh communities (on the seaward side), or with *Melaleuca* species and eucalypts (more landward). The ecological community mostly occurs as scattered remnant patches along the coast between Curtis Island (south-east Queensland) and Bermagui (southern NSW), up to 50 m asl. but typically, less than 20 m asl. Most occurrences are within 30 km of the coast but in some areas, such as along tidal river catchments, the ecological community can occur more than 100 km inland.	-	-	None. Suitable habitat not present within the study area.
Coastal Upland Swamp in the Sydney Basin Bioregion		E	E	✓	-	-	-	-	Includes open graminoid heath, sedgeland and tall scrub associated with periodically waterlogged soils on the Hawkesbury Sandstone Plateau. Generally associated with acidic soils. Confined to the Sydney Basin Bioregion where it occurs on the at elevations between 20 and 600 m. The flora comprising the upland swamp is diverse with 73 plant species being listed as characteristic of this ecological community.	-	-	Low. In the north of the Sydney Basin Bioregion this community is confined to the Somersby-Hornsby Plateau and confined to the Woronora Plateau in the south of the bioregion.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion		E	CE	✓	✓	-	-	-	Ranges from open forest to low woodland with a canopy dominated by *Eucalyptus fibrosa* and *Melaleuca decora*. The dense shrubby understory includes *Melaleuca nodosa* and *Lissanthe strigosa* with a range of other shrubs such as *Dillwynia tenuifolia*, *Pultenaea villosa* and *Daviesia ulicifolia*. Occurs in western Sydney in the Castlereagh and Holsworthy areas. Smaller remnants occur in the Kemps Creek area and eastern parts of the Cumberland Plain. Mainly occurs on clay soils derived from ancient river systems or on shale soils from the Wianamatta Shale.	-	-	Low. This community has a highly restricted distribution which occurs in western Sydney and other parts of the Cumberland Plain and is not known to extend to the Warragamba Dam area.
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest		E	CE	✓	✓	-	-	-	The Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest lies in a coastal valley rain shadow that occupies the driest part of the Cumberland Plain. It typically occurs on flat to undulating or hilly terrain, at elevations up to about 350 m asl., and on clay soils (derived from Wianamatta Group shales), with some occurrences on other soils. This ecological community has several vegetation layers in its natural state. The tree canopy is typically dominated by *Eucalyptus moluccana* (Grey Box), *E. tereticornis* (Forest Red Gum), and/or *E. fibrosa* (Red Ironbark). The Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest is endemic to NSW, specifically the area in and around western Sydney (DEWHA 2010).	-	-	None. The study area does not occur within the Cumberland Plain.
Cumberland Plain Woodland in the Sydney Basin Bioregion		CE	CE	-	✓	-	-	-	Dominant canopy trees include *Eucalyptus moluccana*, *E. tereticornis*, *E. crebra*, *E. eugenioides* and *Corymbia maculata*. Shrub layer is dominated by *Bursaria spinosa* and grasses such as *Themeda australis* and *Microlaena stipoides* var. *stipoides* are common. Occurs on heavy clay soils derived from the Wianamatta Shale and through the driest part of the Sydney Basin. The only existing remnants are scattered across the Cumberland Plain.	-	-	Low. Known distribution is restricted to the Cumberland Plain of western Sydney.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion		CE	-	-	✓	-	-	-	Occurs only in the Elderslie area near Camden in Sydney's south-west. Occurs only on sand deposits on the old terraces deposited by ancient river systems. A scrub community dominated by *Banksia integrifolia* subsp. *integrifolia*. Other canopy species include *Angophora subvelutina*. The understory is diverse and includes species such as *Ricinocarpos pinifolius*, *Pimelea linifolia* subsp. *linifolia* and *Brachyloma daphnoides*.	-	-	None. Community is restricted to the Elderslie area near Camden.
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	-	✓	-	-	-	-	This ecological community is associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, back swamps, lagoons and lakes associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Freshwater Wetlands on Coastal Floodplains generally occur below 20 m elevation in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community may vary from sedge lands and reed lands to herb fields, and woody species of plants are generally scarce. Typically, these wetlands form mosaics with other floodplain communities, and often they include or are associated with ephemeral or semi-permanent standing water.	-	-	Low. Community is restricted to coastal floodplains that occur below 20 m in altitude.
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion		V	CE	-	✓	-	-	-	This community mainly occurs on the southern side of the Hunter Valley from near Bulga to the Bylong/Goulburn River National Park area. It occurs on colluvial soils on exposed footslopes associated with the interface between Triassic Narrabeen sandstones and Permian sediments. This community is known to occur in the Mid-Western Regional LGA. It tends to occur in relatively hot and dry parts of the landscape.	-	-	Low. Likely restricted to the lower Hunter Valley.

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Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	CE	-	✓	-	-	-	Occurs on sand dunes and on soil derived from underlying rocks. Stands on headlands exposed to strong winds may take the form of dense, wind-pruned thickets. Stands are generally taller in sheltered areas. Most stands occur within 2 kilometres of the ocean. Species composition varies with latitude with more species occurring in the south compared to the north. Species composition is also determined by rainfall and size of community.	-	-	None. Community is restricted to the coast where it occurs on headlands and sand dunes.
Moist Shale Woodland in the Sydney Basin Bioregion		E	CE	-	✓	-	-	-	Similar to Cumberland Plain Woodland. It differs by having a shrubby understory that contains plants from moist habitats such as *Clerodendrum tomentosum*, *Breynia oblongifolia* and *Sigesbeckia orientalis* subsp. *orientalis*. Canopy species are similar to that of the Cumberland Plain for example, *Eucalyptus tereticornis* and *E. moluccana*. Usually occurs on soils derived from the Wianamatta shale in the hilly country with higher elevations and increased rainfall.	-	-	Moderate. Suitable marginal habitat occurs in the study area. This community is known from the Wollondilly LGA.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Montane Peatlands and Swamps of the New England Tablelands, North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions		E	E	-	✓	-	-	-	The Montane Peatlands community is associated with accumulated peaty or organic-mineral sediments on poorly drained flats in the headwaters of streams. It occurs on undulating tablelands and plateaux, above 400-500 m elevation, generally in catchments with basic volcanic or fine-grained sedimentary substrates or, occasionally, granite. It is the only type of wetland that may contain more than trace amounts of *Sphagnum* spp., the hummock peat-forming mosses. Small trees may be present as scattered emergents or absent from the community. Typically has an open to very sparse layer of shrubs, 1-5 m tall, including species of *Baeckea*, *Callistemon* and *Leptospermum*. Species of *Epacris* and *Hakea microcarpa* are also common shrubs. In some peatlands and swamps, particularly those with a history of disturbance to vegetation, soils or hydrology, the shrub layer comprises dense thickets of *Leptospermum* species. In other peatlands and swamps with a history of grazing by domestic livestock, the shrub layer may be very sparse or absent. Montane Peatlands typically have a dense groundcover of sedges, grasses and forbs, except where a dense cover of tall shrubs casts deep shade. Soft-leaved species of *Carex* and *Poa* typically make up most of the groundcover biomass, while other common sedges include *Baloskion* spp., *Baumea rubiginosa*, *Empodisma minus*, *Juncus* spp. and *Schoenus apogon*. Forbs growing amongst the sedges include *Drosera* spp., *Geranium neglectum*, *Gratiola* spp., *Mitrasacme serpyllifolia*, *Ranunculus spp*. and *Viola spp*. Hummocks of Sphagnum moss may occur amongst other components of the ground layer.	-	-	Low. Lower than preferred altitude. No previous mapping of similar vegetation types in locality.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Mount Gibraltar Forest in the Sydney Basin Bioregion		E	E	-	✓	-	-	-	A variable community occurring as open forest, woodland or scrub. Floristic assemblage reflects the topography and aspect. Dominant tree species are *Eucalyptus radiata*, *E. piperita*, *E. fastigata* and *E. viminalis*. The shrub or small tree layer is dominated by *Acacia melanoxylon*, *Hedycarya angustifolia*, *Notelaea venosa* and *Pittosporum undulatum*. Dominant ground layer species include *Stypandra glauca*, *Dianella caerulea*, *Dichondra repens* and *Themeda australis*. This community is restricted to a number of small pockets in the Southern Highlands region with minor occurrences in extending into the south of the Sydney Basin Bioregion. It is restricted to clay soils on microsyenite intrusions. Occurs on gentle to steep slopes with varying soil depths.	-	-	Moderate. Usually restricted to the Southern Highlands however it can occur in other locations of higher altitudes in the south of the Sydney Basin Bioregion.
Natural Temperate Grassland of the South Eastern Highlands		-	CE	✓	-	-	-	-	Natural Temperate Grassland is a grassland community dominated by a range of perennial grass species and in highly intact sites, containing a large range of herbaceous species in many plant families, including daisies, peas, lilies, orchids and plants in many other families, all collectively known as forbs, or "wildflowers" in the case of the showier species. Natural Temperate Grassland is confined to the Southern Tablelands, a region bounded by the ACT, Yass, Boorowa, the Abercrombie River, Goulburn, the Great Eastern Escarpment, the Victorian border and the eastern boundary of Kosciusko National Park. The community occurs in a number of distinct plant associations (see Armstrong *et al*., 2013).	-	-	None. The distribution for this community does not overlap with the study area.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion		E	E	✓	-	-	-	-	Dominated by shrubs and sedges and occurs on sites with impeded drainage in low slope headwater valleys on the Newnes Plateau in the upper Blue Mountains. Shrubs include *Baeckea linifolia*, *Grevillea acanthifolia* subsp. *acanthifolia*, *Epacris paludosa* and various *Leptospermum* species. Common sedges include *Baloskion australe*, *Empodisma minus*, *Lepyrodia scariosa* and *Lepidosperma limicola*. *Lomandra longifolia* may be present along swamp margins. Occurs in narrow, elongated swamps formed in the low-slope headwaters of the Newnes Plateau between 900 and 1,200 m asl. With decreasing altitude, Newnes Plateau Shrub Swamp grades into Blue Mountains sedge swamp. This transition occurs around Bell and Clarence at approx. 850-950 m asl.	-	-	Low. This community is known only to occur on the Newnes Plateau however small parts of suitable habitat may occur at isolated locations in the study area.
O'Hares Creek Shale Forest		E	-	✓	-	-	-	-	Occurs on small outcrops of Hawkesbury shale in the Drakes Forest area of the Woronora Plateau. Dominated by *Eucalyptus piperita*, *E. globoidea* and *Angophora costata*. The shrub layer is variable in density and height and usually includes *Acacia binervata*, *Acacia longifolia*, *Leucopogon lanceolatus* var. *lanceolatus* and *Banksia spinulosa* var. *spinulosa*. The ground cover is often the distinguishing feature of the community with an impressive cushion of ferns, lilies, grasses and rushes. Examples include *Calochlaena dubia*, *Pteridium esculentum* and *Doryanthes excelsa*. The depth of the shale soil where the community occurs is variable and consequently, a greater influence of sandstone vegetation is found on the edge of larger shale patches or throughout smaller isolated examples. Trees within the community are distinctively taller than those in the surrounding sandstone woodland vegetation.	-	-	None. This community is restricted to the Hawkesbury Shale outcrops of the Woronora Plateau.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	CE	✓	-	-	✓	HN553	Found on the river flats of coastal floodplains. It has a tall and open canopy that can exceed 40 m in height but can be much shorter in regrowth sites or sites of poorer quality soils. The dominant tree species include *Eucalyptus tereticornis*, *Eucalyptus amplifolia*, *Angophora floribunda* and *A. subvelutina*. *Eucalyptus baueriana*, *Eucalyptus botryoides* and *Eucalyptus elata* may be common south of Sydney where *Eucalyptus grandis* is found north of Sydney and *Eucalyptus benthamii* being restricted to the Hawkesbury floodplain. A layer of small trees may be present, including *Melaleuca decora*, *M. stypheloides*, *Backhousia myrtifolia*, *Casuarina cunninghamiana* and *C. glauca*. Scattered shrubs include *Bursaria spinosa*, *Solanum prinophyllum*, *Rubus parvifolius*, *Breynia oblongifolia*, *Ozothamnus diosmifolius*, *Acacia floribunda* and *Phyllanthus gunnii*. The groundcover is made up of abundant forbs, scramblers and grasses and include such species as *Microlaena stipoides*, *Dichondra repens*, *Glycine clandestina*, *Oplismenus aemulus*, *Desmodium gunnii* and *Pratia purpurascens*. The combination of features that distinguish this community from other communities on the coastal floodplains include: its dominance by either a mixed eucalypt canopy or by a single species of eucalypt belonging to either the genus Angophora or the sections Exsertaria or Transversaria of the genus Eucalyptus; the relatively low abundance or sub-dominance of Casuarina and Melaleuca species; the relatively low abundance of *Eucalyptus robusta*; and the prominent groundcover of soft-leaved forbs and grasses.	-	-	Known, assuming subject site is 'coastal' floodplain.
Robertson Basalt Tall Open-Forest in the Sydney Basin and South Eastern Highlands Bioregions		CE	E	-	✓	-	-	-	An open forest or woodland with a sparse to moderately dense shrub layer and a dense herbaceous ground layer. Dominant tree species include *Eucalyptus fastigata, E. viminalis*, *E. radiata* and *E. cypellocarpa*. *Acacia melanoxylon* is a common small tree species. Common shrubs include *Coprosma quadrifida* and *Senecio linearifolius*. This forest is restricted to the Robertson Basalt on the Southern Highlands but can also be found on the Cambewarra Range to the south. May occur elsewhere in the Sydney Basin Bioregion.	-	-	Low. While the study area supports tall open forest, the geology of the area (not Robertson Basalt) makes the occurrence of this community unlikely.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Shale Gravel Transition Forest in the Sydney Basin Bioregion		E	CE	✓	✓	-	-	-	An open forest structure with a canopy dominated by *Eucalyptus fibrosa*, *Eucalyptus moluccana* and *Eucalyptus tereticornis*. *Melaleuca decora* is common in the small tree layer. A sparse shrub layer is usually present and includes *Bursaria spinosa*, *Daviesia ulicifolia* and *Lissanthe strigosa*. Mainly in the northern area of the Cumberland Plain in western Sydney. Occurs primarily where shallow deposits from ancient river systems overlay shale soils, but also associated with localised concentrations of iron-hardened gravel. This is a transitional plant community which grades into Cumberland Plain Woodland where the influence of gravel soil declines, and grades into Cooks River/Castlereagh Ironbark Forest or Castlereagh Scribbly Gum Woodland where gravel deposits are thick.	-	-	Moderate. Suitable soil conditions occur in certain locations in the study area although no recording of this community has been made.
Shale Sandstone Transition Forest in the Sydney Basin Bioregion		CE	CE	✓	✓	-	-	-	Occurs at the edges of the Cumberland Plain, where clay soils form the shale rock intergrade with sandstone soils or where shale caps overlay sandstone. The boundaries are indistinct, and the species composition varies depending on the soil. The main tree species include *Eucalyptus tereticornis*, *Eucalyptus punctata*, *Eucalyptus globoidea*, *Eucalyptus eugenioides*, *Eucalyptus fibrosa*, and *Eucalyptus crebra*. Areas of low sandstone influence have an understory that is closer to Cumberland Plain Woodland. Original distribution was around the edges of the Cumberland lowlands throughout western Sydney, most prominently in the southern half. This distribution is now highly fragmented. This community is well adapted to fire, often being close to sandstone areas.	-	-	High. This community occurs on sandstone or sandstone/shale transition zones around the edges of the Cumberland Plain, an area that overlaps with this study area. Known from the Hawkesbury, Penrith and Wollondilly LGAs.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
South Highlands Shale Forest and Woodlands in the Sydney Basin Bioregion		E	CE	✓	-	-	-	-	A variable community in terms of both structure and composition, occurring as tall open forest, grassy woodland or scrub. Common species throughout much of the community's range are *Eucalyptus cypellocarpa*, *E. piperita*, *E. ovata*, *E. radiata* and *E. globoidea*. Other less common trees include *Eucalyptus mannifera*, *E. pauciflora*, *E. amplifolia* and *Angophora floribunda*. *Eucalyptus macarthurii* occurs only in the south west of the distribution. The shrub layer is usually open and includes *Oxylobium ilicifolium*, *Melaleuca thymifolia* and *Olearia microphylla*. The ground layer is diverse and usually dominated by grasses such as *Themeda australis*, *Austrostipa rudis*, *Microlaena stipoides* and *Austrodanthonia* species. This community is confined to a small area in the Southern Highlands bounded by the Illawarra Escarpment in the east, Bundanoon in the south, Canyonleigh in the west and Berrima in the north. Restricted to clay soils derived from Wianamatta Shale where it occurs at altitudes between 600 and 800 m asl and annual rainfall levels between 1,400 to 900 mm.	-	-	Low. This community is confined to a small area in the Southern Highlands that does not overlap with the study area.
Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion		E	CE	✓	-	-	-	-	An open forest dominated by eucalypts with scattered sub-canopy trees, a diverse shrub layer and well-developed groundcover of forbs, ferns and grasses. The dominant tree species include *Angophora costata*, *Eucalyptus piperita* and occasionally *E. pilularis* and *Corymbia gummifera*. Distinguishing this community from other communities more typical of sandstone gullies in the Sydney Basin Bioregion include the occurrences of *Eucalyptus pilularis*, *Acacia binervata*, *Elaeocarpus reticulatus*, *Pittosporum undulatum* and its relatively dense ground cover. This community is found within an extent of 45,000 ha which is bounded by Hurstville, Carss Park, Bundeena, Otford, Stanwell Tops, Darkes Forest, Punchbowl Creek and Menai. The terrain it occurs on is primarily gentle and where sandstone outcrops occur infrequently. The community is associated with sheltered heads and upper slopes of gullies on transitional zones where sandstone outcrops may exist.	-	-	Moderate. May occur on the gentle slopes below the sandstone escarpments, particularly towards the south of the study area.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Sun Valley Cabbage Gum Forest in the Sydney Basin Bioregion		CE	-	-	✓	-	-	-	Dominated by *Eucalyptus amplifolia* with *Eucalyptus eugenioides* as an associated tree. Native understory species include *Acacia parramattensis*, *Imperata cylindrica*, *Lomandra longifolia* and *Pteridium esculentum*. This community has only been found in the Sun Valley of the Blue Mountains where only approx. 15 ha remains, most of which is in poor conditions. Occurs on soils formed from diatremes (pipes of volcanic material) at Sun Valley. Before disturbance this community formed a tall open forest.	-	-	Low. Other diatreme substrates in the area support different dominant tree species and do not have *Eucalyptus amplifolia*.
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	E	-	✓	-	-	-	This community is found on the coastal floodplains of NSW. It has a dense to sparse tree layer in which *Casuarina glauca* (Swamp Oak) is the dominant species northwards from Bermagui. Other trees including *Acmena smithii* (Lilly Pilly), *Glochidion* spp. (cheese trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui. The understorey is characterised by frequent occurrences of vines, *Parsonsia straminea*, *Geitonoplesium cymosum* and *Stephania japonica* var. *discolor*, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter. The composition of the ground stratum varies depending on levels of salinity in the groundwater. Under less saline conditions prominent ground layer plants include forbs such *Centella asiatica*, *Commelina cyanea*, *Persicaria decipiens* and *Viola banksii*; graminoids such as *Carex appressa*, *Gahnia clarkei*, *Lomandra longifolia*, *Oplismenus imbecillis*; and the fern *Hypolepis muelleri*. On the fringes of coastal estuaries, where soils are more saline, the ground layer may include the threatened grass species, *Alexfloydia repens*, as well as *Baumea juncea*, *Juncus kraussii*, *Phragmites australis*, *Selliera radicans* and other saltmarsh species.	-	-	None. Associated with saline and sub-saline groundwater occurring with coastal floodplains. Occurs below 20 m in elevation.

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				NSW Atlas	PMST	SEARs	BBCC					
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	-	-	✓	-	-	-	This swamp community has an open-to-dense tree layer of eucalypts and paperbarks although some remnants now only have scattered trees as a result of partial clearing. The trees may exceed 25 m in height but can be considerably shorter in regrowth stands or under conditions of lower site quality where the tree stratum is low and dense. For example, stands dominated by *Melaleuca ericifolia* typically do not exceed 8 m in height. The community also includes some areas of fernland and tall reedland or sedgeland, where trees are very sparse or absent. The most widespread and abundant dominant trees include *Eucalyptus robusta* (Swamp Mahogany), *Melaleuca quinquenervia* (Paperbark) and, south from Sydney, *Eucalyptus botryoides* (Bangalay) and *Eucalyptus longifolia* (Woollybutt). Other trees may be scattered throughout at low abundance or may be locally common at few sites, including *Callistemon salignus* (Sweet Willow Bottlebrush), *Casuarina glauca* (Swamp Oak) and *Eucalyptus resinifera* subsp. *hemilampra* (Red Mahogany), *Livistona australis* (Cabbage Palm) and *Lophostemon suaveolens* (Swamp Turpentine). A layer of small trees may be present, including *Acacia irrorata* (Green Wattle), *Acmena smithii* (Lilly Pilly), *Elaeocarpus reticulatus* (Blueberry Ash), *Glochidion ferdinandi* (Cheese Tree), *Melaleuca linariifolia* and *M. styphelioides* (paperbarks). Shrubs include *Acacia longifolia*, *Dodonaea triquetra*, *Ficus coronata*, *Leptospermum polygalifolium* subsp. *polygalifolium* and *Melaleuca* spp. Occasional vines include *Parsonsia straminea*, *Morinda jasminoides* and *Stephania japonica* var. *discolor*. The groundcover is composed of abundant sedges, ferns, forbs, and grasses including *Gahnia clarkei*, *Pteridium esculentum*, *Hypolepis muelleri*, *Calochlaena dubia*, *Dianella caerulea*, *Viola hederacea*, *Lomandra longifolia*, *Entolasia marginata* and *Imperata cylindrica*. On sites downslope of lithic substrates or with soils of clay-loam texture, species such as *Allocasuarina littoralis*, *Banksia oblongifolia*, *B. spinulosa*, *Ptilothrix deusta* and *Themeda australis*, may also be present in the understorey.	-	-	None. Restricted to coastal floodplains.

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				NSW Atlas	PMST	SEARs	BBCC					
Sydney Freshwater Wetlands in the Sydney Basin Bioregion		E	-	✓	-	-	-	-	A complex of vegetation types largely restricted to freshwater swamps in coastal areas. These also vary considerably due to fluctuating water levels and seasonal conditions. Characteristic species include sedges and aquatic plants such as various *Baumea species*, *Eleocharis sphacelata*, various *Gahnia* species, *Ludwigia peploides* subsp. *montevidensis* and a few *Persicaria* species. Areas of open water may occur where drainage conditions have been altered and there may also be patches of emergent trees and shrubs. This community occurs on sand dunes and low nutrient sand plains along coastal areas in the Sydney Basin Bioregion. It is restricted to freshwater swamps in swales and depressions on sand dunes.	-	-	None. Occurs on sand dunes and low nutrient sand plains along coastal areas.
Turpentine-Ironbark Forest of the Sydney Basin Bioregion		E	CE	✓	✓	-	✓	HN606	Open forest, with dominant canopy trees including Turpentine *Syncarpia glomulifera*, Grey Gum *Eucalyptus punctata*, Grey Ironbark *E. paniculata* and Thin-leaved Stringybark *Eucalyptus eugenioides*. In areas of high rainfall (over 1050 mm per annum) Sydney Blue Gum *E. saligna* is more dominant. The shrub stratum is usually sparse and may contain mesic species such as Sweet Pittosporum *Pittosporum undulatum* and Elderberry Panax *Polyscias sambucifolia*. Occurs in Sydney and is heavily fragmented, with only 0.5 percent its original extent remaining intact. Remnants mostly occur in the Baulkham Hills, Hornsby, Ku-ring-gai, Parramatta, Ryde, Sutherland and Hurstville local government areas. Good examples can be seen in small reserves such as Wallumatta Nature Reserve and Newington Nature Reserve. A transitional community, between Cumberland Plain Woodland in drier areas and Blue Gum High Forest on adjacent higher rainfall ridges.	-	-	Low. While communities with similar species composition do occur in the study area, the scientific determination of this particular community describes a distribution occurring farther to the east.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions		E	-	✓	-	-	-	-	This ecological community is found on plateaux and tablelands with loam or clay soils derived primarily from basalt, but may also be derived from mudstones, granites, alluvium and other substrates. Its distribution spans altitudes from approximately 600 m to 900 m above sea level, usually on undulating or hilly terrain. The community typically has an open canopy of eucalypts with sparse shrubs and a dense groundcover of herbs and grass, although disturbed stands may lack either or both of the woody strata. The community therefore includes 'derived' native grasslands which result from removal of the woody components from the woodland and forest forms of the community.	-	-	Moderate. Known from the Burragorang IBRA subregion however the soils in the study area do not appear to be fertile enough to support this community.
Temperate Highland Peat Swamps on Sandstone		-	E	✓	✓	-	-	-	The Temperate Highland Peat Swamps on Sandstone are temporary or permanent swamps in the Blue Mountains, Lithgow, Southern Highlands and Bombala regions. They all occur on sandstone and share similar vegetation. Sphagnum bogs and ferns occupy the wetter parts while sedge and shrub associations occur in the drier parts of the swamps. Some, like the Blue Mountains swamps, are hanging swamps that are prominent on steep valley sides, where water exits the ground between sandstone and claystone layers of rock. Other swamps, like Wingecarribee Swamp, occur in natural depressions or along watercourses (DoEH 2005).	-	-	None. No swamps present on sandstone geology within the study area.
Themeda Grassland on Seacliffs and Coastal Headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions		E	-	✓	-	-	-	-	The community is found in the NSW North Coast, Sydney Basin and South East Corner Bioregions, on sea cliffs and coastal headlands. The structure of the community is typically closed tussock grassland but may be open shrubland or open heath with a grassy matrix between the shrubs.	-	-	None. This community is restricted to coastal margins on headlands and cliff complexes.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Upland Basalt Eucalyptus Forests of the Sydney Basin Bioregion		-	E	✓	✓	-	-	-	This ecological community is typically tall open eucalypt forests found on basalt and basalt-like substrates in, or adjacent to, the Sydney Basin Bioregion. The ecological community usually occurs at elevations between 650 m and 1,050 m asl., although outliers may occur at elevations as low as 350 m (for example, closer to the coast) or as high as 1,200 m asl. (for example, on higher plateaux). The ecological community occurs in areas of high rainfall, generally ranging from 1,000 to 1,800 mm/year. The structure of the ecological community varies from tall open forest to woodland depending on aspect, slope, soil conditions, soil depth, and previous disturbance. Typically, the ecological community has a sparse to dense layer of shrubs and vines, and a diverse understorey of native grasses, forbs, twiners and ferns (DEE 2011).	-	-	None. Suitable soil and parent geology not present within the study area
Western Sydney Dry Rainforest in the Sydney Basin Bioregion		E	CE	✓	✓	-	✓	HN538	A dry vine scrub community of the Cumberland Plain. Canopy trees include *Melaleuca styphelioides*, *Acacia implexa* and *Alectryon subcinereus*. There are many rainforest species in the shrub layer such as *Notolaea longifolia*, *Clerodendrum tomentosum* and *Pittosporum revolutum*. The vines that combine with the shrub layer include *Aphanopetalum*, *Pandorea pandorana* and *Cayratia clematidea*. This community contains many more species. This community is highly restricted, occurring most commonly in the far southern section of the Cumberland Plain, in the Razorback Range near Picton. Small patches are known to occur as far north as the Hawkesbury LGA. Restricted to hilly country where it occurs on sheltered lower slopes and gullies on clay soils derived from Wianamatta Shale. Is found at higher elevations, in areas with more rainfall than Cumberland Plain Woodland.	-	-	Moderate. Suitable habitat conditions occur for the community to exist in the study area, particularly in gullies located below the plateaux. This community has not been recorded in the study area, however.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
White Box-Yellow Box-Blakely's Red Gum Woodland		E	CE	✓	✓	-	✓	HN557	This community is found on relatively fertile soils on the tablelands and western slopes of NSW and generally occurs between the 400 and 800 mm isohyets extending from the western slopes, at an altitude of c. 170 m to c. 1,200 m, on the northern tablelands (Beadle 1981). The community occurs within the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands and NSW South Western Slopes bioregions. This community includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations - *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box) or *Eucalyptus blakelyi* (Blakely's Red Gum). Grass and herbaceous species generally characterise the ground layer. In some locations, the tree overstorey may be absent as a result of past clearing or thinning and at these locations only an understorey may be present. Shrubs are generally sparse or absent, though they may be locally common.	-	-	Moderate. Suitable habitat conditions are present for the community to occur in the study area.
Plants												
Acacia baueri subsp. *aspera*	-	V	-	✓	-	-	✓	HN566	Occurs in low heathlands, often on exposed rocky outcrops over a wide range of climatic and topographical conditions. Appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development; and many of the observations of this species have been made following fire, suggesting that the species prefers early successional habitats.	10	29/11/2006	Moderate. Prefers early-successional habitat, or habitat with no established canopy of any kind. Such habitat occurs infrequently in the study area, with the majority occurring on the Warragamba Walls.
Acacia bynoeana	Bynoe's Wattle	E	V	✓	✓	✓	✓	HN564 HN566 HN568	Occurs mainly in heath and dry sclerophyll forest, open woodland with dense to sparse heath understorey; open woodlands with a sparse shrub cover and a grass/sedge ground cover; and heathlands with sparse overstorey. With sand or sandy clay substrate, often with ironstone gravel and usually well drained, infertile soil.	1	1/9/1968	Moderate. Suitable habitat occurs throughout study area. Closest previously recorded sightings are the main ridge of the upper Blue Mountains and north of Mittagong.

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				NSW Atlas	PMST	SEARs	BBCC					
Acacia clunies-rossiae	Kanangra Wattle	V	-	✓	-	-	✓	HN525 HN527 HN532 HN535 HN536 HN537 HN538 HN557 HN574 HN598	Grows in the Kowmung and Coxs river areas entirely within the Kanangra-Boyd and Blue Mountains national parks. Grows in dry sclerophyll forest on skeletal soils on rocky slopes, or on alluvium along creeks.	66	11/10/2017	Known. Recorded during current surveys. Suitable habitat occurs throughout the study area. Numerous recorded sightings.
Acacia flocktoniae	Flockton's Wattle	V	V	✓	✓	-	✓	HN525 HN527 HN533 HN535 HN536 HN564 HN568 HN598	Found in the southern Blue Mountains (Mt Victoria, Megalong Valley and Yerranderie) where it grows in dry sclerophyll forest predominantly on sandstone. Species is not known to occur below 500 metres AHD.	21	18/9/2018	Moderate. Suitable habitat occurs throughout the study area. Numerous recorded sightings within the Yerranderie Area.
Acacia gordonii	Gordon's Wattle	E	E	-	-	✓	✓	HN564 HN566	Grows in dry sclerophyll forest and heathlands among or within rock platforms on sandstone outcrops. Flowers August to September and produces fruit October to February. The fruit is a pod containing hard-coated seed. The seed ultimately forms a persistent soil-stored seedbank.	-	-	Moderate. Suitable habitat occurs in study area. Most records found in the Grose Valley and north-west outskirts of Sydney. On record near Bilpin.
Acacia pubescens	Downy Wattle	V	V	✓	✓	✓	✓	HN564 HN566 HN568	Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravely soils, often with ironstone. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland. Concentrated around the Bankstown-Fairfield-Rookwood area and the Pitt Town area.	180	7/8/2008	Moderate. Suitable habitat occurs near the dam wall and along Warragamba Walls. Largely restricted to the Cumberland Plain, but numerous records around Oakdale.

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				NSW Atlas	PMST	SEARs	BBCC					
Acrophyllum australe	-	V	V	✓	✓	✓	✓	HN517 HN566 HN606	Grows in sheltered gullies beneath waterfalls and drip zones of rock overhangs and cliff faces, usually with a south-east to south-west aspect. Typically found in areas where there is a more-or-less constant supply of water. Usually grows in shale interbeds at the base of small cliffs, in crevices on the sandstone rock face or on talus slopes. The rock overhangs are of Hawkesbury or Narrabeen sandstone.	24	22/7/2007	High. Known to occur (24 records) within or near edge of study area. Suitable habitat found throughout study area.
Allocasuarina glareicola	-	E	E	-	✓	✓	-	HN564	Occurs in Castlereagh Woodland on lateritic soil. Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool.	-	-	Low. Restricted to the north-west of the Cumberland Plain, however certain habitat requirements and vegetation association occur in the study area.
Ancistrachne maidenii	-	V	-	✓	-	✓	✓	HN564 HN566 HN606	Populations occur in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes. Grows in dry sclerophyll forest on sandstone-derived soils. Restricted to northern Sydney, around St Albans – Mt White – Maroota – Berowra areas and to the Shannon Creek area south-west of Grafton.	1	6/3/1999	Moderate. Some suitable habitat occurs throughout the study area. Most records in Sydney region found between Hornsby and St Albans, although one identified approximately 4 km NW of Warragamba Dam.
Asterolasia buxifolia	-	E	-	✓	-	-	✓	HN574	Known from a single site at a granite outcrop in the riparian zone of the Lett River. Apparently restricted to dense riparian scrub along rocky watercourses with a granitic substrate.	1	4/3/2008	Low. Known from one population that occurs over 30 km from the study area.
Asterolasia elegans	-	E	E	-	-	✓	-	HN564 HN566 HN606	Occurs in the northern hills of Sydney. Habitat requirements are wet, sheltered sclerophyll forests on the mid- to lower slopes of moist gullies and rocky outcrops.	-	-	Moderate. Sheltered wet sclerophyll forest occurs in certain parts of the study area, however the site is outside the species known distribution.

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Astrotricha crassifolia	Thick-leaf Star-hair	V	V	-	-	-	✓	HN566 HN607	Occurs near Patonga (Central Coast LGA), in the Royal National Park and on the Woronora Plateau. Occurs in dry sclerophyll woodland on sandstone.	-	-	Low. This species has a distribution that does not overlap with the study area, however suitable habitat is present.
Baloskion longipes	Dense Cord-rush	V	V	-	✓	-	✓	HN574	Has been recorded from the Kanangra-Boyd area to the Southern Tablelands, however all populations are small. Commonly found in swamps or depressions in sandy alluvium, sometimes growing with sphagnum moss. Also occurs in swales within tall forest, and in Black Gum Woodland.	-	-	Moderate. Known to occur in the Kanangra-Boyd and Blue Mountains area. Suitable habitat occurs in the study area however there is no data on any previous recordings.
Boronia deanei	Deane's Boronia	V	V	✓	✓	-	-	-	Grows in wet heath, often at the margins of open forest adjoining swamps or along streams. Can occasionally be found in drier open forest on poorly-drained peat soils over granite or sandstone.	1	23/2/1995	Low. Associated plant community types or edaphics not present within the study area.
Bossiaea oligosperma	Few-seeded Bossiaea	V	V	✓	✓	✓	✓	HN525 HN532 HN574	Limited info on this plant's ecology. Occurs on sandstone slopes or ridges in the Yerranderie area and in low woodland on loamy soil in the Windellama area.	30	12/10/2017	Recorded.
Caesia parviflora var. *minor*	Small Pale Grass-lily	E	-	-	-	-	✓	HN564 HN566	Found in damp places in open forest on sandstone.	-	-	High. Suitable habitat occurs in certain parts of the study area. This species has a recorded distribution that includes the nearby Kanangra-Boyd National Park.

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Caladenia tessellata	Thick Lip Spider Orchid	E	V	-	✓	-	-	HN525 HN527 HN532 HN535 HN536 HN553 HN557 HN564 HN566 HN568	The Thick Lip Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil.	-	-	Low. The known distribution of this species does not overlap with the study area.
Callistemon linearifolius	Netted Bottle Brush	V	-	-	-	-	-	HN564 HN566 HN606	Inhabits dry sclerophyll forest on the coast and adjacent ranges.	-	-	Known. Identified during the current survey. All records for the Sydney region are more coastal (east from Liverpool/ Parramatta/ Castle Hill) than the suitable habitat describes.
Callistemon megalongensis	Megalong Valley Bottlebrush	CE	CE	-	✓	✓	✓	HN533	Occurs in shrubby swamp-habitat and swampy woodland. Associated species include *Callistemon citrinus*, *Leptospermum morrisonii*, *L. juniperinum*, *L. polygalifolium*, *L. obovatum*, *Empodisma minus* and *Grevillia asplenifolia*.	-	-	Moderate. Suitable habitat occurs within the study area; however, all recordings are from the Megalong Valley.
Callistemon purpurascens	-	CE	-	-	✓	-	-	-	Swampy, moist riparian shrubland, swamp woodland and swamp forest with *Melaleuca linariifolia*, *M. styphelioides* and *Eucalyptus camphora*. Often found after disturbance such as fire or after winds have opened the canopy of the larger trees.	-	-	Low. The species is highly restricted, known from only a single population. preferred swampy habitat not present within the study area.

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				NSW Atlas	PMST	SEARs	BBCC					
Calomnion complanatum	-	E	-	-	-	-	✓	HN517	Occurs only in south-eastern Australia (including Tasmania and Victoria) and New Zealand. In NSW, it has been recorded from only 3 locations: Cambewarra Mountain (near Nowra), Rocky Creek Canyon (Newnes Plateau), and 2 sites at Mount Wilson (Waterfall Reserve and Zircon Creek). Each record is of only a few plants. The species grows on the trunks of tree ferns, and occasionally on sandstone rock. Records are from moist, shaded gullies within closed forests in mountainous areas with relatively high rainfall. At both Mount Wilson and Cambewarra Mountain, the closed forests are associated with basalt soils, overlying shales and/or sandstone. The closed forest on Cambewarra Mountain is quite diverse, with many genera and many species of rainforest trees, vines and ferns. The closed forest at Mount Wilson is dominated by Coachwood (*Ceratopetalum apetalum*) and Sassafras (*Doryphora sassafras*). The Rocky Creek Canyon site is cut into sandstone with underlying shales on the Newnes Plateau.	-	-	Moderate. Suitable habitat occurs within the study area, however nearest recordings north of study area near Mt Wilson.
Commersonia prostrata	Dwarf Kerrawang	E	E	✓	✓	-	-	-	Occurs on sandy, sometimes peaty soils in a wide variety of habitats, for example, Snow Gum Woodland and Brittle Gum Low Open Woodland. Appears to respond positively to some forms of disturbance. Associated native species may include *Imperata cylindrica*, *Empodisma minus* and *Leptospermum continentale*.	73	19/1/2017	Low. Associated vegetation associations not present within the study area.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	-	✓	-	-	HN566	The Leafless Tongue Orchid has been recorded from as far north as Gibraltar Range National Park south into Victoria and around the coast as far as Orbost.	-	-	Moderate. This species has a large distribution yet no well-defined habitat preferences making its presence difficult to exclude from the study area.

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Cynanchum elegans	White-flowered Wax Plant	E	E	-	✓	✓	-	HN537 HN538	The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree *Leptospermum laevigatum* – Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* coastal scrub; Forest Red Gum *Eucalyptus tereticornis* aligned open forest and woodland; Spotted Gum *Corymbia maculate* aligned open forest and woodland; and Bracelet Honey myrtle *Melaleuca armillaris* scrub to open scrub.	-	-	Moderate. Certain vegetation associations and habitat requirements occur throughout the study area.
Darwinia biflora	-	V	V	-	-	✓	-	HN564 HN566	Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Occurs in Sydney Sandstone Ridgetop Woodland, often on rock shelves. Associated overstorey species include *Eucalyptus haemastoma*, *Corymbia gummifera* and/or *E. squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath.	-	-	Moderate – suitable habitat present.
Darwinia peduncularis	-	V	-	-	-	-	✓	HN536 HN566 HN598 HN607	Usually grows on or near rocky outcrops on sandy, well-drained, low nutrient soil over sandstone. Flowers in winter to early spring.	-	-	Moderate - Some suitable habitat present as floristic and structural associations, edaphic and landscape features.
Dillwynia tenuifolia	-	V	-	✓	-	✓	✓	HN564	In western Sydney, may be locally abundant particularly within scrubby/dry heath area within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland.	1	6/1/1995	Moderate. Suitable habitat occurs in this study area, although the nearest records are from Kanangra in the west, Linden in the north, Glenbrook to the north-east, and the Wallacia area to the east.

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				NSW Atlas	PMST	SEARs	BBCC					
Diuris aequalis	Buttercup Doubletail	E	V	-	✓	-	-	-	The Buttercup Doubletail has been recorded in Kanangra-Boyd National Park, Gurnang State Forest, towards Wombeyan Caves, the Taralga-Goulburn area, and the ranges between Braidwood, Tarago and Bungendore. Recorded in forest, low open woodland with grassy understorey and secondary grassland on the higher parts of the Southern and Central tablelands (especially on the Great Dividing Range).	-	-	Low. The study area does not contain PCTs, specific species associations, and soil type/edaphics associated with this species.
Epacris hamiltonii	-	E	E	-	✓	-	✓	HN517 HN607	Found at 72 sites within three creek catchments of the Blue Mountains. The creeks occur in an altitude range of 810-940 m asl. and are all located on the northern side of the escarpments and flow into the Grose Valley. All known sites occur within a radius of approximately 5 km. This species has a very specific habitat, being found on or adjacent to Narrabeen sandstone cliffs alongside perennial creeks, often below plateau hanging swamps.	-	-	Low. The known populations occur outside of the study area and are restricted to higher altitudes in the Grose Valley. Some marginal broad floristic associations occur within the study area, with poor development of edaphic and landscape features.
Epacris purpurascens var. *purpurascens*	-	V	-	✓	-	✓	-	HN564 HN566 HN607	Found in a range of habitat types, most of which have a strong shale soil influence.	2	6/10/2016	High. Suitable habitat occurs throughout study area with one record at Nattai and another near the southern side of Warragamba gorge.
Epacris sparsa	Sparse Heath	V	V	-	-	✓	✓	HN607	Grows in riparian sandstone scrub, where it can be found on the base of cliffs or rock faces, on rock ledges or among rocks in the riparian flood zone. Grows in pockets of damp clay soil, chiefly on south-west facing slopes.	-	-	Low. Suitable habitat can be found in the study area however records of this species are restricted to the lower Grose River.

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Eucalyptus aggregata	Black Gum	V	V	-	✓	-	✓	-	Grows in the lowest part of the landscape. Grows on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. Often grows in association with other cold-adapted eucalypts such as Snow Gum (*Eucalyptus pauciflora*), Manna or Ribbon Gum (*Eucalyptus viminalis*), Candlebark (*Eucalyptus rubida*), Black Sallee (*Eucalyptus stellulata*) and Swamp Gum (*Eucalyptus ovata*).	-	-	Low. The study area does not contain PCTs, specific species associations, and soil type/edaphics associated with this species.
Eucalyptus benthamii	Camden White Gum	V	V	✓	✓	✓	✓	HN532 HN553 HN574	Occurs on the alluvial flats of the Nepean River and its tributaries. Requires a combination of deep alluvial sands and a flooding regime that permits seedling establishment.	245	13/8/2017	Recorded within the study area.
Eucalyptus copulans	-	E	E	✓	✓	-	-	-	Due to poor records habitat requirements are poorly known. It is assumed to have occurred in the swampy areas adjacent to Jamison Creek around Wentworth Falls. Associated species at the sites where this species is found include *Eucalyptus radiata*, *Eucalyptus parramattensis*, *Eucalyptus stricta*, *Grevillea acanthifolia*, *Hakea dactyloides*, *Gleichenia dicarpa*, *Leptospermum juniperinum*, *Leptospermum flavescens*, *Todea barbara* and *Petrophile pulchella*.	22	10/04/2007	Low. The study area does not contain PCTs, specific species associations, and soil type/edaphics associated with this species.
Eucalyptus glaucina	Slaty Red Gum	V	V	-	-	-	✓	-	Grows in grassy woodland and dry eucalypt forest. Grows on deep, moderately fertile and well-watered soils. Previously known only on the north coast of NSW and in separate districts: near Casino where it can be locally common; and farther south, from Taree to Broke, west of Maitland.	-	-	Known. Identified during the current survey.
Eucalyptus macarthurii	Paddys River Box	E	E	✓	✓	-	-	-	Occurs on grassy woodland on relatively fertile soils on broad cold flats within the Southern Highlands.	34	31/7/2018	Low. The study area does not contain PCTs, specific species associations, and soil type/edaphics associated with this species.

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Eucalyptus pulverulenta	Silver-leafed Gum	V	V	-	✓	-	✓	HN533	The Silver-leafed Gum is found in two quite separate areas, the Lithgow to Bathurst area and the Monaro (Bredbo to Bombala). It grows in shallow soils as an understorey plant in open forest, typically dominated by Brittle Gum (*Eucalyptus mannifera*), Red Stringybark (*Eucalyptus macrorhyncha*), Broad-leafed Peppermint (*Eucalyptus dives*), Silvertop Ash (*Eucalyptus sieberi*) and Apple Box (*Eucalyptus bridgesiana*).	-	-	Low. The study area does not contain known vegetation associations or edaphics.
Euphrasia arguta	-	CE	CE	-	✓	-	-	-	Rediscovered in the Nundle area of the NSW north western slopes and tablelands in 2008. Prior to this, it had not been collected for 100 years. Historically, it has only been recorded from relatively few places within an area extending from Sydney to Bathurst and north to Walcha. Historic records of the species noted the following habitats: 'in the open forest country around Bathurst in sub humid places', 'on the grassy country near Bathurst', and 'in meadows near rivers'. Plants from the Nundle area have been reported from eucalypt forest with a mixed grass and shrub understorey; here, plants were most dense in an open disturbed area and along the roadside, indicating the species had regenerated following disturbance.	-	-	Low. The species is known from a handful of locations.
Euphrasia bowdeniae	-	V	V	✓	✓	-	-	HN517	Endemic to the upper Blue Mountains where it is confined to wet or damp vertical sandstone rock faces on major cliff-lines that face south or east. Grows in small pockets of damp, sandy soil on ledges or at the cliff base. These rock faces receive seepage moisture and support a range of heath plants, particularly epacrids and ferns. Sites associated with the Hassans Walls soil landscape with steep Narrabeen sandstone cliffs.	22	9/12/2016	Moderate. Very isolated marginal habitat may be found in the study area.
Genoplesium baueri	Bauer's Midge Orchid	E	E	-	✓	✓	✓	HN566	Occurs in coastal areas. Habitats include heathland, open forest, shrubby forest, heathy forest and woodland with sandy/sandy loam and well-draining soils.	-	-	Moderate. Cryptic species with broad habitat preferences. Noted as occurring within the Warragamba catchment.

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				NSW Atlas	PMST	SEARs	BBCC					
Genoplesium superbum	Superb Midge Orchid	E	-	-	-	-	✓	HN533				
Gentiana wingecarribiensis	*Wingecarribee Gentian*					✓						
Grammitis stenophylla	Narrow-leaf Finger Fern	E	-	-	-	-	✓	HN517 HN538 HN606 HN607	Grows on basalt, conglomerate, granite and sandstone substrate and rocks in rainforest and in wet sclerophyll forest.	-	-	Known.
Grevillea evansiana	Evan's Grevillea	V	V	-	-	-	✓	HN566	Grows in dry sclerophyll forest or woodland, occasionally in swampy heath, in sandy soils, usually over Narrabeen sandstone; known only from an area east of Rylstone, mostly on the western catchment but just getting into the Colo River catchment.	-	-	Low. Suitable habitat occurs throughout the study area however this species' known distribution occurs further to the north in Wollemi NP and the Rylstone LGA.
Grevillea juniperina subsp. *juniperina*	Juniper-leaved Grevillea	V	-	✓	-	-	-	-	Grows on reddish clay to sandy soils derived from Wianamatta Shale and tertiary alluvium (often with shale influence), typically containing lateritic gravels.	4	14/9/2016	Low. Endemic to western Sydney centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kemps Creek and Pitt Town. Suitable habitat occurs in the study area. Preferred soil landscapes not noted as present.

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Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	E	-	✓	✓	-	✓	HN564 HN566	Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Hunter occurrences are usually 30-70 m asl., while the southern Sydney occurrences are typically at 200-300 m asl. Often occurs in open, slightly disturbed sites such as along tracks.	1	30/11/2006	High. Identified in construction area during current surveys. This species grows in association with a range of vegetation types and in a variety of different substrates. The nearest record is at Lakelands, west of Picton.
Gyrostemon thesioides	-	E	-	✓	-	✓	✓	HN532 HN535 HN536 HN553 HN557 HN564 HN574 HN598 HN607	Grows on hillsides and riverbanks and may be restricted by fine sandy soils. A fire-opportunist, with recruitment occurring from a soil-stored seed bank following fire.	2	15/11/2001	High. Suitable habitat occurs in the study area and two records found near Butchers Creek.
Hakea dohertyi	Kowmung Hakea	E	E	✓	✓	✓	✓	HN525 HN535 HN536 HN557	Confined to a small area in the Kowmung Valley of the Kanangra-Boyd National Park along with smaller populations at Lake Burragorang, Tonalli Cove and the Bindook area. Grows in dry sclerophyll forest, usually dominated by grey gum or silvertop ash, with a sparse groundcover and midstorey.	6	21/12/2007	Known. Identified during current surveys. Suitable habitat occurs within the study area. Recorded sightings have been made from the southern part of Lake Burragorang.
Haloragis exalata subsp. *exalata*	Square Raspwort	V	V	-	✓	✓	✓	HN538 HN574 HN607	Square Raspwort occurs in 4 widely-scattered localities in eastern NSW. It is disjunctly distributed in the Central Cost, South Coast and North Western Slopes botanical subdivisions of NSW. Appears to require protected and shaded damp situations in riparian habitats.	-	-	Low. Suitable habitat occurs throughout the study are however the species' known distribution is scattered with no populations occurring in the Warragamba area.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Haloragodendron lucasii	Hal	E	E	-	✓	✓	✓	HN566 HN607	Associated with dry sclerophyll forest. Reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff lines that have creeks. This species is highly clonal implying that the true population size may be much smaller than expected.	-	-	Low. Suitable habitat occurs throughout the study area however this species has a known distribution that is restricted to the North Shore of Sydney.
Hibbertia puberula	-	E	-	-	-	✓	✓	HN564 HN566 HN568	Flowering time is October to December, sometimes into January. Occurs on sandy soil often associated with sandstone, or on clay. Habitats are typically dry sclerophyll woodland communities, although heaths are also occupied. One of the recently-described (2012) subspecies also favours upland swamps.	-	-	High. Suitable habitat found throughout the study area. No previous sightings in study area could be attributed to a patchy distribution and past surveying effort.
Hibbertia superans	-	E	-	-	-	✓	-	HN564 HN566	The species occurs on sandstone ridgetops often near the shale/sandstone boundary. Occurs in both open woodland and heathland and appears to prefer open disturbed areas such as tracksides.	-	-	Low. Broad habitat requirements are met but species appears restricted to northern Sydney.
Hygrocybe anomala var. *ianthinomarginata*	-	V	-	-	-	-	✓	HN517 HN536 HN566 HN598 HN606 HN607	Occurs in warm temperate forests dominated by *Acmena smithii*, *Backhousia myrtifolia*, *Glochidion ferdinandi* and *Pittosporum undulatum* on alluvial sandy Hawkesbury Soil Landscape.	-	-	Moderate. Suitable habitat conditions occur within the study area as Hawkesbury sandstone alluvial forest with suitable species. Has a known distribution occurring within the Blue Mountains, Royal and Lane Cove national parks.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Hygrocybe aurantipes	-	V	-	-	-	-	✓	HN517 HN536 HN566 HN598 HN606	Occurs in warm temperate forests dominated by *Acmena smithii*, *Backhousia myrtifolia*, *Glochidion ferdinandi* and *Pittosporum undulatum* on alluvial sandy Hawkesbury Soil Landscape.	-	-	Moderate. Suitable habitat conditions occur within the study area as Hawkesbury sandstone alluvial forest with suitable species. Has a known distribution occurring within the Blue Mountains, Royal and Lane Cove national parks.
Hygrocybe reesiae	-	V	-	-	-	-	✓	HN517 HN536 HN566 HN598 HN606	Occurs in warm temperate forests dominated by *Acmena smithii*, *Backhousia myrtifolia*, *Glochidion ferdinandi* and *Pittosporum undulatum* on alluvial sandy Hawkesbury Soil Landscape.	-	-	Moderate. Suitable habitat conditions occur within the study area as Hawkesbury sandstone alluvial forest with suitable species. Has a known distribution occurring within the Blue Mountains, Royal and Lane Cove national parks.
Isopogon fletcheri	Fletcher's Drumsticks	V	V	-	✓	-	-	HN536	Restricted to a very small area in the Blackheath district of the Blue Mountains on the Central Tablelands. Restricted to moist sheltered cliffs within the spray zone of a waterfall. Grows in dry sclerophyll forest and heath on sandstone and is confined to sheltered moist positions.	-	-	Moderate. Suitable habitat occurs within the study area which occur in close proximity to the Blue Mountains National Park.
Kunzea cambagei	Cambage Kunzea	V	V	-	✓	✓	-	-	The Cambage Kunzea mainly occurs in the western and southern parts of the Blue Mountains, mainly the Yerranderie/Mt Werong area, with four main populations with 20-150 individuals. Populations are also located west of Berrima, along the Wingecarribee River; Loombah Plateau east of Mt Werong; the Oberon-Colong Stock Route within Kanangra-Boyd National Park; and Wanganderry Plateau within Nattai National Park.	-	-	Moderate. Records in Nattai National Park, however, associated PCTs and preferred habitat as outlined within BioNet do not match those present within the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Kunzea rupestris	-	V	V	-	-	✓	-	HN564 HN566	Occurs in shallow, sandy, low nutrient soil in depressions on sandstone rock platforms. It is typically found in short to tall shrubland or heathland at altitudes of 50-300 m.	-	-	Moderate. Marginal habitat occurs throughout the study area, but all records known only from northern Sydney.
Lastreopsis hispida	-	E	-	-	-	-	✓	HN517 HN606 HN607	Grows in moist humus-rich soils in wet forest and rainforest gullies. At Mt Wilson, associated species include *Ceratopetalum apetalum*, *Elaeocarpus holopetalus*, *Fieldia australis*, *Cyathea australis*, *Blechnum nudum*, *Blechnum patersonii* and *Leptopteris fraseri*.	-	-	Moderate. Suitable floristic habitat occurs within the study area. Has a known distribution occurring within the Blue Mountains including Mt Wilson and the Wollondilly area. Unlikely to be differentiated in field from common *Lastreopsis* spp. by a non-expert.
Leionema lachnaeoides	-	E	E	✓	✓	-	✓	HN517 HN598	Populations occur on exposed sandstone cliff tops and terraces between 960-1,000 m in altitude and with aspects from south-east to south-west. Habitat is montane heath that commonly includes *Eucalyptus stricta*, *Allocasuarina nana*, *Dillwynia retorta*, *Epacris microphylla* and *Caustis flexuosa*.	5	7/12/2005	Moderate. Suitable habitat exists within the study area.
Lepidosperma evansianum	Evans Sedge	V	-	✓	-	-	✓	HN517	Grows on wet sandstone cliff faces in the Blue Mountains.	6	30/12/1999	High. Suitable habitat occurs throughout the study area.
Leucochrysum albicans var. *tricolor*	*Leucochrysum albicans var. tricolor*	-	E	-	✓	-	-	-	Occurs on grassland, woodland and forest habitat on heavy soils including modified habitats and roadsides with bare ground after disturbance.	-	-	Low. Most records occur further south or at higher altitude than the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Leucopogon exolasius	Woronora Beard-heath	V	V	✓	✓	-	✓	HN564 HN566 HN568 HN607	Woronora Beard-heath is found along the upper Georges River area and in Heathcote National Park. The plant occurs in woodland on sandstone.	1	29/10/2012	Moderate. Suitable habitat occurs in the study area. A record occurs near Nattai River.
Leucopogon fletcheri subsp. *fletcheri*	-	E	-	-	-	-	✓	HN564 HN566	Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs.	-	-	Moderate. The known distribution includes the Georges River near Minto, the Kenthurst area, the lower Blue Mountains, the Newnes area, and sites north-west of Sydney within the Grose and lower-Nepean catchments.
Marsdenia viridiflora subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs	Native Pear	EP	-	✓	-	✓	-	HN538	Grows in vine thickets and open shale woodland.	206	29/3/2017	None. Study area outside the listed LGAs. While some suitable structural, floristic associations and soil landscapes found in certain locations in the study area, the species is more associated with the coastal plains at the southern extent of the species.
Melaleuca biconvexa	Biconvex Paperbark	V	V	-	-	✓	-	-	Occurs in scattered populations found in the Jervis Bay area in the south and the Gosford-Wyong area to the north. Generally, grows in damp places, often near streams or low-lying areas with alluvial soils. Also known to occur on low slopes that have sheltered aspects.	-	-	Low. Suitable habitat occurs near some of the lower streams. This species' known distribution is from lower, coastal locations however.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Melaleuca deanei	Deane's Paperbark	V	V	-	-	✓	✓	HN564 HN566	Endemic to Sydney Basin region and grows in heath on sandstone or flat broad ridge tops. Strongly associated with sandy loam soils that are low in nutrients, sometimes with ironstone present.	-	-	Moderate. Some suitable habitat occurs throughout the study area. Incidental observation of new record between Kelpie Point area and Kedumba River.
Melaleuca groveana	Grove's Paperbark	V	-	-	-	-	✓	HN566	Grows in heath, often in exposed sites. This species is rare, being restricted to higher areas in coastal districts north from Port Stephens and at Torrington.	-	-	Moderate. This species prefers heathlands and shrublands in exposed sites, although it can occur in shrubby open forest and woodlands. Its known distribution does not overlap with the study area.
Micromyrtus blakelyi	-	V	V	-	-	✓	-	HN564 HN566	Typically occurs within heathlands in shallow sandy soil in cracks and depressions of sandstone rock platforms. Flowers in spring from September to November and produces fruit (an indehiscent nut) October to November.	-	-	Moderate. Some broad habitat features, including associated PCTs, present. Known distribution is restricted to the Hawkesbury River area.
Micromyrtus minutiflora	-	E	V	✓	-	✓	-	-	Grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, open forest on tertiary alluvium and consolidated river sediments.	2	15/7/2014	Low. Distribution is largely restricted to the Cumberland Plain area between Richmond and Penrith.
Olearia cordata	-	V	V	-	-	✓	✓	HN564 HN566	Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges. Flowers November to May, with seed released from February to May, depending on environmental factors.	-	-	Moderate. Certain vegetation associations and habitat requirements occur throughout the study area. Known distribution does not extend to the lower Blue Mountains.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Pelargonium sp. *Striatellum*	Omeo Storksbill	E	E	-	-	✓	-	-	Known from only 4 locations in NSW, with three on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. It occurs at altitudes between 680 and 1030 m. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	-	-	Low. Has a highly restricted distribution which does not overlap with the study area.
Persicaria elatior	Tall Knotweed	V	V	✓	✓	-	-	-	Normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	2	22/12/2010	Moderate. Suitable damp habitat occurs within the study area.
Persoonia acerosa	Needle Geebung	V	V	✓	✓	✓	✓	HN566 HN568	The Needle Geebung occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils. Plants are likely to be killed by fire and recruitment is solely from seed. This species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides.	186	23/10/2015	Moderate. Suitable habitat occurs throughout the study area. Nearest record is in upper Kedumba Valley (1 sighting).
Persoonia bargoensis	Bargo Geebung	E	V	-	✓	-	✓	HN564 HN566 HN568 HN606 HN607	Occurs in woodland or dry sclerophyll forest on sandstone and on heavier, well drained, loamy, gravelly soils of the Wianamatta Shale and Hawkesbury Sandstone. It favours interface soil landscapes such as the one found between the Blacktown Soil Landscape and the complex Mittagong Formation soils.	-	-	Moderate. The study area contains PCTs, specific species associations, and soil type/edaphics associated with this species.
Persoonia glaucescens	Mittagong Geebung	E	V	✓	✓	-	✓	HN564 HN566 HN568	Grows in woodland or dry sclerophyll forest on clayey or gravely laterite, preferably on ridge-tops, plateaux and upper slopes. Aspect does not appear to be a significant factor.	10	30/10/2008	Moderate. Suitable habitat found within study area. Recorded sightings to the south of the study area.
Persoonia hirsuta	Hairy Geebung	E	E	✓	✓	✓	✓	HN564 HN566 HN568	Occurs in shrub-woodlands and dry sclerophyll forest. It grows in sandy to stony soils derived from sandstone or very rarely on shale, from near sea level to 600 m altitude.	1	14/5/2001	High. Suitable habitat occurs throughout the study area. Fewer recorded sightings could be down to past survey effort.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Persoonia nutans	Nodding Geebung	E	E	-	✓	✓	-	-	Restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south. The species has a disjunct distribution, with the majority of populations (and 99% of individuals) occurring in the north of the species range in the Agnes Banks, Londonderry, Castlereagh, Berkshire Park and Windsor Downs areas. Northern populations are confined to aeolian and alluvial sediments and occur in a range of sclerophyll forest and woodland vegetation communities. The southern and northern populations have distinct habitat differences.	-	-	Low. Distribution is mainly restricted to the Cumberland Plain between Richmond and Macquarie Fields, and further south.
Pherosphaera fitzgeraldii	Dwarf Mountain Pine	E	E	✓	✓	-	-	HN517	Found within the spray zones or associated drip lines and seepage areas of waterfalls.	74	04/03/2008	Moderate. Waterfall spray-zone habitat is marginal in study area. All recorded sightings are from the Katoomba and Wentworth Falls areas.
Phyllota humifusa	Dwarf Phyllota	V	V	✓	✓	-	✓	HN568	Occurs in dry sclerophyll forest, sometimes near swamps, in deep sandy soils or gravely loams over a sandstone substrate. Often accompanied by *Eucalyptus mannifera*, *E. radiata* or *E. piperita*.	1	1/10/1990	Moderate. Suitable habitat occurs in the study area however this species is usually restricted to the Southern Highlands near Bowral and Bundanoon.
Pilularia novae-hollandiae	Austral Pillwort	E	-	-	-	✓	-	-	Occurs within waterways and swamps, typically with grasses and sedges. Extant populations known from Lake Cowal and Oolambeyan National Park. However, species is cryptical and has an ephemeral life history pattern therefore be present in additional locations.	-	-	Low. Suitable habitat not present within the study area. Species is known from two extant populations in western NSW.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Pimelea curviflora var. *curviflora*	-	V	V	-	✓	✓	-	HN564 HN566	Confined to the coastal area of the Sydney and Illawarra regions. Occurs on shaly/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. Also recorded in Illawarra Lowland Grassy Woodland habitat at Albion Park on the Illawarra coastal plain.	-	-	Moderate. Associated PCTs and soil landscapes occur within the study area, however, the site fall outside the species known distribution and associated IBRA subregions.
Pimelea spicata	Spiked Rice-flower	E	E	✓	✓	✓	-	-	Occurs on an undulating topography on well-structured clay soils. On Cumberland Plain sites it is associated with Grey Box communities (particularly Cumberland Plain Woodland variants and Moist Shale Woodland) and in areas of ironbark.	4	21/4/2017	Low. Suitable well-structured clay soils are present however the know vegetation associations are not. Currently known only from the Cumberland Plain and Illawarra regions.
Pomaderris brunnea	Brown Pomaderris	E	V	✓	✓	✓	✓	HN532 HN564 HN574 HN607	Brown Pomaderris grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	5	15/12/2016	Known. Identified during the current surveys. Suitable riparian and lakeside habitat occurs in the study area.
Pomaderris cotoneaster	Cotoneaster Pomaderris	E	E	✓	✓	-	✓	-	Has been recorded in predominantly forested habitats. In forests it can be found growing in deep, friable soils, amongst rocks beside a creek, on rocky slopes and in steep gullies between sandstone cliffs.	4	30/10/2001	Moderate. Suitable habitat found within the study area.
Pomaderris pallida	Pale Pomaderris	V	V	-	✓	-	-	-	Pale Pomaderris has been recorded from near Kydra Trig (north-west of Nimmitabel), Tinderry Nature Reserve, the Queanbeyan River (near Queanbeyan), the Shoalhaven River (between Bungonia and Warri), the Murrumbidgee River west of the ACT and the Byadbo area in Kosciuszko National Park. It is also found along the Murrumbidgee River in the ACT and has been recently recorded in eastern Victoria. This species usually grows in shrub communities surrounded by Brittle Gum (*Eucalyptus mannifera*) and Red Stringybark (*Eucalyptus macrorhyncha*) or *Callitris* spp. woodland.	-	-	Low. The study area occurs outside the species known distribution.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Prasophyllum fuscum	Slaty Leek Orchid	CE	V	✓	✓	-	-	HN564	The type specimen is from "moist meadows towards the Georges River" in the Sydney area. The species is likely to be extinct from this area. Harden (1993) states that it is confined to the Blue Mountains area. Grows in moist heath, often along seepage lines.	1	30/11/1888	Low. Moist heath growing along seepage lines does not occur within the study area.
Pterostylis chaetophora	-	V	-	✓	-	-	-	-	The preferred habitat is seasonally moist, dry sclerophyll forest with a grass and shrub understory. Plants are deciduous and die back to the large, underground tubers after seed release.	1	9/10/1989	Low. While suitable broad habitat occurs throughout the study area, records are generally more coastal from Sutherland north.
Pterosylis saxicola	Sydney Plains Greenhood	E	E	✓	✓	✓	-	HN535 HN564 HN566	Restricted to western Sydney between Freemans Reach in the north and Picton in the south. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines.	1	18/9/2001	Moderate. Distribution is largely restricted to western Sydney; however, another record occurs from the Oberon LGA to the general west of the study area. Broadly suitable habitat occurs throughout the study area.
Pultenaea elusa	Elusive Bush-pea	CE	E	-	-	✓	-	-	Species recorded twice at Penrose and Wingello on the Southern Tablelands. Records of both collections note habitat only as 'swamp'.	-	-	Low. This species has been recorded twice in 1938 as occurring in swamp. The study area does not contain the known associated PCTs or soil type.
Pultenaea glabra	Smooth Bush-pea	V	V	✓	✓	✓	✓	HN566 HN568	Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	362	28/9/2015	High. Suitable habitat occurs throughout the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Pultenaea parviflora	-	E	V	✓	✓	✓	-	HN566	Endemic to the Cumberland Plain. Core distribution is from Windsor to Penrith and east to Dean Park. May be locally abundant, particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays.	41	29/3/2017	Moderate. Suitable habitat occurs in the eastern fringes of this study area, but all records are restricted to the Cumberland Plain.
Pultenaea sp. Olinda	-	E	-	-	-	-	✓	HN566 HN598	Grows in crevices between sandstone boulders with other shrubs. Has only been found in a very limited area of pagoda rock formation east of Rylstone. Likely to be fire sensitive, with recruitment occurring from a persistent soil stored seed bank following fire.	-	-	Low. There are no records of this species in the study area, with records being restricted to the Rylstone/Wollemi area.
Pultenaea villifera – endangered population	*Pultenaea villifera Sieber* ex DC. population in the Blue Mountains local government area	EP	-	-	-	-	✓	HN564 HN566	Grows on sandy soils favouring sheltered spots in dry sclerophyll forest and woodlands. Fire sensitive, with recruitment occurring from a persistent soil stored seed bank following fire.	-	-	High. Records for Yerranderie area and in Nattai National Park. Suitable habitat occurs within the study area.
Rhizanthella slateri	Eastern Australian Underground Orchid	V	E	-	✓	✓	✓	HN517 HN606 HN607	Occurs from South-East QLD to South-Eastern NSW. In NSW it is currently known from only 10 locations which includes the Blue Mountains. Habitat requirements are poorly understood, and no particular vegetation type has been associated with the species apart from it being known to occur in sclerophyll forest. Highly cryptic given that it grows almost completely below the soil surface, with the flowers being the only part of the plant that can occur above ground.	-	-	Moderate. Ecology is poorly understood apart from occurring in sclerophyll forest, which is abundant in the study area.
Rhodamnia rubescens	Scrub Turpentine	CE	-	✓	-	-	-	HN517 HN537 HN538 HN606	Shrub or small tree that occurs within littoral, warm temperate, and subtropical rainforest, and wet sclerophyll forest. The study area contains PCTs associated with the species.	3	21/2/2018	Moderate – suitable vegetation associations present within the study area.

Scientific name	Common name	BC Act	EPBC Act	Source: NSW Atlas	Source: PMST	Source: SEARs	Source: BBCC	Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
Seringia denticulata – endangered population (*Keraudrenia corollata* var. *denticulata* – endangered population)	*Seringia denticulata* in the Hawkesbury local government area (*Keraudrenia corollata* var. *denticulata* in the Hawkesbury local government area)	EP	-	-	-	✓	-	-	Occurs on low-nutrient, well-drained sandy soil on sandstone banks, the edge of floodplains or on road verges. Occurs in tall open forest with *Eucalyptus deanei*, *Tristaniopsis laurina*, *Backhousia myrtifolia*, *Commersonia fraseri*, *Rulingia dasyphylla* and *Hibiscus heterophyllus*. All locations of this species within the Hawkesbury LGA are associated with the endangered Sydney Coastal River-flat Forest.	-	-	None. Study area not in Hawkesbury LGA.
Solanum armourense	-	E	-	✓	-	✓	✓	HN525 HN527 HN532 HN535 HN536 HN538 HN557 HN568	Occurs in eucalypt woodland, in shallow soil on steep rocky hillsides. Fire sensitive obligate seeder, with adult plants killed by fire and recruitment occurring from a soil stored seed bank.	122	24/2/2017	Recorded.
Syzygium paniculatum	Magenta Lilly Pilly	E	V	-	✓	-	✓	-	Grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest.	-	-	Moderate. Generally restricted to rainforest closer to the coast, however the distribution of this species is not well understood.
Tetratheca glandulosa	-	V	-	✓	-	✓	✓	HN517 HN564 HN566 HN568 HN598 HN606 HN607	Strongly associated with areas of shale-sandstone transition habitat and occupies ridgetops, upper-slopes and mid-slope sandstone benches. Preferred vegetation includes heaths, scrub, woodlands/open woodlands and open forest.	3	18/5/2001	High. Some at least marginal habitat occurs within study area, with records within catchment and at least one in study area (Nattai Reserve).

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Tetratheca juncea	Black-eyed Susan	V	V	-	-	✓	-	-	Confined to the local government areas of Central Coast, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. Usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest.	-	-	Low. Some suitable habitat occurs; however, this has been described as a lowland species with no records in the locality. Nearest records are downstream near Sackville or Hurstville.
Thelymitra kangaloonica	Kangaloon Sun Orchid	CE	CE	-	✓	-	-	-	Only known to occur on the southern tablelands of NSW in the Moss Vale/Kangaloon/Fitzroy Falls area at 550-700 m asl. It is known to occur at 3 swamps that are above the Kangaloon Aquifer. It is found in swamps in sedgelands over grey silty grey loam soils.	-	-	Low. Known vegetation associations and edaphics do not occur within the study area. The species has a restricted distribution.
Thesium australe	Austral Toadflax	V	V	-	✓	✓	✓	-	Suitable habitat for this species includes grassland and grassy woodland, often in damp sites.	-	-	Moderate. Suitable habitat occurs over much of the study area.
Trachymene scapigera	Mountain Trachymene	E	E	-	-	-	✓	HN553 HN557 HN574	Associated vegetation across known sites varies from riparian tea-tree thickets to tall forest, to frost hollows and includes the following species: *Leptospermum obovatum*, *Eucalyptus fastigata*, *Eucalyptus dalrympleana*, *Acacia melanoxylon*, *Eucalyptus stellulata*, *Eucalyptus pauciflora*, *Eucalyptus rubida*. The species occurs at around four general locations between Jenolan caves and Gurnang State Forest on the Central Tablelands south east of Oberon. Among these locations, the species occurs in Kanangra-Boyd National Park.	-	-	Moderate Marginal habitat conditions occur within the study area. Has a known distribution occurring west of the study area in higher parts of Kanangra-Boyd National Park.
Velleia perfoliata	-	V	V	-	-	-	✓	HN532 HN536 HN564 HN566 HN598	Found in shallow depressions on Hawkesbury sandstone shelves, on rocky hill sides, under cliffs or on rocky/sandy soils along tracks and trails. Occurs on fairly shallow soils of sandy loam texture and can also be found growing on moss and lichen mats formed on rocks.	-	-	Moderate. Suitable habitat occurs in the study area, however almost all recorded sightings are from north of Kurrajong to Yengo National Park.

Scientific name	Common name	BC Act	EPBC Act	Source				Associated PCT within site	Habitat and distribution	Records within 10 km	Most recent record	Likelihood of occurrence
				NSW Atlas	PMST	SEARs	BBCC					
Xanthosia scopulicola	-	V	-	✓	-	-	✓	HN598 HN606	Grows in cracks and crevices of sandstone cliff faces or on rocky outcrops above the cliffs.	16	05/05/2017	High. Sandstone cliff habitat is common in the study area.
Xerochrysum palustre	Swamp Everlasting	-	V	-	✓	-	-	-	Swamp Everlasting is endemic to south-eastern Australia, where it is widely distributed from south-eastern NSW through Victoria to north-eastern Tasmania. In NSW it occurs as far north as the Southern Tablelands and ranges up to about 1,300 m altitude. Swamp Everlasting grows in wetlands including sedge-swamps and shallow freshwater marshes, often on heavy brick clay soils. At higher altitudes in NSW it also grows in Sphagnum moss bogs.	-	-	Low. The study area is outside the species known distribution.
Zieria covenyi	Coveny's Zieria	E	E	✓	✓	-	✓	HN566 HN598	Occurs in open sclerophyll forest dominated by *Eucalyptus sieberi*. Occurs on gentle east and south-facing slopes and on ridges in shallow sandy soil. Likely to be fire tolerant and able to resprout following fire from root suckers.	39	20/12/2004	High. Suitable habitat occurs within the study area. Previous records from near the northern part of the study area.
Zieria involucrata	-	E	V	-	-	✓	✓	HN606	Occurs primarily on Hawkesbury sandstone however also occurs on Narrabeen Group sandstone. Found primarily in sheltered forests on mid to lower slopes and valleys.	-	-	Moderate. Suitable sheltered sandstone valley habitat occurs throughout the study area; however, most records are to the north-east parts of the Grose, Hawkesbury and Colo catchments.
Zieria murphyi	Velvet Zieria	V	V	-	✓	-	✓	HN566 HN598	Found in sheltered positions in moist gullies of wet eucalypt forest with sandy soil.	-	-	Moderate. Suitable habitat occurs within the study area. Has been found at Mt Tomah in the Blue Mountains and Morton National Park in the Southern Highlands, meaning populations between these two locations could possibly exist.

Appendix H
CSIRO report: *Eucalyptus benthamii*

NATIONAL COLLECTIONS & MARINE INFRASTRUCTURE
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Eucalyptus benthamii Inundation Experiment

Two-year report on stand growth and health

David Bush and Nigel England

24 April 2019

Prepared for WaterNSW

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Executive summary

A trial to test the effects of soil waterlogging induced by controlled periods of flood irrigation on mature *Eucalyptus benthamii* trees has been conducted at Deniliquin NSW. The trial objective was to investigate the consequences of protracted waterlogging on tree health and survival. Trees in two separate experiments (Experiment 1, commencing March 2017 and Experiment 2, commencing October 2017) were flooded with fresh water for between 1 and 6 weeks to an above-ground depth of around 30 cm. Control treatments receiving no irrigation were also provided. Tree growth and health parameters were measured before and after commencement of the flooding and again at four, seven, 11, 18 and 24 months post-commencement of flooding in Experiment 1. At the time of issue of the major report in February 2018, Experiment 2 had been monitored up to 4-months post application of irrigation. This report provides analysis of data from an 18 month measure of Experiment 2 that has been pooled with the 18-month data from Experiment 1 to provide increased replication and statistical power.

A small (5.6% on average) but statistically-significant diameter growth increment was recorded between the initial and 24-month measures in Experiment 1. The treatment that was flooded for longest (6-weeks) recorded the largest increment (8%), versus around 4% for the Control treatment (not flooded). Though there was no mortality during the first 11 months of the trial, two trees had died by the 12-month measure and by 24-months ten trees had died, five of which were controls, two trees each in 1- and 2- week treatments and one tree from the 4-week treatment. It is probable that the deaths were due to protracted water stress (i.e. drought). Evidence of bark splitting with kino exudation was recorded on a number of trees in Experiment 1 and Experiment 2 and also outside of the trial area in the general plantation. These observations contributed to a minor but significant downgrade in the assessed Health parameter for Experiment 1. Growth in Experiment 2 continued in a manner similar to Experiment 1, with irrigated treatments generally growing more than the Controls for the DBH trait. There was little mortality (one tree died) in Experiment 2, and though some trees were assessed as having declined in health relative to the baseline, the difference was not statistically significant overall. Nor was there a significant difference among treatments.

As expected, analysis of 18-month data pooled across the two Experiments gave results generally in accord with those reported from the single-site analyses, with significant treatment-by-experiment interaction noted for the height trait, but neither DBH nor the health-related traits.

The combination of heavy soil texture, providing very slow drainage of applied irrigation treatments thereby inducing anaerobic soil conditions, and very dry climatic conditions in the 18-month period post-application, have resulted in excellent experimental conditions to test the resilience of *E. benthamii* to short-term inundation. This report strengthens our earlier assessment that *E. benthamii* appears to be tolerant of shallow flooding of up to 6-weeks duration.

1 Introduction

This investigation is being undertaken as follow-up monitoring to a study conducted between September 2017 and February 2018 at Deniliquin, NSW by CSIRO on behalf of WaterNSW (Bush et al. 2018). The study examined the effect of temporary inundation of up to six weeks' duration on health and survival of *Eucalyptus benthamii* and soil physical and chemical properties for up to one year after the initial flooding treatments were applied.

The aim of the original study and this follow-up was to provide supporting data for an environmental impact assessment associated with raising Warragamba Dam for temporary storage of flood water in Lake Burragorang. In the event of heavy rain resulting in river flow that cannot be absorbed by the dam's existing capacity, the additional wall height will provide a flood mitigation zone and opportunity for delayed release of water downstream. As a consequence of operating a flood mitigation zone, areas in the catchment above the current full supply level could be temporarily inundated. The duration of inundation is expected to be about two weeks, but this would be dependent on antecedent conditions and ongoing inflows. There would also be some probability of back-to-back events.

The inundation area contains Ecologically Endangered Communities and threatened species. The 1995 Environmental Impact Statement adopted a 14- day flood inundation tolerance threshold for the listed Vulnerable species *Eucalyptus benthamii* (Camden white gum). Further testing of this critical threshold assumption is required to evaluate the potential impact of operating Warragamba Dam for flood mitigation on the Hinterland Burragorang River-flat Forest or Riparian Forest and, particularly, on *E. benthamii*.

Protracted immersion leads to anaerobic soil conditions (waterlogging) that will eventually cause the death of roots, particularly fine roots. This condition can occur with relatively shallow immersion – the soil only needs to be saturated. Eucalypts have varying tolerance of this condition, being able to withstand waterlogging for periods ranging from only a few days to many weeks or months in the case of species such as *E. camaldulensis* and *E. occidentalis*. Adaptation to waterlogging varies markedly among eucalypt species. Riverine species such as *E. camaldulensis* possess physiological adaptations such as the ability to form adventitious roots in waterlogged soils, while species adapted to well-drained soils such as *E. globulus* do not (e.g. Sena Gomes and Kozlowski, 1980). This will not necessarily cause the immediate death of the tree, which may follow in hot or dry periods several months after the waterlogging event when the tree needs its entire root system to extract enough water. Alternatively, the tree may permanently recover if conditions are favourable, i.e. there may be an interaction between the timing of flooding and post-flood seasonal conditions.

The initial results of the study provisionally indicated that *E. benthamii* is tolerant of shallow flooding, of up to six weeks duration, that resulted in waterlogging characterised by markedly-reduced soil oxygen and accompanying soil physical and chemical changes. Trees in the flooded plots continued to grow actively throughout the flooding and monitoring period (up to 11 months) without apparent negative health impacts. Moreover, growth of trees in the inundated plots was relatively greater than the non-irrigated controls. At the final, 12-month assessment, mortality of two trees, one in each of a Control and 2-week irrigation treatment was observed in Experiment-1. No trees had died in Experiment-2. The mortality was attributed to drought rather than damage caused by flooding, with some deaths in surrounding plantations outside the experimental area also noted.

This report builds on the results reported by Bush et al. (2018) with additional measures of survival, health and growth of Experiment-1, up to 24 months post irrigation-application, and Experiment-2 to 18 months post application. The extended monitoring period enhances the inference that can be made about the possibility of delayed responses to soil waterlogging that may have resulted in damage to the tree root systems.

1.1 Trial design

The study was designed to collect quantitative data on the likely impacts of the ephemeral flooding that may come as a consequence of the proposed dam wall raising. The study was conducted at a field site at Deniliquin, NSW (approximately 35° 31'S 145 02'E, 90 m ASL). The stand was established from seedlings in 1999 (age 18 years at commencement of experiment). The stand was initially established in rows that had been deep ripped and mounded. The rows were approximately 4 m apart and trees were initially 2.5 m spaced along the rows. The planting mounds are approximately 20 cm higher than the inter-row ground level. After thinning the spacing within rows is variable between 2.5 and 15 m, though the overall stocking density within the stand is quite uniform at approximately 200 trees per hectare.

The trial site is situated adjacent to flood irrigation canals originally used for crop cultivation, and the trees have been periodically irrigated to supplement rainfall which averages around 360 mm per year at Deniliquin. The site has a very slight slope allowing water from the feeder channel to enter at one end of each experiment and drain through to a drainage channel at the other end (Figure 1). The heavy-textured soil at the site was classified during the first phase of this study (Bush et al. 2018) as a Subnatric Brown Sodosol according to the system of Isbell (2016). A-horizon field texture is silty clay loam and the B-horizon is a medium clay soil. The upper 1 m of the soil is considered non-saline to slightly saline, whereas the 100-140 cm layer is moderately saline, meaning that salinity levels could adversely affect the growth of some plants. The soil from 0-40 cm is non-sodic, but from 40-140 cm depth the soil is sodic, meaning that there are excessive amounts of exchangeable sodium present. Sodicity causes soil aggregates to disperse which can result in a dense soil matrix (large bulk density) with greatly reduced porosity, decreased permeability to water and air, and poor soil drainage.

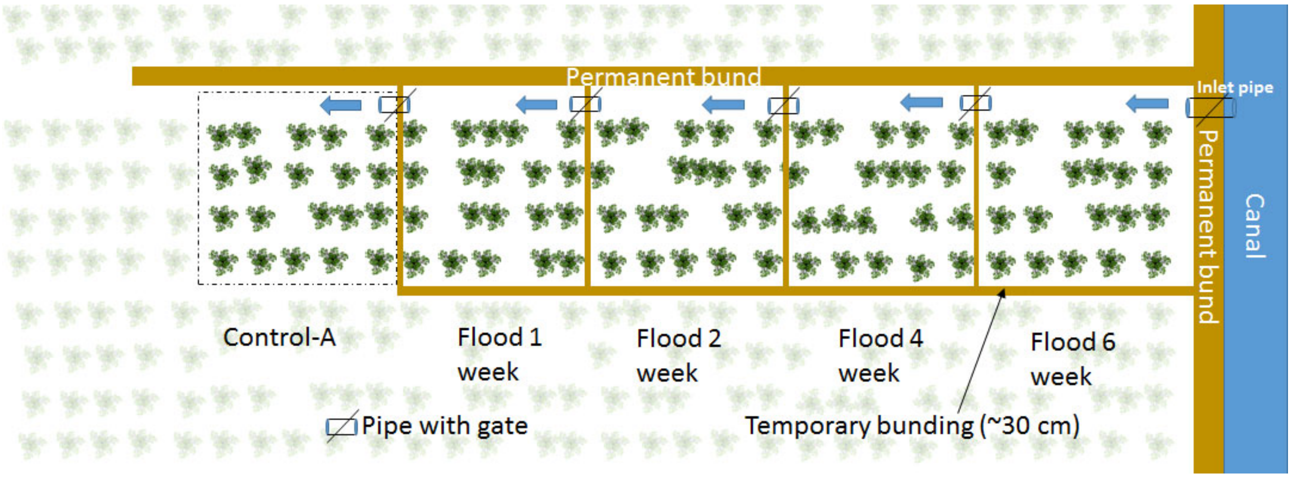

Figure 1 Schematic showing irrigation trial layout. The same layout was used for both Experiment 1 and 2. The *E. benthamii* plantation area is adjacent to an irrigation canal into which an inlet pipe was installed. Temporary bunds were constructed around the four irrigated treatments. The site slopes slightly between the inlet pipe at the high end and the outlet in the temporary bund between treatment 1 and Control-A at the low end. The blue arrows indicate the natural flow of water across the site. Control-B (not shown on the diagram) is a plot of 20 trees situated separate to the irrigation area. Control-A, while not subject to retained water, is in the drainage path of water released from the flooded plots.

Two separate experiments (Experiment 1 and Experiment 2) were conducted at the trial site. For Experiment 1, sections of the trial site were temporarily flooded, commencing in March 2017, for durations of 1, 2, 4 and 6 weeks (the *treatments*) corresponding to flooding scenarios determined by WaterNSW modelling. Existing water-management bunds on the site were supplemented with temporarily-constructed bunds allowing controlled flooding of groups of 20 trees allocated to each of the four flooding treatments (Treatments 6, 4, 2 and 1). A control group of 20 trees that received no flooding treatment (Control A) was also situated adjacent to the flooded treatments. As this control was situated downslope from the flooded treatments, and water drained from the flooded treatments passed through the control plot, an additional control block of 20 trees (Control B) was delineated. In Experiment 1, Control B was situated approximately 200 m across slope from the main trial area, while in Experiment 2 it was around 15 m but in a completely separate irrigation zone controlled by permanent bunds (Figure 2).

The flooding, drainage and trial measurement events associated with Experiments 1 and 2 are given in Table 1.

Table 1 Activities carried out for Experiments 1 and 2 at Deniliquin, NSW

Activity	Date (Expt 1)	Date (Expt 2)
Bund construction, baseline data collection	20 March 2017	22 August 2017
Irrigation applied	21 March 2017	11 October 2017
1-week treatment drained	28 March 2017	18 October 2017
2-week treatment drained	4 April 2017	25 October 2017
4-week treatment drained	18 April 2017	8 November 2017
6-week treatment drained and assessment (growth,	2 May 2017	22 November 2017
4-month assessment (growth, health, photography*, analysis)	21 July 2017	6 February 2018
7-month assessment (growth, health, analysis)	11 October 2017	-
1-year assessment	20 March 2018	8 November 2018
18-month assessment	8 November 2018	1 April 2019
24-month assessment	1 April 2019	-

* Photography carried out in Experiment 1

Figure 2 GoogleEarth TM satellite image with overlay indicating relative positions of the trial plots for the two Experiments. Top of figure is north. Experiment 1, 1- to 6-week flooding and Control-A treatments are located within a block of trees to the south of the trial area labelled *Expt. 1*. The configuration of the treatments within this area is shown in Figure 2. The blue arrows indicate the direction of downward slope which is also the direction of the planting mounds. Experiment 1, Control-B lies approximately 250 m to the north in a separate area of the plantation. Experiment 2, 1 to 6-week flooding and Control-A treatments are also located in this area of plantation, though Experiment 2 does not drain through Experiment 1, Control-B. Experiment 2, is located to the north of all other plots and is isolated from Expt.2 by a permanent bund that does not allow water to travel between the two areas.

Traits selected for baseline measurement in both Experiments 1 and 2 are given in Table 2. These include growth traits and health traits. The traits were selected based on CSIRO's experience with numerous eucalypt trials that have been assessed under exposure to different stressors, including drought, insect attack, irrigation and dryland salinity in Australia and overseas. The stand selected for this study did not include trees displaying symptoms at the more serious end of the scales selected for the three health-related traits.

At the penultimate measure (October 2018), the effects of protracted summer and autumn drought had become visible throughout parts of the trial and the surrounding plantation. The most notable symptom of this was cracking of bark accompanied by kino (gum) exudation in the lower stems of trees. The presence or absence of cracking with kino was recorded for each tree as part of the Health score.

Table 2 Traits that were measured for each tree (Experiments 1 and 2)

Trait	Description	Unit of measure
Diameter at breast height (DBH)	Standard measure of stem growth at 1.3 m above ground	cm
Height	Measure of tree overall height	m
Height to live crown	Measured as the height to the first live branch. Stress can lead to canopy shedding	m
Epicormic shoots	Shoots that can emerge from the stem, sometimes in response to stress	Scored 1 -6 (1 no epicormics to 6, very numerous epicormics)
Lignotuberous shoots	Shoots that can emerge from the base of the tree, sometimes in response to stress	Scored 1 -6 (1 no epicormics to 6, very numerous shoots)
Health	Perceived health of the tree incorporating observations on foliage colour, stem splits and kino exudation, insect infestation and any other factor that may impact on tree health	Scored 1 – 6 (1 death likely within the next 12 months to 6, no discernible health problems)

1.2 Statistical analysis

Each growth and health trait measured in Experiments 1 and 2 was analysed using a linear model solved by the restricted maximum likelihood (REML) method described by

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Zu} + \mathbf{e} \qquad \text{[Equation 1]}$$

where **y** is the vector of individual tree observations on each trait, **b** and **u** are vectors of fixed- and random- effect estimates respectively, **X** and **Z** are incidence matrices for fixed and random model terms and **e** is a vector of random residual effects. Each trait was analysed separately for each assessment time at each trial, with vector **b** containing fixed effects relating to the *treatments* and vector **u** containing random effects of planting *rows* and *columns* (tree positions within the rows). This helps account for within-site variance in the experiment.

Binomial individual-tree survival data in Experiment 1 was analysed using Equation 1 implemented as a generalized mixed model assuming a binomial distribution and a logit link function.

A pooled analysis of baseline and 1-year data across Experiments 1 and 2 was also performed with additional terms in **b** for *experiment* and experiment-by-treatment interaction and separate subvectors in **e** to account for heterogeneity of residual variance in the two experiments. While this approach confounds temporal (seasonal) differences in the timing of the treatments and is comparing baseline growth at different ages (Experiment 2 was approximately 6 months older at time of baseline assessment than Experiment 1), it does incorporate spatial replication of the trial. It should also be noted that the spatial order of the treatments in Experiments 1 and Experiment 2 was not randomly assigned: it was identical in both trials, with the longest 6-week treatment furthest upslope and the Control-A treatment downslope due to the drainage requirements (Figure 1). Predicted means and their average standard errors of difference were generated for each trait.

Inundation has been followed by an 24-month monitoring period in Expt. 1 and a 18-month monitoring period in Expt. 2 during which time the health of the trees subjected to the flooding treatments have been compared with their initial condition and the condition of the unflooded control treatments.

2 Results

2.1 Baseline health and growth data

Baseline health data, measured before the flooding treatments commenced in Experiment 1 and Experiment 2, indicated that the selected trees were free from serious pests and diseases and symptoms of stress (Table 3). The overall stand health was very good, with only four dead stems present (these not included as experimental trees) in experiment 1 and two in Experiment 2, consistent with a healthy, thinned stand of this age. Overall mortality in the plantation was 3% (assessed by a count of existing dead stems over an area of 5 ha containing 1225 stems). Trees in Experiment 1 were between 13 and 24 m tall, with diameters at breast height (1.3 m above ground) between 15 and 41 cm. At the commencement of Experiment 2, the trees were slightly larger, with DBH between 17.3 and 37.0 cm and 14.6 and 25.5 m tall. There was no significant difference among treatment plots for the DBH trait in either Experiment 1 or 2. Trees in the 6-week treatment of Experiment 1 were slightly shorter on average than the other treatments (p<0.05), though this was due to a single, smaller tree in that treatment. In Experiment 2, the Control-A treatment was significantly shorter (p=0.022) than the Control-B plot (which is situated in another part of the plantation), but there was no significant difference among treatment DBH means or height means in the contiguous treatments including Control-A. There were no significant differences in health scores among the treatments in either experiment.

Table 3 Summary of baseline (pre-flooding) trait data in Experiments 1 and 2

TRAIT	MEAN		MINIMUM		MAXIMUM		STANDARD DEVIATION	
EXPERIMENT	1	2	1	2	1	2	1	2
DBH (cm)	22.9	25.7	15.5	17.3	40.7	37.0	4.2	3.6
Height (m)	17.3	19.3	13.1	14.6	23.9	25.5	1.8	1.7
Height to live crown (m)	5.9	6.1	2.4	2.4	10.9	10.2	1.5	1.5
Epicormics (1, absent to 6, numerous)	1.1	1.0	1.0	1.0	3.0	1.0	0.4	0
Lignotubers (1, absent to 6, numerous)	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0
Health (1, poor to 6, excellent)	5.1	5.8	3.0	5.0	6.0	6.0	0.5	0.4

Considering pooled data from Experiments 1 and 2, there was a significant difference (p<0.001) between experiments for both height and DBH, reflective of either the difference in age at which the data were gathered, or slightly different growing conditions in the different sections of the plantation, or both.

2.2 Climate trends

Monthly rainfall data for the period of experimentation commencing in March 2017, compared with long-term monthly average values, are shown in Figure 3. Of note is the long period of below-average rainfall from January to September 2018 and below-average rainfall during the 2018-2019 summer. The average annual rainfall at Deniliquin Airport station is 375 mm. The trial has received approximately 70% of the rainfall expected on the basis of mean monthly totals during the 24 month period since experimentation started, but less than 50% since February 2018.

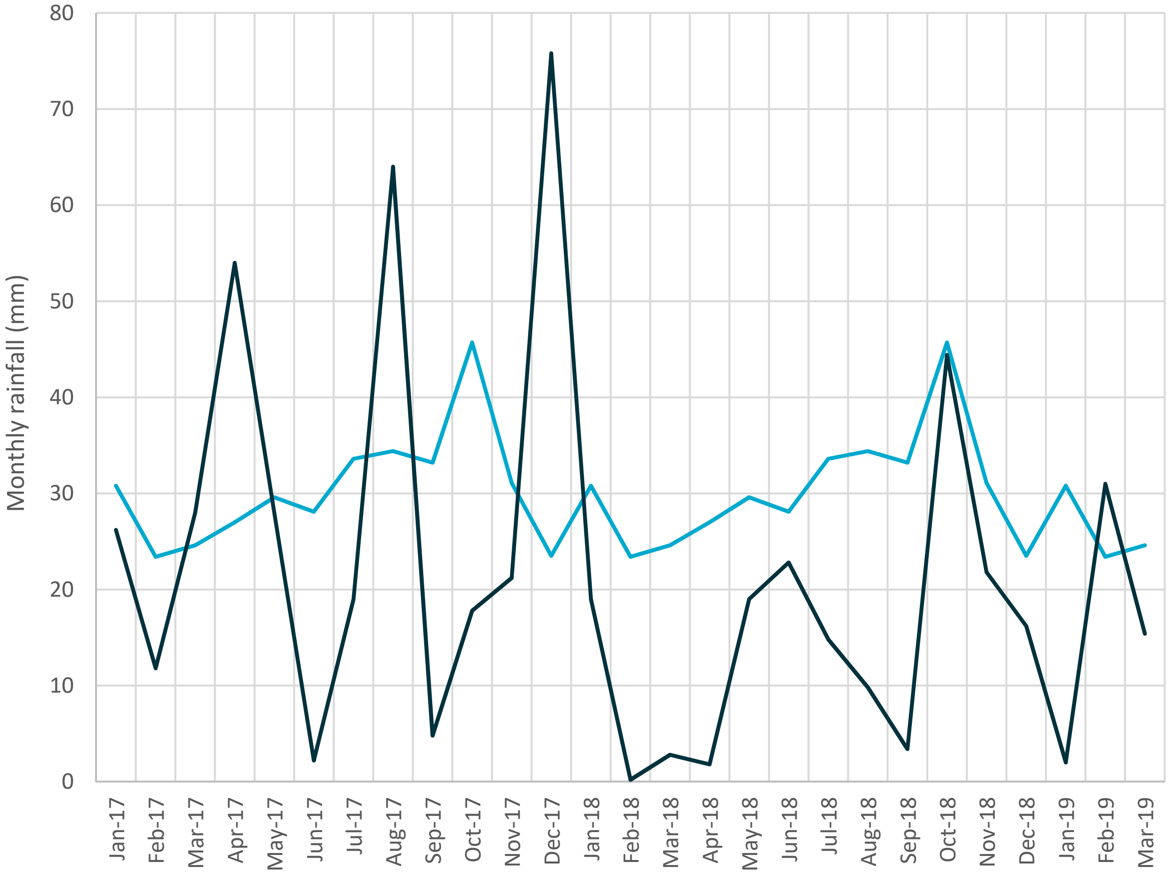

Figure 3 Monthly rainfall during the 2017-2019 trial period (dark trace) versus long-term mean monthly rainfall (light blue trace). A protracted period of below-average rainfall occurred between February and September 2018 followed by below-average rainfall in the 2018-2019 summer

2.3 Health

Up until 11-months post-flooding there was no mortality or reduction in health noted in the two experiments. However, between February and March 2018 two trees in Experiment 1 died. One of these trees was in Control-A and the other in the 2-week flooding treatment. By October 2018 a total of five trees had died in Experiment 1, with no mortality in Experiment 2 (overall 2% mortality across the two experiments). By April 2019 10 trees had died in Experiment 1 and one tree had died in the 1-week treatment of Experiment 2.

Deaths by treatment for each experiment are shown in Table 4. There was no significant difference among treatments in either Experiment 1 or 2. There was a general decline in health throughout Experiment 1 (including Control-A) and the rest of the plantation in the irrigation bay downslope of the trial area consistent with moisture stress. There was a significant difference (decline) between overall health scores at the 24-month and baseline measures (p=0.001) but no significant difference among treatments at either time. However the greatest decline was observed in unwatered Contol-A. The most obvious manifestation of this, apart from mortality of trees, was the increase of deep bark cracks with kino exudation in the lower stems of 10% of trees in Experiment 1 (Table 4). The occurrence of cracking did not increase between the 18 and 24-month measures in Experiment 1. This was accounted for in the Health score assigned to each tree.

Table 4 Comparison of health score means by irrigation treatment at the baseline and 18- and 24-month measures. The Health score integrated the mortality status and the stem splitting with kino exudation trait

Treatment	Control-A	Control-B	1-week	2-week	4-week	6-week	SED	*p*
Experiment 1 (24 months)								
Health baseline	5.55	5.80	5.61	5.91	5.75	5.80	0.17	0.19
Health 24 months	4.50	5.29	5.21	5.05	5.25	5.15	0.49	0.62
Trees with cracking/ kino (18 and 24 months)	3	5	1	-	2	2		
Deaths 24 months	4	1	2	2	1	-		0.22
Experiment 2 (18 months)								
Health baseline	5.85	5.91	5.85	5.73	5.80	5.82	0.12	0.74
Health 18 months	5.85	5.86	5.60	5.68	5.85	5.82	0.18	0.59
Trees with cracking/ kino (18 months)	3	2	3	3	-	-		
Deaths 24 months	-	-	1	-	-	-		0.90

Health in Experiment 2 did not decline significantly between the baseline and April 2019 measures (p=0.12).

A survey of the wider *E. benthamii* plantation (around 1200 trees) in March 2018 revealed three additional trees had recently died (mortality of 0.4%), and overall mortality of 3.3% (assessed on the basis of standing dead stems) since 2012 when the stand had last been thinned, indicating that the stand was undergoing a low and typical amount of mortality due to normal competition, with trees most likely to succumb after periods of heat and water stress.

There were no significant differences among treatment means for height to live crown (i.e. the height from ground-level to the bottom of the crown). There were no statistically-significant differences in the other two health-related measures (epicormics and lignotubers) between the baselines given in Table 3 and the 18- or 24-month measures of Experiments 1 and 2, respectively.

2.4 Growth

Figure 4 shows percentage growth in DBH up until 28-months post-flooding in Experiment 1. The means shown, and probabilities given hereafter, are adjusted for planting row variance (refer Equation 1) which was generally minor but statistically significant. Planting position within rows (within treatments) did not explain significant additional variance. Considering all of the treatments, there were significant differences among means at each measurement after 6 weeks ($p \leq 0.003$) up until the 24-month measure, with the exception of the 18-month measure. The lack of difference at 18-months may be explained by relatively-poor measurement precision due to many of the trees which were actively sloughing bark (i.e. the standard error of each treatment mean is greater than at other measures). It is thought that measurement of loosening bark (which tends to give an overestimate of true DBH) followed by the loss of this bark combined with very low growth through the 2018-19 summer accounts for the significant decline in percentage growth observed at the last measure, except in the 6-week treatment. A further cause is the mortality of an additional five trees which affects all except the 6-week treatment which experienced no mortality. In most cases trees that have died have been above the treatment means and their loss has led to an overall reduction in the mean. This result is associated with the continuing drought experienced by the stand through the 2018-19 summer (see Figure 3).

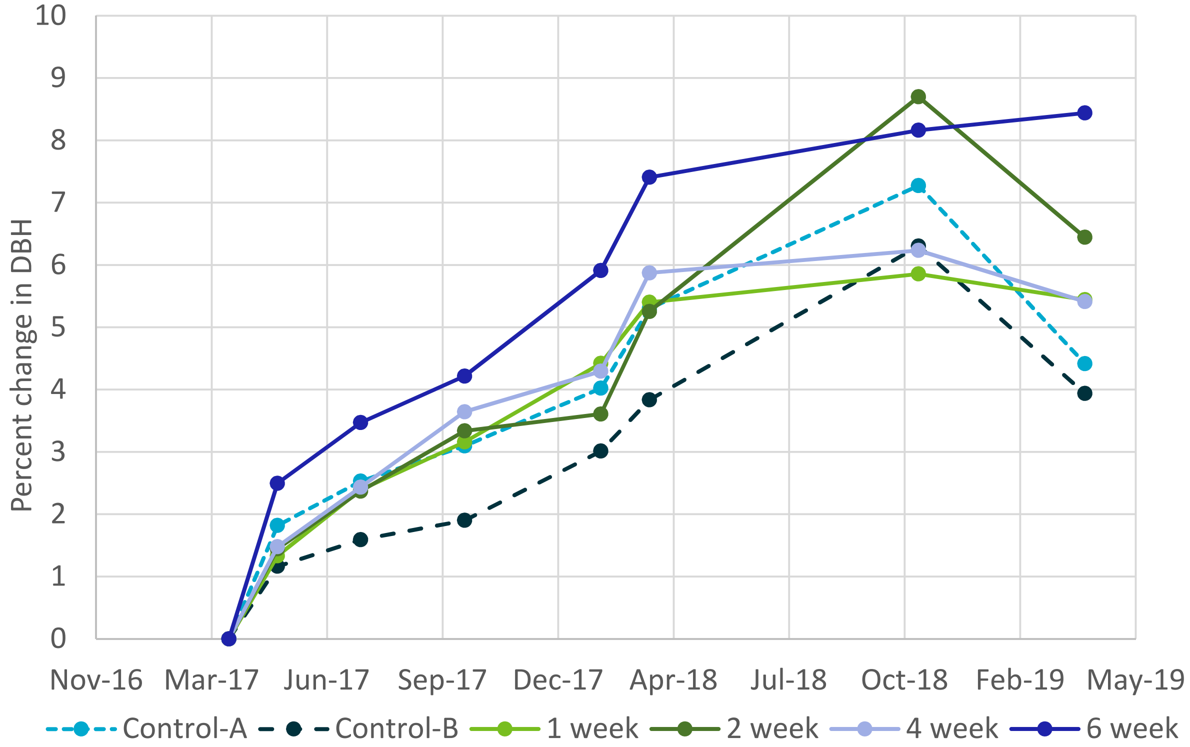

Figure 4 Percent change in stem diameter at 1.3 m above ground between March 2017 and April 2019 in Experiment 1. Control-A is immediately adjacent to the flooded plots, control-B is in a separate block of trees (see Figure 2). There is a statistically significant difference between the 6-week and other treatments at the April 2019 measure.

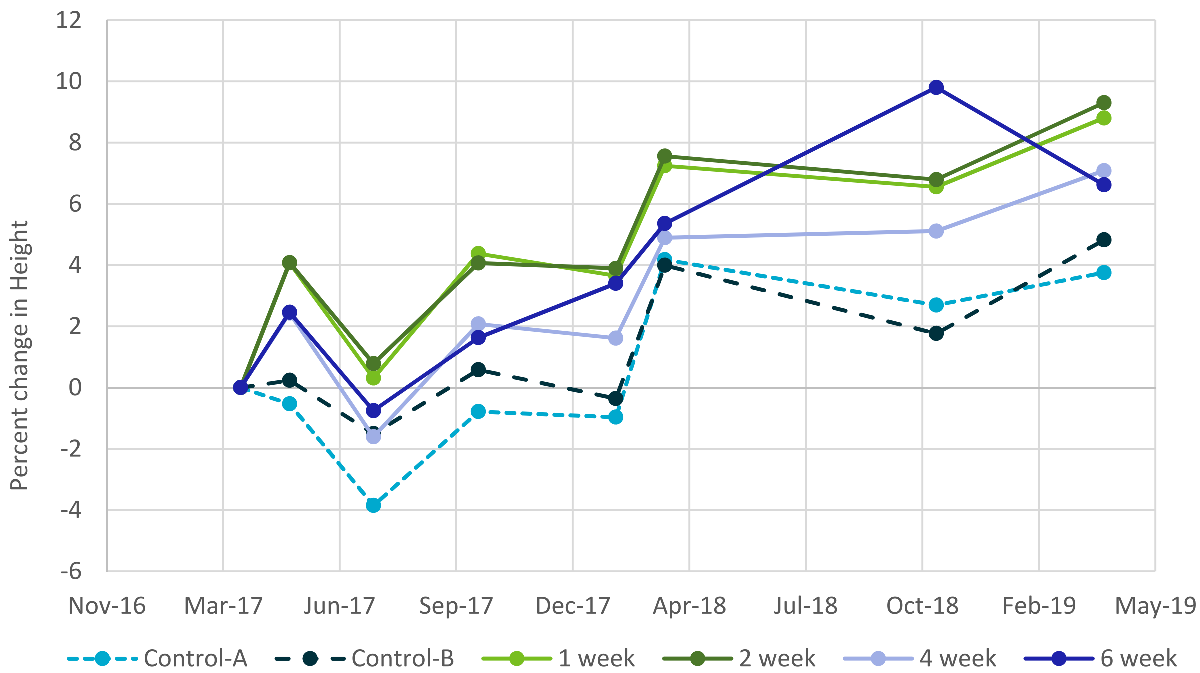

Figure 5 Percent change in height between March 2017 and assessments up until April 2019 in Experiment 1. Control-A is immediately adjacent to the flooded plots, control-B is in a separate block of trees. There is a statistically-significant difference among treatments (1- and 2-week treatments significantly taller than the Control-A and –B treatments) for the April 2019 measure. Note that ten trees have died by the 24-month measure, and these trees do not contribute to the treatment means.

Figure 5 shows the percentage change in height relative to the baseline measure in Experiment 1. Up until 12 months after irrigation treatment, there was no significant difference among treatment means, however at the most recent measure there was a significant difference (P<0.001) between the 1- and 2-week treatments and the control treatments.

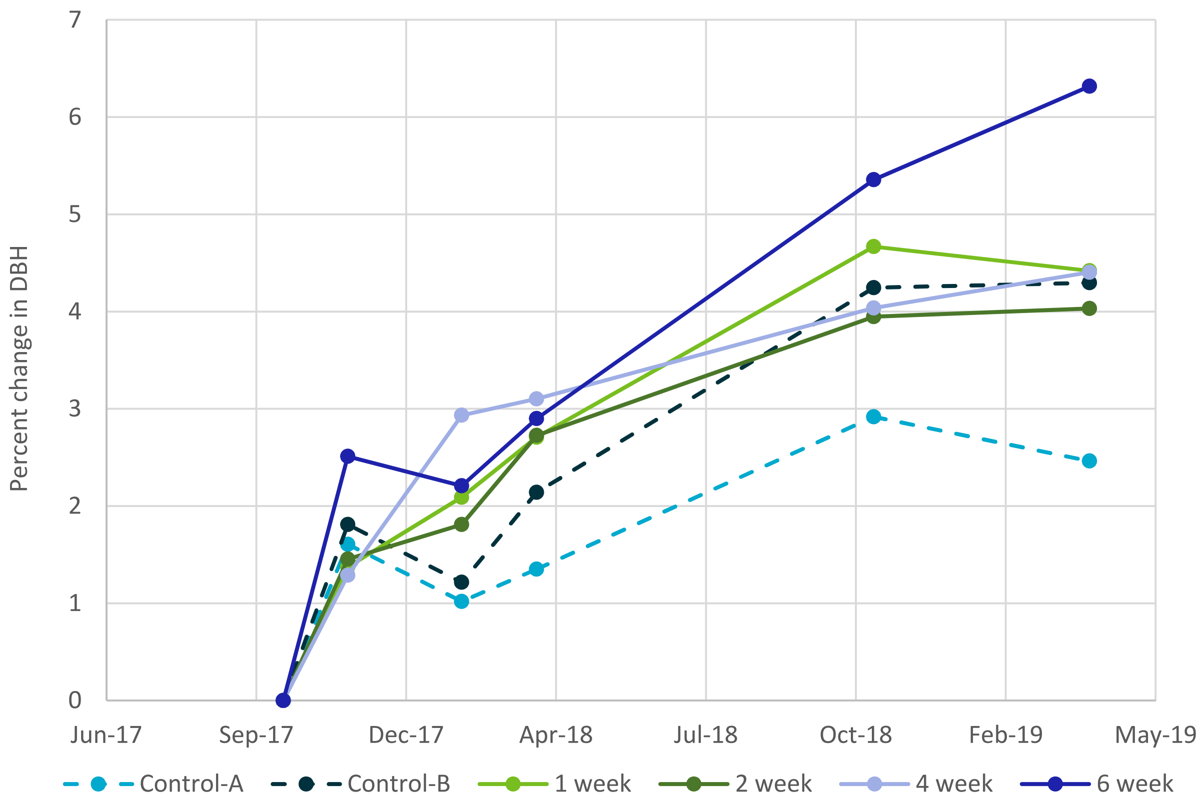

Figure 6 Percentage change in DBH between September 2017 and assessments up until April 2019 in Experiment 2. Control-A is immediately adjacent to the flooded plots, control-B is in a separate block of trees. There is a statistically-significant difference among treatments (Control-A treatment significantly lower and 6-week significantly higher diameter growth than the other treatments) for the April 2019 measure.

There were minor but significant differences among treatments in Experiment 2 at the April 2019 (18-month) measure for both DBH (p<0.001) and height (p<0.001). For DBH, the Control-A treatment grew significantly less than the other treatments, while the 6-week treatment grew more than all other treatments (Figure 6). For height, the 6-week treatment grew significantly taller than the other irrigated treatments, but not the Controls: the Controls were not significantly different to any other treatment (Figure 7). While the latter height result is perhaps surprising, it should be noted that the range of treatment means is only around 4%. The minor reduction of average height in Treatment 4 discussed in the last, 12-month report has largely been regained over summer. The overall height result is not practically significant.

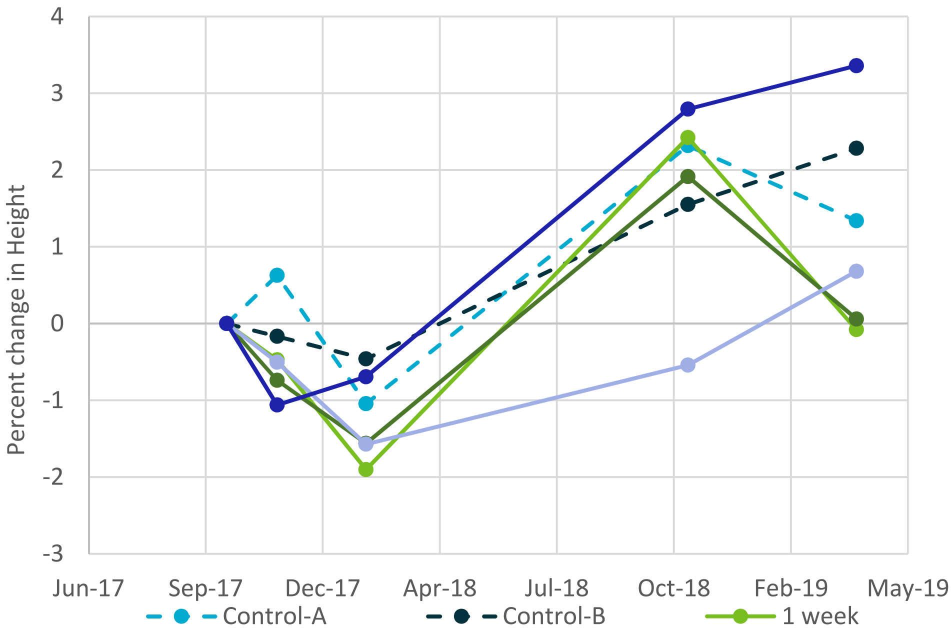

Figure 7 Percentage change in height between September 2017 and assessments up until April 2019 in Experiment 2. Control-A is immediately adjacent to the flooded plots, control-B is in a separate block of trees. There is a statistically-significant difference among treatments (6-week treatment significantly taller than the other irrigated treatments) for the October 2018 measure.

2.4.1 Across-experiments data for one-year measure

Data were pooled across the two Experiments for the 18-month measure. This approach benefits from the spatial replication of the treatments in the two Experiments, but time of commencement, which differs by six months for the two experiments, is confounded with this. There was a minor but significant difference between Experiment 1 and 2 for both DBH and Height (p<0.001). Growth was greater in Experiment 1 by 1.5% (DBH) and 3.6% (Height). There was also a significant difference among treatments (p<0.001). There was a significant treatment-by-experiment interaction effect for height (p<0.001) but not diameter (p=0.07). There were no significant differences for the health traits. Table 5 shows the treatment means across the two experiments. This is most meaningful for DBH, for which there was no significant treatment-by-experiment interaction: generally the flooded treatments, particularly the 6-week treatment, grew more than the controls.

Table 5 Across-sites means and the standard error of difference (SED) for percent growth traits at the 18-month measure of each trial

Treat	Height (% growth)	DBH (% growth)
1-week	3.6	5.7
2-week	2.7	5.3
4-week	3.3	5.2
6-week	3.3	6.5
Control-A	2.0	3.9
Control-B	1.9	4.2
SED	0.7	0.6

3 Discussion

The results to April 2019 in Experiment 1 and 2 do not substantially change the conclusions made in the final report to WaterNSW made in February 2018. There is no statistical evidence or suggestion that shallow flooding has led to a decline in *E. benthamii* health and survival over a period of up to 24 months after the application of flooding treatments that led to anaerobic soil conditions (soil waterlogging). The deaths and stress symptoms evident in Experiment 1 and to a lesser extent in Experiment 2 are consistent with protracted hot and dry conditions at Deniliquin and appear to extend outside the trial area into the surrounding plantation. While there is no significant difference in mortality (or health score) among the treatments, including the two Control treatments, in Experiment 1, it is notable that there has been no mortality in the 6-week flooding treatment, the treatment exposed to waterlogged conditions for the longest time. Moreover, in Experiment 2, it has now been more than 18 months since the commencement of flooding, with only a single tree death noted. This suggests that the extra water is unlikely to have had negative impacts on the trial. Indeed it may be the case that the later application of water to Experiment 2, combined with the very slow drainage in the heavy-textured soil profile as demonstrated by the previously-reported soil study, has resulted in extended water availability in this section of the plantation resulting in lower moisture stress during the extended dry period during summer and autumn of 2018 and the extended dry spell through the 2019 summer. Ideally two supplemental irrigations would have been made during the latter period by the site owner, however, water was not available after the first application in late 2018.

Continued diameter and height growth in most treatments of both Experiments throughout the dry period of the 2018 summer is consistent with the response expected of fast-growing eucalypts including *E. globulus*, *E. nitens* and *E. benthamii*. These species are typically not well-adapted to coping with soil moisture deficit and do not reduce stomatal conductance in response to drought to the same extent as do species that inhabit xeric, or periodically-dry environments such as *E. camaldulensis*. Generally, growth slowed in the two experiments over the 2018-2019 summer, reflecting low moisture availability.

The extension of the measurement period has enabled an analysis of data replicated across the two Experiments to approximately 18 months which has increased statistical power. The results from the combined analysis do not change the overall message from previous single-site analyses. However, it is confirmed that there are minor differences among the growth performance of treatments between the two trials for height growth but not diameter growth. This is of little practical significance but, in combination with the extension of the measurements of Experiment-1 to two years post application of flooding treatments, increases confidence in the overall findings of the report issued in February 2018.

The previously-reported analyses of soil chemical and physical properties before, during and after application of the irrigation treatments confirm that the trees in the irrigated plots were subject to anaerobic conditions that would cause damage to the root systems of susceptible species. If damage did occur, it did not give rise to symptoms in the short-to-medium term during and after application (i.e. to 12-months post irrigation), in fact the trees continued to grow actively. The possibility that fine root damage did occur, but was asymptomatic, due to low water stress appears to be increasingly unlikely. The plantation has been subject to hot and dry weather throughout 2018 and extending into 2019, providing excellent conditions to test the hypothesis that flooding may have caused a delayed impact on tree health. While there has been minor mortality in Experiment 1, this has occurred in the Control treatments as well as some of the irrigated plots with similar levels of mortality also observed outside the trial area. Experiment 2, which was irrigated later, has continued to grow throughout the monitoring period with mortality of only a single tree in treatment 1 and some minor decline in health noted in the Control treatments. It is expected that the broader plantation, including the trial, will continue to self-thin if managed under the current irrigation regime, however the trial conducted is considered unlikely to have caused negative long-term consequences for the stand.

4 References

Bush, D., H. Cresswell, B. Macdonald, N. England, G. McLachlan, N. McKenzie, M. Thomas, and S. Tuomi. 2018. Report on stand health and soil properties over a 12-month monitoring period. CSIRO, Canberra, 56p.

Isbell, R.F. and National Committee on Soil and Terrain. 2016. *The Australian Soil Classification*. CSIRO Publishing, Melbourne, 152 p.

Sena Gomes, A., and T. Kozlowski. 1980 Effects of flooding on *Eucalyptus camaldulensis* and *Eucalyptus globulus* seedlings. *Oecologia* **46**, 139-142.

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Appendix I
Water NSW correspondence

Planning, Industry & Environment

DOC19/845634

Mr David Harper
Program Director Major Projects
WaterNSW
PO Box 398
PARRAMATTA NSW 2124

Dear Mr Harper

Application of the Framework for Biodiversity Assessment – Environmental Impact Statement for Warragamba Dam Wall Raising

I refer to the 19 September 2019 meeting with representatives of WaterNSW, Infrastructure NSW and the Department of Planning, Industry and Environment to discuss the biodiversity assessment in the Environmental Impact Statement (EIS) being prepared for the Warragamba Dam wall raising project.

As discussed, the assessment of biodiversity impacts in accordance with the Framework for Biodiversity Assessment (FBA), as required by the Secretary's Environmental Assessment Requirements (SEARs), includes provisions for assessing impacts that are infrequent, cumulative or difficult to measure. The Department supports consideration of these provisions in the EIS, including consideration of how an adaptive management plan could be used to address infrequent and variable impacts on threatened ecological communities, species and their habitat.

Should specific guidance be required on applying these provisions, please contact Susan Harrison, Senior Team Leader Planning, on 9995 6864 or at Susan.Harrison@environment.nsw.gov.au.

Yours sincerely

ALEX GRAHAM
Director Greater Sydney
Climate Change and Sustainability

CC: Dominic Crinnion, Team Leader, Water and Intermodal Assessments, Planning and Assessment Division, DPIE

Appendix J
Expert report: *Pterostylis saxicola*

Expert report on the Sydney Plains Greenhood, *Pterostylis saxicola* in the area predicted to be affected by the Warragamba Dam wall raising project. 1. Upstream impacts

Peter H. Weston
Botanical Consultant
[redacted]

Table of Contents

1. Introduction

1.1 Project context

WaterNSW, a corporation owned by the State Government of New South Wales, is planning to raise the wall of Warragamba Dam by approximately 14 metres for the purpose of flood mitigation in the Hawkesbury Nepean River catchment ("the project"). This is a Major Project of State Significant Infrastructure for which WaterNSW must conduct an Environmental Assessment and prepare an Environmental Impact Statement (EIS), as directed by the Secretary's Environmental Assessment Requirements (SEARs) (where "the Secretary" is the Secretary of the Department of Planning and Environment). The EIS will determine the impact of raising the dam wall on threatened species and ecological communities upstream of, downstream of, and in the immediate vicinity of the dam wall. The EIS will also provide conservation measures to mitigate any impact, as specified by NSW and Commonwealth environmental legislation. The EIS must include plans for compensating for the damage caused by the project to native biodiversity, as specified in the State Government's NSW Biodiversity Offsets Policy for Major Projects. This policy requires WaterNSW to apply the Framework for Biodiversity Assessment (FBA) to assess impacts on biodiversity (NSW Office of Environment and Heritage 2014). The FBA specifies that each threatened species that is likely to be impacted by the project should be surveyed in the affected areas, or, if that is not feasible, that an export report be prepared to assess the presence, total area and geographic distribution of suitable habitat in the impacted areas, and to estimate the number of individuals likely to occur there.

The FBA specifies that an expert report must:
6.6.2.3 … document the information that was considered, and/or rejected as unsuitable for consideration, to reach the determination made in the expert report.
6.6.2.5 … set out whether:
(a) for development sites – the species is unlikely to be present on the development site – in this case no further assessment of the species is required, or
(b) for all development sites – the species is likely to be present on the site – in this case the expert report must provide an estimate of the number of individuals or area of habitat to be impacted by the development or the management actions (according to the unit of measurement identified for the species in the Threatened Species Profile Database).

According to Section 6.5.2 of the Biodiversity Assessment Method (NSW Office of Environment and Heritage 2017), an expert report must also:

- identify the relevant species or population
- justify the use of an expert report
- indicate and justify the likelihood of presence of the species or population
- include a description of how the estimate [of the number of individuals or area of habitat] was made
- identify the expert and provide evidence of their expert credentials.

1.2 Purpose of the expert report

In March 2019 I was engaged by SMEC Australia on behalf of WaterNSW to produce three expert reports on the distribution and abundance of an endangered species of orchid, *Pterostylis saxicola*, within the area predicted to be impacted by the Warragamba Dam wall raising project. This report is the first of these and deals with impacts in the area affected by periodic inundation upstream from the dam wall (collectively termed "the survey area" herein). The aim of this exercise is to assess whether *P. saxicola* is native to the survey area and, if so, to assess where suitable habitat is located, to estimate the area occupied by *P. saxicola* in the survey area and to estimate the number of plants of *P. saxicola* there.

1.3 Survey area

The survey area for this report is located upstream of Warragamba Dam, west and south west of the Sydney Metropolitan Area, between latitudes 33° 49′ 00″ S and 34° 13′ 30″ S and longitudes 150° 14′ 30″ E and 150° 36′ 00″ E (figure 1). This survey area has been restricted to the 1% Annual Exceedance Probabability (AEP), assuming that the top of the spillway is at an elevation of 124 metres. Its area is about 3,740 hectares, running more or less adjacent, at varying widths, to the shores of the current reservoir and affected tributaries. Its boundary can be roughly approximated by a line halfway between the 120 and 130 metre contour lines on 1:25,000 topographic maps.

1.4 Reasons for use of expert report

Pterostylis saxicola has never been collected or observed within the survey area. However, sites at which the species has been collected or observed, according to the BioNet Wildlife Atlas, are known to the north east, east, south east and west of the survey area, so the survey area largely overlaps the extent of occupancy (EOO) of *P. saxicola*, suggesting that it is part of the distributional range of the orchid. Moreover, according to Tozer *et al.* (2010), a plant community type (PCT) in which populations of *P. saxicola* are known to occur, PCT 1181 (Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney), is one of several co-dominant plant community types in the eastern part of the survey area, raising the strong possibility that suitable habitat for *P. saxicola* might exist there. If this were so, *P. saxicola* might once have lived there, or still exist in the survey area as unrecorded populations.

Pterostylis saxicola is a perennial, deciduous herb that can only be identified with confidence when flowering in Spring (late September to early November) and the timetable of the project precluded surveying for this species at that time of year. Moreover, the cryptic coloration and small size of this plant render it a challenging subject for conventional surveying: aerial and "drive by" surveys are not feasible and even experienced orchid spotters need to be standing within a few metres of a flowering plant to notice it. In any case, plants may not flower if climatic conditions during the growing season from March to December (see section 2.2 below) are poor. Another limitation to conventional surveying is the relative inaccessibility of most of the survey area. These limitations and the possibility that *P. saxicola* might be native to the survey area triggered the need for an expert report.

An alternative surveying approach involves the construction of a general habitat model for *Pterostylis saxicola*, which can then be used, in conjunction with environmental maps, to identify suitable habitat across the survey area.

1.5 Credentials of expert

I prepared this report as an independent botanical consultant but I am also currently an Honorary Research Associate at the National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust (the New South Wales state herbarium). In 2016, I retired from my role as a Senior Principal Research Scientist at the state herbarium, having worked there since 1982 as a Systematic Botanist and as curator of the herbarium's collections of specimens of Orchidaceae (including *Pterostylis saxicola*) (see my Curriculum Vitae, attached). I now work, part-time, at the National

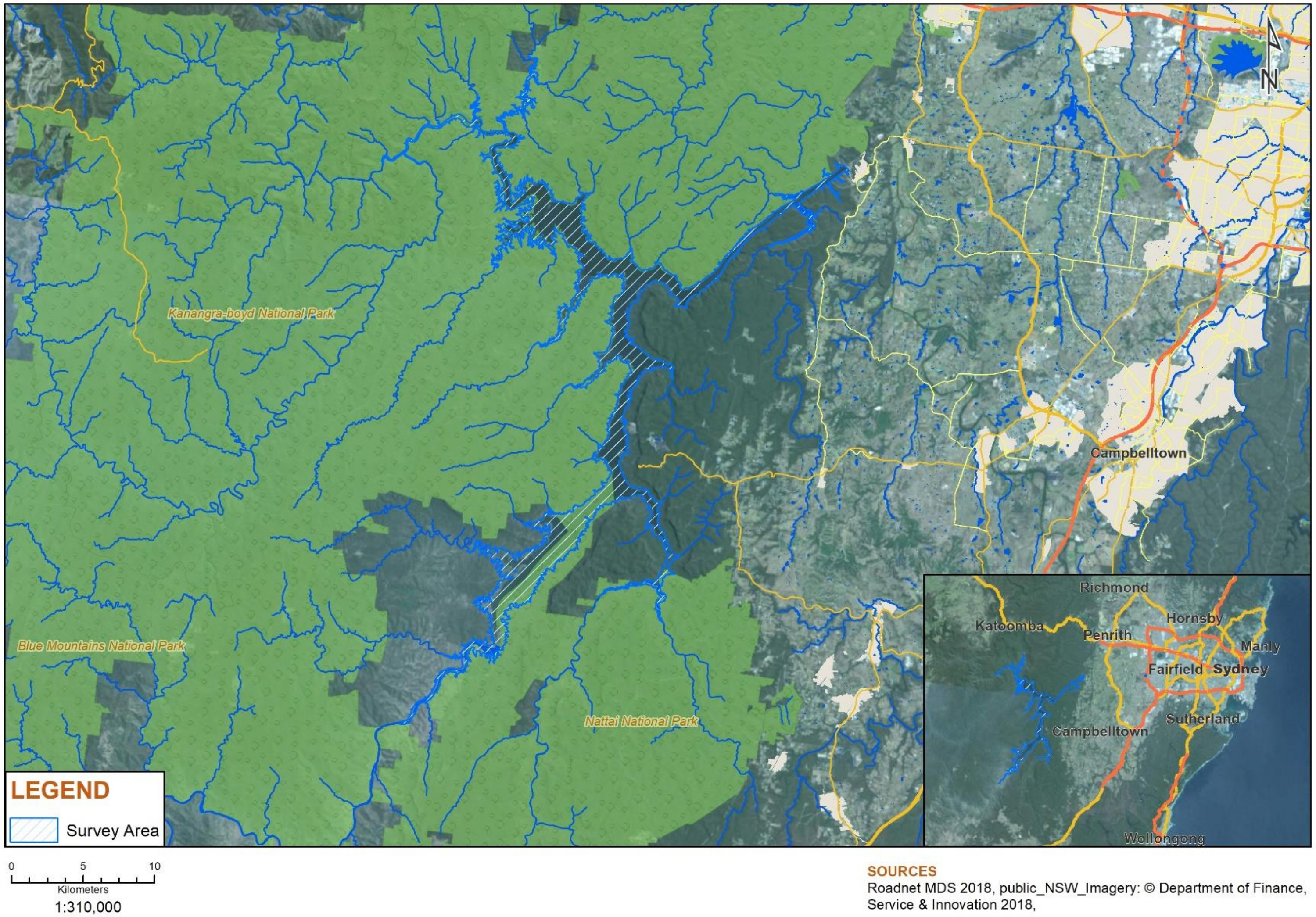

Figure 1. Map of the survey area, indicated by blue hatching.

Herbarium of New South Wales as an Honorary Research Associate. I have published, either as sole author or as a co-author, 16 papers on the systematics and ecology of the Orchidaceae in the peer-reviewed scientific literature, including the most comprehensive phylogenetic analysis of the predominantly Australian subtribe Diurideae yet published (Weston et al. 2014). As curator of Orchidaceae at the state herbarium, I examined all specimens of P. saxicola incorporated into the collection between 1986 and 2016. I was invited to contribute to floristic treatments of the Orchidaceae for Flora of New South Wales, (see my Curriculum Vitae, attached). I was also asked to be lead author of the essay on the ecology of the Orchidaceae that accompanied the “Ecology of Sydney Plants” (Weston et al. 2005). Throughout my career I have participated in numerous collecting trips in the field, collecting specimens in all Australian states for the state herbarium. In documenting these specimens I had to describe the habitat at each collecting site, including associated plant species, substrate, aspect, degree and kind of disturbance. I have also cultivated numerous species of Pterostylis as an orchid enthusiast and advised horticulturalists at the Royal Botanic Gardens on appropriate techniques for cultivating species of Pterostylis and other orchids.

In 2018 I was appointed to prepare expert reports on *Pterostylis saxicola* in the Greater Macarthur, Wilton, and Western Sydney Aerotropolis Growth Areas and in the Greater Penrith to Eastern Creek Urban Release Investigation Area (Weston unpublished a,b), during the preparation of which I characterised in detail the associated plant species and other ecological attributes of seven plots, each of 30 metre radius, centred on highly precise grid references of sites at which *P. saxicola* had previously been collected, at one of which I found flowering plants of *Pterostylis saxicola* and another of which I found pre-flowering leaf rosettes that were indistinguishable from those of the orchid. I am personally familiar with this taxon and the habitats in which it lives.

In November 2018 I was approved by the Office of Environment and Heritage as a species expert for *Pterostylis saxicola* under section 6.5.2 of the Biodiversity Assessment Method. This approval is current for a period of six years.

2. Species information

2.1 Species description

The following morphological description of *Pterostylis saxicola* is a modified version of that published by Jones and Clements (1997), updated with data gathered from more recently collected specimens held by the National Herbarium of N.S.W (see figures 2, 3).

Tuberous, terrestrial herb. Tubers oblate, c. 15-20 mm wide. Leaves oblong-elliptical to ovate-elliptical or obovate, 10-45 mm long, 5-15 mm wide, 5-10 in a radical rosette, green, the margins entire, shortly petiolate, apex subacute to apiculate, often withered at anthesis. Inflorescence 10.5-35 cm tall, slender, with 3-6 ensheathing, lanceolate sterile bracts. Floral bracts lanceolate, 6-19 mm long, 3-4 mm wide, acuminate, closely sheathing. Pedicels 3-26 mm long, slender, straight or slightly curved. Ovary narrowly obovoid, 3-5 mm long, 1-2 mm wide, reddish brown. Flowers 1-10, porrect to semi-erect, 12-12 mm long, transparent with dark red-brown markings and suffusions in the galea, the lateral sepals wholly red-brown, shiny; galea gibbous at the base, curved medially, decurved suddenly to the apex; petal flanges poorly developed, not touching and not closing off the base of the galea. Dorsal sepal 11-13 mm long, cucullate, obliquely erect, Abruptly decurved in distal quarter, apical point c. 3 mm long, filamentous, acuminate. Lateral sepals deflexed, ovate in outline when flattened, fused part 7-10 mm long, 9-11 mm wide, shallowly concave, the margins strongly incurved, glabrous; sinus narrow; free points filamentous, c. 5 mm long, curved forwards, divergent, 8-10 mm apart at the tips. Petals ovate-lanceolate, 11-14 mm long, 3.5-5 mm wide, nearly straight, transparent, with brown basal markings and two or three brown lines, dorsal margin brown, ciliate, proximal flange poorly developed. Labellum highly irritable, attached by a ligulate basal claw c. 2 mm long, c. 2 mm wide; lamina broadly obovate, 4.5-6 mm long, 2.5-3.5 mm wide, dark red-brown, constricted in the proximal quarter, adaxial surface shallowly concave to broadly grooved, apex obtuse; marginal trichomes 3-5 pairs, white, the longest pair c. 3.5 mm long, arising near the proximal constriction, basal lobe large, with 1-3 pairs of trichomes c. 0-.7 mm long, abaxial surface with a narrow central channel extending from the basal lobe to the apex. Column porrect from the end of the ovary, 10-12 mm long, c. 2.5 mm wide; column wings c. 3.3 mm long, c. 2.5 mm wide, more or less rectangular, anterior margins ciliate. Stigma elliptical to broadly scutiform, c. 5 mm long, c. 2.5 mm wide, the upper margins irregular. Anther c. 1.2 mm long, obtuse. Pollinia linear-oblong to clavate, c. 2 mm long, yellow, mealy. Fruiting capsules obovoid, 7-8 mm long, c. 4-5 mm wide, brownish, erect.

2.2 Life cycle

Pterostylis saxicola is a perennial, deciduous, tuberous herb that germinates from a minute, dust-like seed. Like all other orchids, germination is reliant on invasion of the seed by the hyphae of a specific fungal associate, which, in the case of *P. saxicola*, is an unnamed species of *Ceratobasidium* (Basidiomycota: Cantharellales) (Sommerville et al. 2008). The first morphological change that an orchid seed undergoes during germination is swelling to form a protocorm, a rootless, shootless 'blob'. The orchid fungus forms an intracellular relationship with its host, usually in the roots and/or tubers and is thus classed as an endomycorrhiza. It forms hyphal coils, called pelotons, in the cells of its host, which are beneficial to the orchid in that they provide the host plant with nutrients such as soluble sugars (Rasmussen 1995, Warcup 1990). The duration of the association varies according to the life history of the particular orchid species, with some species of orchids being completely dependent on their mycorrhizal fungi for life while other species are capable of living without their fungi from shortly after germination. The ease of cultivation of *Pterostylis* species and the green colour of almost all plant parts strongly suggest that adult plants are not obligately dependent on their mycorrhizal associates as adult plants.

Plants of *Pterostylis saxicola*, like those of most other species in Orchidaceae subfamily Orchidoideae, are deciduous, with the whole shoot system growing anew every year from a dormant tuber. The new shoot usually starts growing from an apical meristem on the tuber in late summer, with new shoots usually breaking the soil surface by March. The shoot develops into a "rosette" of crowded leaves just above ground level and in late winter a terminal raceme starts growing from the centre of the rosette, reaching anthesis in spring. While the shoot is growing above ground, a new replacement tuber is growing below ground, from the base of the shoot. Some species of *Pterostylis* multiply and spread vegetatively by producing additional new tubers on the ends of long roots but the subgenus to which *P. saxicola* belongs, *Oligochaetochilus*, does not share this attribute (Jones 2006).

Almost all species of *Pterostylis* are deceptively pollinated by male flies that attempt to copulate with the labellum of the flower. The labellum mimics a female fly of a particular species (or species group) in size, appearance and texture and by exuding an allomone that is identical to the pheromone released by the female flies (Phillips et al. 2013, Kuiter & Findlater-Smith 2017). In species of *Pterostylis* for which the pollination process has been studied and described, the labellum is highly motile ("irritable"), like that of *Pterostylis* saxicola, and a male fly that lands on it is tossed inside the hood (galea) formed by the dorsal sepal and lateral petals, and trapped there. The only escape route provided by the flower is a tunnel through which the male fly must squeeze in order to escape. In the process of negotiating its exit, the fly is forced to rub past the stigma of the flower, depositing on it any pollinaria that it was already carrying. The fly is then forced to contact the anther, sticking a pollinarium on its thorax, before it can finally escape. The pollinator of *P. saxicola* is still unknown, but the pollinators of other species of *Pterostylis* subgenus *Oligochaetochilus*, where known, are males of unnamed species of *Orfelia* (Mycetophilidae) (Kuiter & Findlater-Smith 2017). Sexually deceptive pollination has evolved multiple times in the Australian terrestrial orchid flora, involving hundreds of species (Weston et al. 2014). Most of those for which pollinators have been identified are pollinated by the males of only one species of insect and *P. saxicola* is most likely pollinated by a single species of fly too.

Fruiting capsules of *Pterostylis saxicola* mature quickly, with the most proximal capsules sometimes dehiscing before the most distal flowers have withered. They split down six sutures to release thousands of minute, wind-dispersed seeds in November to early December.

Figure 2. Flowering plant of *Pterostylis saxicola*, at Scheyville National Park, showing the basal rosette of crowded leaves lying flat on the ground and a terminal, erect inflorescence, bearing one open flower from the side and an unopened flower bud.

Figure 3. Flower of *Pterostylis saxicola*, at Scheyville National Park, frontal view, showing galea, labellum and paired lateral sepals.

2.3 Distribution and abundance

Records for *Pterostylis saxicola* are widely distributed across the Cumberland Plain and lower Blue Mountains in an area bounded by Scheyville, Freemans Reach, Euroka Campground, Douglas Park, Picnic Point, and Cattai, with two outlying records from the Gingra Range in Kanangra Boyd National Park and Anvil Hill in the Hunter Valley (BioNet Atlas, as held records received 22 February 2019; National Herbarium of New South Wales specimen database, accessed 8 April 2019) (figure 4). It has been recorded at altitudes ranging from 30 to 440 metres. It is very sporadically distributed, partly because much of this land has been cleared for agriculture and suburban development but large parts of the Warragamba catchment are remote and inaccessible. However, the outlying records suggest that any habitat model is unlikely to be a powerful predictor of the presence of populations at particular locations.

Plants of *Pterostylis saxicola* are usually gregarious, with most collectors and observers noting multiple plants co-occurring together. Counts of the number of individual plants at sites vary from one to 280, with a mean population size of 82. As *P. saxicola* does not usually multiply vegetatively (Jones 2006, as *Oligochaetochilus saxicola*), these clusters are most likely the result of seeds germinating close to their parents.

2.4 Habitat requirements

The habitat model published in the endangered species profile for *Pterostylis saxicola* (NSW Office of Environment and Heritage 2018a) states that it is "most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where *P. saxicola* occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils". This description applies accurately to the habitat associated with the type collection and with some other records in the southern half of the species' distribution but not to those found elsewhere. The distributional range and habitat requirements of *P. saxicola* can be subdivided into two main sub-populations and two outlying populations.

The northern sub-population is in an area bounded by Scheyville, Freemans Reach, The Ironbarks near Glenbrook, Toongabbie, Ryde, Glenhaven and Cattai. I have visited four sites with precise grid references at which *Pterostylis saxicola* has been observed or collected in this area and identified the plant community types found there (see section 4.4, appendix 1). The substrate underlying the sites at Scheyville and Freemans Reach, both of which I have visited, is deep Ashfield Shale (Wianamatta Group) and the Ryde record is also mapped to this substrate. I have also visited the Cattai and The Ironbarks sites, which are on Mittagong Formation substrates (transition zones between Ashfield Shale and Hawkesbury Sandstone). The Toongabbie record also maps to this substrate. All of these sites are in elevated, well-drained but gently rolling country, not on rugged sandstone outcrops.

The plant communities that I identified at the four sites mentioned above are the following:

- 849 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain (see figure 5);
- 1395 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain (see figure 6).

Most records from the southern sub-population, in an area bounded by Macquarie Fields, Minto, Douglas Park, Woronora River and Picnic Point differ in habitat from the northern records. Although a recent record from Menangle is from Ashfield Shale, in most cases where they have highly precise locality data and/or detailed habitat descriptions, collections and observations from this area have been made on Hawkesbury Sandstone, on the rims and sides of the gorges of the Nepean, Georges

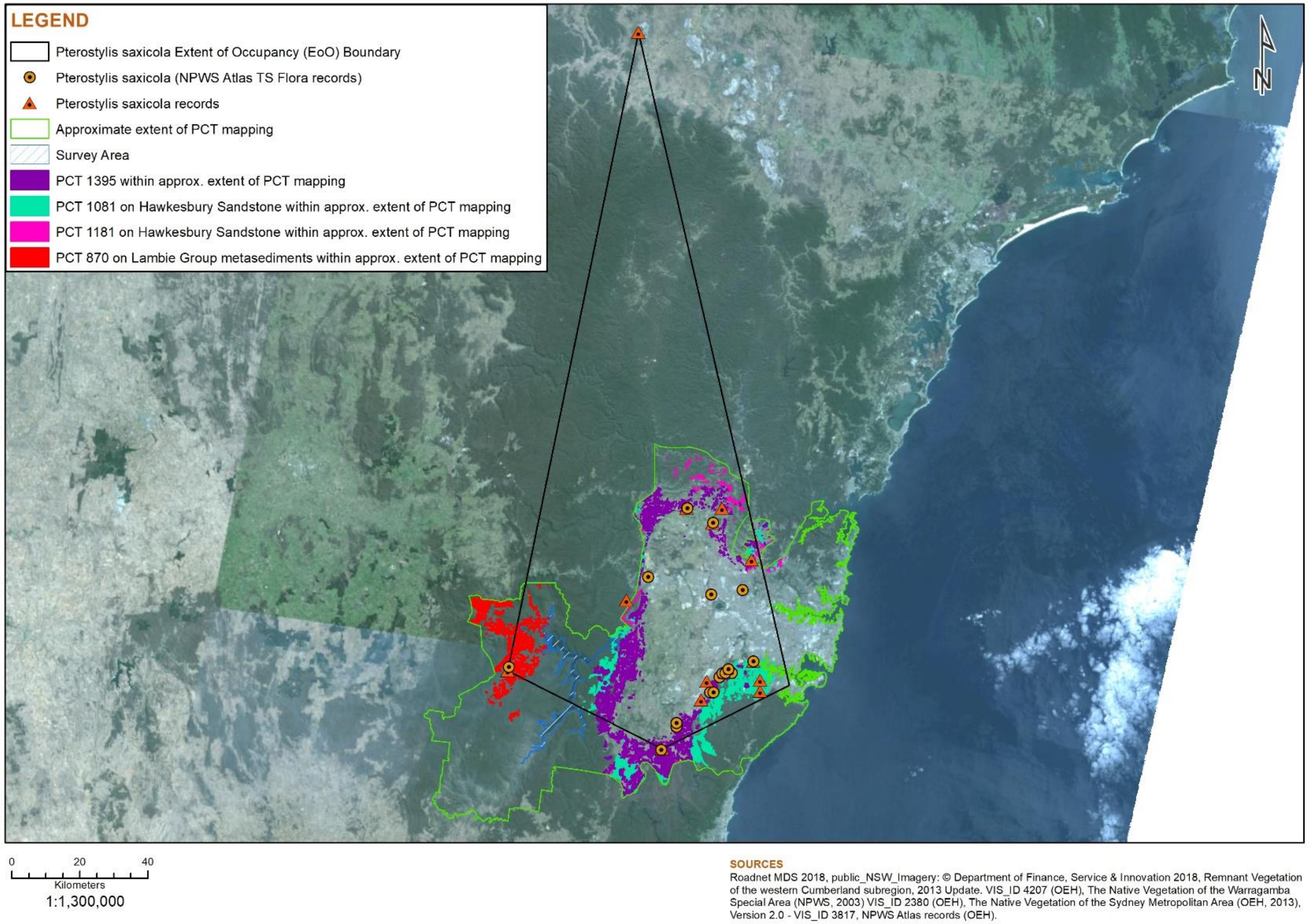

Figure 4. Map showing known records, extent of occupancy (EOO) and recorded habitats of *Pterostylis saxicola*.

Figure 5. PCT 849 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, on Ashfield Shale at Scheyville National Park (my site PS1, appendix 1).

Figure 6. PCT 1395 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, on Mittagong Formation at The Ironbarks (my site PS8, appendix 1).

Figure 7. PCT 1081 Red Bloodwood - grey gum woodland on the edges of the Cumberland Plain (my site PS3, appendix 1)

Figure 8. PCT 1181 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, east of Appin.

Figure 9. PCT 870 Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Gingra Range, Kanangra-Boyd National Park (my site PS 9, appendix 1).

and Woronora Rivers. I have visited four precisely georeferenced sites at which *Pterostylis saxicola* has been observed or collected in this area and identified the plant community types found there (see appendix 1). Observers' notes repeatedly describe the soils as very shallow sands overlying sandstone rock shelves, as stated in the published habitat model (NSW Office of Environment and Heritage 2018a) and the four sites that I visited and characterised were consistent with this description. However, although all were elevated, well-drained sites, only some of them were recorded above cliff lines, contrary to the published model. All of these sites occur close to outcrops of Ashfield Shale, mostly downhill from them, but for some of these sites, the only evidence of shale influence on the environment seems to be associated plant community types. I identified the following plant community types at these sites:

- 1081 Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain (see figure 7);
- 1181 Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney (see figure 8);
- 1395 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain.

In addition to the two main sub-populations, there are also two outlying, precisely georeferenced, herbarium records. One of this is from the Gingra Range in Kanangra Boyd National Park. This site is on metasediments of the Devonian Lambie Formation, and was mapped by Tozer *et al.* (2010) to their map unit DSF p37 Kowmung-Wollondilly Grassy Gorge Woodland. According to the references cited in the BioNet Vegetation Classification, this is equivalent to the following PCT:

- 870 Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges (see figure 9).

However, this site is so close to a mapped boundary between PCT 870 and PCT 1107 (River Peppermint - Narrow-leaved Peppermint open forest on sheltered escarpment slopes, Sydney Basin Bioregion and South East Corner Bioregion) that a field survey of the site was required in order to confidently identify the PCT or transition zone there. I visited this site on 2 April 2019 (see below) and confirmed that it is unequivocally located in PCT 870. The precise locality of the record occurs within an area mapped by Warragamba VIS map 2380 as the map unit Kanangra Gorge Sheltered Grey Gum Forest, which is a map unit that has been assessed as equivalent to PCT 870 by SMEC in the Upstream Assessment BAR for the upstream survey area.

The outlying population in the upper Hunter River Valley is represented by a specimen collected on the top of Anvil Hill, an isolated mesa composed of Narrabeen Group sandstone and conglomerate. This site is inaccessible, being surrounded by the Mangoola open-cut coal mine. However, the collectors' notes described the habitat as "Open woodland of *Eucalyptus crebra* with shrub layer dominated by *Notelaea microcarpa* and *Spartothamnella juncea*. Skeletal soils derived from Triassic sandstone and conglomerate". This is the only record of *Pterostylis saxicola* from a Narrabeen Group substrate, and is a significant discovery in the context of this report because sandstones of the Narrabeen Group form most of the walls of the Warragamba arm of Lake Burragorang. The plant community on Anvil Hill is not identifiable from the habitat description above but it is worth noting that *Eucalyptus crebra* is a co-dominant tree at three of the nine *P. saxicola* sites that I have characterised.

As well as identifying suitable habitats for *Pterostylis saxicola* it is also possible to identify habitats that are unequivocally unsuitable for this orchid. While many of these need not be listed because they are trivially obvious, such as perennially aquatic environments, some habitats are more subtly unsuitable. The most important of these in the context of this report are flood-prone habitats and areas on substrates of quarternary alluvium. *Pterostylis saxicola* has not been recorded in such environments nor have any of its close relatives. Moreover, these orchids are quite exacting in their horticultural requirements, especially with respect to watering. They require sufficient water to sustain growth when the shoots are actively growing or to prevent desiccation of the tubers during dormancy but not so much that the soil becomes soggy. Over-watering, especially when the plants are dormant, causes them to rot. Well-drained soils, combining course sand, loam and some organic matter, are recommended (Jones 2006). In cultivation, these plants will not tolerate more than very brief inundation, and it is most unlikely that wild populations would survive flooding of their habitat. Any plants of *Pterostylis saxicola* living in the survey area will be exterminated the first time they are flooded

Pterostylis saxicola has mostly been recorded growing in intact native vegetation but there is one notable exception: a plant described in a "Car Park growing through bitumen", adjacent to a large area of bushland from which other substantiated records had been made. Several others have come from small patches of remnant urban bushland, in some cases less than a hectare in area, surrounded by highly disturbed land. However, no records mention heavily weed-infested habitats or evidence of heavy grazing by introduced herbivores. Sites with significant edge effects are probably not sustainable reserves for conserving this species.

3. Description of the survey area

3.1 Land use history

This section is based primarily on information from NSW NPWS (2003), except where other sources are explicitly cited. The first human inhabitants of the survey area were Aborigines who moved there many thousands of years ago. People of the Gundungarra language group were occupants of the survey area when the British first started to settle in the Sydney Region in 1788. If they practised agriculture (Pascoe 2014) then it would have been restricted to small strips of alluvial soil lining the major watercourses, such as the Wollondilly and Coxs Rivers upstream from their confluence (Geological Survey of NSW 1966a, 1966b). They might have used traps to catch fish from streams and fire-stick farming methods to manage game in the grassy woodlands and forests that dominate large parts of the western side of the catchment. However, the rugged terrain would have imposed a hunter-gatherer economy on the first human occupants. They would have used the natural landscape seasonally, taking advantage of different food sources depending on availability, establishing temporary open camps of simple gunyahs near water courses.

In 1802 Frances Barrallier led the first British expedition into the Burragorang Valley, unsuccessfully attempting to find a route across the Blue Mountains. By 1822, European settlements had reached the eastern boundary of the catchment and by 1835 the rolling hills of the floor of the Burragorang Valley had been settled and cleared by graziers. Sheep and cattle grazing continued to be an important industry here until 1960, when the completion of Warragamba Dam started to flood the valley.

Other primary industries that exploited the natural resources of the Burragorang Valley were logging and mining. In the 19th century, timber getters sought out red cedar (*Toona ciliata*) and coachwood (*Ceratopetalum apetalum*) trees from rainforests on sheltered sites, while the more extensive sclerophyll forests provided several large species of myrtaceous trees including turpentine (*Syncarpia glomulifera*) blackbutt (*Eucalyptus pilularis*), mountain blue gum (*Eucalyptus deanei*) and blue-leaved stringybark (*Eucalyptus agglomerata*), which were selectively cut. Evidence of past logging is most obvious on the eastern side of Burragorang Valley, where access to the timber mill in Picton was easiest. Although logging would have removed some of the most heavily yielding seed trees of selected species, it is hard to find evidence of long-term effects on the composition of plant communities in the catchment.

Minerals exploited in the Burragorang Valley have included silver, at Yerranderie between 1898 and 1927, and coal, at several underground collieries under the eastern margin of the catchment, from the 1920s to the 1990s. Silver mining at Yerranderie has caused only localised disturbance and limited weed incursion but coal mining may have adversely affected the biodiversity values of the survey area in several ways. Subsidence-related cliff collapse has caused severe, albeit localised habitat modification at several sites, most notably at the cliff line 2 km NW of the now defunct Nattai Bulli Colliery, where about 14,000,000 cubic metres of sandstone collapsed towards the eastern shore of Lake Burragorang between 1965 and 1985, transforming about 50 hectares of sclerophyll forest into a boulder field (Fathi Salmi et al. 2017). Hydrology and ground water quality may also have been compromised as a result of bed rock fracturing caused by coal mine subsidence (Pells et al. 2014).

3.2 Landscape context

The Sydney Basin is a geological entity, composed of sedimentary rocks, which is shaped a bit like a tilted, triangular, art deco saucer. On its south western rim lies the Burragorang Valley and thus the survey area. Lake Burragorang's main southern, western and northern source rivers, the Wollondilly, Kowmung, and Coxs Rivers, flow down from landscapes composed of rocks of a much older geological entity, the Lachlan Fold Belt (Geological Survey of NSW 1966a, 1966b). The whole catchment area is located west of two step-like geological folds, the Lapstone and Oakdale Monoclines (Martyn 2018), on rocks that were uplifted and tilted to the east as a result of two phases of mountain building over the past 120 million years (Czarnota et al. 2014). From 120 to 80 Ma, uplift of the eastern Australian highlands, including the Central Tablelands of New South Wales, was driven by the eastward motion of what is now eastern Australia's margin away from the sinking eastern Gondwana slab (Müller et al. 2016). From 80 to 10 Ma it coincided with Cenozoic volcanism as eastern Australia drifted over the edge of the large Pacific mantle upwelling (Czarnota et al. 2014; Müller et al. 2016). Total uplift over the two phases amounted to about 800 metres. Pre-existing rivers eroded deep valleys through the gently rising strata during this time, creating rugged landscapes that vary starkly in shape, depending on the rock types through which the valleys, gorges and canyons were cut.

The most commonly exposed substrates in the survey area are Permian siltstones, shales, and sandstones of the Berry Formation (Shoalhaven Group), one of the lower strata in the Sydney Basin (Geological Survey of NSW 1966a, 1966b). The soft, moderately fertile siltstones and shales have eroded to form the lower talus slopes of most of the Burragorang Valley and the valley floor of the lower Wollondilly River. The harder sandstones form impressive cliff lines in places such as Kanangra Walls.

The second most commonly exposed substrates in the survey area are rocks of the Lachlan Fold Belt: Upper Devonian quartzites, sandstones, siltstones and claystones of the Lambie Group, which underlie the western side of the Sydney Basin (Geological Survey of NSW 1966a, 1966b). These are restricted to the western side of the Burragorang Valley but in the survey area are extensively exposed along the Kowmung and lower Coxs River valleys, where they form steep to rolling landscapes of the valley sides and floors. Above the western side of the study area, Lambie Formation rocks have eroded to form very steep-sided valleys and talus slopes below outcrops of Berry Formation sandstones in the upper Kowmung and Kanangra River valleys.

Along parts of the Coxs and Wollondilly Rivers, Quaternary alluvia accumulated in places where the valley floor formed a gently rolling landscape but most of these deposits were inundated by the damming of the Warragamba River (cf. Geological Survey of NSW 1952, 1956, 1966a, 1966b). Some alluvial terraces have survived within the survey area along the lower Wollondilly.

The upper Wollondilly River cuts through an extensive outcrop of Upper Devonian Bindook Porphyry, a plutonic igneous rock, and an approximately six km stretch of this substrate occurs in the survey area (Geological Survey of NSW 1966b).

Occupying a stratigraphic position immediately above the Berry Formation in the Sydney Basin are the Illawarra Coal Measures: Permian shales, sandstones, conglomerates, chert, torbanite, and, of course, coal that was mined in the valley until the 1990s (Martyn 2018). This group forms a narrow band at the top of Berry Formation Talus slopes, often below vertical cliff lines of Narrabeen Group rocks. The Coal Measures are exposed in the survey area to a limited extent around the confluence of the Coxs, Wollondilly and Warragamba Rivers (Geological Survey of NSW 1966a).

Rocks of the Triassic Narrabeen Group occur stratigraphically above the Illawarra Coal Measures and compose the rugged sandstone cliffs lining the tops of the eastern and northern escarpments of the Burragorang Valley, including famous rock formations of the higher Blue Mountains such as the Three Sisters, as well as various isolated mesas scattered through the valley, such as Lacys and Tonalli Tablelands and Mount Solitary (Martyn 2018). The Narrabeen Group consists of three thick layers of sandstone separated by thin layers of much softer claystones, which often form narrow ledges in the cliff lines. These claystone ledges support strikingly different plant communities than the sandstones between which they are sandwiched. Narrabeen Group outcrops are mostly positioned well above the survey area in elevation but they reach the maximum water level of Lake Burragorang in its Warragamba Arm, forming most of the walls of Warragamba Gorge.

Triassic Hawkesbury Sandstone caps the Narrabeen Group in the lower Blue Mountains and on the eastern side of the Burragorang Valley and so is almost always located well above the survey area in elevation. However, at the extreme north eastern end of the Warragamba Arm of Lake Burragorang, 2.5 km upstream from Warragamba Dam it reaches down to maximum water level.

The Triassic Mittagong Formation and Ashfield Shale of the Wianamatta Group form shallow caps on Hawkesbury Sandstone in parts of the lower Blue Mountains, including the eastern side of the Warragamba catchment. These kinds of rock do not occur in the survey area but south east of the Warragamba Arm of Lake Burragorang they are close enough to it to influence the vegetation on Hawkesbury Sandstone outcrops downslope from them. Ashfield Shale has a significantly higher phosphate content than Hawkesbury Sandstone (Martyn 2018) and the Mittagong Formation has a structure like a gateau of Ashfield Shale and Hawkesbury Sandstone layers. Ashfield Shale colluvium mixing with siliceous, acidic, low nutrient sands derived from Hawkesbury Sandstone produce shale-sandstone transition soils that support a distinct plant community type, Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest on the edges of the Cumberland Plain (PCT 1395 of the BioNet Vegetation Classification system).

Topographic variation, as well as distance from the sea influence climate and the survey area is surrounded by sharply elevated landscapes. To the west, the elevation of the Great Dividing Range varies from 900 to 1362 m for the full latitudinal extent of the survey area. In the north, the Blue Mountains range from 800 m to 1112 m in elevation, in the east the Kedumba, Dallawang, Burragorang, Wanganderry and West Nattai Walls rise to between 500 and 896 m and in the south the Bullnigang and Tomang Heights vary from 760 to 840 m in elevation. These precipitous borders form an almost enclosed amphitheatre around the survey area, inducing orographic rainfall and rain shadow effects and channelling cold air drainage to the bottom of the valley.

The climate of the study area is warm-temperate but a gradient in temperature runs from west to east, with mean temperatures lowest in the west. The whole survey area is subject to winter frosts. No weather stations are placed within the study area, so knowledge of geographic variation in climate needs to be inferred from data gathered by stations surrounding the area (table 1). A map of variation in rainfall across the Warragamba Special Area is presented in NPWS (2003: 9, map 5), which presumably is a predictive model produced by integrating data from weather stations and patterns of topographic variation.

Weather station	Mean annual rainfall (mm)	Mean maximum temperature (°C)	Mean minimum temperature (°C)
Jenolan Caves (1895-) (24 km W, 690 m higher)	970.6	25.6	0.2
Penrith Lakes AWS (1995-) (20 km NNE, 90 m lower)	718.6	31.0	5.3
Springwood (1883-) (21 km N, 250 m higher)	1082.1	29.0	6.5
Katoomba (1885-) (15 km N, 890 m higher)	1399.6	23.4	2.6
Picton Council Depot (1880-) (15 km SE, 60 m higher)	794.3	29.3	1.7

Table 1. Key climatic statistics for weather stations near the survey area.

3.3 Native vegetation communities

In terms of the plant community types recognised in the BioNet Vegetation Classification and their equivalent map units in the draft vegetation maps provided by SMEC for the survey area (received from James Taylor, 15 May 2019), the native vegetation of the survey area consists of the plant community types listed in table 2.

PCT identification number	Descriptive name of PCT
769	Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion
832	Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion
840	Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion
860	Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes on the Blue Mountains, Sydney Basin Bioregion
862	Grey Gum - Hard Leaved Scribbly Gum woodland of the Cox River Valley
870	Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion
871	Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion
877	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East corner Bioregion
941	Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion
1081	Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain
1083	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin
1086	Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion
1105	River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion
1246	Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion
1281	Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion
1284	Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion
1292	Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion
1401	Narrow-leaved Ironbark - Forest Red Gum open forest on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion

Table 2. Plant community types mapped in the survey area by Tozer *et al.* (2010).

In the survey area, according to the vegetation maps provided by SMEC for the survey area (received from James Taylor, 15 May 2019), and the seamless GIS compilation of the best available vector geology data for New South Wales provided by the N.S.W. Department of Planning and Environment (2018), the following substrates support the plant community types listed next to them:

- Devonian Bindook Porphyry: 840, 877, 1105, 1401;
- Devonian Lambie Group: 832, 870, 877, 941, 1105, 1401;
- Permian Illawarra Coal Measures: 860, 862, 871, 877, 941, 1105, 1246, 1284, 1292;
- Permian Berry Formation: 832, 860, 862 871, 877, 1105, 1246, 1284, 1292, 1401;
- Triassic Narrabeen Group: 769, 860, 871, 877, 941, 1083, 1086, 1105, 1246, 1284, 1292;
- Triassic Hawkesbury Sandstone: 769, 860, 871, 877, 941, 1081, 1083, 1086, 1105, 1246, 1281;
- Quaternary alluvia: 840, 1105.

Grey Gum - Broad-leaved Ironbark dry open forest (PCT 860) is the most abundant plant community type in the survey area, dominating the western flanks of the central part of Lake Burragorang south of Policeman Point and much of its Wollondilly arm, on Berry Formation siltstones, shales and sandstones.

Forest Red Gum - Narrow-leaved Ironbark open forest (PCT 832) is also abundant, occupying the lower valley slopes along the lower Coxs, Kowmung and Kedumba Rivers, on Lambie Group metasediments.

Vegetation on the eastern side of Lake Burragorang between McMahons Point and Brereton Head is dominated by Sydney Peppermint - Grey Gum shrubby open forest (PCT 1246), where sediments of the Illawarra Coal Measures are exposed for several kilometres.

Small patches of Grey Gum shrubby open forest (PCT 871) are scattered throughout the survey area on several substrates but long stretches of it are found on the western shore of the Wollondilly arm of Lake Burragorang between Hunt Point and Higgins Bay, on Berry Formation sediments.

Narrow-leaved Ironbark - Forest Red Gum open forest (PCT 1401) clothes most of the rocky slopes of Lake Burragorang's Nattai arm and southern end of the Wollondilly arm between Higgins Bay and Colemans Bend on Berry Formation sediments.

Extensive riparian vegetation lines the banks of the rivers and major streams flowing into Lake Burragorang. Along the Coxs, Kowmung, Tonalli, Jooriland and Wollondilly Rivers, River Oak open forest (PCT 1105) is the dominant riparian plant community type but this is replaced by Mountain Blue Gum - Thin-leaved Stringybark open forest (PCT 941) on the Kedumba, Nattai and Little Rivers and along Cedar, Green Wattle and Butchers Creeks.

Rainforest communities are usually restricted to sheltered sites, especially the lower slopes of steep-sided valleys. Grey Myrtle dry rainforest (PCT 877) occurs just outside the riparian zones along much of the lower Kowmung, Coxs and Tonalli Rivers and their tributaries. Two other rainforest community types, Grey Myrtle - Lilly Pilly dry rainforest (PCT 875) and Coachwood - Lilly Pilly warm temperate rainforest (PCT 769) are represented by a few, tiny patches in the survey area.

Grey Gum - Thin-leaved Stringybark grassy woodland (PCT 870) is widespread on steep ridges of Lambie Group metasediments on the western side of the Burragorang valley and some patches occur low enough to impinge on the survey area.

The steep sandstone slopes of the Warragamba arm of Lake Burragorang are clothed in a mosaic of four plant communities, with Red Bloodwood - scribbly gum heathy woodland (PCT 1083) restricted to the crests of ridges descending to the lakeside, occasionally accompanied by Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest (PCT 1086) and Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain (PCT 1081). Turpentine - Smooth-barked Apple moist shrubby forest (PCT 1284) fills the bottoms of the gullies.

A few other plant community types occur as small scattered patches in the survey area.

4. Assessment of species presence and habitat

The approach that I took in assessing the presence or absence of *Pterostylis saxicola* in the survey area started with the construction of a general habitat model for *P. saxicola*, from existing records and my own surveys, outside the survey area but within the known geographical range of the orchid. I then used this model, in conjunction with environmental maps, to identify suitable habitat within the survey area. I then estimated the density of populations within each suitable habitat type and used these estimates, and the mapped area of each habitat type in the survey area, to calculate the expected number of individual plants of *Pterostylis saxicola* in the survey area as a whole and in each suitable habitat type within it.

4.1 Methodological limitations

Assessing the suitable habitat of *Pterostylis saxicola*, given the present state of knowledge of the biology of this species, has to be a largely descriptive exercise. The causal processes that constrain its distribution and abundance are largely unknown but probably include physiological limits to tolerance of temperature and humidity, the availability of mineral nutrients and water, factors limiting the distribution and abundance of its obligate symbionts – its pollinators and mycorrhizal associates, and the distribution and abundance of native herbivores, pathogens and parasites. Suitable habitat has to be estimated on the basis of associations between its distribution and environmental proxies such as substrate types and plant community types, and interactions between them. Multidimensional bioclimatic modelling would extend this approach to climatic variables but such analysis is beyond the scope of this report.

It could also be argued that predicting the presence of populations of *Pterostylis saxicola* in the survey area is based on questionable assumptions. The assumptions on which my predictions were based are as follows:

- Combinations of plant community type and substrate are reasonable indicators of environmental space. That is, they can be used to predict the distribution and abundance of species, such as *Pterostylis saxicola*, that did not figure prominently in the process by which the indicators were defined.
- Although *P. saxicola* is patchily distributed, the probability of its presence is equally spread across the geographic distribution of each combination of plant community type and substrate.
- The environmental preferences of *Pterostylis saxicola* do not vary across its distributional range.

These simplifying assumptions are testable in principle, although only the first one can be said to have been empirically tested to any extent. The fact that about 1500 plant community types have been recognised in New South Wales, but that *Pterostylis saxicola* has been recorded from only five of them suggests that plant community types do have useful predictive value.

In addition to the assumptions listed above, the method I have used to estimate the number of individual plants in each PCT-substrate combination (outlined in section 4.8.4) relies on the following implicit assumptions:

- The distributional range of *Pterostylis saxicola* is accurately circumscribed by existing records. This is likely to be an underestimate of the true distributional range.
- Observers who counted plants of *P. saxicola* did not overlook any non-flowering individuals, which are often difficult or impossible to see because their leaves often wither before flowering time. These counts are likely to underestimate the true number of plants in each population.
- *P. saxicola* does not multiply vegetatively and each leafy shoot represents a genetically distinct individual plant. This assumption is consistent with the generalisation that all members of *Pterostylis* section *Oligochaetochilus*, including *P. saxicola*, only rarely multiply vegetatively (see section 2). It has also been empirically tested and corroborated by observations made by the horticultural research team based at the Australian Botanic

Garden, Mt Annan, which has propagated a large number of plants of *P. saxicola* by seed (Karen Sommerville, personal communication).

- The 8 populations for which counts or estimates were made represent a random sample of the metapopulation of *P. saxicola*.
- The PCT-substrate combinations in which *P. saxicola* has been recorded are assumed to be restricted to areas for which PCT maps are available as digital layers. This assumption had to be made because vegetation maps are available for only part of the total extent of occupancy of *P. saxicola*. This assumption is probably untrue and is likely to over- estimate the number of plants in the survey area.
- Mean population size does not vary significantly between different PCT-substrate combinations.
- All populations of *P. saxicola* have already been discovered and are listed in the BioNet Atlas. This assumption is clearly unrealistic, as new populations of *P. saxicola* continue to be discovered, including two in October 2018, only one of which has already been recorded in the BioNet Atlas. However, discovery of new populations is so sporadic that it would be impossible to model the asymptote of a curve representing cumulative growth of observational records. The number of populations of *P. saxicola* used in my calculations should be regarded as a minimal estimate. My estimates of the number of individual plants in each PCT-substrate combination and in the survey area as a whole, are therefore likely to be underestimates.

These assumptions render the expected numbers of individual plants in the different PCT-substrate combinations in the survey area tenuous. It would be more reasonable to use the distribution of suitable habitat in the survey area as a proxy for calculating offsets, as in the Biodiversity Assessment Method (NSW Office of Environment and Heritage 2017) than to use these numbers, as required by the Framework for Biodiversity Assessment (NSW Office of Environment and Heritage 2014).

4.2 Existing records and surveys

As a designated sensitive species, unredacted records of *Pterostylis saxicola* collections and observations held in the BioNet Atlas are not publicly available, so I formally applied for these records, which I received by email on 22 February 2019. This table contains 62 records, most of which are unvouchered observations. To this collection can be added 10 herbarium specimen records held by the National Herbarium of New South Wales, to which I have access as an Honorary Research Associate.

Although several targeted surveys of this species seem to have been conducted since 2000, none has been done in the survey area. Teresa James surveyed for this species across the species' distribution in spring 2007, for the NSW Department of Environment Climate Change and Water, submitting an unpublished report, observational records at five sites and a herbarium specimen (Teresa James personal communication). From November 2010 to January 2011, Total Earth Care Pty Ltd conducted a survey of threatened plant species in the Simmos Beach Recreation Reserve, Macquarie Fields for Campbelltown City Council, submitting an unpublished report and observational records at eight sites (Lachlan Laurie personal communication). In spring 2011, *P. saxicola* was again targeted at Simmos Beach Recreation Reserve by a research group from The Royal Botanic Gardens and Domain Trust that investigated the mycorrhizal associates of the orchid, with the aim of identifying and culturing the relevant fungus or fungi, adding seeds of this species to the seed collection at the Australian Plantbank, and germinating seeds of the orchid in septic culture. Two scientific papers were published, and three herbarium specimens collected as part of this project.

Highly precise grid references associated with a number of the BioNet records enabled me to identify the plant community types (as mapped by Tozer *et al.* (2010) and substrates (as mapped by Geological Survey of New South Wales 1966a,b, 1969, 1985, 1991) at sites at which these records of *Pterostylis saxicola* occurred. They were:

- 849 Grey Box – Forest Red Gum grassy woodland on Flats of the Cumberland Plain, on Ashfield Shale;
- 870 Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, on Lambie Group metasediments;
- 1081 Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain, on Hawkesbury Sandstone;
- 1181 Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, on Hawkesbury Sandstone;
- 1395 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest on the edges of the Cumberland Plain, on Mittagong Formation transitional substrates;
- An unidentified plant community type dominated by *Eucalyptus creba*, on Narrabeen Group sandstone and conglomerate.

4.3 Surveys completed for the Environmental Assessment

No targeted surveys for *Pterostylis saxicola* were conducted within the survey area for the Environmental Assessment for the reasons detailed in section 1.4 and because of the inaccessibility of the survey area.

4.4 Surveys completed for this expert report

4.4.1 Survey Methods

In the course of preparing this expert report and my earlier expert reports on *Pterostylis saxicola* in the Greater Macarthur and Wilton Growth Areas (Weston unpublished a, b), I characterised nine plots of native vegetation in detail, each plot being a circle of radius 30 m (an area of 2827 m^2), centred either on a plant of *P. saxicola* or on the grid point where an observation of it had been made (at times when *P. saxicola* could not be observed because it was dormant). All of those plots were sampled from outside the survey area in order to develop an improved habitat model for the species. At each plot I listed all vascular plant species that could feasibly be identified, taking photographs and sometimes specimens of plants for later reference in cases where the plant's identity was in question. The latitude and longitude of the centre of each plot was determined using a GPS instrument. The elevation of each site was determined later from 1:25,000 topographic maps. The soil and topography at each site was described and the substrate identified using the Wollongong – Port Hacking and Penrith 1:100,000 geological maps (NSW Department of Mineral Resources 1985, NSW Department of Minerals and Energy 1991) and the Sydney 1:250,000 geological map (Geological Survey of New South Wales 1966a). I identified the plant community type in each plot using the PCT identification tool in BioNet, and my list of plant species found in each plot.

4.4.2 Results of my surveys

Site and ecological data for my nine plots outside the survey area are shown in Appendix 1. According to my identifications of plant community types, *Pterostylis saxicola* was present in the following PCTs, on the following substrates in my plots:

- 849 Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain , on Ashfield Shale (2 plots);
- 870 Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges on Lambie Group metasediments (1 plot);
- 1081 Red Bloodwood - grey gum woodland on the edges of the Cumberland Plain on Hawkesbury Sandstone (3 plots);
- 1181 Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney on Hawkesbury Sandstone (1 plot);
- 1395 Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain on Mittagong Formation transitional substrates (2 plots).

The results of my surveys corroborate results drawn from existing records regarding the habitats in which *Pterostylis saxicola* is known to occur. Although I did not sample any sites at which *P. saxicola* had been found on Narrabeen Group sandstone in my surveys, records of the species from a site with a precise grid reference has been mapped to this substrate (section 4.2).

4.5 Inference of predicted habitat of *Pterostylis saxicola*

The outlying records of *Pterostylis saxicola* from the Gingra Range and Anvil Hill suggest that the habitats at those sites should be integrated into a general habitat model for the orchid. However, they also suggest that consideration be given to habitats intermediate between those at the outlying sites and those in the species' "core" distributional range on the margins of the Cumberland Plain.

For example, the discovery of *P. saxicola* on Narrabeen Group sandstone at Anvil Hill suggests that the orchid is likely to occur on Narrabeen Group sandstone elsewhere, especially in plant community types in which it has already been recorded on Hawkesbury Sandstone. These are:

- 1081 Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain;
- 1181 Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney.

Similarly, the record of *P. saxicola* from Lambie Group metasediments on the Gingra Range not only demonstrates that *P. saxicola* is capable of growing on this substrate but that other plant community types that grow on it should also be assessed as potential habitat. For the purposes of this report, only those plant community types that are known from the survey area are relevant. According to Tozer *et al.* (2010) and geological maps covering the survey area (Geological Survey of New South Wales 1966a,b), these are:

- 832 Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion;
- 860 Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes on the Blue Mountains, Sydney Basin Bioregion;
- 862 Grey Gum - Hard Leaved Scribbly Gum woodland of the Cox River Valley;
- 871 Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion;
- 877 Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East corner Bioregion;
- 941 Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion;

- 1105 River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion.

The first four of these plant community types are dominated by tree species that are co-dominants of other plant community types from which *P. saxicola* has been recorded. Moreover, the first two also share over 90% of their sub-dominant diagnostic species with my survey plots (table 3, appendix 1).

Plant Community Type	Percentage of diagnostic species shared
860	95%
832	91%
871	86%
862	70%
877	58%
941	58%
1105	44%

Table 3. Percentage of diagnostic species of selected plant community types on Lambie Group metasediments shared with my plots in which *Pterostylis saxicola* has been recorded.

Given this high degree of ecological similarity, a precautionary approach should treat plant community types 832 and 860, growing on Lambie Group metasediments, as potentially suitable habitat of *P. saxicola*.

4.6 An improved habitat model for *Pterostylis saxicola*

I have argued that the habitat model that was published as part of OEH's threatened species profile of *Pterostylis saxicola* (NSW Office of Environment and Heritage 2018a) needs updating (section 2.4 of this report, Weston unpublished a,b). It needs to be broadened to include habitats in which *P. saxicola* has been recorded and habitats in which it has been inferred to occur, but which were not taken into account when the profile was written.

My improved habitat model is as follows:

Pterostylis saxicola occurs along an ecological gradient from:

- Clay soils derived from Ashfield Shale (Wianamatta Group) on gently hilly landscapes in PCT 849 Grey Box – Forest Red Gum grassy woodland on Flats of the Cumberland Plain;
- to: clay to sandy soils derived from Mittagong Formation substrates on gently hilly to steep landscapes, in PCT 1395 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest on the edges of the Cumberland Plain;
- to: thin accumulations of humus-rich sandy soil on sheets and rock shelves of Hawkesbury Sandstone, on the rims and sides of river valleys, growing in PCT 1081 Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain, or PCT 1181 Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney.

This ecological gradient is inferred to extend to:

- thin accumulations of humus-rich sandy soil on sheets and rock shelves of Narrabeen Group sandstone, growing in PCTs 1081 Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain or 1181 Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney.

Pterostylis saxicola also occurs on:

- Lambie group metasediments, in PCT 870 Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges.

This habitat is inferred to be part of an ecological gradient of *Pterostylis saxicola* habitats that extends to:

- Lambie group metasediments, in PCT 832 Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, and PCT 860 Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes on the Blue Mountains, Sydney Basin Bioregion.

4.7 Assessment of species presence

4.7.1 Likelihood of species presence in the survey area

Given the extent of suitable habitat that has been mapped there, the rarity of *Pterostylis saxicola* within its known distributional range, and the low number of individuals estimated to occur there (see section 4.8.5), my subjective assessment of the probability of *P. saxicola* occurring in the survey area is about 50%.

4.7.2 Justification for determining presence

Pterostylis saxicola has been recorded from two combinations of substrate and plant community type that have been mapped in the survey area and inferred to occur in a further two such combinations (see sections 4.4.2, 4.5). Although these habitats cover only 167.69 hectares, or 1.58% of the survey area (see section 4.8.3), one PCT-substrate combination is estimated to be home to more than one plant of *P. saxicola* in the survey area (see section 4.8.5). *P. saxicola* has been neither collected nor observed in the survey area but absence of evidence should not be treated as evidence of absence, especially in an area that has been inaccessible, with rare exceptions, to botanists for the last 60 years. Although the probability of *P. saxicola* occurring in the survey area is low, it is not zero. Moreover, my estimate of the number of plants in each PCT-substrate combination in the survey area is more likely to be an underestimate than an over-estimate (see section 4.1).

4.8 Assessment of suitable habitat and abundance of *Pterostylis saxicola* within the survey area

4.8.1 Suitable habitat for *Pterostylis saxicola* within the survey area

The following habitats that have been mapped in the survey area are potentially suitable habitat for *P. saxicola*:

- thin accumulations of humus-rich sandy soil on sheets and rock shelves of Hawkesbury Sandstone, on the rims and sides of river valleys, growing in PCT 1081 Red Bloodwood – Grey Gum woodland on the edges of the Cumberland Plain;
- Lambie group metasediments, in PCT 870 Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, in PCT 832 Forest Red Gum - Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion, and in PCT 860 Grey Gum - Broad-leaved Ironbark dry open forest on gorge slopes on the Blue Mountains, Sydney Basin Bioregion.

4.8.2 Species polygons for *Pterostylis saxicola*

My species polygons for *Pterostylis saxicola* (figures 10, 11) include all patches of the habitats listed in section 4.8.1 in the survey area. They were prepared with the assistance of James Taylor (SMEC), using the ESRI ArcGIS software package, from vegetation maps of the survey area produced by SMEC on 15 May 2019. A shape file for these polygons is held by SMEC. My arguments justifying these polygons have been set out in sections 2.3, 2.4, 4.1, 4.2, and 4.4 to 4.7.

4.8.3 Estimate of area of habitat of *Pterostylis saxicola* in the survey area

The areas estimated to represent suitable habitat for *Pterostylis saxicola* in figures 10 and 11are as follows:

- PCT 832 on Lambie Group metasediments: 130.31 ha
- PCT 860 on Lambie Group metasediments: 5.44 ha
- PCT 870 on Lambie Group metasediments: 28.08 ha
- PCT 1081 on Hawkesbury Sandstone: 3.87 ha
- Total area of suitable habitat in the survey area: 167.69 ha.

These estimates were calculated with the assistance of James Taylor (SMEC), using the ESRI ArcGIS software package on 14 May 2019, from vegetation maps of the survey area produced by SMEC. My arguments justifying the polygons from which these estimates were calculated have been set out in sections 2.3, 2.4, 4.1, 4.2, and 4.4 to 4.7.

4.8.4 Method for estimating the number of plants of *Pterostylis saxicola* in the survey area

The following method was used to estimate the number of plants of *Pterostylis saxicola* in the survey area, given a set of simplifying assumptions, which are listed in section 4.1:

1. The known distributional range of *Pterostylis saxicola* was estimated by drawing the minimal convex polygon enclosing all records of the species.
2. An estimate or count of the total number of individual plants has been recorded in **6** populations of *P. saxicola* listed in the BioNet Atlas and I counted the number of plants in the populations at Scheyville National Park and Simmos Beach Reserve.
3. The numbers of plants counted or estimated in the **8** populations of *P. saxicola* cited above is: **100, 12, 4, 280, 150, 32, 22, 57**.
4. The sum of these numbers is **657**.
5. Then **657/8 = 82.125** is the mean population size for *P. saxicola* (SE = 33.236).
6. Let **b, c, e, f** be the different combinations of plant community type and substrate in which *P. saxicola* has been recorded.
7. Let $\mathbf{a_b}$ **ha** be the total area covered by PCT-substrate combination **b** within the known distributional range of *P. saxicola* for which PCT mapping was available. This was calculated for each PCT-substrate combination (**b, c, e, f**) from the draft vegetation maps provided by SMEC for the survey area (received from James Taylor, 15 May 2019) and NSW Office of Environment and Heritage (2013), using the ESRI ArcGIS software package.
8. Let $\mathbf{n_b}$ be the number of populations of *P. saxicola* that have been recorded within PCT-substrate combination **b**.
9. Then $\mathbf{n_b/a_b = d_b}$ populations per hectare, is the density of populations of *P. saxicola* in PCT-substrate combination **b** within the known distributional range of *P. saxicola*.
10. The density $\mathbf{d_c, d_e, d_f}$, of *P. saxicola* populations in PCT-substrate combinations **c, e, f** was calculated in the same way as for PCT-substrate combination **b**.

11. Let **A_b ha** be the total area covered by PCT-substrate combination **b** within the survey area. This was calculated for each PCT-substrate combination (**b, c, e, f**) from vegetation maps produced for the Environmental Assessment and from Tozer *et al.* (2010) using the ESRI ArcGIS software package.
12. Then $\mathbf{n_b/a_b = N_b/A_b}$, where $\mathbf{N_b}$ is the expected number of populations of *P. saxicola* in PCT-substrate combination **b** within the survey area.
13. Re-arranging, $\mathbf{N_b = A_b \times n_b/a_b}$.
14. Substituting $\mathbf{d_b}$ for $\mathbf{n_b/a_b}$, $\mathbf{N_b = A_b \times d_b}$.
15. The expected number of populations, $\mathbf{N_c, N_e, N_f}$, of *P. saxicola* in PCT-substrate combinations **c, e, f** within the survey area was calculated in the same way as for PCT-substrate combination **b**.
16. Then $\mathbf{82.125 \pm 33.236 \times N_b = i_b}$, is the expected number of individual plants of *P. saxicola* in PCT-substrate combination **b** within the survey area.
17. The expected number of individual plants, $\mathbf{i_c, i_e, i_f}$, of *P. saxicola* in PCT-substrate combinations **c, e, f** within the survey area was calculated in the same way as for PCT-substrate combination **b**.
18. Confidence intervals for the number of plants in each PCT-substrate combination were calculated by repeating steps 6-17 above using the mean population size (82.125) plus or minus the standard error (33.236).

The method outlined above was used to estimate the expected number of individual plants of *Pterostylis saxicola* in the survey area for the four PCT-substrate combinations in which *P. saxicola* has been recorded. However, it could not be used to estimate this number for the four PCT-substrate combinations in which *P. saxicola* has been inferred, but never recorded, because there are no baseline data for these combinations. Instead, the density of populations of *P. saxicola* in each of these PCT-substrate combinations was extrapolated from that of the most similar PCT-substrate combination in which *P. saxicola* has been recorded. These equivalences are tabulated in table 4.

PCT-substrate combination inferred to be suitable habitat for *Pterostylis saxicola*	PCT-substrate combination from which population density of *Pterostylis saxicola* was extrapolated
PCT 832 on Lambie Group metasediments	PCT 870 on Lambie Group metasediments
PCT 860 on Lambie Group metasediments	PCT 870 on Lambie Group metasediments

Table 4. pairs of PCT-substrate combinations showing putatively suitable habitats for *Pterostylis saxicola* that have been inferred, not observed (left hand column) and their most similar PCT-substrate combinations in which *P. saxicola* has been observed (right hand column).

4.8.5 Estimate of the number of plants of *Pterostylis saxicola* in the survey area

The number of individual plants of *Pterostylis saxicola* estimated to be present in the survey area are as follows:

- PCT 832 on Lambie Group metasediments: 1.55 plants ± 0.63;
- PCT 860 on Lambie Group metasediments: 0.06 plants ± 0.03;
- PCT 870 on Lambie Group metasediments: 0.33 plants ± 0.13;
- PCT 1081 on Hawkesbury Sandstone: 0.12 plants ± 0.02.

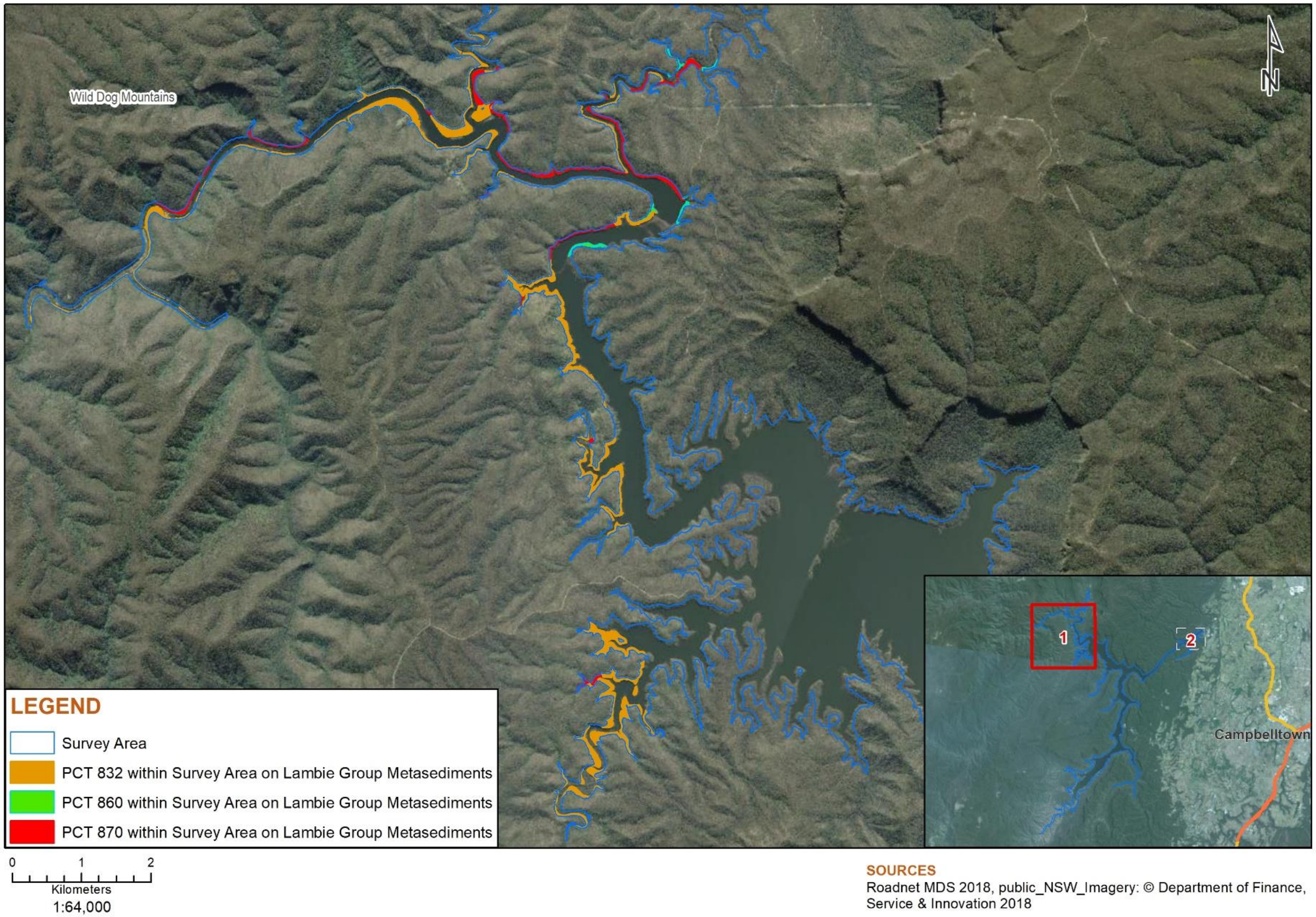

Figure 10. Polygons of suitable habitat for *Pterostylis saxicola* on Lambie Group metasediments in the survey area: PCTs 832, 860 and 870.

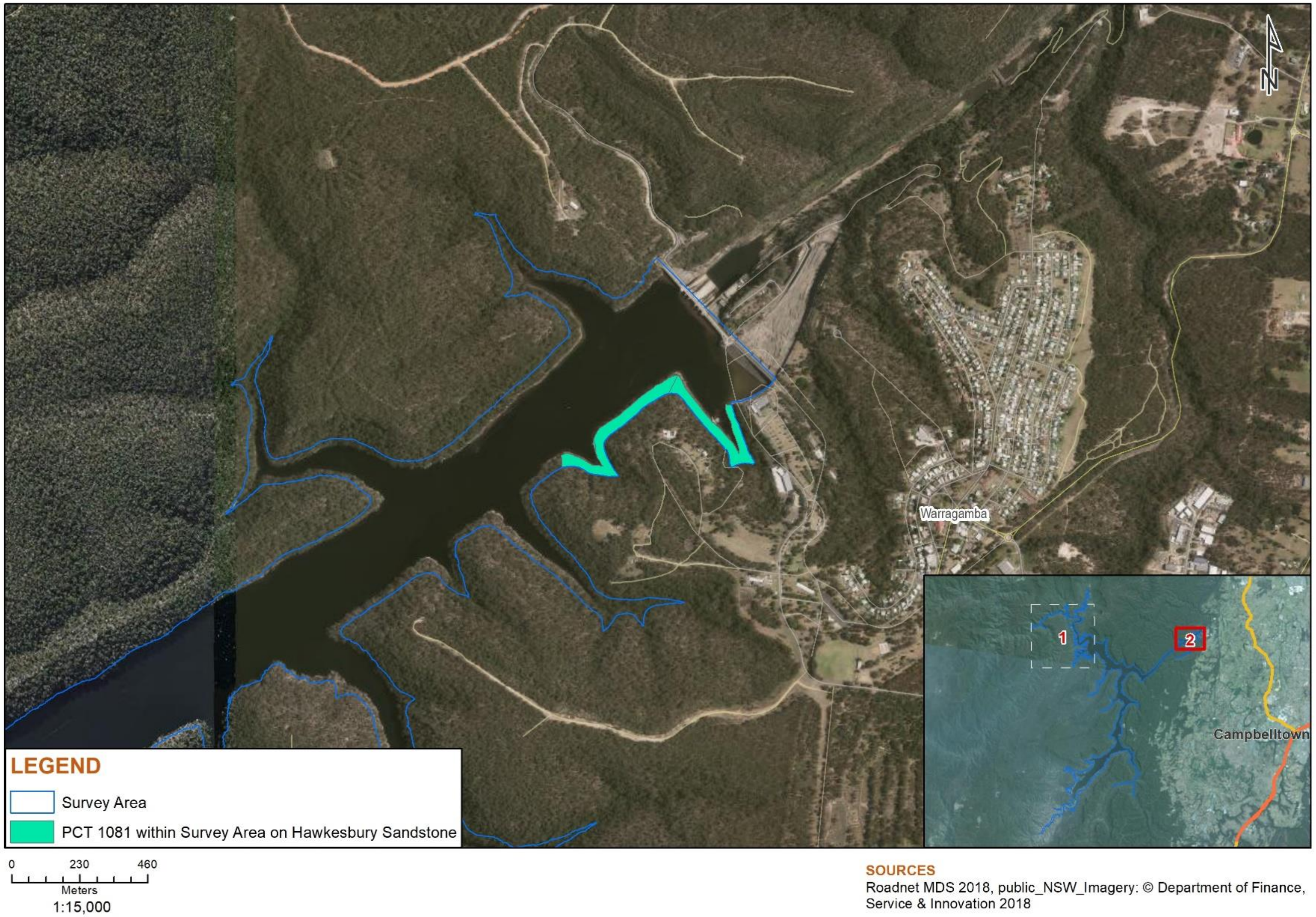

Figure 11. Polygon of suitable habitat for *Pterostylis saxicola* on Hawkesbury Sandstone in the survey area: PCT 1081

5. Information used in this assessment

My assessment was based on information obtained from a diversity of sources:

- Databases of observational and vouchered specimen records of *Pterostylis saxicola*:
    - National Herbarium of New South Wales specimen database;
    - BioNet Wildlife Atlas;
- Interviews with collectors, observers, propagators and scientists of *P. saxicola* (see section 6, acknowledgements);
- Fieldwork at 9 sites at which *P. saxicola* had previously been collected or observed (see Appendix 1);
- The scientific and scholarly literature (see section 7, references);
- A GIS map of the survey area with layers representing the boundaries, plant community types, substrates, prepared by SMEC;
- Background information on the survey area provided by SMEC;
- My personal knowledge and experience, gained from 40 years as a professional botanist specialising in the systematics and ecology of the Orchidaceae.

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7. References

Czarnota K, Roberts GG, White NJ, Fishwick S (2014), Spatial and temporal patterns of Australian dynamic topography from river profile modelling. Journal of Geophysical Research: Solid Earth 119: 1384–1424, doi:10.1002/2013JB010436.

Fathi Salmi E, Nazem M, Karakus M (2017) Numerical analysis of a large landslide induced by coal mining subsidence. *Engineering Geology* 217: 141-152 doi:10.1016/j.enggeo.2016.12.021.

Jones DL (2006) ‘A Complete Guide to Native Orchids of Australia Including the Island Territories’. New Holland, Sydney, Australia.

Jones DL, Clements MA (1997) Characterisation of *Pterostylis gibbosa* and description of *Pterostylis saxicola*. *The Orchadian* 12: 128-136, 144.

Kuiter RH, Findlater-Smith MJ (2017) ‘Overview of *Pterostylis* Pollination (Orchidaceae) in Victoria’. Aquatic Photographics, Seaford, Victoria, Australia.

Geological Survey of New South Wales (1952) Wollongong. 1:250,000 Geological Series Sheets SI 56-9 1st Edition. Bureau of Mineral Resources, Geology and Geophysics, Canberra, Australia.

Geological Survey of New South Wales (1956) Sydney. 1:250,000 Geological Series Sheets SI 56-5 & 6 1st Edition. Bureau of Mineral Resources, Geology and Geophysics, Canberra, Australia.

Geological Survey of New South Wales (1966a) Sydney. 1:250,000 Geological Series Sheets SI 56-5 3rd Edition. New South Wales Department of Mines, Sydney, Australia.

Geological Survey of New South Wales (1966b) Wollongong. 1:250,000 Geological Series Sheets SI 56-9 2nd Edition. New South Wales Department of Mines, Sydney, Australia.

Geological Survey of New South Wales (1969) Singleton. 1:250,000 Geological Series Sheets SI 56-1 1st Edition. New South Wales Department of Mines, Sydney, Australia.

Geological Survey of New South Wales (1985) 'Wollongong-Port Hacking 100K Geological Sheet 9029-9129'. NSW Department of Mineral Resources, Sydney, Australia.

Geological Survey of New South Wales (1991) 'Penrith 100K Geological Sheet 9035'. NSW Department of Minerals and Energy, Sydney, Australia.

Martyn J (2018) 'Rocks and Trees: A Photographic Journey through the Rich and Varied Geology, Scenery and Flora of the Sydney Region'. STEP Inc, Turramurra, NSW, Australia.

Müller RD, Flament N, Matthews KJ, Williams SE, Gurnis M (2016) Formation of Australian continental margin highlands driven by plate–mantle interaction. *Earth and Planetary Science Letters* 441: 60–70, http://dx.doi.org/10.1016/j.epsl.2016.02.025.

NPWS (2003) The Native Vegetation of the Warragamba Special Area. NSW National Parks and Wildlife Service, Sydney, Australia.

NSW Department of Planning and Environment (2018) NSW Seamless Geology. https://datasets.seed.nsw.gov.au/dataset/nsw-seamless-geology, downloaded 14/5/2019.

NSW Office of Environment and Heritage (2013) Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207. https://datasets.seed.nsw.gov.au/dataset/remnant-vegetation-of-the-western-cumberland-subregion-2013-update-vis_id-4207fd1f4 downloaded 14/5/2019.

NSW Office of Environment and Heritage (2014) Framework for Biodiversity Assessment: NSW Biodiversity Offsets Policy for Major Projects. NSW Office of Environment and Heritage, Sydney, Australia.

NSW Office of Environment and Heritage (2017) Biodiversity Assessment Method. NSW Office of Environment and Heritage, Sydney, Australia.

NSW Office of Environment and Heritage (2018) Sydney Plains Greenhood – profile. https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10705, downloaded 25/7/2018.

Pells PJN, Young A, Turner P (2014) On the establishment of acceptability criteria for subsidence impacts on the natural environment. Pp. 133-149 in Proceedings of the 9th Triennial Conference on Mine Subsidence. Mine Subsidence Technological Society, Australia.

(http://www.pellsconsulting.com.au/downloads/OntheEstablishmentofAcceptabilityCriteriaforSubsidenceImpactsontheNaturalEnvironment.pdf, downloaded 9/4/2019).

Phillips RD, Scaccabarozzi D, Retter BA, Hayes C, Brown GR, Dixon KW, Peakall R (2013) Caught in the act: pollination of sexually deceptive trap-flowers by fungus gnats in Pterostylis (Orchidaceae). *Annals of Botany* 113: 629–641.

Rasmussen HN (1995) "Terrestrial Orchids: From Seed to Mycotrophic Plant". Cambridge University Press, Cambridge, UK.

Sommerville KD, Siemon JP, Wood CB, Offord CA (2008) Simultaneous encapsulation of seed and mycorrhizal fungi for long-term storage and propagation of terrestrial orchids. *Australian Journal of Botany* 56: 609–615.

Tozer MG, Turner K, Keith DA, Tindall D, Pennay C, Simpson C, MacKenzie B, Beukers P, Cox S (2010) Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. *Cunninghamia* 11: 359–406.

Weston PH (unpublished a) Expert report on the Sydney Plains Greenhood, *Pterostylis saxicola* in the Greater Macarthur and Wilton Growth Areas. Report to Department of Planning and Environment for the Strategic assessment for Cumberland Plain Conservation Plan.

Weston PH (unpublished b) Expert report on the Sydney Plains Greenhood, *Pterostylis saxicola* in the Western Sydney Aerotropolis Growth Area, and Greater Penrith to Eastern Creek Urban Release Investigation Area. Report to Department of Planning and Environment for the Strategic assessment for Cumberland Plain Conservation Plan.

Weston PH, Perkins AJ, Entwisle TJ (2005) More than symbioses: orchid ecology, with examples from the Sydney Region. *Cunninghamia* 9: 1–15.

Weston PH, Perkins AJ, Indsto JO, Clements MA (2014) Phylogeny of Orchidaceae tribe Diurideae and its implications for the evolution of pollination systems. Pp. 91-154 in Edens-Meier R, Bernhardt P (eds) 'Darwin's Orchids: Then and Now'. University of Chicago Press, Chicago, Ill, USA.

8. Appendices

8.1 Appendix 1: Characterisation of habitat at selected sites

The tables on following pages record data that I collected at sites outside the survey area. Each site was centred on an arbitrarily selected plant of *Pterostylis saxicola*, or at a precisely specified latitude and longitude at which *P. saxicola* had been recorded. At each site the precise latitude and longitude, elevation, substrate, and soil description, were recorded. Also, at each site all plant species that could be reliably identified were recorded within a radius of 30 metres. Locations at which *P. saxicola* has been recorded by me and/or others have had their latitudes and longitudes transformed to the nearest 10 minutes.

Site	Location	Latitude	Longitude	Elevation (m)	Substrate
PS1	Old Schofield Trail, Scheyville National Park	33°40'S	150°50'E	70	Ashfield Shale
PS2	Simmos Beach Recreation Reserve Macquarie Fields	34°00'S	150°50'E	45	Hawkesbury Sandstone
PS3	Simmos Beach Recreation Reserve Macquarie Fields	34°00'S	150°50'E	43	Hawkesbury Sandstone
PS4	Boronia Rd Reserve, Peter Meadows Creek, Kentlyn	34°00'S	150°50'E	98	Hawkesbury Sandstone
PS5	Amberdale Reserve, Picnic Point	34°00'S	151°00'E	36	Hawkesbury Sandstone
PS6	Hawkesbury High School, Freemans Reach	33°30'S	150°50'E	40	Ashfield Shale
PS7	Mitchell Park Road, Cattai	33°30'S	150°50'E	25	Ashfield Shale-Mittagong Formation-Hawkesbury Sandstone
PS8	Euroka Road, The Ironbarks	33°50'S	150°40'E	170	Ashfield Shale-Mittagong Formation-Hawkesbury Sandstone
PS9	Gingra Range, Kanangra-Boyd National Park	34°00'S	150°10'E	435	Lambie Formation

Site	Soil description	Vegetation structure (canopy)	Vegetation structure (understorey)	PCT (my identification)
PS1	brown clay-loam	Dry sclerophyll forest	sparse shrubby understory	849
PS2	brown sand	Dry sclerophyll woodland	moderately dense shrubby understory	1081
PS3	dark brown humus-rich sand	dry sclerophyll forest	moderately dense shrubby understory	1081
PS4	dark brown humus-rich sand	Dry sclerophyll woodland	moderately dense shrubby understory under dense subcanopy	1081
PS5	dark brown humus-rich sand	Dry sclerophyll woodland	moderately dense shrubby understory	1181
PS6	red-brown clay with lateritic pebbles	dry sclerophyll forest	grassy, sparsely to densely shrubby understory	849
PS7	fine, mid-brown sand	dry sclerophyll forest	grassy, moderately to densely shrubby understory	1395
PS8	brown clay-loam	dry sclerophyll forest	moderately dense shrubby understory	1395
PS9	Dark brown clay-loam	dry sclerophyll forest	grassy, sparsely to densely shrubby understory	870

Appendix 1a: Environmental data for sites visited as part of this study

Associated species	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9
Acacia falcata	0	0	0	0	0	0	0	1	0
Acacia falciformis	0	0	0	0	0	0	0	0	1
Acacia floribunda	0	0	0	0	0	0	1	0	0
Acacia implexa	0	0	0	1	0	0	0	1	0
Acacia linifolia	0	1	1	0	1	0	0	0	0
Acacia parvipinnula	0	0	0	0	0	0	0	1	0
Acacia suaveolens	0	0	0	0	1	0	0	0	0
Acacia terminalis	0	1	1	0	1	0	0	0	0
Acacia ulicifolia	0	0	1	0	1	0	0	0	0
Acrotriche divaricata	0	0	0	1	0	0	0	0	0
Adiantum aethiopicum	0	0	0	0	0	0	0	0	1
Allocasuarina littoralis	0	0	0	1	1	0	1	0	0
Allocasuaruna torulosa	0	0	0	0	0	0	0	1	1
Angophora bakeri	0	1	1	1	1	0	1	0	0
Angophora costata	0	0	0	0	1	0	0	0	0
Angophora floribunda	0	0	0	0	0	0	0	0	1
Aristida ramosa	?	?	?	?	?	1	0	0	1
Aristida vagans	?	?	?	?	?	1	0	1	0
Arthropodium milleflorum	0	0	0	0	0	1	0	0	1
Asplenium flabellifolium	0	0	0	0	0	0	0	0	1
Astroloma pinifolium	0	0	0	0	1	0	0	0	0
Banksia serrata	0	0	0	0	1	0	0	0	0
Banksia spinulosa	0	1	1	1	1	0	0	0	0
Billardiera scandens	0	0	0	0	0	0	0	1	1
Brachyloma daphnoides	0	0	1	0	0	0	0	0	0
Brachyscome graminea	0	0	0	0	0	0	0	1	1
Breynia oblongifolia	1	0	0	0	0	1	0	0	0
Brunoniella australis	1	0	0	0	0	1	0	1	0
Bursaria spinosa	1	0	0	0	0	1	1	1	1
Calandrinia pickeringii	?	?	?	?	?	0	1	0	0
Calotis dentex	0	0	0	0	0	0	0	1	0
Cassytha sp.	0	0	0	0	0	0	0	1	0
Cheilanthes sieberi	1	1	0	1	0	1	1	1	1
Clematis aristata	0	0	0	0	0	0	?	0	1
Commelina cyanea	?	?	?	?	?	0	1	0	0
Commelina ensifolia	?	?	?	?	?	1	0	0	0

Appendix 1b (continued on following page): Data on presence (1) or absence (0) of associated species for sites characterised as part of this study.

Associated species	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9
Coronidium scorpioides	0	0	0	0	0	0	0	0	1
Corymbia gummifera	0	0	0	1	1	0	0	0	0
Crassula sieberiana	?	?	?	?	?	0	1	0	0
Cymbidium suave	0	0	0	0	0	0	1	0	0
Daviesia ulicifolia	1	0	0	0	0	1	0	0	0
Daviesia squarrosa	0	0	0	0	0	0	0	1	0
Desmodium brachypodium	0	0	0	0	0	0	0	0	0
Desmodium gunnii	0	0	0	0	0	0	0	0	1
Desmodium rhytidophyllum	0	0	0	0	0	1	0	1	0
Dianella longifolia var. *stenophylla*	?	?	?	?	?	0	1	?	0
Dichondra repens	1	0	0	0	0	1	1	0	1
Dillwynia sieberi	1	0	0	0	0	0	0	0	0
Dodonaea triquetra	0	0	0	0	1	0	0	1	0
Doodia aspera	0	0	0	0	0	0	0	0	1
Echinopogon sp.	?	?	?	?	?	0	0	1	0
Einadia hastata	?	?	?	?	?	1	1	0	0
Entolasia stricta	0	0	0	0	0	0	1	1	1
Eremophila debilis	1	0	0	0	0	0	0	0	0
Eriostemon australasius	0	0	0	1	0	0	0	0	0
Eucalyptus beyeriana	0	0	0	0	0	0	0	1	0
Eucalyptus crebra	1	0	0	0	0	1	0	0	1
Eucalyptus eugenioides	0	0	0	0	0	0	0	0	1
Eucalyptus fibrosa	0	0	0	0	0	0	0	1	0
Eucalyptus globoidea	0	0	0	0	0	0	1	0	0
Eucalyptus moluccana	1	0	0	0	0	0	0	0	0
Eucalyptus piperita	0	0	0	0	1	0	0	0	0
Eucalyptus punctata	0	0	1	1	1	0	1	1	1
Eucalyptus sclerophylla	0	1	1	1	0	0	0	0	0
Eucalyptus sparsifolia	0	1	0	0	0	0	0	1	0
Eucalyptus tereticornis	0	0	0	0	0	1	1	0	1
Exocarpos cupressiformis	1	0	0	0	1	0	0	0	0
Exocarpos strictus	0	0	1	1	1	0	0	0	1

Appendix 1b (continued from previous page): Data on presence (1) or absence (0) of associated species for sites characterised as part of this study.

Associated species	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9
Glycine tabacina	0	0	0	0	0	1	1	0	1
Glycine clandestina	0	0	0	0	0	0	1	1	0
Gompholobium grandiflorum	0	1	0	0	0	0	0	0	0
Goodenia hederacea	0	0	1	0	0	1	1	0	0
Grevillea sericea	0	0	0	0	1	0	0	0	0
Grevillea sphacelata	0	1	1	0	0	0	0	0	0
Hakea laevipes	0	1	1	1	0	0	0	0	0
Hakea sericea	0	1	1	1	1	0	0	0	0
Hardenbergia violacea	1	0	0	0	0	1	0	0	0
Hibbertia aspera	0	0	0	0	0	0	0	1	0
Hibbertia diffusa	?	?	?	?	?	1	1	1	0
Hibbertia obtusifolia	0	0	0	0	0	0	0	0	1
Hypericum gramineum	0	0	0	0	0	0	0	0	1
Hypoxis hygrometrica	?	?	?	?	?	0	0	1	0
Imperata cylindrica	0	0	0	0	0	0	1	0	0
Indigofera australis	0	0	0	0	0	0	0	0	1
Isopogon anemonifolius	0	1	1	1	0	0	0	0	0
Jacksonia scoparia	0	0	0	1	0	0	0	0	0
Kunzea ambigua	0	1	1	1	1	0	1	0	0
Lagenophora gracilis	0	0	0	0	0	0	0	1	1
Lagenophora stipitata	0	0	0	0	0	1	1	0	0
Lambertia Formosa	0	1	1	0	1	0	0	0	0
Laxmannia gracilis	?	?	?	?	?	0	1	0	0
Lepidosperma laterale	0	0	0	0	0	0	1	1	1
Leptospermum parvifolium	0	1	0	0	0	0	0	0	0
Leptospermum trinervium	0	1	1	1	1	0	1	0	0
Leucopogon juniperinus	0	0	0	0	0	0	0	0	1
Lissanthe strigosa	0	0	0	1	0	0	0	1	0
Lobelia purpurascens	?	?	?	?	?	1	1	1	1
Lomandra longifolia	0	0	0	0	1	0	1	0	1
Lomandra multiflora	0	0	0	0	0	0	1	1	1
Lomandra obliqua	0	1	1	1	1	0	0	0	0
Lomatia silaifolia	0	0	0	0	1	0	0	0	0
Macrozamia spiralis	0	0	0	1	0	0	0	0	0
Melaleuca nodosa	0	0	1	0	1	0	0	0	0
Microlaena stipoides	?	?	?	?	?	1	1	0	0

Appendix 1b (continued from previous page): Data on presence (1) or absence (0) of associated species for sites characterised as part of this study.

Associated species	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9
Monotoca scoparia	0	0	1	1	1	0	0	0	0
Notelaea longifolia	0	0	0	0	1	0	0	0	1
Olearia viscidula	0	0	0	0	0	0	0	0	1
Opercularia diphylla	?	?	?	?	?	1	1	1	1
Oplismenus imbecilis	?	?	?	?	0	0	1	0	0
Oxalis perennans	?	?	?	?	?	0	1	0	1
Ozothamnus diosmifolius	1	0	1	0	0	1	0	1	0
Pandorea pandorana	0	0	0	0	0	0	0	0	1
Panicum simile	?	?	?	?	?	0	0	1	0
Parsonsia straminea	0	0	0	0	0	0	1	0	0
Pellaea falcata	0	0	0	0	0	0	0	0	1
Persoonia levis	0	1	1	1	1	0	0	0	0
Persoonia linearis	0	0	1	1	1	0	0	1	1
Petrophile sessilis	0	1	0	1	1	0	0	0	0
Phyllanthus hirtellus	0	0	0	0	0	0	0	1	0
Pittosporum undulatum	0	0	0	0	1	0	0	0	0
Plantago debilis	?	?	?	?	?	1	0	0	1
Plectranthus sp.	0	0	0	0	0	1	0	0	1
Pomax umbellata	0	0	0	0	0	0	0	1	0
Pteridium esculentum	0	0	0	0	1	0	0	0	0
Pterostylis saxicola	1	?	1	?	?	1	?	?	?
Pultenaea villosa	0	0	0	0	0	0	0	1	0
Ricinocarpos pinifolius	0	0	0	0	1	0	0	0	0
Sigesbeckia orientalis	0	0	0	0	0	0	0	0	1
Solanum prinophyllum	1	0	0	0	0	1	1	1	1
Stellaria pungens	0	0	0	0	0	0	0	0	1
Stylidium laricifolium	0	0	0	1	0	0	0	0	0
Stypandra glauca	0	0	0	0	0	0	0	0	1
Themeda triandra	0	0	0	0	0	1	1	0	0
Tricoryne elatior	?	?	?	?	?	1	1	0	0
Tylophora barbata	0	0	0	0	0	0	0	0	1
Viola hederacea	?	?	?	?	?	0	1	0	0
Xanthorrhoea concava	0	0	0	0	1	0	0	0	0
Xanthorrhoea media	0	1	1	0	1	0	0	1	0
Xanthosia pilosa	0	0	0	0	1	0	0	0	0

Appendix 1b (continued from previous page): Data on presence (1) or absence (0) of associated species for sites characterised as part of this study.

8.2 Appendix 2: Peter Weston's curriculum vitae

Personal details

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Academic Qualifications

i) **B.Sc.** (first class honours; equal first in order of merit) School of Biological Sciences, University of Sydney; 1975-78, conferred 7 April 1979.
Thesis title: "The evolution and classification of *Boronia* Sm."

ii) **Ph.D.**, School of Biological Sciences, University of Sydney, 1979-83; conferred 18 May 1985.
Thesis title: "Systematics and biogeography of the Persooniinae (Proteaceae)".

Awards, Fellowships and Scholarships

2014	Nancy Burbidge Medal (awarded by the Australasian Systematic Botany Society to a person who has made a longstanding and significant contribution to Australasian systematic botany. It is the foremost award that can be conferred by ASBS).
2014	Australian Biological Resources Study-sponsored Winston Churchill Fellowship for an established career researcher in taxonomy.
2009	Grady L. Webster Structural Botany Publication Award for 2008 and 2009 from the Botanical Society of America. The BSA component of the award (it is awarded in alternate years by the BSA and the American Society of Plant Taxonomists) recognizes the most outstanding paper published in the *American Journal of Botany* in the field of structural and developmental botany (i.e., anatomy and morphology) over a two-year period. It was awarded to Gregory J. Jordan, Peter H. Weston, Raymond J. Carpenter, Rebecca A. Dillon and Timothy J. Brodribb for: "The evolutionary relations of sunken, covered, and encrypted stomata to dry habitats in Proteaceae," American Journal of Botany, Volume 95, Issue 5; May 2008.
2006	Carrick Award for Australian University Teaching from the Australian Learning and Teaching Council (one of five members of a teaching team from the University of New England cited for Outstanding Contributions to Student Learning).
1992-93	Posting to Royal Botanic Gardens, Kew, as Australian Botanical Liaison Officer.
1982	Charles Gilbert Heydon Travelling Fellowship for the biological sciences (not taken up).
1980-82	University of Sydney Postgraduate Scholarship.

1979-82	Commonwealth Postgraduate Award.
1977	G.S. Caird Scholarship for Third Year Botany, University of Sydney.
1976	Slade Prize for Practical Plant Biology, University of Sydney.

Employment

Present Position: Honorary Research Associate, National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust, Sydney and independent botanical consultant.

Previous positions held:
2008-2016 Senior Principal Research Scientist, National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust, Sydney.

2000-2008 Principal Research Scientist, National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust, Sydney.

1994-2000 Senior Research Scientist, National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust, Sydney.

1989-1994 Research Scientist, National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust, Sydney.

1982-1989 Scientific Officer, National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust, Sydney.

1979-82 Part-time demonstrator, School of Biological Sciences, University of Sydney.

Adjunct and visiting university appointments

2018-	Visiting Fellow, Western Sydney University.
2013-	Adjunct Associate Professor, La Trobe University.
2011-2016	Adjunct Associate Professor, University of New South Wales.
2006	Visiting Lecturer, Rhodes University, Grahamstown, South Africa.
2004-2009	Adjunct Associate Professor, University of New England.
2000-2004	Adjunct Senior Lecturer, University of New England.

Administrative/management experience

2009	Acting Manager Plant Diversity
2002-2003	Member, Plant Diversity Research Program Leaders Committee
1998-99	Systematics Liaison Officer
1997-98	Member RBGS Market testing working party
1997	Member, RBGS advisory committee for restructuring senior management
1990-91	Systematics Co-ordinator
1996-98	Member, RBGS Joint Consultative Committee

Membership of Learned Societies

1996-	Society of Australian Systematic Biologists
1984-	Willi Hennig Society (Elected Fellow, 1992-, Council member, 1998-2000)
1979-	Society of Systematic Biologists (member, Editorial Board 1993-95)

1978- Australasian Systematic Botany Society (formerly Australian Systematic Botany Society: President, 2009-2012, Vice President, 2008-2009, Chairman, Hansjörg Eichler Research Fund Committee, 1998-2002, Council member, 1996-2002)

Membership of External Committees

2015- Financial Grants Standing Committee (formerly the Grants Policy Standing Committee) of the Australasian Systematic Botany Society

2012-2013 Conference Organising Committee of *Systematics Without Borders*, a joint conference of the Australasian Systematic Botany Society, Society of Australian Systematic Biologists and Invertebrate Biodiversity and Conservation, University of Sydney (Chairman)

2011- Editorial Board, *Phytotaxa*

2008-2009 Corresponding Member, Editorial Advisory Committee, *Australian Systematic Botany*

2006-2014 Ira Butler Memorial Trophy Committee (a joint committee of the Australasian Native Orchid Society and the Orchid Society of New South Wales) (Chairman)

2004- Editorial Advisory Board, *Kew Bulletin*

2001-2006 Panel of Judges, Eureka Prize for Biodiversity Research

2000-2012 Bushland Management Advisory Committee, Lane Cove Council (Chairman, 2008-2010)

1999-2004 Editorial Advisory Committee, *Australian Systematic Botany*

Spoken presentations at conferences (not including presentations delivered by others)

2015 Building Our Botanical Capital, annual conference of the Australasian Systematic Botany Society: “A database of variation in floral characters in the Proteaceae, and implications for key questions in floral evolution”.

2014 Next Generation Systematics, annual conference of the Australasian Systematic Botany Society: Nancy Burbidge Memorial Lecture: “Problems and progress in plant systematics since Nancy Burbidge”

2013 Genetics Society of Australasia conference, Sydney *Genetics in the Harbour City*: “Molecular phylogeny of the subtribe Hakeinae (Green Plants: Proteaceae tribe Embothrieae) and its implications”.

2013 Joint conference of the Australasian Systematic Botany Society, Society of Australian Systematic Biologists and Invertebrate Biodiversity and Conservation, Sydney, *Systematics Without Borders*: “Molecular phylogeny of the subtribe Hakeinae (Green Plants: Proteaceae tribe Embothrieae) and its implications”.

2012 Australasian Systematic Botany Society conference, Perth, *Local knowledge, global delivery*: “Contested, Uncontested and Potentially Controversial Taxonomic Changes in the Proteaceae: How Do They Differ?”

2011 37th annual conference of the South African Association of Botanists, *Plants in a Changing World* and 9th conference of the South African Society of Systematic Biologists, *Biodiversity Matters*; plenary address: “Cenozoic environmental change and the systematics of southern hemisphere plants”

2011 XVIII International Botanical Congress, Melbourne: “Floral evolution in animal-pollinated Australian angiosperm clades: patterns and potential explanations”.

2010 VI Southern Connection Congress, Bariloche: “Cladistic biogeography, molecular dating, fossils and the Proteaceae”

2010 VI Southern Connection Congress, Bariloche: “Diversification of the Proteaceae in Mediterranean hotspots of the Southern Hemisphere and in tropical rainforests”

2010 Australian Systematic Botany Society conference *Systematic Botany Across the Ditch: Links Between Australia and New Zealand*; Keynote address: “Cenozoic environmental change and the systematics of southern hemisphere plants”
1999 XVI International Botanical Congress, Saint Louis: “Historical biogeography of Proteaceae”.
1997 II Southern Connection Congress, Valdivia: “Cladistic biogeography of a key woody group: Proteaceae”.
1997 First Biennial International Conference of the Systematic Association, Oxford: “Rolf Sattler’s Plant Morphology and Cladistic Analysis”.
1996 *An International Symposium on the Biology of Proteaceae*, Melbourne: “ITS squence variation in the Proteaceae and what it tells us about phylogeny”.
1993 Joint conference of The Systematics Associations and The Linnean Society on *Models in Phylogeny Reconstruction*, London: “Direct methods for polarising character transformation series”.
1990 IXth meeting of the Willi Hennig Society, Canberra: “Transoceanic cladistic patterns in the Proteaceae”.
2003 The Third International Conference on *the Comparative Biology of the Monocotyledons*, Ontario: “Co-evolution of *Chiloglottis* (Orchidaceae) and its Thynnine wasp pollinators”.
2005 XVII International Botanical Congress, Vienna: “Food is good but sex is better: the evolution of deceptive pollination in the tribe Diurideae (Orchidaceae)”.
2006 Australian Systematic Botany Society conference, Cairns, *Plant Diversity in the Tropics*: “A new suprageneric classification of the Proteaceae”.
2007 5th Southern Connection Congress, Adelaide: “‘I’m not dead yet’ – Gondwana (the Proteaceae are at least partially congruent with Gondwanic fragmentation)”.
1989 Australian Systematic Botany Society symposium, on *Gondwanan Elements in the Australian Flora*, Sydney: “Transpacific cladistic patterns in the Proteaceae and Elaeocarpaceae”.
1988 Symposium on *Panbiogeography of New Zealand*, Wellington: “Problems with the statistical testing of panbiogeographic hypotheses”.
1985 Australian Flora Foundation Symposium on *Waratahs*, Canberra: “Drifting waratahs or continents?”
1984 Australian Systematic Botany Society symposium on *Cladistics, Systematics and Phylogeny*, Canberra: “A reappraisal of Nelson's direct method of character analysis”.

Refereeing manuscripts, grant applications, reports and examining postgraduate theses (last five years)

2018: *Candollea*; *Flora of the Hunter Region*; *Journal of Biogeography.*
2017: *Australian Systematic Botany*; *Evolution*; *New Zealand Journal of Botany*; *Nuytsia*; *South African Journal of Botany.*
2016: *Australian Systematic Botany*; *Botanical Journal of the Linnean Society*, *National Research Foundation* (South Africa).
2015: *American Journal of Botany*; Australian Research Council (4); *Australian Systematic Botany*; *Muelleria*; *Nuytsia*; *Phytotaxa*; *PLOS One*; *Telopea* (6).
2014: Australian Research Council (3); *Australian Systematic Botany* (2); *Cunninghamia*; *Journal of Biogeography* (2); *Muelleria*; National Research Foundation (South Africa); *Orchadian*; *Perspectives in Plant Ecology, Evolution and Systematics*; *Plant Systematics and Evolution*; *Telopea* (3).

Research

My research has been in the theoretical and practical aspects of systematic botany, with emphasis on the theory and practice of phylogenetic analysis, and the broader uses to which phylogenetic knowledge may be applied. I have phylogenetically analysed groups in the plant families Proteaceae, Fabaceae, Orchidaceae, Rutaceae, Winteraceae and Lauraceae, contributed to more general analyses of angiosperm phylogeny, and used the results of these analyses to improve biological classification and to test theories of historical biogeography, trait evolution, co-evolution and adaptation. I have earned an international reputation for my contributions to both theoretical and empirical developments in this field.

Herbarium curation and collections

My curatorial responsibilities at the National Herbarium of New South Wales have included the families Rutaceae (1982-1998), Proteaceae (1982-2016), Orchidaceae (1986-2016) and Fabaceae subfamily Faboideae (1986-2016). I have collected plant specimens (mostly angiosperms) in Australia, England, New Zealand, New Caledonia, Chile, South Africa, and Argentina, mostly for the herbarium and living collections of the Royal Botanic Gardens and Domain Trust, Sydney. Duplicates of my collections have been distributed to over 20 herbaria in 8 different countries.

Teaching

I have been actively involved in the preparation and teaching of four third year undergraduate courses in biosystematics:
Western Sydney University (2015-2018): “Principles of Evolution” (unit 300980), “Botany” (unit 300836).
University of New South Wales (2010-2016): “Assembling the Tree of Life” (BIOS3221)
University of New England (2000-2010): Biosystematics (Biosyst 301, Biosyst 302, Evol 301/501).
Botany Department, Rhodes University, Grahamstown, South Africa (February-March 2006): “Plant Biodiversity” course in collaboration with Associate Professor Nigel Barker.

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I have examined 14 honours and postgraduate theses:
Australian National University (Ph.D., 2003, 2007, 2008)
University of Melbourne (Ph.D., 1995, 2011)
University of Newcastle (M.Phil., 2003)
University of Queensland (Ph.D., 2003)
University of Sydney (Ph.D., 1991, 1994, 1997, 2009)
University of Wollongong (B.Sc. Hons., 2001, 2003)
Victoria University (Ph.D., 2007)

Competitive Research and Infrastructure Grants

Peakall, R., Pichersky, E., Linde, C., Weston, P.H. (2015-2019) The biosynthesis and evolution of novel semiochemicals in orchids. $644,800, Australian Research Council Discovery Grant DP150102762.

Hoebee, S.E., Weston, P.H., & Edwards, T.J. (2015-19) Evolution in action or the demise of iconic Australian flora? $217,700, Australian Research Council Discovery Grant DP150100508.

He, T., Lamont, B., Weston, P.H., & Cowling, R. (2012-2014) Origin and evolution of plant functional traits in relation to fire. $310,000, Australian Research Council Discovery Grant DP120103389.

Rossetto, M., Crayn, D.M. & Weston, P.H. (2008-2010) Integrating molecular and morphological data for generic delimitation and species identification in Lauraceae. $73,333, Australian Biological Resources Study.

Cantrill, D., Murphy, D. & Weston, P.H. (2008-10) Understanding the origins of the Australian flora by integrating molecular phylogenies and fossil data in the Proteaceae. $88,900, Hermon Slade Foundation.

Rossetto, M. & Weston, P.H. (2007-2009) Speciation in the Australian flora: testing explanatory hypotheses in waratahs and their allies. $78,000, Hermon Slade Foundation.

Considine, J.A., Krauss, S.L. & Weston, P.H. (2002-2004) A biological basis for the efficient breeding of native plants for export markets: a case study with the Australian Goodeniaceae. $168,126, ARC – Linkage (Krauss and Weston representing industry partners)

Whelan, R.J., Ayre, D.J., England, P., Auld, T.D., & Weston, P.H. (2000-2002) Ecology and genetics of fire-sensitive *Persoonia* species: threatened species recovery and management. $126,480, Australian Research Council (ARC– SPIRT, Auld and Weston representing industry partners).

Trent, R. *et al.* (2000) Enhancement of DNA sequencing equipment for the Sydney University and Prince Alfred Molecular Analysis Centre. $600,000, Australian Research Council (ARC-REIF).

Weston, P.H. (1999-2001) Comparative biology of *Chiloglottis* (Orchidaceae) and its thynnine wasp pollinators (Tiphiidae). $75,000, Hermon Slade Foundation.

Weston, P.H. (1997-2000) Taxonomic revision of *Dillwynia* (Fabaceae: Faboideae: Mirbelieae). $62,836, Australian Biological Resources Study.

Weston, P.H. & Thomson, J.A. (1993) A molecular approach to the evolution and biogeography of the Queensland tree waratahs. $4000, Queensland Wet Tropics Management Authority

Weston, P.H. & Thomson, J.A. (1991-92) A molecular approach to the evolution and biogeography of the waratahs. $80,100, Australian Research Council (large grants scheme).

Weston, P.H. (1984) Establishment of a data bank for eucalypt specimens held by NSW. $20,000, Australian Biological Resources Study.

Scientific Publications

[the numbers in square brackets following a reference indicates: 1. the journal's 2016-17 impact factor according to ISI Web of Knowledge, then the number of literature citations for the paper found by Google Scholar, as of 13 Feb 2019]

H-index = 34, total number of citations = 4081 as of 13 Feb 2019

1. Craw, R.C. & **Weston, P.H.** (1984) Panbiogeography: a progressive research program? *Systematic Zoology* 33: 1-13. [8.917, 90]

2. **Weston, P.H.**, Carolin, R.C., & Armstrong, J.A. (1984) A cladistic analysis of *Boronia* Sm. and *Boronella* Baill. (Rutaceae). *Australian Journal of Botany* 32: 187-203. [0.793, 49]

3. Morrison, D.A. & **Weston, P.H.** (1985) Analysis of morphological variation in a field sample of *Caladenia catenata* (Smith) Druce (Orchidaceae). *Australian Journal of Botany* 33: 185-195. [0.793, 11]

4. Crisp, M.D. & **Weston, P.H.** (1987a) Waratahs - how many species? Pp. 3-15, in J.A. Armstrong (ed.) *Waratahs, Their Biology, Cultivation and Conservation* (Australian National Botanic Gardens: Canberra). [-, 13]

5. Crisp, M.D. & **Weston, P.H.** (1987b) Cladistics and legume systematics, with an analysis of the Bossiaeeae, Brongniartieae and Mirbelieae. Pp. 65-130, in C.H. Stirton (ed.) *Advances in Legume Systematics Part 3* (Royal Botanic Gardens: Kew). [-, 131]

6. **Weston, P.H.** (1987) *Persoonia* (Proteaceae). Pp. 348-350, in N.G. Marchant *et al*. (eds.) *Flora of the Perth Region* (Western Australian Herbarium: Perth). [-, 0]

7. **Weston, P.H.** & Crisp, M.D. (1987) Evolution and biogeography of the Waratahs. Pp. 17-34, in J.A. Armstrong (ed.) *Waratahs, Their Biology, Cultivation and Conservation* (Australian National Botanic Gardens: Canberra). [-, 14]

8. **Weston, P.H.**, Wilson, P.G., & Hill, K.D. (1987) Identification of *Cannabis*. *Department of Agriculture New South Wales Miscellaneous Bulletin* 25: 148-150. [-, 0]

9. **Weston, P.H.** (1988a) A revision of *Hicksbeachia* (Proteaceae). *Telopea* 3: 231-239. [0.6, 3]

10. **Weston, P.H.** (1988b) Indirect and direct methods in systematics. Pp. 27-56, in C.J. Humphries (ed.) *Ontogeny and Systematics* (Columbia Univ. Press: New York). [-, 76]

11. **Weston, P.H.** (1989) Problems with the statistical testing of panbiogeographic hypotheses. *New Zealand Journal of Zoology* 16: 511. [0.811, 7]

12. **Weston, P.H.** (1990) Notes on *Boronia* (Rutaceae) in New South Wales, including descriptions of three new species. *Telopea* 4: 121-128. [0.6, 6]

13. **Weston, P.H.** & Johnson, L.A.S. (1991) Taxonomic changes in *Persoonia* (Proteaceae) in New South Wales. *Telopea* 4: 269-306. [0.6, 9]

14. Crisp, M.D. & **Weston, P.H.** (1991) *Almaleea*, a new genus of Fabaceae from south-eastern Australia. *Telopea* 4: 307-311. [0.6, 10]

15. **Weston, P.H.** & Crisp, M.D. (1991) *Alloxylon* (Proteaceae), a new genus from New Guinea and eastern Australia. *Telopea* 4: 497-507. [0.6, 12]

16. **Weston, P.H.** (1991) Key to genera, *Persoonia* (Proteaceae), *Medicago*, *Trifolium*, *Pultenaea* and *Dillwynia* (Fabaceae). Pp. 2-19, 452-455, 456-461, 481-497, 499-504, in G. Harden (ed.) *Flora of New South Wales* vol. 2 (New South Wales Univ. Press: Sydney). [-, 0]

17. **Weston, P.H.** & Crisp, M.D. (1991) *Alloxylon* (Proteaceae) and *Almaleea* (Fabaceae). Pp. 29-30, 497-498, in G. Harden (ed.) *op. cit.* [-, 0]

18. **Weston, P.H.** & Porteners, M.F. (1991) *Boronia*, *Eriostemon* and *Phebalium* (Rutaceae). Pp. 227-236, 250-254, 255-263, in G. Harden (ed.) *op. cit.* [-, 0]

19. Porteners, M.F. & **Weston, P.H.** (1991) *Correa* and *Crowea* (Rutaceae). Pp. 247-249, 254-255, in G. Harden (ed.) *op. cit.* [-, 0]

20. Crisp, M.D. & **Weston, P.H.** (1991) *Telopea*. Pp. 30-31, in G. Harden (ed.) *op. cit.* [0.6, 0]

21. Gross, C.L. & **Weston, P.H.** (1992) *Macadamia jansenii* (Proteaceae), a new species from central Queensland. *Australian Systematic Botany* 5: 725-28. [0.75, 8]

22. Crisp, M.D. & **Weston, P.H.** (1993) Geographic and ontogenetic variation in morphology of Australian waratahs (*Telopea*: Proteaceae). *Systematic Biology* 42: 49-76. [14.387, 76]

23. Gilmore, S., **Weston, P.H.**, & Thomson, J.A. (1993) A simple, rapid, inexpensive and widely applicable technique for purifying plant DNA. *Australian Systematic Botany* 6: 139-148. [0.75, 41]

24. **Weston, P.H.** (1993) Key to genera, *Cyrtostylis*, *Cryptostylis*, *Zeuxine*, *Cheirostylis*, *Pseudovanilla*, *Erythrorchis*, *Epipogium*, *Gastrodia*, *Oberonia*, *Liparis*, *Dendrobium*, *Calanthe*, *Phaius*, *Geodorum*, *Dipodium*, *Cymbidium*, *Sarcochilus*, *Rhinerrhiza*, *Peristeranthus*, *Papillilabium*, *Schistotylus*, *Plectorrhiza*, *Taeniophyllum* (Orchidaceae). Pp. 134-138, 218-219, 219-221, 221-233, 236-247, in G. Harden (ed.) *Flora of New South Wales* vol. 4 (New South Wales Univ. Press: Sydney). [-, 0]

25. **Weston, P.H.** & Hill, K.D. (1993) *Bulbophyllum* (Orchidaceae). Pp. 233-236, in G. Harden (ed.) *op. cit.* [-, 0]

26. **Weston, P.H.** & Crisp, M.D. (1994) Cladistic biogeography of Waratahs and their allies (Embothrieae: Proteaceae) across the Pacific. *Australian Systematic Botany* 7: 225-249. [0.75, 73]

27. **Weston, P.H.** (1994) The Western Australian species of subtribe Persooniinae (Proteaceae: Persoonioideae: Persoonieae). *Telopea* 6: 51-165. [0.6, 19]

28. **Weston, P.H.** & Johnson, L.A.S. (1994) Three new species of *Persoonia* (Proteaceae) from Queensland. *Telopea* 6: 31-37. [0.6, 1]

29. **Weston, P.H.** (1994) Methods for rooting cladistic trees. Pp. 125-155, in D.J. Siebert, R.W. Scotland and D.M. Williams (eds.) *Models in Phylogeny Reconstruction* (Oxford Univ. Press: Oxford). [-, 38]

30. Crisp, M.D. & **Weston, P.H.** (1995) Mirbelieae. Pp. 245-282, in J.J. Doyle and M.D. Crisp (eds.) *Advances in Legume Systematics Part 7: Phylogeny* (Royal Botanic Gardens: Kew). [-, 37]

31. Crisp, M.D. & **Weston, P.H.** (1995) Subtribe Embothriinae (Proteaceae). *Flora of Australia* 16: 382-390. [-, 0]

32. Crisp, M.D., Linder, H.P. & **Weston, P.H.** (1995) Cladistic biogeography of plants in Australia and New Guinea: congruent pattern reveals two endemic tropical tracks. *Systematic Biology* 44: 457-473. [8.917, 121]

33. Thomson, J.A., **Weston, P.H.** & Tan, M.K. (1995) A molecular approach to tracing the major lineages in *Pteridium*. Pp. 21-28, in R.T. Smith and J.A. Taylor (eds.) *Bracken: an Environmental Issue* (University of Leeds: Leeds). [-, 13]

34. **Weston, P.H.** (1995) Key to the genera of Proteaceae in Australia, Subfamily Persoonioideae, Subfamily Bellendenoideae, Subtribe Gevuininae, Subtribe Hicksbeachiinae. *Flora of Australia* 16: 41-46, 47-125, 125-127, 409-410. [-, 0]

35. Bernhardt, P. & **Weston, P.H.** (1996) The pollination ecology of *Persoonia* (Proteaceae) in eastern Australia. *Telopea* 6: 775-804. [0.6, 48]

36. **Weston, P.H.** & Crisp, M.D. (1996) Trans-Pacific biogeographic patterns in the Proteaceae. Pp. 215-232, in A. Keast & S.E. Miller (eds.) *The Origin and Evolution of Pacific Island Biotas, New Guinea to Eastern Polynesia: Patterns and Processes* (SPB Academic Publishing: Amsterdam). [-, 34]

37. **Weston, P.H.** & Johnson, L.A.S. (1997) *Persoonia hindii* (Proteaceae), a new species from the Newnes Plateau, New South Wales. *Telopea* 7: 199-203. [0.6, 6]

38. Jobson, P.C. & **Weston, P.H.** (1998) *Dillwynia glaucula* (Fabaceae: Mirbelieae), a new species from the Southern Tablelands, New South Wales. *Telopea* 8: 1-5. [0.6, 1]

39. **Weston, P.H.** (1999) *Persoonia pauciflora* (Proteaceae), a new species from the Hunter Valley, New South Wales. *Telopea* 8: 159-164. [0.6, 5]

40. Crisp, M.D., Gilmore, S.R. & **Weston, P.H.** (1999) The phylogenetic relationships of two anomalous species of *Pultenaea* (Fabaceae: Mirbelieae) from molecular and morphological data, and description of a new genus. *Taxon* 48: 701-714. [2.447, 21]

41. Jobson, P.C. & **Weston, P.H.** (1999) Two new species of *Dillwynia* (Fabaceae: Mirbelieae), from the Southern Tablelands of New South Wales. *Telopea* 8: 363-369. [0.6, 0]

42. Thomson, J.A., **Weston, P.H.** and Tan, M.K. (1999) A molecular approach to tracing major lineages in *Pteridium*: update and amendment. Pp. 35-36 in J.A. Taylor & R.T. Smith (eds.) *Bracken Fern: Toxicity, Biology and Control* (International Bracken Group: Aberystwyth). [-, 1]

43. **Weston, P.H.** (2000) Process morphology from a cladistic perspective. Pp. 124-144 in R. Scotland & T. Pennington (eds.) *Homology and Systematics: Coding Characters for Phylogenetic Analysis* (Taylor & Francis: Basingstoke). [-, 24]

44. Indsto, J. & **Weston, P.H.** (2000) Near-ultraviolet reflectance in *Dendrobium* (Orchidaceae). Pp. 326-334 in K.L. Wilson and D.A. Morrison (eds.) *Monocots: Systematics and Evolution*. (CSIRO: Melbourne). [-, 5]

45. Kores, P.J., **Weston, P.H.**, Molvray, M., & Chase, M.W. (2000) Phylogenetic relationships within the Diurideae (Orchidaceae); inferences from plastid *mat*K DNA sequences. Pp. 449-456 in K.L. Wilson and D.A. Morrison (eds.) *Monocots: Systematics and Evolution*. (CSIRO: Melbourne). [-, 60]

46. Savolainen, V., Fay, M.F., Albach, D.C., Backlund, A., van der Bank, M., Cameron, K.M., Johnson, S.A., Lledo, M.D., Pintaud, J.-C., Powell, M., Sheahan, M.C., Soltis, D.E., Soltis, P.S., **Weston, P.H.**, Whitten, W.M., Wurdack, K.J., & Chase, M.W., (2000) Phylogeny of the eudicots: a nearly complete familial analysis based on *rbc*L gene sequences. *Kew Bulletin* 55: 257-309. [0.577, 467]

47. Crisp, M.D. & **Weston, P.H.** (2000) *Telopea* (Proteaceae) Pp. 115-117 in G.J. Harden, D.W. Hardin & D.C. Godden (eds.) *Proteaceae of New South Wales* (New South Wales Univ. Press: Sydney). [-, 0]

48. **Weston, P.H.** (2000) *Persoonia* (Proteaceae) Pp. 89-105 in G.J. Harden, D.W. Hardin & D.C. Godden (eds.) *Proteaceae of New South Wales* (New South Wales Univ. Press: Sydney). [-, 0]

49. **Weston, P.H.** & Crisp, M.D. (2000) *Alloxylon* (Proteaceae) P. 115 in G.J. Harden, D.W. Hardin & D.C. Godden (eds.) *Proteaceae of New South Wales* (New South Wales Univ. Press: Sydney). [-, 0]

50. Hill, R.S. & **Weston, P.H.** (2001) Southern (austral) ecosystems. Pp. 361-370 in S.A. Levin (ed.) *Encyclopedia of Biodiversity* vol. 5 (Academic Press: San Diego). [-, 1]

51. Kores, P.J., Molvray, M., **Weston, P.H.**, Hopper, S.D., Brown, A., Cameron, K.M., and Chase, M.W (2001) A phylogenetic analysis of Diurideae (Orchidaceae) based on plastid DNA sequence data. *American Journal of Botany* 88: 1903-1914. [3.05, 135]

52. Jobson, P.C. & **Weston, P.H.** (2001) *Dillwynia rupestris* (Fabaceae: Mirbelieae), a new species from the New England Tableland of New South Wales. *Telopea* 9: 323-327. [0.6, 0]

53. Barker, N.P., **Weston, P.H.**, Rourke, J.P., & Reeves, G. (2002) The relationships of the southern African Proteaceae as elucidated by internal transcribed spacer (ITS) DNA sequence data. *Kew Bulletin* 57: 867-883. [0.577, 33]

54. Mant, J.G., Schiestl, F.P., Peakall, R., & **Weston, P.H.** (2002) A phylogenetic study of pollinator conservatism among sexually deceptive orchids. *Evolution* 56: 888-898. [4.201, 96]

55. **Weston, P.H.** (2002) Key to genera, *Persoonia* (Proteaceae), *Medicago*, *Trifolium* (Fabaceae), Pp. 3-20, 622-632 in G.J. Harden (ed.) *Flora of New South Wales* vol. 2, second, revised edition (New South Wales Univ. Press: Sydney). [-, 0]

56. **Weston, P.H.** & Duretto, M.F. (2002) *Boronia* (Rutaceae). Pp. 265-276 in G.J. Harden (ed.) *Flora of New South Wales* vol. 2, second, revised edition (New South Wales Univ. Press: Sydney). [-, 3]

57. **Weston, P.H.** & Harden, G.J. (2002) *Correa, Philotheca*, *Eriostemon, Crowea, Phebalium, Nematolepis*, *Leionema* (Rutaceae) Pp. 289-310, in G.J. Harden (ed.) *Flora of New South Wales* vol. 2, second, revised edition (New South Wales Univ. Press: Sydney). [-, 4]

58. **Weston, P.H.** & Jobson, P.C. (2002) *Dillwynia* (Fabaceae). Pp. 542-549 in G.J. Harden (ed.) *Flora of New South Wales* vol. 2, second, revised edition (New South Wales Univ. Press: Sydney). [-, 0]

59. **Weston, P.H.** & de Kok, R. (2002) *Pultenaea* (Fabaceae). Pp. 549-565 in G.J. Harden (ed.) *Flora of New South Wales* vol. 2, second, revised edition (New South Wales Univ. Press: Sydney). [-, 1]

60. **Weston, P.H.** & Kooyman, R.M. (2002) Systematics of *Eidothea* (Proteaceae), with the description of a new species, *E. hardeniana*, from the Nightcap Range, north-eastern New South Wales. *Telopea* 9: 821-832. [0.6, 15]

61. Bernhardt, P., Sage, T., **Weston, P.H.**, Azuma, H., Lam, M., Thien, L.B., & Bruhl, J. (2003) The pollination of *Trimenia moorei* (Trimeniaceae): floral volatiles, insect/wind pollen vectors, and stigmatic self-incompatibility in a basal angiosperm. *Annals of Botany* 92: 445-458. [4.041, 87]

62. Qiu, H. & **Weston, P.H.** (2003) Proteaceae. *Flora of China* 5: 192-199 (Science Press: Beijing and Missouri Botanical Garden Press: St Louis). [-, 0]

63. Thien, L.B., Sage, T.L., Jaffré, T., Bernhardt, P., Pontieri, V., **Weston, P.H.**, Malloch, D., Azuma, H., Graham, S.W., McPherson, M.A., Rai, H.S., Sage, R.F., & Duprey, J.-L. (2003) The population structure and floral biology of *Amborella trichopoda* Baillon (Amborellaceae). *Annals of the Missouri Botanical Garden* 90: 466-490. [2.838, 72]

64. Mill, R.R. & **Weston, P.** (2004). Proposals to reject the names *Polypodiopsis* and *Polypodiopsis muelleri* (*Plantae vasculares, incertae sedis*). *Taxon* 53: 203-205. [2.447, 2]

65. **Weston, P.H.** (2004) Proteaceae. Pp. 313-316 in N. Smith, S.A. Mori, A. Henderson, D.W. Stevenson & S.V. Heald (eds.) *Flowering Plants of the Neotropics* (The New York Botanical Garden and Princeton University Press: Princeton). [-, 0]

66. **Weston, P.H.** & Turton, M. (2004) *Phebalium bifidum* (Rutaceae), a new species from the Capertee Valley, New South Wales. *Telopea* 19: 787–792. [0.6, 2]

67. Entwisle, T.J. & **Weston, P.H.** (2005) Majority rules, when systematists disagree. *Australian Systematic Botany* 18: 1–6. [0.75, 29]

68. Indsto, J.O., **Weston, P.H.**, Clements, M.A. & Whelan, R.J. (2005) Highly sensitive DNA fingerprinting of orchid pollinia remnants using AFLP. *Australian Systematic Botany* 18: 207–213. [0.75, 9]

69. Jordan, G.J., Dillon, R.A. & **Weston, P.H.** (2005) Solar radiation as a factor in the evolution of scleromorphic leaf anatomy in Proteaceae. *American Journal of Botany* 92: 789–796. [3.05, 96]

70. Kurzweil, H., **Weston, P.H.** & Perkins, A.J. (2005) Morphological and ontogenetic studies on the gynostemium of some Australian members of Diurideae and Cranichideae (Orchidaceae). *Telopea* 11: 11–33. [0.6, 9]

71. Mant, J., Bower, C.C., **Weston, P.H.** & Peakall, R. (2005) Phylogeography of pollinator-specific sexually deceptive *Chiloglottis* taxa (Orchidaceae): evidence for sympatric divergence? *Molecular Ecology* 14: 3067–3076. [6.086, 26]

72. Mant, J., Peakall, R. & **Weston, P.H.** (2005) Specific pollinator attraction and the diversification of sexually deceptive *Chiloglottis* (Orchidaceae). *Plant Systematics and Evolution* 253: 185–200. [1.239, 33]

73. Mant, J., Brown, G.R. & **Weston, P.H.** (2005) Opportunistic pollinator shifts among sexually deceptive orchids indicated by a phylogeny of pollinating and non-pollinating thynnine wasps (Tiphiidae). *Biological Journal of the Linnean Society* 86: 381–395. [2.288, 16]

74. Rymer, P.D., Whelan, R.J., Ayre, D.J. & **Weston, P.H.** (2005) Reproductive success and pollinator effectiveness differ in common and rare *Persoonia* species (Proteaceae). *Biological Conservation* 123: 521–532. [4.022, 57]

75. **Weston, P.H.**, Perkins, A.J., & Entwisle, T.J. (2005) More than symbioses: orchid ecology, with examples from the Sydney Region. *Cunninghamia* 9: 1–15. [-, 34]

76. **Weston, P.H.** & Barker, N.P. (2006) A new suprageneric classification of the Proteaceae, with an annotated checklist of genera. *Telopea* 11(3): 314-344. [0.6, 86]

77. Indsto, J.O., **Weston, P.H.**, Clements, M.A., Dyer, A.G., Batley, M. & Whelan, R.J. (2006) Pollination of *Diuris maculata* (Orchidaceae) by male *Trichocolletes venustus* bees. *Australian Journal of Botany* 54: 669-679. [0.793, 37]

78. **Weston, P.H.** (2007) Proteaceae. Pp. 364-404 in K. Kubitzki (ed.) *Families and Genera of Vascular Plants* Volume IX (Springer Verlag: Berlin). [-, 26]

79. **Weston, P.H.** (2007) Proteaceae. Pp. 268-269 in V.H. Heywood, R.K. Brummitt, A. Culham & O. Seberg (eds.) *Flowering Plant Families of the World* (Royal Botanic Gardens, Kew: London). [-, 0]

80. Staedler, Y.M., **Weston, P.H.** & Endress, P.K. (2007) Floral phyllotaxis and floral architecture in Calycanthaceae (Laurales). *International Journal of Plant Sciences* 168: 285–306. [1.748, 36]

81. Indsto, J.O., **Weston, P.H.**, Clements, M., Dyer, A., Batley, M. & Whelan, R. (2007) Generalised pollination of *Diuris alba* R.Br. (Orchidaceae) by small bees and wasps. *Australian Journal of Botany* 55: 628-634. [0.793, 17]

82. Barker, N.P., **Weston, P.H.**, Rutschmann, F. & Sauquet, H. (2007) Molecular dating of the "Gondwanan" plant family Proteaceae is only partially congruent with the timing of Gondwanan break-up. *Journal of Biogeography* 34: 2012-2027. [4.248, 166]

83. Jordan, G.J., **Weston, P.H.**, Carpenter, R.J., Dillon, R.A. & Brodribb, T.J. (2008) The evolutionary relations of sunken, covered, and encrypted stomata to dry habitats in Proteaceae. *American Journal of Botany* 95:521-530. [3.05, 82]

84. Mast, A.R., Willis, C.L., Jones, E.H., Downs, K.M., & **Weston, P.H.** (2008) A smaller *Macadamia* from a more vagile tribe: Inference of phylogenetic relationships and divergence times in *Macadamia* and relatives (tribe Macadamieae; Proteaceae). *American Journal of Botany* 95: 843-870. [3.05, 55]

85. Sauquet, H., **Weston, P.H.**, Anderson, C.L., Barker, N.P. Cantrill, D.J., Mast, A.R., & Savolainen, V. (2009) Contrasted patterns of hyperdiversification in Mediterranean hotspots. *Proceedings of the National Academy of Sciences of the U.S.A.* 106: 221-225. [9.661, 169]

86. Staedler, Y.M., **Weston, P.H.** & Endress, P.K. (2009) Comparative gynoecium structure and development in Calycanthaceae (Laurales). *International Journal of Plant Sciences* 170: 21-41. [1.748, 25]

87. Sage, T.L., Hristova-Sarkovsi, K., Koehl, V., Lyew, J., Pontieri, V., Bernhardt, P., **Weston, P.**, Bagha, S., & Chiu, G. (2009) Transmitting tissue architecture in relictual-basal angiosperms: implications for transmitting tissue origins. *American Journal of Botany* 96: 183-206. [3.05, 34]

88. Crisp, M.D., Arroyo, M.T.K., Cook, L.G., Gandolfo, M.A., Jordan, G.J., McGlone, M.S., **Weston, P.H.**, Westoby, M., Wilf, P., & Linder, H.P. (2009) Phylogenetic biome conservatism on a global scale. *Nature* 458: 754-758. [40.137, 465]

89. Indsto, J.O., **Weston, P.H.**, & M.A. Clements (2009) A molecular phylogenetic analysis of *Diuris* (Orchidaceae) based on AFLP and ITS reveals three major clades and a basal species. *Australian Systematic Botany* 22: 1-15. [0.75, 7]

90. Sauquet, H., **Weston, P.H.**, Barker, N.P. Anderson, C.L., Cantrill, D.J. & Savolainen, V. (2009) Using fossils and molecular data to reveal the origins of the Cape proteas (subfamily Proteoideae). *Molecular Phylogenetics and Evolution* 51: 31-43. [4.419, 40]

91. Rossetto, M., Thurlby, K.A.G., Offord, C.A., Allen, C.B., & **Weston, P.H.** (2011) The impact of distance and a shifting temperature gradient on genetic connectivity across a heterogeneous landscape. *BMC Evolutionary Biology* 11(126):1-11. [3.221, 18]

92. Byrne, M., Steane, D., Joseph, L., Yeates, D., Jordan, G.J., Crayn, D., Aplin, K., Cantrill D., Cook, L.G., Crisp, M.D., Keogh, J.S., Melville, J., Moritz, C., Porch, N., Sniderman, J.M.K., Sunnucks P., & **Weston, P.H.** (2011) Decline of a biome: evolution, contraction, fragmentation, extinction and invasion of the Australian mesic zone biota. *Journal of Biogeography* 38: 1635–1656. [4.590, 216]

93. Mast, A.R., Milton, E.F., Jones, E.H., Barker, R.M., Barker, W.R., & **Weston, P.H.** (2012) Time-calibrated phylogeny of the woody Australian genus *Hakea* (Proteaceae) supports multiple origins of insect-pollination among bird-pollinated ancestors. *American Journal of Botany* 99: 472-487. [3.05, 32]

94. Stimpson, M.L., **Weston, P.H.**, Telford, I.R.H., & Bruhl, J.J. (2012) First instalment in resolution of the *Banksia spinulosa* complex (Proteaceae): *B. neoanglica*; a new species supported by phenetic analysis, ecology and geography. *Phytokeys* 14: 57–80. [0.686, 6]

95. Rossetto, M., Allen, C., Thurlby, K., **Weston, P.H.**, & Milner, M. (2012) Genetic structure and bio-climatic modelling support allopatric over parapatric speciation along a latitudinal gradient. *BMC Evolutionary Biology* 12:149. [3.221, 13]

96. Clark, V.R., Perera, S.J., Stiller, M., Stirton, C.H., **Weston, P.H.**, Stoev, P., Coombs, G., Morris, D., Ratnayake-Perera, D., Barker, N.P., & MacGregor, G.K. (2012) A rapid multi-disciplinary biodiversity assessment of the Kamdebooberge (Sneeuberg, Eastern Cape, South Africa): implications for conservation. *SpringerPlus* 1:56 [0.982, 5]

97. Milner, M.L., Rossetto, M., Crisp, M.D., & **Weston, P.H.** (2012) The impact of multiple biogeographic barriers and hybridization on species-level differentiation. *American Journal of Botany* 99: 2045–2057. [3.05, 17]

98. Ford, A.J. & **Weston, P.H.** (2012) A taxonomic revision of *Hollandaea* Anon. (Proteaceae). *Austrobaileya* 8: 670-687. [-, 0]

99. Hidayat, T., **Weston, P.H.**, Yukawa, T., Ito, M., & Rice, R. (2012) Phylogeny of subtribe Aeridinae (Orchidaceae) inferred from DNA sequences data: advanced analyses including Australasian genera. *Jurnal Teknologi (Sciences and Engineering)* 59 (suppl. 1): 87-95. [0.096, 4]

100. **Weston, P.H.** & Hill, R.S. (2013) Southern (austral) ecosystems. Pp. 612-619 in S.A. Levin (ed.) *Encyclopedia of Biodiversity* second edition, vol. 6 (Academic Press: Waltham, MA). [-, 9]

101. Jordan, G.J., Brodribb, T.J., Blackman, C.J., & **Weston, P.H.** (2013) Climate drives vein anatomy in Proteaceae. *American Journal of Botany* 100: 1483-1493.
[3.05, 19]

102. **Weston, P.H.** & Woods, L.A. (2013) Correction of a typographical error in the protologue of *Banksia conferta* A.S.George var. *penicillata* A.S. George. *Telopea* 15: 67–69. [0.6, 0]

103. Milner, M.L., McIntosh, E.J., Crisp, M.D., **Weston, P.H.**, & Rossetto, M. (2013) Microsatellite variation for phylogenetic, phylogeography and population genetic studies in *Lomatia* (Proteaceae). *Australian Systematic Botany* 26: 186-195. [0.75, 2]

104. **Weston, P.H.** (2014) What has molecular systematics contributed to our knowledge of the Proteaceae? Pp. 365-397 in P. Besse (ed.) *Molecular Plant Taxonomy: Methods and Protocols*, *Methods in Molecular Biology*, vol. 1115 (Springer: New York). [-, 11]

105. McIntosh, E., Rossetto, M., **Weston, P.H.**, & Wardle, G. (2014) Maintenance of strong morphological differentiation despite ongoing natural hybridization between sympatric species of *Lomatia* (Proteaceae). *Annals of Botany* 113: 861-872. [4.041, 16]

106. Stimpson, M.L., Bruhl, J.J. & **Weston, P.H.** (2014) Could this be Australia's rarest *Banksia*? *Banksia vincentia* (Proteaceae), a new species known from fourteen plants from south-eastern New South Wales, Australia. *Phytotaxa* 163: 269–286. [1.24, 1]

107. Thomas, N., Bruhl, J.J., Ford, A., & **Weston, P.H.** (2014) Molecular dating of Winteraceae reveals a complex biogeographic history involving both ancient Gondwanan vicariance and long-distance dispersal. *Journal of Biogeography* 41: 894-904. [4.590, 28]

108. **Weston, P.H.**, Perkins, A.J., Indsto, J.O., & Clements, M.A. (2014) Phylogeny of Orchidaceae tribe Diurideae and its implications for the evolution of pollination systems. Pp. 91-154 in Edens-Meier, R. & P. Bernhardt (eds.) *Darwin's Orchids: Then and Now* (University of Chicago Press: Chicago). [-, 10]

109. Kooyman, R.M., Wilf, P., Barreda, V.D., Carpenter, R.J., Jordan, G.J., Sniderman, J.M.K., Allen, A., Brodribb, T.J., Crayn, D., Feild, T.S., Laffan, S.W., Lusk, C., Rossetto, M., & **Weston, P.H.** (2014) Paleo-Antarctic rainforest into the modern Old World tropics: the rich past and threatened future of the 'southern wet forest survivors'. *American Journal of Botany* 101: 2121 – 2135. [3.05, 36]

110. Lambers, H., Clode, P., Hawkins, H.-J., Laliberté, E., Oliveira, R., Reddell, P., Shane, M.W., Stitt, M., & **Weston, P.H.** (2015) Metabolic adaptations of the non-mycotrophic Proteaceae to soil with a low phosphorus availability. *Annual Plant Reviews* 48: 289–336 (Plaxton, W.C. & Lambers, H. (eds.) *Phosphorus Metabolism in Plants in the Post-genomic Era: From Gene to Ecosystem* (Wiley-Blackwell Publishing: Chichester, UK)). [-,34]

111. Mast, A.R., Olde, P., Makinson, R.O., Jones, E., Kubes, A., Miller, E. & **Weston, P.H.** (2015) Paraphyly changes understanding of timing and tempo of diversification in subtribe Hakeinae (Proteaceae), a giant Australian plant radiation. *American Journal of Botany* 102: 1634-1646. [3.05, 15]

112. Thiele, K.R., **Weston, P.H.** & Mast, A.M. (2015) Paraphyly, modern systematics and the transfer of *Dryandra* into *Banksia* (Proteaceae): a response to George. *Australian Systematic Botany* 28: 194–202 [0.75, 1]

113. Milner, M.L., **Weston, P.H.,** Rossetto, M., & Crisp, M.D., (2015) Biogeography of the Gondwanan genus *Lomatia* (Proteaceae): vicariance at continental and intercontinental scales. *Journal of Biogeography* 42: 2440–2451. [4.590, 9]

114. Stimpson, M.L., **Weston, P.H.**, Whalley, R.D.B., & Bruhl, J.J. (2016) A morphometric analysis of the *Banksia spinulosa* complex (Proteaceae) and its complex taxonomic implications. *Australian Systematic Botany* 29: 55-86. [0.75, 0]

115. Onstein, R.E., Jordan, G.J., Sauquet, H., **Weston, P.H.**, Bouchenak-Khelladi, Y., Carpenter, R.J., & Linder, H.P. (2016) Evolutionary radiations of Proteaceae are triggered by the interaction between traits and climates in open habitats. *Global Ecology and Biogeography* 25: 1239–1251. [6.045, 17].

116. van der Merwe, M., Crayn, D., Ford, A., Rossetto, M., & **Weston, P.H.** (2016) Evolution of Australian *Cryptocarya* (Lauraceae) based on nuclear and plastid phylogenetic trees: evidence of recent landscape-level disjunctions *Australian Systematic Botany* 29: 157–166. [0.75, 3]

117. Citerne, H., Reyes, E., Le Guilloux, M., Delannoy, E., Sannier, J., Simmonet, F., Sauquet, H., Nadot, S., **Weston, P.H.**, & Damerval, C. (2017) Characterisation of CYCLOIDEA-like genes in

Proteaceae, a basal eudicot family with multiple shifts in floral symmetry. *Annals of Botany* 119: 367-378. [4.041, 13]

118. **Weston, P.H.**, & Jordan, G.J. (2017) Evolutionary biogeography of the Australian flora in the Cenozoic Era. Pp. 40-62 in D.A. Keith (ed.) *Australian Vegetation*, 3rd edition (Cambridge University Press: Cambridge). [-, 1]

119. Cardillo, M., **Weston, P.H.**, Reynolds, Z., Olde, P.M., Mast, A.R., Lemmon, E., Lemmon, A. & Bromham, L. (2017) The phylogeny and biogeography of *Hakea* (Proteaceae) reveals the role of biome shifts in a continental plant radiation. *Evolution* 71: 1928–1943. [4.201, 10]

120. Holmes, G., **Weston, P.H.**, Murphy, D., Gardner, S., Connelly, C., & Cantrill, D.J. (2018) The genealogy of geebungs: phylogenetic analysis of *Persoonia* (Proteaceae) and related genera in subfamily Persoonioideae. *Australian Systematic Botany* 31: 166–189. [0.75, 0]

121. **Weston, P.H.** (in press) Proteaceae. *Flora of North America North of Mexico* 10-11 (Oxford University Press: New York and Oxford). [-,-]

122. Steenbeeke, G., Dowle, M., Laurence, M.H., Liew, E.C.Y., Newby, Z.-J., Renner, M., Sommerville, K., Weston, P.H., Ward, S. (in review) Phylogeny of selected *Microtis* (Orchidaceae) in south eastern Australia and its implications for taxonomy and conservation priorities. *Telopea.* [0.6, -]

123. Nguyen, C.H., Beattie, G.A.C., Haigh, AM, Astuti, I.P., Mabberley, D.J., **Weston, P.H.**, & Holford, P. (in review) Molecular differentiation of the Murraya paniculata complex (Rutaceae: Aurantioideae: Aurantieae), *BMC Evolutionary Biology.* [3.027,-]

124. Bernhardt, P., Camilo, G., & Weston, P.H. (in review) Shaken vs. scraped: floral presentation contributes to pollinator guild segregation in co-blooming *Symphionema montanum* R.Br. and *Isopogon anemonifolius* Knight (Proteaceae). *The Gardens' Bulletin Singapore.* [-,-]

125. Stimpson, M.L., **Weston, P.H.**, Wright, B.R., Whalley, R.D.B., & Bruhl, J.J. (in review) Homoblasty and heteroblasty contribute to taxonomic resolution of the *Banksia spinulosa* complex (Proteaceae). *Australian Journal of Botany*. [0.793,-]

Conference Abstracts

1. **Weston, P.H.** (1984) A reappraisal of Nelson's direct method of character analysis. P. 9, Programme and Abstracts, Australian Systematic Botany Society symposium on *Cladistics, Systematics and Phylogeny*, Canberra.

2. Wilson, P.G. & **Weston, P.H.** (1984) A preliminary cladistic analysis of the *Metrosideros* suballiance (Myrtaceae). P. 19, Programme and Abstracts, Australian Systematic Botany Society symposium on *Cladistics, Systematics and Phylogeny*, Canberra.

3. **Weston, P.H.** (1984) Drifting waratahs or continents? P. 9, Abstracts, *Waratahs: Their Biology Cultivation and Conservation*, an Australian Flora Foundation Symposium, Canberra.

4. Crisp, M.D. & **Weston, P.H.** (1984) Waratahs – one species or two? P. 5, Abstracts, *Waratahs: Their Biology Cultivation and Conservation*, an Australian Flora Foundation Symposium, Canberra.

5. **Weston, P.H.** (1988) Problems with the statistical testing of panbiogeographic hypotheses. Abstracts, Symposium on *Panbiogeography of New Zealand*, Wellington.

6. **Weston, P.H.** (1989) Transpacific cladistic patterns in the Proteaceae and Elaeocarpaceae. P. 37, Program and Abstracts, Australian Systematic Botany Society symposium, on *Gondwanan Elements in the Australian Flora*, Sydney.

7. **Weston, P.H.** & Crisp, M.D. (1990) Transoceanic cladistic patterns in the Proteaceae. P. 51, Abstracts, *Systematics and Biogeography of the Austral Biota*, IXth meeting of the Willi Hennig Society, Canberra.

8. **Weston, P.H.** (1993) Direct methods for polarising character transformation series. P. 13, Programme and Abstracts, *Models in Phylogeny Reconstruction*, a joint conference of The Systematics Association and The Linnean Society, London.

9. Crisp, M.D., Linder, H.P., & **Weston, P.H.** (1994) Cladistic biogeography of Australia: is there more than one endemic tropical track? P. 14, Program and Abstracts, *Origin and Evolution of the Flora of the Monsoon Tropics*, a symposium of the Australian Systematic Botany Society, Kuranda.

10. **Weston, P.H.** (1996) ITS sequence variation in the Proteaceae and what it tells us about phylogeny. P. 49, Abstracts, *An International Symposium on the Biology of Proteaceae*, Melbourne.

11. **Weston, P.H.** (1997) Rolf Sattler's plant morphology and cladistic analysis. P. 54, Abstracts, *First Biennial International Conference of the Systematic Association*, Oxford, U.K..

12. **Weston, P.H.** & Crisp, M.D. (1997) Cladistic biogeography of a key woody group: Proteaceae. P. 5, Abstracts, *II Southern Connection Congress*, Valdivia, Chile.

13. Kores, P.J., Molvray, M., **Weston, P.H.**, & Chase, M.W. (1998) Phylogenetic relationships within the Diurideae (Orchidaceae); inferences from plastid *mat*K DNA sequences. Pp. 33-34, Abstracts. Monocots II Conference, Sydney.

14. **Weston, P.H.** (1999) Historical biogeography of Proteaceae. Abstracts, XVI International Botanical Congress, Saint Louis.

15. **Weston, P.H.** (2002) Proteaceae: Brown and now. P. 16, Abstracts, Robert Brown 200 Conference, Sydney.

16. Mant, J.G., **Weston, P.H.**, Peakall, R., & Schiestl, F.P. (2003) Coevolution of *Chiloglottis* (Orchidaceae) and its Thynnine wasp pollinators. P. 55, Abstracts, *Monocots III*, The Third International Conference on the Comparative Biology of the Monocotyledons, Ontario, U.S.A..

17. **Weston, P.H.,** Clements, M.A., Indsto, J.O., Mant, J., Peakall, R., & Perkins, A.J. (2005) Food is good but sex is better: the evolution of deceptive pollination in the tribe Diurideae (Orchidaceae). XVII International Botanical Congress, Vienna.

18. Sauquet, H., **Weston, P.H.**, Cantrill, D.J., & Savolainen, V. (2006) Bringing together the living and the dead: integrating extant and fossil biodiversity in evolutionary studies of Proteaceae (Proteales). P. 39 Conference Book, *Plant Diversity in the Tropics,* Australian Systematic Botany Society conference, Cairns, Australia.

19. **Weston, P.H.** (2006) A new suprageneric classification of the Proteaceae. P. 45 Conference Book, *Plant Diversity in the Tropics,* Australian Systematic Botany Society conference, Cairns, Australia.

20. Staedler, Y.M., **Weston, P.H.**, & Endress, P.K.. (2006). Floral architecture and phyllotaxis in Calycanthaceae (Laurales). Abstract 192, Botany 2006 (Botanical Society of America conference, Chico, U.S.A).

21. Sauquet, H., Cantrill, D.J., **Weston, P.H.**, Barker, N., Mast, A., & Savolainen, V. (2006). A phylogenetic approach to the evolution of pollen morphology in Proteaceae (Proteales). Abstract 405, Botany 2006 (Botanical Society of America conference, Chico, U.S.A).

2. Milton, E.F., **Weston, P.H.**, Mast, A. (2006) The diversification of ecologically significant traits in the species-rich Australian genus *Hakea* (Proteaceae). Abstract 324, Botany 2006 (Botanical Society of America conference, Chico, U.S.A).

23. Mast, A., **Weston, P.H.**, Jones, E., Sauquet, H., Cantrill, D., Jordan, G., & Barker, N. . (2006) The timing of disjunctions in the southern hemisphere family Proteaceae: Sensitivity analysis with 6 genes, multiple calibration points, and 70+ genera. Abstract 327, Botany 2006 (Botanical Society of America conference, Chico, U.S.A).

24. Willis, C.L., **Weston, P.H.**, & Mast, A. (2007) Inference of phylogenetic relationships in *Macadamia* and relatives (tribe Macadamieae; Proteaceae) using three chloroplast and three nuclear DNA regions. Abstract 1677, Botany & Plant Biology 2007 (Botanical Society of America conference, Chicago).

25. Staedler, Y.M., **Weston, P.H.**, & Endress, P.K. (2007) Structure and development of the gynoecium in Calycanthaceae (Laurales). Abstract 1121, Botany & Plant Biology 2007 (Botanical Society of America conference, Chicago).

26. Sauquet, H., Cantrill, D.J., **Weston, P.H.**, Barker, N., Mast, A., & Savolainen, V. (2007) Bringing together the living and the dead: integrating extant and fossil biodiversity in evolutionary studies of Proteaceae (Proteales). Abstract 1593, Botany & Plant Biology 2007 (Botanical Society of America conference, Chicago).

27. Milton, E.F., **Weston, P.H.**, Barker, W., Barker, R., & Mast, A. (2007) Inference of phylogenetic relationships in *Hakea* (Proteaceae) using morphology and four chloroplast and three nuclear DNA regions. Abstract 1712, Botany & Plant Biology 2007 (Botanical Society of America conference, Chicago).

28. Kubes, A., **Weston, P.H.**, Makinson, R.O., Olde, P., & Mast, A.R. (2007) Resolving relationships in *Grevillea* (Proteaceae), the third largest Australian plant genus. Abstract 1814, Botany & Plant Biology 2007 (Botanical Society of America conference, Chicago).

29. **Weston, P.H.**, Barker, N.P., Rutschmann, F., & Sauquet, H. (2007) 'I'm not dead yet' – Gondwana (the Proteaceae are at least partially congruent with Gondwanic fragmentation). P. 76, Conference Program, 5th International Southern Connection Congress, Adelaide.

30. Sauquet, H., **Weston, P.H.**, Cantrill, D.J., & Savolainen, V. (2007) Bringing together the living and the dead: integrating extant and fossil biodiversity in evolutionary studies of Proteaceae (Proteales). P. 58, Conference Program, 5th International Southern Connection Congress, Adelaide.

31. Mast, A., Jones, E., Barker, R., Barker, W., **Weston, P.H.** (2009) The phylogeny and age of the woody Australian genus *Hakea* (Proteaceae) and the evolution of its leaf and fire persistence features. Abstract 335, Botany & Mycology 2009 (Botanical Society of America conference, Snowbird, Utah)

32. Holmes, G.D., Porter, C., Murphy, D.J., **Weston, P.H.** and Cantrill, D.J. (2009) What are the relationships among Snottygobbles and Geebungs? A preliminary phylogeny of *Persoonia* (Proteaceae). P 45, Conference Booklet, *Systematic Botany: from Science to Society*, a conference of the Australian Systematic Botany Society, Armidale.

33. **Weston, P.H.**, Sauquet, H., Mast, A.R., & Barker, N.P. (2010) Diversification of the Proteaceae in Mediterranean hotspots of the Southern Hemisphere and in tropical rainforests. P. 29, Program, *Gondwana Reunited: a Southern Perspective for a Changing World*, VI Southern Connection Congress, Bariloche.

34. **Weston, P.H.**, Sauquet, H., Mast, A.R., & Barker, N.P. (2010) Cladistic biogeography, molecular dating, fossils and the Proteaceae. P. 18, Program, *Gondwana Reunited: a Southern Perspective for a Changing World*, VI Southern Connection Congress, Bariloche.

35. Baum, M., Crisp, M., Rossetto, M. & **Weston, P.** (2010) Speciation and phylogeography of *Telopea* and *Lomatia* (Proteaceae). P. 20, Program, *Gondwana Reunited: a Southern Perspective for a Changing World*, VI Southern Connection Congress, Bariloche.

36. **Weston, P.H.** (2010) Cenozoic environmental change and the systematics of southern hemisphere plants. P. 68, *Systematic Botany Across the Ditch: Links Between Australia and New Zealand*, a conference of the Australian Systematic Botany Society, Lincoln University, New Zealand.

37. **Weston, P.H.** (2011) Cenozoic environmental change and the systematics of southern hemisphere plants. P. 34, Abstracts 2nd Book, *Plants in a Changing World*, (37th annual conference of the South African Association of Botanists, Rhodes University, South Africa).

38. **Weston, P.H.**, Indsto, J.O., Perkins, A.J., Clements, M.A., & Peakall, R. (2011) Total evidence phylogenetic analysis of the orchid tribe Diurideae and what it tells us about the evolution of pollination systems. P. 152, Abstract Book, XVIII International Botanical Congress, Melbourne.

39. **Weston, P.H.**, Wilson, P.G., Conn, B.J., Rymer, P.D. (2011) Floral evolution in animal-pollinated Australian angiosperm clades: patterns and potential explanations. P. 266, Abstract Book, XVIII International Botanical Congress, Melbourne.

40. Nguyen, C.H., Beattie, G.A.C., Holford, P., Mabberley, D.J., & **Weston, P.H.** (2011) Determining the origin and diversification of *Murraya paniculata*: one or more species? P. 354, Abstract Book, XVIII International Botanical Congress, Melbourne.

41. Milner, M., Crisp, M.D., Rossetto, M., & **Weston, P.H.** (2011) Speciation and phylogeography of *Telopea* and *Lomatia* (Proteaceae). P. 281, Abstract Book, XVIII International Botanical Congress, Melbourne.

42. **Weston, P.H.** (2012) Contested, uncontested and potentially controversial taxonomic changes in the Proteaceae: how do they differ? P. 49, Program and Abstracts, *Local Knowledge, Global Delivery* (Australasian Systematic Botany Society 2012 Perth Conference Committee: Perth).

43. **Weston, P.H.,** Jones, E.H., Olde, P.M., Makinson, R.O., & Mast, A.R. (2013) Molecular phylogeny of the subtribe Hakeinae (Green Plants: Proteaceae tribe Embothrieae) and its implications. P. 101, *Genetics in the Harbour City* (Program and abstracts of the annual conference of the Genetics Society of Australasia, Sydney).

44. Onstein, R., Jordan, G., Bouchenak-Khelladi, Y., Xing, Y., Wright, I., Sauquet, H., Carpenter, R., **Weston, P.** & Linder, P. (2013) Leaf trait evolution in the Proteaceae. P. 11, *Systematics Without Borders* (Program and abstracts of the combined conference of the Australasian Systematic Botany Society, Society of Australian Systematic Biologists and Invertebrate Biodiversity and Conservation, University of Sydney).

45. Cantrill, D.J., Lewis, E., Murphy, D.J. & **Weston, P.H.** (2013) Variation in pollen morphology within *Persoonia* (Proteaceae) supports clades revealed by molecular data. P. 19, *Systematics Without Borders* (Program and abstracts of the combined conference of the Australasian Systematic Botany Society, Society of Australian Systematic Biologists and Invertebrate Biodiversity and Conservation, University of Sydney).

46. **Weston, P.H.**, Jones, E.H., Olde, P.M., Makinson, R.O. & Mast, A.R. (2013) Molecular phylogeny of the subtribe Hakeinae (Green Plants: Proteaceae tribe Embothrieae) and its implications. P. 20, *Systematics Without Borders* (Program and abstracts of the combined conference of the Australasian Systematic Botany Society, Society of Australian Systematic Biologists and Invertebrate Biodiversity and Conservation, University of Sydney).

47. Schulte, K., Micheneau, C., Simpson, L., **Weston, P.**, Crayn, D. & Clements, M. (2013) The *Dendrobium* alliance revisited: A molecular phylogenetic approach towards reconciling taxonomic concepts in Dendrobiinae (Orchidaceae). P. 32, *Systematics Without Borders* (Program and abstracts of the combined conference of the Australasian Systematic Botany Society, Society of Australian Systematic Biologists and Invertebrate Biodiversity and Conservation, University of Sydney).

48. Stimpson, M.L., Prychid, C.J., **Weston, P.H.** Whalley, R.D.B. & Bruhl, J.J. (2013) Structure and function of the cotyledonary node in the *Banksia spinulosa* complex (Proteaceae). P. 68, *Systematics Without Borders* (Program and abstracts of the combined conference of the Australasian Systematic Botany Society, Society of Australian Systematic Biologists and Invertebrate Biodiversity and Conservation, University of Sydney).

49. **Weston, P.H.** (2014) Problems and progress in plant systematics since Nancy Burbidge. P. 17, *Next Generation Systematics* (Program and abstracts of the conference of the Australasian Systematic Botany Society, Massey University, Palmerston North, New Zealand).

50. Thomas, N., Bruhl, J., Ford, A. & **Weston, P.** (2014) Molecular dating of Winteraceae reveals a complex biogeographical history involving both ancient Gondwanan vicariance and long-distance dispersal. P. 28, *Next Generation Systematics* (Program and abstracts of the conference of the Australasian Systematic Botany Society, Massey University, Palmerston North, New Zealand).

51. **Weston, P.H.** Reyes, E. & Sauquet, H. (2015) A database of variation in floral characters in the Proteaceae, and implications for key questions in floral evolution. P. 35, *Building Our Botanical Capital* (Program and abstracts of the conference of the Australasian Systematic Botany Society, CSIRO Discovery Centre, Canberra).

52. Schulte, K., Micheneau, C., Field, A., **Weston, P.**, Crayn, D. & Clements, M. (2015) The *Dendrobium* alliance revisited: examining macroevolutionary patterns in Dendrobiinae

(Orchidaceae). P. 30, *Building Our Botanical Capital* (Program and abstracts of the conference of the Australasian Systematic Botany Society, CSIRO Discovery Centre, Canberra).

53. Thiele, K., Barker, W.R., Crayn, D.M., Waycott, M., Holland, A., Breitwieser, I., Lockhart, P., Bayly, M., **Weston, P.H.**, & Schulte, K. (2015) Progress towards a decadal plan for Australasian biodiversity science – an update. P. 33, *Building Our Botanical Capital* (Program and abstracts of the conference of the Australasian Systematic Botany Society, CSIRO Discovery Centre, Canberra).

Articles in Magazines, Newsletters, etc.

1. Weston, P.H. (1988c) Proteaceae. Australian Plants 14: 259.

2. Weston, P.H. (1988d) The flower - part 2. *Australian Plants* 14: 262-263.

3. Weston, P.H. (1992) A special tree [an article about *Idiospermum australiense*]. *Friends of the Royal Botanic Gardens Newsletter* 14: 4.

4. Weston, P.H. & Crisp, M.D. (1995) Phylogenetic analysis. *Australasian Biotechnology* 5(5): 291-293.

5. Weston, P.H. (1998) Lust, lies and fungus flies. *The Gardens* 39: 8-9.

6. Weston, P.H. (2000) Flower wasps and bird orchids. *The Gardens* 44: 5.

7. Weston, P.H. (2000) An intriguing case of snottygobbles. *The Gardens* 44: 11.

8. Weston, P.H. (2001) The Nightcap Oak comes out of the bush and into the spotlight. *The Gardens* 50: 6.

9. Weston, P.H. (2001) New tree species discovered in Australia. *Forest Genetic Resources* 29: 26.

10. Weston, P.H. & Kooyman, R.M. (2002) *Eidothea hardeniana*: botany and ecology of the 'Nightcap Oak'. *Australian Plants* 21: 339-342, 344.

11. Weston, P.H. (2003) Proteaceae subfamily Persoonioideae: botany of the geebungs, snottygobbles and their relatives. *Australian Plants* 22: 62-78, 91.

12. Weston, P.H. (2005) Sex and Death in the Sydney Tropical Centre. *The Gardens* 65: 6-7, republished in re-edited form in *Australian Orchid Review* 70(5): 32-33.

14. Weston, P.H. (2009) From the President. *ASBS Newsletter* 141: 1-3.

15. Weston, P.H. (2010) Madagascar: a world of botanical wonders. *The Gardens* 84: 10-11.

16. Weston, P.H. (2010) From the President. *ASBS Newsletter* 142: 1.

17. Weston, P.H. (2010) From the President. *ASBS Newsletter* 143: 1-3.

18. Weston, P.H. (2010) From the President. *ASBS Newsletter* 144-145: 1.

19. Weston, P.H. (2010) ASBS President's Report 2009–2010. *ASBS Newsletter* 144-145: 4-6.

20. Weston, P.H. (2010) Life Membership awarded to John Clarkson. *ASBS Newsletter* 144-145: 16.

21. Weston, P.H. (2010) ASBS 2010 Conference Report, Lincoln, Canterbury, New Zealand. *ASBS Newsletter* 144-145: 17-21.

22. Weston, P.H. (2011) From the President. *ASBS Newsletter* 146: 1-2.

23. Weston, P.H. (2011) From the President. *ASBS Newsletter* 147-148: 1-3.

24. Weston, P.H. (2011) Award of Nancy T. Burbidge Medals to Professors Pauline Ladiges and Michael Crisp. *ASBS Newsletter* 147-148: 3-8.

25. Weston, P.H. (2011) The ARC-ERA journal ranking project has been aborted. *ASBS Newsletter* 147-148: 11-12.

26. Weston, P.H. (2011) Recent advances and new developments in biogeographical reconstruction methods. *ASBS Newsletter* 147-148: 14.

27. Weston, P.H. (2011) [Book review of] The Flowering of Australia's Rainforests: A Plant and Pollination Miscellany. By Geoff Williams and Paul Adam. *ASBS Newsletter* 147-148: 21-23.

28. Weston, P.H. (2011) From the President. *ASBS Newsletter* 149: 1-2.

29. Weston, P.H. (2011). ASBS President's Report 2010-2011. *ASBS Newsletter* 149: 4-7.

30. Weston, P.H. (2012) From the President. *ASBS Newsletter* 150: 1-2.

31. Weston, P.H. (2012) New proposals to change ASBS rules. *ASBS Newsletter* 150: 4-10.

32. Weston, P.H. (2012) From the President. *ASBS Newsletter* 151: 1-2.

33. Weston, P.H. (2012) A remarkable botanical find: the double discovery of *Danhatchia australis* in Australia. *The Gardens* 94: 27.

34. Weston, P.H. (2012) From the President. *ASBS Newsletter* 152: 1-2.

35. Weston, P.H. (2013) Exploring southern Africa. *The Gardens* 96: 18-19.

36. Weston, P.H. (2013) ASBS President's Report 2011-2012. *ASBS Newsletter* 153: 7-10.

37. Weston, P. (2013) Not an exact science. *Sydney Morning Herald,* 19 June 2013: 19.

38. Weston, P.H. (2015) Funding research. *The Gardens* 103:33.

39. Weston, P.H. (2016) Building a database of floral characters for researching the iconic Australian plant family Proteaceae. Report to the Winston Churchill Memorial Trust (https://www.churchilltrust.com.au/media/fellows/Weston_P_2014_Building_a_database_of_floral_characters_of_Proteaceae.pdf).

40. Weston, P.H. (2016) Hunting Proteaceae from European dungeons to the wilds of the Western Cape. *The Gardens* 109: 16-17.

Appendix K
Impacts requiring further consideration - threatened species and populations

K.1 Further consideration of impacts to Regent Honeyeater

Table K-1 details the further consideration of impacts to Regent Honeyeater in accordance with Section 9.2.5 of the FBA.

Table K-1. Further consideration of impacts to Regent Honeyeater

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	The local population potentially impacted by the Project comprises a minimum of 21-35 individuals. This includes the number of adult and juvenile birds detected during targeted Regent Honeyeater surveys conducted in November 2017 (21), and the number of nestlings observed at two nests at the time of surveys (4), assuming each fledged successfully. This figure represents 5-7 % of the estimated population of the Regent Honeyeater (DoE, 2016) (Kvistad *et al*. 2015) and this breeding population represents one of less than five known remaining breeding populations that are known to support at least 20 individuals (DoE, 2016) (Crates *et al*. 2018). The size of the local population potentially impacted by the development is difficult to estimate. This is because there is evidence from colour banding studies that the remaining greater Blue Mountains population of Regent Honeyeaters functions as a metapopulation (R. Crates, unpublished data). It is highly likely that individuals move between the Burragorang Valley and other known breeding areas such as the Capertee Valley, Goulburn River and Lower Hunter Valley. Due to a lack of monitoring effort on Regent Honeyeaters in the Burragorang Valley, the extent to which individuals move between the Burragorang Valley and other key breeding sites in the region is unknown.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	The Regent Honeyeater specialises on *Eucalyptus* species that grow in low-lying areas when breeding (Geering and French, 1998) (Oliver, 1998) (DoE, 2016) (Crates *et al*. 2017a). The spatial extent of Regent Honeyeater habitat present in the impact area is presented in Appendix B of this report. 1,264.55 ha of potential breeding and foraging habitat occur within the impact area. The Regent Honeyeater is likely to be impacted should the Project result in reduced availability and quality of the habitat in the study area.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	Impacts to breeding and foraging habitat in the impact area would affect habitat selection, foraging and nesting location and breeding success of the local Regent Honeyeater population. Temporary inundation would result in either: (1) minimal impact where the breeding and foraging habitat remains largely intact (2) the population relocates to other habitat within the catchment either temporarily or permanently to habitat areas that are either equally productive or potentially to less productive or marginal areas within the catchment, (3) the local population occupies other breeding sites outside of the catchment. Given that suitable breeding habitat is located in the impact area, including an identified population, it is reasonable to consider that the proposed development could impact the ecology of the local population.
(d) a description of the extent to which the local population will become fragmented	Whilst Regent Honeyeaters are known to exhibit a degree of breeding site fidelity when conditions allow (Geering and French, 1998), the species is highly mobile and depends on a network of breeding habitat patches that they exploit

Criteria	Consideration
and isolated as a result of the proposed development	irregularly in space and time (DoE, 2016). The proposed development may increase local fragmentation of breeding habitat but is unlikely to significantly increase degree of isolation of the local population overall given that Regent Honeyeaters can disperse large distances across highly fragmented landscapes to reach suitable habitat..
(e) the relationship of the local population to other populations of the species	Regent Honeyeaters are known to regularly undertake movements in excess of 100 kilometres (DoE, 2016). There is evidence from colour banding studies that the remaining Greater Blue Mountains population of Regent Honeyeaters functions as a metapopulation (R. Crates, unpublished data). It is highly likely that individuals move between the Burragorang Valley and other known breeding sites such as the Capertee Valley and Goulburn River. The extent to which individuals move between the Burragorang Valley and other key regional breeding sites is currently unknown. Given its location and size, however, it is reasonable to assume that the Burragorang Valley population is a key component of the Greater Blue Mountains metapopulation, which is likely to consist of between 150 and 350 individuals (DoE, 2016) (Crates *et al*. 2018). .
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	It is unlikely that the proposed development would lead to an increase in threats and indirect impacts that may in turn lead to a decrease in the viability of the local population. The Noisy Miner (*Manorina melanocephala*) is a major threat to breeding Regent Honeyeaters but is only present in low numbers in the Burragorang Valley at present. It is unlikely that the proposed development would lead to an increase in this species' abundance in the impact area.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	Regent Honeyeater has been assigned to the Site-managed species management stream under the Saving our Species (SoS) program. This SoS strategy aims to secure the species in the wild for 100 years and maintain its conservation status under the BC Act. A National Recovery Plan under the EPBC Act for Regent Honeyeater (DoE, 2016) details two objectives in order to recover the species, including but not limited to: ▪ Reverse the long-term population trend of decline and increase the numbers of regent honeyeaters to a level where there is a viable, wild breeding population, even in poor breeding years; and to ▪ Enhance the condition of habitat across the regent honeyeater range to maximise survival and reproductive success and provide refugia during periods of extreme environmental fluctuation. The recovery plan also details four strategies to achieve the plan's objectives: ▪ Improve the extent and quality of regent honeyeater habitat. ▪ Bolster the wild population with captive-bred birds until the wild population becomes self-sustaining. ▪ Increase understanding of the size, structure, trajectory and viability of the wild population. ▪ Maintain and increase community awareness, understanding and involvement in the recovery program. The Biodiversity Offset Strategy will include offsets for the Regent Honeyeater and its habitat.

K.2 Further consideration of impacts to *Bossiaea oligosperma*

Table K-2 details the further consideration of impacts to *Bossiaea oligosperma* in accordance with Section 9.2.5 of the FBA.

Table K-2. Further consideration of impacts to Bossiaea oligosperma

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	Limited targeted surveys were carried out for *Bossiaea oligosperma* within the survey area, with individuals recorded within four locations. The majority of individuals were observed at Tonalli Point with a few individuals observed on the W4 trail east of Lake Burragorang, and at Higgins Bay. According to the OEH profile (OEH, 2018a), *B. oligosperma* is known from two disjunct areas - the lower Blue Mountains in the Warragamba area (Wollondilly, Allum, Tonalli River catchments) and the Windellama area in Goulburn Mulwaree Shire, where it is locally abundant. It has been estimated that the population within the Warragamba area consists of >2,000 plants (OEH, n.d.b). The size of the local population potentially affected by the Project is unknown. It has therefore been assumed for the purposes of this assessment, that a local population of *B. oligosperma* is present within habitat considered suitable for the species within the study area. Suitable habitat is assumed to be present in 483 hectares within the impact area
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** There is little to no information in scientific literature of the specific habitat requirements of *B. oligosperma*. According to the OEH profile (OEH 2018a), the species generally grows on stony slopes or ridges on sandstone in the Yerranderie area. According to the Commonwealth Conservation Advice (DEWHA 2008a), the distribution of the species is noted to overlap with the EPBC Act listed community – White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. The species has also been noted as occurring in eucalypt woodland including *Grevillea asplenifolia* (Benson and McDougall 1996). Habitats for which the species has been recorded in the Warragamba area generally include dry sclerophyll shrubby forest to heathy woodland on Permian sedimentary substrate (Berry Siltstone) with high clay content featuring iron barks and grey gums (equivalent to PCT 860) and sheltered dry to wet sclerophyll forest on Permian colluvium that equates to 'River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions' listed as an EEC under the BC Act, on the proviso that occurrences are at or below 250 metres AHD (S. Douglas pers. comm.). Change in habitat may be a consequence of impacts associated with the Project **(ii)** Temporary inundation may modify habitat for the species by altering soil properties such as structure and chemistry or causing erosion in turn affecting plant survivability, growth, germination and/or recruitment**.** The potential loss of suitable habitat for *B. oligosperma* is estimated to be 483 hectares within the impact area. **(iii)** There is little to no information in scientific literature on the ecology and biology of *B. oligosperma*. It is not known how the local population would respond to impacts associated with the development and how changed habitat would affect the species' life cycle, genetic diversity and long-term evolutionary development. One known threat to the long-term viability of *B. oligosperma* population in the Warragamba area is known to be inappropriate fire regime (S. Douglas pers. comm.).. The Project will not change the management of fire within the Warragamba Catchment. However, modifications to vegetation structure could potentially lead to more or less susceptibility to fire.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available:	Suitable habitat for *B. oligosperma* is assumed to be present in 483 ha within the impact area. Little is known about the ecology and biology of *B. oligosperma.* The pollination cycle, seedbank and recruitment ecology of *B. oligosperma* and its potential interactions with other species such as pollinators, host species and mycorrhizal associations are not documented in scientific literature. However broader studies of the 'Ecology of the Fabaceae family in the Sydney region' (Auld, 1996) provide

Criteria	Consideration
▪ pollination cycle ▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	some insights into the Fabaceae family although these findings may or may not apply to *B. oligosperma*. Auld (1996) reports that native bees are known to pollinate most legumes while numerous other insects such as native and introduced wasps, beetles and flies are also potential pollinators. Auld also notes that numerous insects may interact with legumes as phytophagous feeders, stem miners, gall formers or seed predators. This study notes that the impact of the introduced honey bee (*Apis mellifera*) on pollination and subsequent seed production of plants in the Fabaceae family is unknown. With regard to seed ecology, it is noted that Fabaceae generally have hard dormant seeds with a few species in the *Bossiaea* genus exhibiting possible change in dormancy levels as seeds age (Auld, 1996). The exact seed dispersal mechanism for *B. oligosperma* is unknown however broadly, species within the Fabaceae family are known to initially release seed through either passive, ballistic or explosive mechanisms although primarily over a short dispersal distance (generally 0-2 m). Another study suggests that in some *Bossiaea* species, ants may play a role in seed dispersal (Berg, 1975) (Rice and Westoby, 1981). Give the lack of understanding of the specific ecology and biology of *B. oligosperma* the impact of the proposal on the local population of the species is not known.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	Suitable habitat for *B. oligosperma* is assumed to be present in approximately 483 ha of the impact area.. The Project may contribute to fragmentation and isolation of the local population.
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. Limited targeted surveys were carried out for *B. oligosperma* within the survey area, with individuals recorded within four locations across the survey area. Specifically, the majority of individuals were observed at Tonalli Point with few individuals also observed on the W4 trail east of Lake Burragorang, and at Higgins Bay. Given the limitation with regards to the effort carried out for targeted threatened species surveys, it has been assumed that individuals may occur in suitable habitat across the study area. The current level of genetic connectivity between all known records of individuals within the Warragamba area (including those in different catchments - Wollondilly, Allum and Tonalli River) as well as any other known populations within the species range is unknown.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	According to the OEH profile (OEH, 2018a), *B. oligosperma* is threatened by frequent fire, clearing associated with rural residential developments (mainly southern part of its range) and habitat loss associated with roadworks or track maintenance. According to the Threatened Species Profile Database (TSPD), the additional threats are listed as weed invasion and altered hydrology. Other sources suggest the long-term viability of the local population is threatened by inappropriate fire regime (S. Douglas pers. comm.).. The Project may result in changes to habitat for the species which may lead to greater susceptibility to other threats and therefore decrease the viability of the local population.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Bossiaea oligosperma* has been allocated to the site-managed stream of the SoS program. The Burragorang Conservation site falls within the study area. Management objectives at this site include: ▪ Maintain appropriate fire regime for the species ▪ Minimise accidental damage on road/track edges ▪ Track species abundance / condition over time The Conservation Advice lists a number of regional priority actions to support the species. These include but are not limited to: ▪ Monitor known populations to identify key threats

Criteria	Consideration
	▪ Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. ▪ Identify populations of high conservation priority. ▪ Minimise adverse impacts from land use at known sites. Species credit species offsets are proposed to offset the potential loss of *B. oligosperma* within the impact area in accordance with the steps outlined in the BOS.

K.3 Further consideration of impacts to *Callistemon linearifolius*

Table K-3 details the further consideration of impacts to *Callistemon linearifolius* in accordance with Section 9.2.5 of the FBA.

Table K-3. Further consideration of impacts to Callistemon linearifolius

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	Limited targeted surveys were carried out for *Callistemon linearifolius*, with 30 individuals recorded at four separate locations within the survey area. At least 23 individuals in PCT 941 were recorded on the Little River, approximately 2.5 kilometres upstream of its confluence with the Nattai River. Similarly, a further 5 individuals were recorded in PCT 1292 on the Little River approximately 500 m upstream of its confluence with the Nattai River. At least 1 individual was also recorded in PCT 941 on Green Wattle Creek, approximately seven kilometres upstream from its confluence with the Cox's River and at least one individual was recorded in PCT 1105 along Tonalli Creek, approximately three kilometres upstream of Lake Burragorang. These records were verified by the Royal Botanic Gardens Sydney (RBGS) and represent new records for the Burragorang IBRA subregion. According to the OEH profile (OEH, 2019h), there are 5-6 populations of *C. linearifolius* in the Sydney area. The nearest known records are to the east of the study area at Reedy Creek near Eastern Creek and along Georges River in Campbelltown, although some of these records are dated. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (OEH, 2019h). It is unlikely that cross-pollination would occur (either at all or on a regular basis) between the individuals recorded within the survey area and the known records further east as mapped on the BioNet Atlas of NSW Wildlife Database, and therefore the records within the study area are assumed to comprise a disjunct local population Based on the FBA it has been assumed that a local population of *C. linearifolius* is present within habitat considered suitable for the species within the study area This represents an assumed impact on 1,968 individuals within the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)**. According to the OEH profile (OEH, 2019h), the species generally grows in dry sclerophyll forest on the coast and adjacent ranges. However, SMEC observed *C. linearifolius* incidentally in PCT 1292, 941 and 1105 which are broadly consistent with forested wetlands rather than dry sclerophyll forestA local population of *C. linearifolius* is assumed to be present in the Study area. This represents an assumed impact on 1,968 individuals within the impact area.. **(ii)** Changes to natural flooding regimes and more specifically, waterlogging of soil for an unspecified period of time would potentially modify habitat for the species by altering soil properties such as structure and chemistry or causing erosion in turn affecting plant survivability, growth, germination and/or recruitment**.** Impacts resulting from unnatural flooding regimes may also mean that areas of adjacent suitable habitat are affected through edge effects and weed invasion. Therefore, the proposed loss of suitable habitat for *C. linearifolius* is estimated to include xx hectares of suitable habitat within the impact area. **(iii)** There is little information in scientific literature on the ecology and biology of *C. linearifolius.* The occurrence of the species within the survey area represents a range extension for the species for which the habitat would differ from what is known regarding habitat for previous occurrences further east towards the coast. It is therefore not known how the local population would respond to impacts associated with the development and how changed habitat would affect the species' life cycle, genetic diversity and long-term evolutionary development.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available:	The pollination cycle, seedbank and recruitment ecology of *C. linearifolius* and its potential interactions with other species such as pollinators, host species and mycorrhizal associations are poorly documented in scientific literature. However broader studies of the *Callistemon* genus suggest the importance of *Callistemon* species in providing a potential food source for Australian nectar-feeding birds (Ford *et al*. 1979). Similarly, there is evidence to suggest that many birds (mostly honeyeaters), carry pollen of *Callistemon* although this is not proof that they are pollinators (Ford *et al*. 1979).

Criteria	Consideration
▪ pollination cycle ▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	If the proposal results in loss of individuals, this is likely to contribute to fragmentation and isolation of the local population..
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. Limited targeted surveys were carried out for *Callistemon linearifolius*, with 30 individuals recorded at four separate locations within the survey area. The individuals and suitable habitat recorded within the study area are assumed to comprise a disjunct local population as all other known records are further east of the study area and within different IBRA subregions. The current level of genetic connectivity between all populations within the species range is unknown. It is important to note that there may be additional populations unknown to science that have yet to be recorded because few surveys have been conducted in the Warragamba Special Area and Lower Blue Mountains.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	According to the NSW Scientific Committee (1999b), the species is threatened by continuing loss of habitat primarily to urban development and there is an elevated risk of local extinction due to low population numbers. According to the OEH profile (OEH, 2019h) for the species, additional threats are that there is 'insufficient understanding of taxonomy' and 'insufficient understanding of distribution' – a likely reason for the OEH 'Saving Our Species (SoS)' program allocating the species to the 'data-deficient species'. The management objective for data-deficient species is to 'address key knowledge gaps for this species, which once resolved, can inform effective management of this species'. As a number of individuals lie within the impact area it is reasonable to expect that the local population could decline if these individuals were impacted by temporary inundation.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Callistemon linearifolius* has been allocated to the data deficient stream of the SoS program. Management objectives for this species include: ▪ Search for the species in suitable habitat in areas that are proposed for development or management actions, protect any such site found. ▪ Protect known habitat from clearing or disturbance. ▪ Determine response of species to fire and develop and promote a recommended fire regime. Species credit species offsets are proposed to offset the potential loss of *C. linearifolius* individuals within the impact area in accordance with the steps BOS..

K.4 Further consideration of impacts to *Eucalyptus benthamii*

Table K-4 details the further consideration of impacts to *Eucalyptus benthamii* in accordance with Section 9.2.5 of the FBA.

Table K-4. Further consideration of impacts to Eucalyptus benthamii

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	The local population of *Eucalyptus benthamii* within the study area and therefore subject to further consideration is confined to the Kedumba Valley. It is expected that the population at Kedumba Valley would be impacted by the project. Three other populations of *E. benthamii* are known from a distribution that incorporated the Nepean River and its tributaries along with the Coxs River. One population occurs at Bents Basin, one along the Nepean River near Camden and another downstream of Bents Basin near Wallacia (Benson, 1985). Other isolated individuals have been recorded along the Nepean River near Agnes Banks and along the Nattai River over 20 kilometres from the edge of Lake Burragorang (Atlas of Living Australia, n.d.). The local population of *E. benthamii* at Kedumba Valley has been estimated to be 6,550 individuals (Butcher *et al.* 2005) or 4,000 individuals (OEH, 2019b) depending on the source. The local population overall consisted of individuals from a variety of different growth stages (that is, juveniles through to mature hollow-bearing trees). There did not appear to be a larger number of individuals in any growth stage nor did there appear to be any sign of recent disturbance for example a bushfire or significant flood (observed in the field, 2017-2019). Within the local population, *E. benthamii* occurred as almost homogenous stands with only the occasional *Eucalyptus deanei* providing any variation to the assemblage of canopy species.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** The local population of *Eucalyptus benthamii* occurs on the alluvial flats of the Kedumba Valley along the Kedumba River and its tributaries. All individuals occur above the full storage level of Lake Burragorang between about 117 metres and 145 metres above sea level. *E. benthamii* requires deep alluvial sands and a flooding regime that allows for seedling establishment. In the Kedumba Valley it occurs in association with the threatened ecological community *River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (from here on in referred to as River Flat Eucalypt Forest). The tolerance of *E. benthamii* to temporary inundation was investigated in a research study carried out between September 2017 and February 2018 in Deniliquin by the CSIRO on behalf of WaterNSW. The paper produced by the CSIRO is found in Appendix H of this report. Specifically, the study examined the effects of temporary inundation on the health and survival of a stand of 18 year-old *E. benthamii* as well as the soil physical and chemical properties. The study found that there was no statistical evidence that temporary inundation to a depth of 30 centimetres led to a decline in *E. benthamii* health and survival over a period of 24 months after the application of flooding treatments which led to anaerobic soil conditions. While there was some evidence of stress within the stands, as well as some limited mortality, this was attributed to protracted hot and dry conditions in Deniliquin as demonstrated by similar stress and loss in control stands. While the study concludes that *E. benthamii* may be tolerant to temporary inundation (Bush and England, 2019), there are some key differences between the scenario within which the experiment was carried out and the modelled conditions expected to occur within the Kedumba River population of *E. benthamii*. Specifically, the depth of inundation is likely to be higher and the extent of duration lower than the experimental situation. Appendix H provides details of the study's limitations in terms of its applicability to the Kedumba population. 44 hectares of suitable habitat would be impacted within the impact area.

Criteria	Consideration
	(ii) Approximately 44 hectares of *E. benthamii* habitat occurs within the impact area.. The extent to which this habitat would be affected is difficult to determine. The *E. benthamii* habitat identified as PCT 941 occurs as a forested wetland (Keith, 2004) occurring on alluvial flats and flood plains therefore requiring intermittent flooding. It would stand to reason then that many of the species within this PCT could survive temporary inundation. The habitat occurring as PCT 860 is less likely to be able to withstand inundation as it is a dry sclerophyll forest as opposed to a forested wetland. Modelled erosion within *Eucalyptus benthamii* habitat may alter the substrate such that tree fall and windthrow were more likely to occur otherwise. This impact may be further compounded by flood stress experienced by the species post-flood and disturbance to the soil stored seedbank. **(iii)** Germination and recruitment in *E. benthamii* are likely to be affected by a changing flooding regime or inundation profile (Myerscough, 1998). Recruitment from seed was shown to be related to episodic flooding in a study by Doug Benson in 1985. In the 1985 Benson paper, it is stated that germination from seed had only been recorded twice since 1933, both times when the Bents Basin population of *E. benthamii* had been flooded and there had been a deposition of alluvial sands. An increase in the frequency of flood and inundation events may be beneficial to germination and recruitment in *E. benthamii*, it may also be impacted by a potential loss of seed due to erosion.
(c) the likely impact on the ecology of the local population. (i) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and interactions with other species (for example, pollinators, host species, mycorrhizal associations)	**Pollination:** It is unclear how pollination in the Kedumba Valley *E. benthamii* would be affected by the Project. *E. benthamii* is known to self-pollinate which has contributed to the observed low levels of gene flow between populations. There is currently low gene flow between the Kedumba Valley and Wallacia populations both of which have been observed to self-pollinate (Benson, 1985) (Hager and Benson, 2010). Although no specific pollinator study has been conducted on *E. benthamii*, it is likely that insects and to a lesser extent birds are involved in the transfer of pollen from one individual to another. **Seedbanks:** The local population of *E. benthamii* extends outside of the impact area. Therefore at least part of the population and its seedbank will not be impacted by the dam raising. As discussed above it is unclear as to the impact of inundation on seedbanks as erosion my result on the loss of some soil stored seedbanks but may also assist in germination. **Recruitment:** Germination and recruitment of new individuals into a population of *E. benthamii* is dependent on flooding and the substrate in which seeds have been stored (Benson, 1985). The change in flooding and inundation regimes along may impact the substrate in which seed is stored but may also assist germination and recruitment. **Interactions with other species:** There are currently no known host species or mycorrhizal associations specific to *E. benthamii.*
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	As demonstrated by the Butcher *et al*. (2005) paper, the Kedumba Valley population of *E. benthamii* is already genetically isolated from the other populations occurring in Western Sydney. The Kedumba Valley population is also geographically isolated from these populations because the original construction of Warragamba Dam created a physical barrier. It is also possible that the original creation of Lake Burragorang flooded other *E. benthamii* occurring on the bottom of the Warragamba, Wollondilly and Coxs River Valleys. The raising of Warragamba Dam has the potential to further fragment the existing local population of *E. benthamii* in the Kedumba Valley should the Project lead to a loss of parts of the local population.
(e) the relationship of the local population to other populations of the species	The Kedumba Valley population is one of four populations of *E. benthamii* however isolated individuals have been recorded along the Nepean River near Agnes Banks and along the Nattai River over 20 kilometres from the edge of Lake Burragorang. A detailed examination of the genetic relationships between the populations at Kedumba, at Bents Basin, along the Nepean River near Camden

Criteria	Consideration
	and another downstream of Bents Basin near Wallacia was conducted by Butcher *et al.*, in 2005. This study found that there was little gene flow between any of these populations.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The raising of Warragamba Dam would change the flooding regime and the inundation profile within parts of the Kedumba Valley. Flooding and inundation of part of the *E. benthamii* habitat may become more frequent and occur for a longer duration. It is possible that increased erosion and increased spread of weeds may result from the disturbance and lead to a decrease in the viability of the local population.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Eucalyptus benthamii* has been allocated to the site-managed stream of the SoS program. The Kedumba Conservation site falls within the study area. Management objectives at this site include: ▪ Reduce pest species densities and maintain at low levels ▪ Maintain appropriate fire regime for the species/community ▪ Track species abundance / condition over time There is no national recovery plan for *Eucalyptus benthamii*. The Conservation Advice (DoE, 2014a) list a number of local priority actions and threat abatement actions to support the recovery of the species. These include, but are not limited to: ▪ Minimise adverse impacts on populations, particularly the effects of nutrient enrichment and weed propagules from all sources. ▪ Ensure there is no disturbance in areas where the *E. benthamii* occurs, excluding necessary actions to manage the conservation of the species. ▪ Manage any changes to hydrology that may result in changes to flood characteristics or sedimentation. ▪ Liaise with relevant New South Wales government agencies on proposals to increase dam storage that may impact the species. Species credit species offsets are proposed to offset the potential loss of *E. benthamii* individuals within the impact area in accordance with the BOS.

K.5 Further consideration of impacts to *Eucalyptus glaucina*

Table K-5 details the further consideration of impacts to *Eucalyptus glaucina* in accordance with Section 9.2.5 of the FBA.

Table K-5. Further consideration of impacts to Eucalyptus glaucina

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	The local population of *Eucalyptus glaucina* within the study area extends around Lake Burragorang with the exception of the main Warragamba River Gorge. It was observed from the edge of Lake Burragorang inland past the edge of the study area. *E. glaucina* was recorded by SMEC up the major rivers feeding into Lake Burragorang which includes the Coxs River, Wollondilly River and Nattai River. The occurrence of *E. glaucina* within the study area varied from being a dominant canopy species with a number of different age classes to occurring sporadically in ecotones with other communities. *E. glaucina* was recorded in seven PCTs across the study area. It is expected that the extents of these PCTs (habitat) occurring in the study area would be impacted by the raising of Warragamba Dam. These PCTs are as follows: ▪ HN525: Forest Red Gum – Narrow-leaved Ironbark open forest of the southern Blue Mountains gorges, Sydney Basin Bioregion ▪ HN527: Forest Red Gum – Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands ▪ HN532: Grey Gum – Broad-leaved Ironbark dry open forest on gorge slopes on the Blue Mountains, Sydney Basin Bioregion ▪ HN535: Grey Gum – Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion ▪ HN536: Grey Gum shrubby open forest on gorge slopes of the Blue Mountains, Sydney Basin Bioregion ▪ HN553: Mountain Blue Gum – Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion ▪ HN557: Narrow-leaved Ironbark – Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion). The *E. glaucina* recorded in the study area represents a range extension to the species. The current understanding of the *E. glaucina* distribution is that is occurs primarily in two locations, the Rappville district south of Casino on the NSW North Coast, and the Hunter Valley about 150 kilometres north of the Sydney CBD. Several other smaller populations have also been recorded from the Taree, Stroud, Dungog and Paterson districts (DEWHA, 2008b).. The closest population in the Hunter Valley is over 100 kilometres away from the *E. glaucina* recorded in the study area. An estimation on the number of individuals within the local population is difficult considering the sizeof the study area and the limitations to which it was surveyed. However for the purposes of the assessment, using the FBA Calculator, an estimate of 10,970 individuals may potentially occur within the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a	**(i)** *E. glaucina* has been recorded in a variety of different habitats. Johnson (1962) recorded the species growing in shallow soils on stony hillsides. Harden (1991) writes that the *E. glaucina* occurs in grassy woodlands on deep, well-watered and moderately fertile soil. Chippendale (1988), on the other hand, observed *E. glaucina* growing on gentle slopes supporting drainage lines along with alluvial and clay soils. The *E. glaucina* habitat in the study area partially matches the recorded habitat provide by these three scientists. The habitat recorded by SMEC within the study area included grassy woodlands, sloping terrain and rocky hillsides, drainage lines and shallow soils that were both alluvial and clay based. Sandy soils were also commonly recorded throughout the study area. The Approved Conservation Advice for *E. glaucina* (DEWHA, 2008b) highlights that the greater distribution of *E. glaucina* overlaps with the distribution of the threatened ecological community White Box – Yellow Box – Blakely's Red Gum

Criteria	Consideration
plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	Woodland. This community (along with *E. glaucina*) was recorded by SMEC in the south of the study area, particularly around the Wollondilly River and Joorilands area. **(ii)** The impacts to *E. glaucina* habitat could include: ▪ Temporary inundation and stress of individual ▪ Deposition or erosion of soil and particulate matter on plants (especially relevant to seedlings and juvenile plants) ▪ weed invasion resulting from soil disturbance **(iii)** *Eucalyptus glaucina* is a medium-sized tree growing up to 30 metres tall. It produces small cream, white or occasionally pink flowers (OEH, 2019i). It is likely pollinated by a range of fauna groups including insects, birds and mammals. While no study into reproduction has been conducted on *E. glaucina*, it is unlikely that fire or flooding is required for seed release and germination. *E. glaucina* is not specifically associated or restricted to flood plains or riparian areas (. Seed is likely contained post-release in a soil-stored seed bank within one kilometre of the parent tree. SMEC is not aware of anystudy that has been conducted on the genetic diversity or the genetic connectivity between populations of *E. glaucina*. Given the physical distances between the main occurrences at the NSW North Coast, the Hunter Valley and within the study area (all over 100 kilometres apart) it is probable that there is limited gene flow between them. Limited genetic exchange was demonstrated between comparatively close populations of *Eucalyptus benthamii* (Butcher *et al*. 2005). In the Butcher *et al*., study, populations in the Kedumba Valley, at Camden, at Bents Basin and along the Nepean River were all demonstrated to be genetically isolated from one another. The population of *E. glaucina* in the study area is also likely to be genetically isolated The area of potential *E. glaucina* habitat (Appendix B) is large compared to the area in the impact area. However, the Project may impact the lifecycle of the population through potential erosion of soils impacting on the seed bank and any seedlings and juveniles.
(c) the likely impact on the ecology of the local population. (i) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	**Pollination**: *Eucalyptus glaucina* likely has a pollinator assemblage comprising different insects, birds and possibly mammals (such as the Grey-headed Flying-fox). The Project may impact certain species within this assemblage however the abundance of habitat away from the edge of Lake Burragorang (and outside the study area) means it is unlikely it would lead to a local extinction of these pollinators. **Seedbanks and recruitment**: The agent of seed dispersal used by *Eucalyptus glaucina* is unknown. As a group of plants, Eucalyptus uses various agents of seed dispersal such as wind (such as *Eucalyptus regnans*) (Cremer, 1966) ants or even the stingless bee (such as *Corymbia torelliana*) (Wallace and Trueman, 1995). There is also variation in how seeds are stored (seedbanks) with both soil-stored seed and canopy-stored seed common in the genus Eucalyptus (Lamont *et al*. 1991). If *Eucalyptus glaucina* stores its seed in the soil (which it most likely does for at least part of a seeds lifecycle), then the Project may impact this seed through local erosion that may result from temporary inundation. Due to erosion risk impact is more likely along the eastern shore of the Wollondilly River arm of Lake Burragorang, south of the confluence with the Nattai River . **Interactions with other species**: Mature *Eucalyptus glaucina* may also provide shelter and roosting habitat for different fauna. Hollows used by small mammals and birds may form in mature *Eucalyptus glaucina*. More complex interactions may also occur such as that between *Eucalyptus glaucina* and different species of mistletoe. Mistletoe in turn, can provide habitat for different bird species such as the critically endangered Regent Honeyeater (*Anthochaera phrygia*).Impacts that result in a loss of trees may therefore have a proportional impact on linked species.

Criteria	Consideration
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The local population of *E. glaucina* has been assessed as occurring in most parts of the study area except for Warragamba Gorge. *E. glaucina* was also recorded above the study area as far as west as Yerranderie Road - W2. Inundation events that result in a loss of trees or recruitment may increase fragmentation broader local population. This impact would be small compared to the extent of the potential population..
(e) the relationship of the local population to other populations of the species	An assessment on the potential isolation of the local population from the greater species distribution is difficult without an understanding of the gene-flow between all populations. The large distances between the populations at Warragamba, the Hunter Valley and the NSW North Coast indicates that gene-flow may be limited. Gene-flow is likely limited by the lack of a pollination vector able to span the distances between populations. It is unlikely that long-range seed dispersal is part of the ecology of *E. glaucina*. Any impacts to the local population of *E. glaucina* are unlikely to further isolate it from the other populations within the species' greater distribution.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The following threats to *Eucalyptus glaucina* have been listed by OEH (2019i): ▪ clearing for agriculture and development ▪ timber harvesting activities ▪ lack of regeneration through grazing pressure ▪ loss of genetic integrity due to hybridisation with other red gum species ▪ canopy die-back; the direct causes are changes to insect populations and repeated defoliation. The Project has the potential to lead to a loss of individual trees as a result of temporary inundation.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Eucalyptus glaucina* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. There are no conservation sites for this species within the study area. There is no national recovery plan for *Eucalyptus glaucina*. The conservation advice (DEWHA, 2008b) list a number of regional priority actions and threat abatement actions to support the recovery of the species. These include, but are not limited to: ▪ Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. ▪ Identify populations of high conservation priority. ▪ Ensure agriculture and timber harvesting activities (or other infrastructure or development activities involving substrate or vegetation disturbance) in areas where *Eucalyptus glaucina* occurs do not adversely impact on known populations. Species credit species offsets are proposed to offset the potential loss of *E. glaucina* individuals within the impact area in accordance with the BOS.

K.6 Further consideration of impacts to *Hakea dohertyi*

Table K-6 details the further consideration of impacts to *Hakea dohertyi* in accordance with Section 9.2.5 of the FBA.

Table K-6. Further consideration of impacts to Hakea dohertyi

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	The local population of *Hakea dohertyi* identified within the study area and therefore subject to further consideration is confined to the southern shore of Tonalli Cove which provides habitat for less than 100 individuals (Offord *et al*. 2003) (DEWHA, 2008c) (OEH, 2019g). SMEC recorded 23 individuals within the local population at Tonalli Cove. *H. dohertyi* has been described as growing in dry sclerophyll forests occurring on steep, dry, north-facing slopes and open rocky ridge tops (Barker *et al*. 1999) (Benson and McDougall, 2000) (Harden, 2002). SMEC recorded *H. dohertyi* on slopes of various aspects, in dry sclerophyll forest. No rocky outcrops were observed nor were the slopes particularly steep. The population was recorded close to the edge of lake Burragorang meaning that steeper and rockier habitat could have occurred before the lake was formed. The recorded *H. dohertyi* occurred in HN527 but is associated with five other PCTs within the TSPD. HN527 occurs frequently throughout the study area. The distribution of *H. dohertyi* seems to be geographically constrained however, with the local population only occurring along the southern shore of the Tonalli Cove. Consequently, the potential available habitat for the species was estimated to be all associated PCTs along western side of Wollondilly arm of Lake Burragorang north from Murphies Crossing, until just north of Higgins Bay. Three other populations have been recorded outside of the study area; a population of about 7,000 individuals occurring in an 18-square kilometre area along the Kowmung River in Kanangra Boyd National Park (Offord *et al*. 2003) (DEWHA, 2008c), a smaller population just outside of Yerranderie in the Yerranderie Regional Park, and a population of 38 individuals in the Shoalhaven Region about 15 kilometres west of Nowra (Mills, 2008).
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** The Project would cresult in temporary inundation under a variety of different flood scenarios. The area of potential habitat for the species within the impact area is 199 ha. The following impacts on *Hakea dohertyi* and its habitat could include: ▪ inundation of the species and surrounding vegetation, inducing flood stress ▪ erosion and deposition of soils and substrates ▪ weed invasion resulting from soil disturbance **(ii)** The identified population of *H. dohertyi* at Tonalli Cove occurred within 50 metres of the edge of Lake Burragorang within a narrow topographic range making it susceptible to impacts that result from temporary inundation. Offord, *et al*. (2003) and the Approved Conservation Advice for *Hakea dohertyi* (2008c) state that 'the main potential threat to *H. dohertyi* is changes to the water level in Warragamba Dam'. **(iii)** *H. dohertyi* is an obligate seeding, bradysporous species. *H. dohertyi* seeds are non-dormant and would begin to germinate between 5-100 days after they have been released from the fruit of a mature plant. An unpublished study by Steenbeeke (1996) states that at room temperature, fresh seeds are almost 100 percent viable however this viability decreases over time with seeds being dead after 10 years. Recruitment of new individuals into a population of *H. dohertyi* is therefore more likely facilitated through germination after seed release from a mature plant (they have an aerial seedbank) rather than from seed contained in a soil-stored seedbank. The temporary inundation of *H. dohertyi* habitat at Tonalli Cove is unlikely to remove a soil-stored seed bank important to recruitment. Fire is likely important to the lifecycle of *H. dohertyi*. It may not be the trigger of germination as is the case in many Australian flora species, however it likely enables the release of seed stored in a population's aerial seed bank – seed

Criteria	Consideration
	stored in the fruit of mature individuals. A change to the fire regime within *H. dohertyi* habitat would affect a population's ability to release seed. The Warragamba Dam Raising project will not result in changes to fire management practices within the study area. No pollination or visitation study has been conducted on *H. dohertyi*. It is likely however, that pollination is facilitated by small to medium sized birds, insects and possibly small mammals (like the Eastern Pygmy Possum) as is the case in other species within the Proteaceae family. The Project may temporarily affect pollinator habitat and foraging behaviour but not likely to the extent that it would cause their local extinction or their ability to facilitate the pollination of any surviving *H. dohertyi*. The genetic relationships between populations and individuals of *H. dohertyi* have not been explored in any previous study. Assuming that cross-pollination occurs within the *H. dohertyi* in the study area and to a larger extent within the species entire distribution, the small number of populations and the few individuals recorded within them may indicate low levels of genetic diversity. Loss of individuals within the Tonalli Point population may adversely impact the species ability to survive in the long-term.
(c) the likely impact on the ecology of the local population. (i) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	**Pollination**: *Hakea* sp are pollinated by a range of fauna groups including birds, insects and mammals. A study into pollination in Western Australian *Hakea* (Hanley *et al*. 2009) identified broad characteristics to separate predominantly insect-pollinated species from predominantly bird-pollinated species. The presence of dense foliage and/or leaf spines protecting inflorescences and the distance of the stigma to the nectary are the characteristics used to separate *Hakea* into these two groups. No flowers were observed on *H. dohertyi* nor have the metrics required to apply the previously mentioned floral characterisation been previously recorded. The foliage of *H. dohertyi* is sparse compared to other *Hakea* species in the Bioregion such as *H. sericea*. As no pollination study has been conducted on *H. dohertyi* nor can the method of pollinator classification described by Hanley, *et al*. be applied, we have precautionarily assumed that both birds and insects pollinate this species. While pollinator habitat within the study area may impacted by the temporary inundation it is unlikely to impact pollination in the future. **Seedbanks**: *H. dohertyi* produces an aerial seedbank – seed is stored in the fruit or follicle until maturity and released after fire (Offord *et al*. 2003) (Steenbeeke, 1996). Seed released by a mature plant is immediately viable with this viability decreasing over time with the seed dying after about 10 years (Steenbeeke, 1996). Inundation caused by raising Warragamba Dam is therefore unlikely to affect recruitment via a soil-stored seed bank. Complete submersion of individual plants could wash away seed stored within fruit or follicles that has recently opened. **Recruitment**: Optimal germination was shown by Offord, *et al*. (2003) to occur at 15°C with the largest number of seeds germinating within 14 days of being exposed to this temperature. Germination slowed when seeds were exposed to temperatures over 30°C and under 5°C. Germination of seed declines after release with the seeds becoming completely unviable after 10 years (Steenbeeke, 1996). Germination is unlikely to be affected by temporary inundation unless an inundation event occurred shortly after seed has been released (eg after a fire event). **Interactions with other species**: Apart from the plant-pollinator interactions occurring between *H. dohertyi* and different bird and insect groups there are no other recorded interactions with other species.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The local population occurs about 10 kilometres from the next closest recorded population at Yerranderie Regional Park, about 25 kilometres from the population along the Kowmung River and over 90 kilometres from the population in the

Criteria	Consideration
	Shoalhaven region. Temporary inundation would be unlikely to fragment the local population of *H. dohertyi*. An assessment on the potential isolation of the local population from the greater species distribution is difficult without an understanding of the gene-flow between all populations. The transfer of pollen likely plays an important role in the exchange of genetic material between populations however no pollinator study or population genetics study has been conducted. Assuming that *H. dohertyi* is pollinated by birds it is possible that genetic material is exchanged between the populations at Tonalli Cove, Yerranderie and along the Kowmung River.
(e) the relationship of the local population to other populations of the species	The local population occurs about 10 kilometres from the next closest population at Yerranderie, about 25 kilometres from the population along the Kowmung River and over 90 kilometres from the population in the Shoalhaven Region. The current level of genetic connectivity between all populations is unknown. It is important to note that there may be additional populations of *H. dohertyi* unknown to science and yet to be recorded as few botanical surveys have been conducted in the Warragamba Special Area and the Lower Blue Mountains.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The following threats listed by OEH (2019g) apply to the *Hakea dohertyi* at Tonalli Cove: ▪ While the population is primarily within a National Park, limited distribution and susceptibility to fire make this species vulnerable to natural catastrophes or environmental changes. ▪ Goats are noted to browse the foliage and bark of plants, leading to their death and potentially reducing seed availability. ▪ The population near the shore of Lake Burragorang would be impacted by raising pondage heights of Warragamba Dam. The threat most likely to be increased comes from the temporary inundation around Lake Burragorang. As the local population lies partially within the impact area it is reasonable to expect that the local population would be impacted if the dam wall was raised.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Hakea dohertyi* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. There are no conservation sites for this species within the study area. There is no national recovery plan for *Hakea dohertyi*. The Conservation Advice (DEWHA, 2008c) list a number of local priority actions and threat abatement actions to support the recovery of the species. These include, but are not limited to: ▪ Monitor known populations to identify key threats. ▪ Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. ▪ Manage any changes to hydrology that may result in changes to the water table levels and/or increased run-off. Species credit species offsets are proposed to offset the potential loss of *H. dohertyi* individuals within the impact area in accordance with the BOS.

K.7 Further consideration of impacts to *Pomaderris brunnea*

Table K-7 details the further consideration of impacts to *Pomaderris brunnea* in accordance with Section 9.2.5 of the FBA.

Table K-7. Further consideration of impacts to Pomaderris brunnea

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	The local population of *Pomaderris brunnea* (Brown Pomaderris) is difficult to define. This is because new records have been made by SMEC during the recent surveys, at scattered locations along the entirety of Lake Burragorang's edge (with the exception of Warragamba Gorge). It is assumed that the entire Warragamba Special Area represents the local population for this assessment. *P. brunnea* is endemic to south-eastern Australia with records as far north as the New England Tableland near Walcha, and as far south as the Snowy Mountains National Park in Victoria (Sutter, 2011) (OEH, 2017d). Majority of the recorded individuals (prior to the recent surveys) however occur in Western Sydney along the upper Colo and Nepean Rivers (Harden, 1990) (Harden, 2000). Prior to the recent surveys of the Warragamba Special area the known distribution of *P. brunnea* comprised 16 populations made up of about 100 individuals (Sutter, 2011). No exact count of *P. brunnea* individuals was untaken within the study area, however estimates indicate the population in the Special Area could be over 1,000 individuals. These individuals were all recorded along the edge of Lake Burragorang making them likely to become temporarily inundated during the Project's operational phase. It is possible that the *P. brunnea* observed adjacent to Lake Burragorang occur as a result of existing temporary inundation. As all individuals observed occurred at a certain topography above the existing full supply level it is possible that this existing impact has encouraged growth of *P. brunnea*.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	(i) *Pomaderris brunnea* occurs in a variety of habitats. Records of this species have been made in moist woodlands and forests on clay soils, in more open woodlands, on alluvial floodplains and along creek lines (Sutter, 2011) (OEH, 2017d). The population on the New England Tableland is associated with canopy species such as *Eucalyptus laevopinea* (Silver-top Stringybark), *Eucalyptus saligna* (Sydney Blue Gum) and *Eucalyptus campanulata* (New England Blackbutt) (Sutter, 2011). Populations further to the south have been noted to occur in association with *Eucalyptus amplifolia* (Cabbage Gum), *Allocasuarina* spp. and *Bursaria* spp. (Sutter, 2011). In the Sydney Basin Bioregion populations occurring on alluvial flood plains occur in association with *Eucalyptus elata* (River Peppermint), *Eucalyptus piperita* (Sydney Peppermint), *Eucalyptus punctata* (Grey Gum), *Bursaria spinosa* and *Pteridium esculentum* (Bracken). The *P. brunnea* in the Warragamba Special Area was found along the edge of Lake Burragorang usually on flat or gently sloping terrain. There were no obvious patterns in the vegetation individuals were associated with, nor did they occur exclusively on creek lines or alluvial plains. The most significant pattern in the occurrence of *P. brunnea* in the Warragamba Special Area was that it was only observed close to the full capacity level of Lake Burragorang, or within the riparian buffer of creeklines, and not higher up the slope. This would indicate that potential habitat would best be assessed based on topography and proximity of water rather than on just Plant Community Type (PCT). According to OEH's BioNet system *P. brunnea* is associated with five PCTs that occur within the study area. These are: ▪ HN564 ▪ HN557 ▪ HN532 ▪ HN607 ▪ HN574

Criteria	Consideration
	The area of potential *P. brunnea* habitat within the impact area is 1146 hectares. (ii) Any loss and modification of *P. brunnea* habitat would vary depending on the length and depth of the inundation event the erosion risk and the tolerance of associated species to being inundated. (iii) The lifecycle of *Pomaderris brunnea* is thought to be between 10 and 20 years. The time to reproductive maturity and ability to produce seed is approximately four to six years (OEH, 2017d). Seeds are likely dispersed by ants (myrmecochorous dispersal) a distance no greater three metres (Gomez and Espadaler, 2003). This could explain why *P. brunnea* was often observed growing in dense stands. *P. brunnea* was also observed to reproduce asexually by suckering – a method of reproduction which would also produce dense stands of individuals. Genetic testing has not been conducted on any population of *P. brunnea* so asexual reproduction cannot be confirmed. There has been little research conducted into germination and pollination in *P. brunnea* however other species of *Pomaderris* have been shown to produce seed requiring fire for germination (Patykowski *et al*. 2016). If the temporary inundation results in erosion there is the potential for the seed bank to be impacted particularly as the seed tends to be located close to its source. If, however, the conditions resulting from temporary inundation encourage growth and establishment of *P. brunnea* there is the potential for the project to result in growth in the local population.
(c) the likely impact on the ecology of the local population. (i) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and interactions with other species (for example, pollinators, host species, mycorrhizal associations)	**Pollination:** Little is known about pollination in *P. brunnea* however it likely that insects play a role. Local insect populations may be impacted during temporary inundation which may result in reduced pollination during and after a flood event. **Seedbanks:** The existing seed bank may be removed or reduced (depending on the severity of the flooding event) by the movement of water associated with the raising of Warragamba Dam. **Recruitment:** As ants are likely the most important facilitator of seed dispersal for *P. brunnea*, any negative impact to their occurrence would also have a negative impact on this species. Ant colonies that are flooded may be destroyed and reestablishment times for the colonies is not known. This is particularly important for the Funnel Ant (*Aphaenogaster longiceps*) a common ant in the Warragamba Special Area that builds colonies in loose topsoil. Seeds are often stored in these colonies facilitating germination (and protecting them from fire) of seedlings when the right conditions occur. Additionally, these funnel colonies roughen the soil and mitigate the erosive impact of water running downhill (Shakesby *et al*. 2006). **Interactions with other species:** The *P. brunnea* of the Warragamba Special Area occurs on the edge of a variety of intact vegetation communities dominated by species such as *Eucalyptus punctata*, *E. glaucina*, *Eucalyptus eugenioides*, *Eucalyptus crebra*, *Eucalyptus fibrosa*, *Angophora floribunda*, *Bursaria spinosa*, *Clerodendrum tomentosum* and *Olearia viscidula*. Within these communities, its distribution often runs parallel to the edge of Lake Burragorang or a waterway feeding into it. Below the FSL, weed species were observed. In many places these species had colonised the native communities just above the current full supply level. It is possible that additional temporary inundation may spread of these weed and exotic species into the areas occupied by *P. brunnea*.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	All the *P. brunnea* observed by SMEC in the Warragamba Special Area occurred along the edge of Lake Burragorang. Temporary inundation caused by the raising of Warragamba Dam would therefore inundate many of the individuals in the *P. brunnea* population. Noting that this area is also subject to inundation from the existing dam. The project may result in the loss of a high proportion of individuals and lead to more isolated individuals.. . It is possible however, that the building of Warragamba Dam and the subsequent creation of Lake Burragorang has facilitated the distribution and abundance of the existing *P. brunnea* population. Conversely, the population

Criteria	Consideration
	observed by SMEC may be the relic of a larger population that spanned the entire Burragorang Valley.
(e) the relationship of the local population to other populations of the species	Information on the distribution of *P. brunnea* prior to European settlement is limited making an assessment on-population isolation difficult. The known populations (with all but three having less than 100 individuals) occur between the New England Tableland and Snowy River National Park – a large distribution considering the small number of populations and individuals that have been recorded to date (Sutter, 2011) (OEH, 2017d). Due to the lack of historical information on *P. brunnea* an assessment has not been made on any possible historic decline in the species.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	Current threats to *P. brunnea* include sand extraction activities, weed and exotic species invasion, logging, browsing from non-native fauna, altered fire regimes, recreational activities and disturbance from storm water run-off (Sutter, 2011) (OEH, 2017d). From the previously mentioned threats, the Project has the potential to exacerbate impacts of invasive flora and fauna . Temporary inundation may increase the spread of weed and exotic flora species further into the surrounding vegetation communities.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Pomaderris brunnea* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. There are no conservation sites for this species within the study area. There is no national recovery plan for *P. brunnea*. There is also no approved conservation advice or listing advice for this species. There is also no threat abatement plan identified as being relevant to this species. Species credit species offsets are proposed to offset the potential loss of *H. dohertyi* individuals within the impact area in accordance with the BOS.

K.8 Further consideration of impacts to *Solanum armourense*

Table K-8 details the further consideration of impacts to *Solanum armourense* in accordance with Section 9.2.5 of the FBA.

Table K-8. Further consideration of impacts to Solanum armourense

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	The local population of *Solanum armourense* within the study area is confined to the area along the Wollondilly River, especially the Joorilands Loop and the W4 track (OEH, 2019j). SMEC identified a population just off the W4 trail on the eastern side of the Wollondilly River. At each of the three locations where the species was observed within the survey area, only a few individuals were recorded. Searches for the species recorded 13 individuals.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** *Solanum armourense* has been described as occurring in eucalypt woodland growing in shallow soils on steep rocky hillsides (OEH, 2019j). Despite the few individuals that were observed by SMEC and have been previously recorded, this habitat type is common throughout the Warragamba Special Area. This would imply that the ecology and habitat preferences of *Solanum armourense* are poorly understood. Eight PCTs mapped by SMEC within the Warragamba Special Area have been identified by OEH to be associated with *Solanum armourense*. The extent of *S. armourense* habitat within the impact area is 470 ha. **(ii)** *Solanum armourense* has been described as *growing amongst other shrubs in eucalypt woodland, on steep rocky hillsides with shallow soil* (OEH, 2019j). The habitat SMEC recorded *S. armourense* in was similar to this description, as it was found growing in a eucalypt forest supported by shallow soils. Shrubs were present however the understory and groundcover were relatively open. *S. armourense* was recorded by SMEC growing on flat terrain however this occurred at the top of a small cliff or rocky hillside. Potential impacts from temporary inundation to *S. armourense* habitat could include erosion or deposition of the shallow soil. **(iii)** *Solanum armourense* most likely disperses seed through animals ingesting seeds stored in the fruit and dispersing them elsewhere. The Project is unlikely to impact such an interaction except during the temporary inundation event. . After deposition, seed is stored in the soil. It is unknown how temporary inundation affects the seed of *S. armourense* and if it would still be viable if it was moved to a different part of the catchment. The genetic relationships between populations and individuals of *S. armourense* have not been explored. Assuming that cross-pollination occurs within the *S. armourense* in the Warragamba Special Area the small number of populations and the few individuals recorded within them may indicate low levels of genetic diversity. Loss of individuals within the Tonalli Point population may adversely impact the local population of the species ability to survive in the long-term.
(c) the likely impact on the ecology of the local population. (i) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and interactions with other species (for example, pollinators, host species, mycorrhizal associations)	**Pollination**: Native *Solanum* are predominantly pollinated by bees (Anderson and Symon, 1988). Temporary inundation would be unlikely to impact the local occurrence of a bee species to the extent that it places *Solanum armourense* individuals without pollinators. **Seedbanks**: Assuming seed is stored in the soil the seed bank could be impacted by temporary inundation and any erosion of soil should this occur. **Recruitment**: It is understood that fire is necessary for recruitment from seed (OEH, 2019j). *S. armourense* is a fire sensitive obligate seeder with germination and recruitment occurring from a soil-stored seed bank (OEH, 2019j). A change in fire regime may impact recruitment. The project will not result in changes to fire management within the catchment **Interactions with other species**: Apart from the plant-pollinator interaction that likely occurs with bees, there are no other recorded interactions with other

Criteria	Consideration
	species. Seeds are likely dispersed by animals however there is no current understanding as to what these may be.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The local population has been defined as the two sub-populations within the study area occurring along the W4 track and along the Joorilands Loop. Both of these sub-populations occur within 20 kilometres of the only other known populations; at Mount Armour west of Yerranderie and along Susan's Gully near the Wollondilly River Nature Reserve (OEH, 2019j). The loss or partial loss of individuals would likely result in increased fragmentation of the local population. An assessment on the potential isolation of the local population from the greater species distribution is difficult without an understanding of the gene-flow between all populations. As the local population lies roughly between the population at Mount Armour and the population at Wollondilly River Nature Reserve, its potential loss could increase their isolation as a distance of over 20 kilometres would now exist. Additional survey may result in identification of further populations within the Special Area.
(e) the relationship of the local population to other populations of the species	The local population occurs within 20 kilometres of the only other populations within the species distribution, one at Mount Armour and another at the Wollondilly River Nature Reserve. The current level of genetic connectivity between all populations within the species range is unknown. It is important to note that there may be additional populations that have yet to be recorded because few surveys have been conducted in the Warragamba Special Area and Lower Blue Mountains.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The following threats listed by OEH (2019j) apply to *Solanum armourense*: ▪ Given extremely small population size and restricted distribution, threatened by local extinction due to environmental and demographic uncertainty. ▪ Habitat loss due to clearing for agriculture and urban development. ▪ Inappropriate fire regimes, particularly frequent fire. ▪ Potential for invasion of habitat by serrated tussock and Pittosporum undulatum. ▪ Most known populations occur adjacent to roads or tracks where potential damage from maintenance activities or fire management is a threat. ▪ Potentially threatened with infestation by the Tomato Red Spider Mite. The Project has the potential to increase the environmental and demographic uncertainty for a species with a small population size and restricted distribution.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Solanum armourense* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. The Joorilands Loop conservation site is located within 1-2 kilometres of the subject site. Management action proposed for this site include: ▪ Maintain appropriate fire regime for the species/community ▪ Minimise accidental damage on road/track edges ▪ Investigate presence/susceptibility/effects of the disease ▪ Track species abundance / condition over time. Species credit species offsets are proposed to offset the potential loss of *Solanum armourense* individuals within the impact area in accordance with the BOS.

K.9 Further consideration of impacts to *Epacris purpurascens* var. *purpurascens*

Table K-9 details the further consideration of impacts to *Epacris purpurascens* var. *purpurascens* in accordance with Section 9.2.5 of the FBA.

Table K-9. Further consideration of impacts to Epacris purpurascens var. purpurascens

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	The species is currently known from approximately 30 locations and the size of the populations, where known, vary from very small (one to five plants) to greater than 1,000 individuals ((NSW Scientific Committee, 1999c). Populations are known from several reserves however the largest known populations occur within Sydney Catchment Authority areas, west of Wollongong (NSW Scientific Committee, 1999c). In some instances, populations may occur locally as the dominant shrub, as localised small groupings, or be of high numbers/low frequency – the population being scattered over a wide area (NPWS, 2002a). According to a search of BioNet Atlas of NSW Wildlife Database, there are three records within 10 kilometres of the study area. One record is approximately six kilometres west of the study area (near Nattai State Conservation Area) and the other two records are approximately three kilometres upstream from the Dam Wall (near Burragorang State Conservation Area) within the survey area. All these records are within the Burragorang IBRA subregion. The size of the local population affected by the Project is unknown. No individuals of *E. purpurascens* var. *purpurascens* were recorded during vegetation surveys and targeted threatened species searches were not undertaken.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** *E. purpurascens* var. *purpurascens* is found in a range of habitat types (OEH, 2017e). Specifically, it has been known to occupy relatively open areas such as drainage lines or depressions, skeletal soil areas such as sandstone outcroppings and areas possessing indurated laterite gravels or rock fragments (NPWS, 2002a). Despite a lack of observational records of the species within the study area, suitable habitat is known to exist. As per Section 6.5.1.9 of the FBA, this species has been assumed to be present within the study area. It has therefore been assumed for the purposes of this assessment, that a local population of *E. purpurascens* var. *purpurascens* is present within habitat considered suitable for the species within the study area. *E. purpurascens* var. *purpurascens* is associated with four PCTs that occur within the impact area totalling with an assumed estimate of 300 individuals. This suitable habitat would be impacted by temporary inundation from the raised Dam. **(ii)** and **(iii)** temporary inundation may modify habitat for the species by altering soil properties such as structure and chemistry or causing erosion in turn affecting life cycle processes, plant survivability, growth, germination and/or recruitment.
(c) the likely impact on the ecology of the local population. (i) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and interactions with other species (for example, pollinators, host species, mycorrhizal associations)	There is little information regarding the life cycle processes of *E. purpurascens* var. *purpurascens.* Pollinators are unknown however it is thought that seed is dispersed via water and wind (NPWS, 2002a). The lifespan of individuals has been reported to be 5-20 years, requiring at least two to four years before seed is produced in the wild (OEH, 2017e). It is killed by fire and re-establishes from soil-stored seed (OEH, 2017e). Given a lack of understanding on the ecology and biology of *E. purpurascens* var. *purpurascens* it is assumed that changes to soil properties soil properties such as structure and chemistry or erosion would in turn negatively affect plant survivability, growth, germination and/or recruitment should the species be present.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	No individuals of *E. purpurascens* var. *purpurascens* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The size of the local population is unknown, but an estimate of the assumed presence in the impact area is 300 individuals .

Criteria	Consideration
	According to NPWS (2002a) the distance between groups of plants which creates isolation is unknown as pollinators are unknown. However, at least some interaction between individuals is likely over distances of up to 250 metres given that wind and water are known dispersal mechanisms. It is unlikely that the Project would cause significant additional fragmentation and isolation of a local population (should it exist) given the availability of suitable habitat within the locality.
(e) the relationship of the local population to other populations of the species	It is not known the relationship of the local population (if any) to other populations of the species, including the BioNet Atlas of NSW Wildlife Database record that is four kilometres south west of the study area.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The following threats listed by the NSW National Parks and Wildlife Services (NPWS)' Environmental Impact Assessment Guidelines (2002a) apply to *E. purpurascens* var. *purpurascens*: ▪ Development Projects that result in the total destruction of habitat, partial destruction of habitat or modification (including changes to hydrology and nitrification of the soil substrate) of the habitat or the vegetation structure which may result in dense monospecific regrowth of large shrubs, trees or invasion of alien species. ▪ Development Projects that result in a requirement for frequent fire hazard reduction, so that the seedbank cannot be adequately replenished. ▪ Increased vehicular, bike or pedestrian access to a population or increased rubbish dumping and associated weed invasion or arson. The main threat according to the NSW Scientific Committee (NSW Scientific Committee, 1999c) is 'clearing and too frequent fire, particularly in areas north of Sydney. Due to the fragmented nature of the northern populations, and their small size, the species is susceptible to localised extinctions'. Additional threats as listed by the 'SoS Program' (OEH, n.d.c) for this species include: ▪ *Slashing/spraying.* ▪ *Establishment and spread of invasive grasses.* ▪ *Inappropriate fire regimes.* If a local population is present the Project is anticipated to contribute to an increase in threats to its viability.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*E. purpurascens* var. *purpurascens* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. There are no conservation sites for this species within the study area. Species credit species offsets are proposed to offset the potential loss of *E. purpurascens* var. *purpurascens* individuals within the impact area in accordance with the BOS.

K.10 Further consideration of impacts to *Gyrostemon thesioides*

Table K-10 details the further consideration of impacts to *Gyrostemon thesioides* in accordance with Section 9.2.5 of the FBA.

Table K-10. Further consideration of impacts to Gyrostemon thesioides (Hook.f.) A.S. George

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	Within NSW, *Gyrostemon thesioides* (Hook.f.) A.S. George has only been recorded at three sites near the Georges and Nepean Rivers (OEH, 2019e). There is little to no information in scientific literature on the ecology and biology of this species. According to a search of BioNet Atlas of NSW Wildlife Database, the closest record is approximately two kilometres to the west of the Study Area (near Butchers Creek), within the Burragorang IBRA subregion (OEH, 2019e). The size of the local population affected by the Project is unknown. No individuals of *G. thesioides* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. It has therefore been assumed for the purposes of this assessment, that a local population of *G. thesioides* is present within habitat considered suitable for the species within the Study Area. In accordance with the FBA, *G. thesioides* is associated with 12 PCTs that occur within 886 hectares in the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** There is little information in scientific literature on the ecology and biology of *G. thesioides*. According to BioNet Atlas of NSW Wildlife Database, the closest record to the Study Area was found in a sandstone gully on sandy loam soils dominated by *Syncarpia glomulifera*, *Callistemon salignus, Backhousia myrtifolia* with emergent *Eucalyptus punctata.* Shrub understorey dominated by *Lasiopetalum macrophyllum, Howittia trilocularis* with groundcover comprising *Microlaena stipoides, Tylophora barbata,* and *Lepidosperma gunnii*. In accordance with the FBA, *G. thesioides* is associated with 12 PCTs that occur within the study area. This suitable habitat may be altered by temporary inundation although the level of alteration to habitat would vary based on the depth, frequency and duration of inundationfor any event. For example, suitable habitat occurring at higher elevations is likely to be less impacted than that of lower elevation and flat areas. **(ii)** Changes to inundation and more specifically, waterlogging of soil may modify habitat for the species by altering soil properties such as structure and chemistry or causing erosion in turn affecting plant survivability, growth, germination and/or recruitment**.** The impacts on potential habitat for *G. thesioides* as a result of the Project is estimated to be 886 hectares within impact area based on the assumption that the species and its habitat is intolerant to inundation. **(iii)** There is little to no information in scientific literature on the ecology and biology of *G. thesioides*. On this basis, through application of the precautionary principle it is assumed that the modification to suitable habitat as a result of the Project would affect the life cycle processes of the species.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	The extent of the local population is unknown and the ecology of the species is poorly understood (OEH, 2019e). The OEH has assigned this species to a 'Data-deficient species' management stream under the 'Saving Our Species (SoS) program' and note a key consideration for developing management objectives to conserve this species include further investigations into the life history dynamics; including seed set, seed viability, dormancy, longevity (in the natural environment and in storage), germination and seedling survival (OEH, n.d.d). *G. thesioides* is a fire-opportunist, with recruitment occurring from a soil stored seed bank following fire (OEH, 2019e). It not known what fire conditions are favourable to the recruitment of *G. thesioides* and therefore it is feasible to assume that any change to the current fire dynamics affecting suitable habitat may affect the recruitment potential for this species. The Project does not propose changes to fire management within the Special Areas

Criteria	Consideration
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	Within NSW, the species has only been recorded at three sites with which two of records occur within the Burragorang IBRA subregion close to the study area (OEH, n.d.d). However, no individuals were recorded by the current study within the study area. The Project would potentially impact suitable habitat for the species. .
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. According to a search of BioNet Atlas of NSW Wildlife Database, the closest record is approximately two kilometres to the west of the study area (near Butchers Creek within the Burragorang IBRA subregion (OEH, 2017b)). The current level of genetic connectivity between all populations within the species range is unknown. It is important to note that there may be additional populations that have yet to be recorded because few surveys have been conducted in the Warragamba Special Area and Lower Blue Mountains. It is not known the relationship of the local population (if any) to other populations of the species, including the BioNet Atlas of NSW Wildlife Database records proximal Study Area.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The following threats listed by OEH (2019e) apply to *G. thesioides:* ▪ Habitat loss due to clearing. ▪ Habitat degradation, particularly from weed invasion. ▪ Insufficient understanding of distribution. ▪ Insufficient understanding of threats. ▪ Insufficient understanding of life history. ▪ Altered Fire Regimes. The Project has the potential to contribute to habitat loss that may result from temporary inundation.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Gyrostemon thesioides* has been allocated to the data deficient stream of the SoS program. Management objectives for this species include: ▪ Search for the species in suitable habitat in areas that are proposed for development or management actions, protect any such site found. ▪ When populations are indentified, assess threates and develop management requirements for each. ▪ Investigate life history dynamics, including seed set and seed viability. Species credit species offsets are proposed to offset the loss of potential *G. thesioides* habitat within the impact area in accordance with the BOS..

K.11 Further consideration of impacts to *Hibbertia puberula*

Table K-11 details the further consideration of impacts to *Hibbertia puberula* in accordance with Section 9.2.5 of the FBA.

Table K-11. Further consideration of impacts to Hibbertia puberula Toelken

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	*Hibbertia puberula Toelken* is found in the central coast botanical subdivision in sandy soil often associated with sandstone (NSW Scientific Committee, 2003). Early records of this species are from the Hawkesbury River area and Frenchs Forest in northern Sydney, South Coogee in eastern Sydney, the Port Hacking River area in south Sydney and the Blue Mountains (OEH, 2019f). According to a search of BioNet Atlas of NSW Wildlife Database, the nearest records are approximately 13 kilometres to the north between Warrimoo and Blaxland in the lower Blue Mountains (OEH, 2017b). These records fall within the Wollemi IBRA subregion. The size of the local population affected by the Project is unknown. No individuals of *H. puberula* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. It has therefore been assumed for the purposes of this assessment, that a local population of *H. puberula* is present within habitat considered suitable for the species within the study area. In accordance with the FBA, *H. puberula* is associated with four PCTs that occur within the study area. A total of 35 ha of potential habitat occurs in the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** *H. puberula* occurs on sandy soil often associated with sandstone, or on clay (OEH, 2019f). Preferred habitat typically includes dry sclerophyll woodland communities, although heaths are also occupied (OEH, 2019f). Potential impacts would vary as a result of the depth, frequency and duration of inundation.. For example, suitable habitat occurring at higher elevations is likely to be less impacted than that of lower elevation and flat areas. **(ii)** Changes to inundation and more specifically, waterlogging of soil for a period of time may modify potential habitat for the species by altering soil properties such as structure and chemistry or causing erosion in turn affecting plant survivability, growth, germination and/or recruitment**.**. The loss of potential habitat for *H. puberula* is estimated to be 35 ha within the impact area based on the assumption that the habitat is intolerant to inundation. **(iii)** There is little to no information regarding the life cycle processes of *H. puberula.* Through application of the precautionary principle it is assumed that the modification to suitable habitat as a result of the Project would affect the life cycle processes of the species.
(c) the likely impact on the ecology of the local population. (i) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and interactions with other species (for example, pollinators, host species, mycorrhizal associations)	There is little to no information regarding the life cycle processes of *H. puberula.* It is assumed that any changes to soil properties would potentially impact plant survivability, growth, germination and/or recruitment**.**
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The size of the local population affected by the Project is unknown. No individuals of *H. puberula* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. It has therefore been assumed for the

Criteria	Consideration
	purposes of this assessment, that a local population of *H. puberula* is present within habitat considered suitable for the species within the Study Area. It is unlikely that the Project would cause significant additional fragmentation and isolation of a local population (should it exist) given the availability of suitable habitat within the locality.
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. No individuals of *H. puberula* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. It is not known the relationship of the local population (if any) to other populations of the species, including the BioNet Atlas of NSW Wildlife Database record that is 13 kilometres north of the study area.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	According to the NSW Scientific Committee (2003), *H. puberula* is threatened by loss of habitat and the very low number of records for the species suggest that it would be threatened by demographic and environmental stochasticity. Additional threats as listed by the 'SoS Program' (OEH, n.d.e) for this species include: ▪ insufficient understanding of distribution and/or abundance ▪ mixed weeds ▪ disturbance from recreational users ▪ road/motorway development ▪ rural/residential/industrial development ▪ slashing/spraying The most likely threat resulting from the Project is the potential loss of suitable habitat where there is insufficient understanding of the distribution and/or abundance of the species in the study area.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*Hibbertia puberula* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. There are no conservation sites for this species within the study area. Species credit species offsets are proposed to offset the loss of potential *H. puberula* habitat within the impact area in accordance with the BOS.

K.12 Further consideration of impacts to *Melaleuca deanei*

Table K-12 details the further consideration of impacts to *Melaleuca deanei* in accordance with Section 9.2.5 of the FBA.

Table K-12. Further consideration of impacts to Melaleuca deanei F. Muell.

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	*Melaleuca deanei F. Muell*. is known mainly from the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas, but there are also isolated occurrences in the Blue Mountains, Nowra and Central Coast areas (OEH, 2019c). It is only known from approximately 94 populations, of which only very few are secure and reproductively viable (Bremner and Goeth, 2010). Within its range, *M. deanei* has been recorded from broad flat ridgetops, dry ridges and slopes and is strongly associated with sandy loam soils that are low in nutrients and sometimes containing ironstone (Bremner and Goeth, 2010). Mostly, the species occurs in ridgetop woodland, with only 5% of sites in heath on sandstone (OEH, 2019c). The size of the local population affected by the Project is unknown. No individuals of *M. deanei* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. One individual was recorded incidentally outside the study area near Medlow Gap, approximately three kilometres from the northern part of the study area. According to a search of BioNet Atlas of NSW Wildlife Database, the nearest records of *M. deanei* to the study area are approximately 15 kilometres to the north, between Glenbrook and Blaxland. These records are within the Wollemi IBRA subregion (OEH, 2017b). It has been assumed for the purposes of this assessment, that a local population of *M. deanei* could be present within habitat considered suitable for the species within the study area. *M. deanei* is associated with two PCTs that cover an area of 9 ha within the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** There is little information in scientific literature on the ecology and biology of *M. deanei*. The habitat for which *M. deanei* was incidentally recorded by SMEC outside the study area (near Medlow Gap) can be broadly described as being low open dry sclerophyll forest. In accordance with the FBA, *M. deanei* is associated with two PCTs that occur within the study area. This suitable habitat may be impacted by temporary inundation although the level of impact would vary across the extent of the study area based on the depth, frequency and duration of inundation. **(ii)** Temporary inundation may modify habitat for the species by altering soil properties such as structure and chemistry or causing erosion that may affect plant survivability. *M. deanei* is associated with two PCTs that cover an area of 9 ha within the impact area. based on the assumption that the species is likely to be intolerant to inundation. **(iii)** There is little information in scientific literature on the ecology and biology of *M. deanei*. It is known that *M. deanei* tends to reproduce by suckering and clones are therefore common while seedlings are rare. A study of the reproductive capacity of this species has been compared with that of the more common species *M. nodosa, M. thymifolia* and *M. styphelioides* which found that *M. deanei* has a lower rate of seed production than the more common species because of lower rates of flowering rather that poorer pollination rate or rate of seed setting after pollination (Hewitt *et al*. 2014). Temporary inundation may result in modification of species habitat that could affect t the life cycle processes of the species.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle	The size of the local population affected by the Project is unknown. No individuals of *M. deanei* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. *M. deanei* is a clonal species with the ability to re-sprout from a swollen rootstock (lignotuber) to produce coppiced growth, and it can also sucker from its rootstock (Felton, 1993). The species seems to breed successfully very rarely and mostly subsists vegetatively as clones originating from lignotubers (Myerscough, 1998). The exact age at which *M. deanei* starts to produce flowers and seed is unknown,

Criteria	Consideration
▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	with a number of observers stating different estimates (Bremner and Goeth, 2010). It is also not known exactly how *M. deanei* is pollinated, though insects have been suggested and self-fertilisation cannot be ruled out (Turnball and Doran, 1997 cited in Virtue (1991)). Seeds in *M. deanei* are produced in woody capsules held in the canopy for several years, until dehydration allows the capsules to open and release between 500-600 seeds (Felton, 1993). Seed release is triggered by fire, occasionally also by drought or frost, and is dispersed by wind (Virtue, 1991). It is unknown whether *M. deanei* possesses a persistent soil seedbank or if seeds retain viability beyond at least nine weeks (Felton, 1993). Fire and possibly other physical disturbances that increase light levels without impacting upon the soil may play a role in providing for the recruitment and long-term persistence of the species (Bremner and Goeth, 2010). It is not known the degree of impact (if any) the Project would have on the pollination cycle, seedbanks, recruitment and interactions with other species for *M. deanei*.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The Project would potentially impact approximately 9 hectares of suitable habitat within the impact area.
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. One individual was recorded incidentally outside the study area near Medlow Gap, approximately three kilometres from the northern part of the study area. According to a search of BioNet Atlas of NSW Wildlife Database, the nearest records of *M. deanei* to the study area are approximately 15 kilometres to the north, between Glenbrook and Blaxland. These records are within the Wollemi IBRA subregion (OEH, 2017b). The current level of genetic connectivity between all populations within the species range is unknown. It is important to note that there may be additional populations yet to be recorded because few surveys have been conducted in the Warragamba Special Area and Lower Blue Mountains. It is not known the relationship of the local population (if any) to other populations of the species, including the individual opportunistically recorded near Medlow Gap and the BioNet Atlas of NSW Wildlife Database records .
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	According to the Threatened Species Scientific Committee (TSSC) (Department of Agriculture, Water and the Environment, 1999), key threats to *M. deanei* include: habitat disturbance, clearing, altered fire regimes, trail maintenance and weed encroachment. Whilst the National Recovery Plan (Bremner and Goeth, 2010) lists the following as key threats: ▪ low fecundity and viability ▪ habitat loss and fragmentation ▪ inappropriate fire regimes ▪ mechanical methods of bushfire fuel hazard reduction ▪ construction and maintenance of tracks and easements ▪ unrestricted access and rubbish dumping ▪ weed invasion ▪ hybridisation. Additional threats as listed by OEH (2019c) include elevated risk of extinction due to low population numbers where the species shows evidence of a limited capacity to regenerate, with many sites having little or no seeds set. Other threats according to the NSW Scientific Committee (1999d) include small population size, regimes of frequent fire, urban development, trail maintenance, runoff and weed encroachment. The Project has the potential to impact on this species. Temporary inundation would potentially impact approximately 9 hectares within the impact area. <u>Noting that no individuals have been recorded or were identified in the study or impact areas.</u>

Criteria	Consideration
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*M. deanei* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. There are no conservation sites for this species within the study area. A National and NSW State Recovery Plan under the EPBC Act and BC Act for *M. deanei* (DECCW, 2010c) details eight objectives in order to recover the species: ▪ Coordinate the recovery of *M. deanei* ▪ Protect known occurrences of M. deanei using land-use and conservation planning mechanisms ▪ To identify and minimise the threats operating at M. deanei sites ▪ To improve awareness of M. deanei amongst operational staff working within easements, walking tracks and fire trails Species credit species offsets are proposed to offset the potential loss of *M. deanei* individuals within the impact area in accordance with the BOS.

K.13 Further considerations of impacts to *Dillwynia tenuifolia*

Table K-13 details the further consideration of impacts to *Dillwynia tenuifolia* in accordance with Section 9.2.5 of the FBA.

Table K-13. Further considerations of impacts to Dillwynia tenuifolia DC.

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	*Dillwynia tenuifolia* DC. is primarily known from the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee (OEH, 2019d). Other populations in western Sydney are recorded from Voyager Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire (OEH, 2019d). Disjunct localities outside the Cumberland Plain include the Bulga Mountains at Yengo in the north, and Kurrajong Heights and Woodford in the Lower Blue Mountains (OEH, 2019d). The size of the local population affected by the Project is unknown. No individuals of *D. tenuifolia* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. According to a search of BioNet Atlas of NSW Wildlife Database, the nearest record for *D. tenuifolia* to the study area is approximately 6.5 kilometres to the east of Warragamba Dam. This record is within the Burragorang IBRA subregion (OEH, 2017b). In accordance with the FBA, a total of 2 hectares of suitable habitat for *D. tenuifolia* occurs within the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	In accordance with the FBA, a total of 2 hectares of suitable habitat for *D. tenuifolia* occurs within the impact area This suitable habitat may be impacted by temporary inundation although the level of impact would vary across the extent of the study area based on the depth, frequency and duration of inundation.. Changes to inundation and more specifically, waterlogging of soil for a period of time may modify potential habitat for the species by altering soil properties such as structure and chemistry or causing erosion in turn affecting plant survivability, growth, germination and/or recruitment. These impacts may affect the lifecycle, genetic diversity and long-term evolutionary development of *D. tenuifolia* to some degree as a reduction of suitable habitat would reduce the area of potential occupancy for the species. Noting that only about 2 ha of potential habitat may be impacted. While a study by Rymer, *et al*. (2002) found that some known populations of the species (from eight locations) are relatively safe from the effects of genetic drift, it has been suggested that smaller, less-connected populations may ultimately be in danger through the loss of suitable habitat leading to population crashes and genetic bottlenecks. Should a small population exist within the impact it may be subject to this danger.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	The size of the local population affected by the Project is unknown. No individuals of *D. tenuifolia* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The BioNet Atlas of NSW Wildlife Database lists the nearest record for *D. tenuifolia* as approximately 6.5 km to the east of Warragamba Dam. This record is within the Burragorang IBRA subregion (OEH, 2017b). BioNet Atlas of NSW Wildlife Database records occur outside the study area and known plants would not be impacted by the Project. However, the Project would impact on potential habitat for this species. *D. tenuifolia* is a fire-sensitive species with a facultative breeding system (being both self- and cross-pollination compatible) (Rymer *et al*. 2002). Pollinators are unknown however one study suggests pollination by native bees (Rymer *et al*. 2002). Seeds are hard-coated and are persistent in the soil seed bank, primarily dispersing via dehiscence over a short distance (generally 0-2 m) (OEH, 2019d) (Rymer *et al*. 2002). Secondary seed dispersal is by ants however is localised (OEH, 2019d) (Rymer *et al*. 2002). The Project may reduce areas of potential habitat for the species (up to 2ha)and this

Criteria	Consideration
	may have some but limited implications for the pollination cycle, seedbanks, recruitment and interactions with other species.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The size of the local population affected by the Project is unknown. No individuals of *D. tenuifolia* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. It is unlikely that the Project would cause significant fragmentation and isolation of a local population (should it exist) given the availability of suitable habitat within the broader area. However, a total of 2 hectares of suitable habitat for *D. tenuifolia* occurs within the impact area..
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. No individuals of *D. tenuifolia* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The core distribution of the species is the Cumberland Plain with other populations in Western Sydney and further north in Yengo and Blue Lountains National Parks (OEH 2o19d) It is not known the relationship of the local population (if any) to other populations of the species, including the BioNet Atlas of NSW Wildlife Database record that is 6.5 km east of Warragamba Dam.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	Known threats to *D. tenuifolia* include habitat loss and degradation due to infrastructure maintenance activities or urban development, invasive grasses, slashing, grazing, trampling, partial clearance (for example, removal or thinning of canopy) which may impact vegetation structure and habitat modification through inappropriate fire regimes, urban runoff, weeds, rubbish dumping, indiscriminate vehicular and pedestrian access (OEH, 2019d) (NPWS, 2002b). The Project may lead to an increase in threats that may lead to a decrease in the viability of the local population if it was present. However, the local population of *D. tenuifolia* is unknown and therefore the extent to which the Project would affect the viability of the local population cannot be ascertained.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*D. tenuifolia* has been allocated to keep-watch stream of the SoS program. The species action statement aims to ensure the security of this species in the long-term. There are no identified conservation sites for this species, but a number of state-wide actions have been identified. These include, but are not limited to: ▪ In circumstances where impacts are unavoidable, as part of any consent, approval or license that is issued, ensure that offset measures are undertaken within the priority conservation lands where practicable. ▪ DPIE will review the priority conservation lands and assessment methodology within five years of the date of approval of the Cumberland Plain Recovery Plan. . ▪ Preferentially target any future investment associated with management to the priority conservation lands where practicable. ▪ Support and promote the adoption of best practice standards for bushland management and restoration (as specified in Appendix 2 of the Cumberland Plain Recovery Plan) on public and private lands within the Cumberland Plain. Species credit species offsets are proposed to offset the potential loss of *D tenuifolia* habitat within the impact area in accordance with the BOS.

K.14 Further consideration of impacts to *Rhodamnia rubescens*

Table K-14 details the further consideration of impacts to *Rhodamnia rubescens* in accordance with Section 9.2.5 of the FBA.

Table K-14. Further considerations of impacts to Rhodamnia rubescens.

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	*Rhodamnia rubescens* is a shrub or small tree that is currently known to occur in coastal districts north from Batemans Bay in NSW, to areas inland of Bundaberg in Queensalnd. The size of the local population affected by the Project is unknown. No individuals of *R. rubescens* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The BioNet Atlas of NSW Wildlife Database contains three records for *R. rubescens* within 10 kilometres of the study area. Two of these records are located approximately 4 kilometres north-east of the study area, within the Cumberland IBRA subregion (OEH, 2017b). The third record occurs to the west of the study area, north-west of Higgins Bay. In accordance with the FBA, a 78 hectares of suitable habitat for *R. rubescens* occurs within the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	78 hectares of potential habitat for *R. rubescens* occurs within the impact area. The Project may reduce the viability of suitable habitat for *R. rubescens* within the study area as a result of temporary inundation. Quantifying the extent and implications of these impacts is however difficult. Impacts may affect the lifecycle, genetic diversity and long-term evolutionary development of *R. rubescens* to some degree as impacts on suitable habitat may reduce the area of potential occupancy for the species.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	The size of the local population affected by the Project is unknown. No individuals of *R. rubescens* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The BioNet Atlas of NSW Wildlife Database contains three records for *R. rubescens* within 10 km of the study area. Two of these records are located approximately 4 kilometres north-east of the study area, within the Cumberland IBRA subregion (OEH, 2017b). The third record occurs to the west of the study area, north-west of Higgins Bay. These records occur outside the study area and would not be impacted by the Project. The Project may impact areas considered to be suitable habitat for this species which may reduce areas of occupancy/potential occupancy for the species. If this occurs, there may be implications for the pollination cycle, seedbanks, recruitment and interactions with other species, although the extent of impact on these processes is unknown. This is because there is little to no information available in scientific literature on how the species responds to disturbance as well as limited information on the general ecology and biology of the species.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The size of the local population affected by the Project is unknown. No individuals of *R. rubescens* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. It is unlikely that the Project would cause additional significant fragmentation and isolation of a local population (should it exist) given the availability of suitable

Criteria	Consideration
	habitat within the locality. However, a total of 78 hectares of suitable of suitable habitat for *R. rubescens* occurs within the impact area.
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. No individuals of *R. rubescens* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The relationship of the local population (if any) to other populations of the species is unknown, including to the BioNet Atlas of NSW Wildlife Database record that is four kilometres north-east of the study area (OEH, 2017b). There is no information as to the genetic connectedness of populations.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	*R. rubescens* is threatened by the exotic rust fungus *Austropuccinia psidii*, which has caused a decline of the species since the introduction of the pathogen in 2010. The vector of *A. psidii* include transfer of spores by wind, water, fauna and people, infected nursery plants and associated plant growing material, and infected plant material in the environment (for example, fallen affected leaves). As there is currently no effective or practical chemical, biological, or management control for the rust fungus in the introduction of *A. psidii* may result in a significant decline in the health and viability of any *R. rubescens* occurring within the study area. In certain circumstances, the Project may increase flood stress on *R. rubescens,* which may lead to an increased susceptibility to Myrtle Rust should it be present in any populations within the study area, thus decreasing the viability of the local population. The size and distribution of any local population of *R. rubescens* is unknown and therefore the extent to which the Project may affect the viability of the local population cannot be determined.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*R. rubescens* has been allocated to the landscape species stream of the SoS program. This management stream aims to ensure that the species is secure in the wild in NSW and that its NSW geographic range is extended or maintained. The study area site falls within the management site for the species. Management objectives at this site include, but are not limited to: ▪ Undertake a desktop review of species records and historical survey data and engage with consultants, NGO's and volunteer 'spotters' to identify rapid survey sites. ▪ Complete rapid field surveys across the entire species range to determine rust impact, identify rust resistant populations, sites or individuals. Use standardised protocols for recording myrtle rust incidence, severity and demographic impacts. ▪ Undertake genetically representative germplasm collections. Collect genetic material (min. 6 individuals) from every germplasm collection site for genetic analysis of population structure and genetic representativeness of collections. ▪ Develop a long-term management plan for the eventual management/re-establishment of wild populations for the species. Species credit species offsets are proposed to offset the potential loss of *R rubescens* habitat within the impact area in accordance with the BOS.

K.15 Further consideration of impacts to *Ancistrachne maidenii*

Table K-15 details the further consideration of impacts to *Ancistrachne maidenii* in accordance with Section 9.2.5 of the FBA.

Table K-15. Further consideration of impacts to Ancistrachne maidenii (A.A. Ham.) Vickery

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	*Ancistrachne maidenii* (A.A. Ham.) Vickery is known from around northern Sydney, around St Albans, Mt White, Maroota, Berowra areas and to the Shannon Creek area south-west of Grafton (OEH, 2017a). The size of the local population affected by the Project is unknown. No individuals of *A. maidenii* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The BioNet Atlas of NSW Wildlife Database contains one record for *A. maidenii* within 10 km of the study area. This record is approximately two km north west of the study area, within the Wollemi IBRA subregion (OEH, 2017b). A total of 29 hectares of potential habitat for *A. maidenii* occurs within the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	A total of 29 hectares of potential habitat for *A. maidenii* occurs within the impact area and would be potentially impacted by temporary inundation as a result of the Project. The Project may reduce the viability of suitable habitat for *A. maidenii* within the study area as a result of temporary inundation. Quantifying the extent and implications of these impacts is however difficult. Impacts may affect the lifecycle, genetic diversity and long-term evolutionary development of *A. maidenii* to some degree as impacts on suitable habitat may reduce the area of potential occupancy for the species.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	The size of the local population affected by the Project is unknown. No individuals of *A. maidenii* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The Project may impact areas considered to be suitable habitat for this species. This would reduce areas of potential occupancy for the species and this may have implications for the pollination cycle, seedbanks, recruitment and interactions with other species although the extent of impact on these processes is unknown. This is because there is little to no information available in scientific literature on how the species responds to disturbance as well as limited information on the general ecology and biology of the species.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The size of the local population affected by the Project is unknown. No individuals of *A. maidenii* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. It is unlikely that the Project would cause additional significant fragmentation and isolation of a local population (should it exist) given the availability of suitable habitat within the locality.

Criteria	Consideration
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. No individuals of *A. maidenii* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The relationship of the local population (if any) to other populations of the species is unknown, including to the BioNet Atlas of NSW Wildlife Database record that is two km northwest of the study area (OEH, 2017b). There is no information as to the genetic connectedness of populations.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	Known threats to *A. maidenii* include habitat loss and degradation due to infrastructure maintenance activities or urban development, weed spraying and inappropriate fire regimes (OEH, 2017a). Previous surveys undertaken by Botanists along urban creeklines have failed to record the species, suggesting that this species is sensitive to pollution or weed invasion (NSW Scientific Committee, 1999a). The Project could lead to an increase in threats and indirect impacts that may lead to a decrease in the viability of the local population if present. The size and distribution of any local population of *A. maidenii* is unknown and therefore the extent to which the Project may affect the viability of the local population cannot be determined.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*A. maidenii* has been allocated to keep-watch stream of the SoS program. The species action statement aims to ensure the security of this species in the long-term. There are no identified conservation sites for this species, but a number of state-wide actions have been identified as follows: ▪ Undertake surveys of potential habitat. ▪ Undertake conservation status review once surveys of potential habitat are completed. ▪ Develop actions for protection and management once surveys of potential habitat are completed. ▪ Ensure staff undertaking track and roadside maintenance activities are aware of species, its habitat and habitat requirements. ▪ Investigate habitat requirements. Species credit species offsets are proposed to offset the potential loss of *A. maidenii* habitat within the impact area in accordance with the BOS.

K.16 Further consideration of impacts to *Tetratheca glandulosa*

Table K-16 details the further consideration of impacts to *Tetratheca glandulosa* in accordance with Section 9.2.5 of the FBA.

Table K-16. Further consideration of impacts to Tetratheca glandulosa Sm.

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	There are approximately 150 populations of *Tetratheca glandulosa* Sm. ranging from Sampsons Pass (Yengo National Park) in the north to West Pymble (Lane Cove National Park) in the south (OEH, 2019k). The eastern limit is at Ingleside (Pittwater Local Government Area) and the western limit is at East Kurrajong (Wollemi National Park) (OEH, 2019k). Note that the study area falls outside this range description being further west and south than these locations. According to a search of BioNet Atlas of NSW Wildlife Database, there are three records for *T. glandulosa* in the Blue Mountains National Park. Two of these records are approximately 13 kilometres to the north west and one record is four kilometres to the north of the study area (OEH, 2017b). All three of these records are in the Wollemi IBRA subregion. There are also three records for *T. glandulosa* in the Nattai National Park, approximately 20 kilometres to the east of the study area in the Burragorang IBRA subregion (OEH, 2017b). The size of the local population affected by the Project is unknown. No individuals of *T. glandulosa* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. Based on the FBA the area of suitable habitat in the impact area is 305 hectares.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	A total of 305 hectares of potential habitat for *T. glandulosa* occurs within the impact area. The Project may reduce the viability of suitable habitat for *T. glandulosa* within the study area as a result of temporary inundation. Quantifying the extent and implications of these impacts is however difficult. Impacts may affect the lifecycle, genetic diversity and long-term evolutionary development of *T. glandulosa* to some degree as impacts on suitable habitat may reduce the area of potential occupancy for the species.
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and ▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	The size of the local population affected by the Project is unknown. No individuals of *T. glandulosa* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The Project may impact areas considered to be suitable habitat for this species. This would reduce areas of potential occupancy for the species and this may have implications for the pollination cycle, seedbanks, recruitment and interactions with other species although the extent of impact on these processes is unknown.
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The size of the local population affected by the Project is unknown. No individuals of *T. glandulosa* were recorded during vegetation surveys and targeted threatened species searches were not undertaken.

Criteria	Consideration
	It is unlikely that the Project would cause significant further fragmentation and isolation of a local population (should it exist) given the availability of suitable habitat within the locality. The presence of a broad area of linked suitable habitat within a 10 kilometre radius would maintain connected unimpacted areas if a population is present.
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown. No individuals of *T. glandulosa* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The relationship of the local population (if any) to other populations of the species is unknown, including the BioNet Atlas of NSW Wildlife Database record four km from the study area (OEH, 2017b). However, Keith *et al*. (1997) use a one km "rule of thumb" to define a local population that is, all *T. glandulosa* individuals occurring within one km of the subject site (between which there is likely to be genetic exchange for example, pollen exchange) would constitute the 'local population' (OEH, 2019k). Assuming that the BioNet Atlas of NSW Wildlife Database record four km from the study area is accurate (that is, not denatured), with little to no GPS error, then it is likely to assume that the relationship of *T. glandulosa* (if there are any) within the study area would bear little to no relationship with the nearest known population with regard to the exchange of genetic material.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	Known threats to *T. glandulosa* include habitat loss through vegetation clearing and habitat degradation, habitat fragmentation, intensified run off, competition from weeds, soil erosion and sedimentation and fire control activities (in particular hazard reduction activities and access track construction and maintenance) (OEH, 2019k) (OEH, n.d.f). The fact that the full extent of population is unknown is also listed as a threat (OEH, n.d.f). The Project may lead to an increase in threats and indirect impacts that may lead to a decrease in the viability of the local population. However, the local population of *T. glandulosa* is unknown and therefore the extent to which the Project would affect the viability of the local population cannot be ascertained and the response of this species to these disturbances is unknown.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*T. glandulosa* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. There are no conservation sites for this species within the study area. Species credit species offsets are proposed to offset the potential loss of *T. glandulosa* habitat within the impact area in accordance with the BOS.

K.17 Further consideration of impacts to *Genoplesium baueri*

Table K-17 details the further consideration of impacts to *Genoplesium baueri* in accordance with Section 9.2.5 of the FBA.

Table K-17. Further consideration of impacts to Genoplesium baueri

Criteria	Consideration
(a) the size of the local population directly and indirectly impacted by the development	The species is currently known from Ulladulla on the NSW South Coast to Port Stephens on the NSW Mid-North Coast (OEH 2012). Within its recognised distribution about half of the recorded sightings of *Genoplesium baueri* were made before 1960. Most of the older records are from suburbs in Sydney such as Asquith, Cowan, Gladesville, Longueville and Wahroonga (OEH 2018). Remaining populations are now contained within Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. These populations support about 200 plants over 13 sites. OEH (2018d) acknowledges however that unrecorded populations may occur within the Woronora, O'Hares, Metropolitan and Warragamba catchments. According to a search of BioNet Atlas of NSW Wildlife Database, there is one record of the species within 10 kilometres of the study area. This record is generalised to 0.1 degree and is assumed to be near the study area to the north-west. The record falls within the Burragorang IBRA subregion. The size of the local population affected by the Project is unknown. No individuals of *G. baueri* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. In accordance with the FBA, this species has been assumed to be present within the study area for f this assessment. *G. baueri* is associated with one PCT that occurs within 223 hectares of the impact area.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	**(i)** *G. baueri* is found in a range of habitat types (OEH, 2017e). Despite a lack of observational records of the species within the study area, potential habitat is present This habitat may be altered as a result of temporary inundation although the level of alteration to habitat would vary across the extent of the impact area based on the depth, frequency and duration of temporary inundation. For example, suitable habitat occurring at higher elevations is likely to be less impacted than that of lower elevation and flat areas. **(ii)** Temporary inundation and waterlogging of soil may modify habitat for the species by altering soil properties such as structure and chemistry or causing erosion in turn affecting plant survivability, growth, germination and/or recruitment. **(iii)** There is little information regarding the life cycle processes of *G. baueri*. Unlike some other orchids, *G. baueri* does not produce a new tuber after every time it emerges from the ground. Instead *G. baueri* persists from a single tuber-like perennial root (DoE 2014). *G. baueri* individuals may not emerge every year though, and when they do, they are only visible for about two months before dying back to their tuber-like roots. It is not known what triggers the emergence of individuals, but it has been reported that the species is most often seen shortly after fire (Riley and Banks 2002).
(c) the likely impact on the ecology of the local population. (ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available: ▪ pollination cycle ▪ seedbanks ▪ recruitment, and	There is little information regarding the life cycle processes of *G. baueri*. Given a lack of understanding on the ecology and biology of *G. baueri* it is assumed that changes to soil properties would impact on plant survivability, growth, germination and/or recruitment.

Criteria	Consideration
▪ interactions with other species (for example, pollinators, host species, mycorrhizal associations)	
(d) a description of the extent to which the local population will become fragmented and isolated as a result of the proposed development	The size of the local population affected by the Project is unknown, and no individuals of *G. baueri* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. The potential impacts caused by the Project to the *G. bauera,* should a local population be present, could result in additional fragmentation and isolation..
(e) the relationship of the local population to other populations of the species	The size of the local population affected by the Project is unknown, no individuals of *G. baueri* were recorded during vegetation surveys and targeted threatened species searches were not undertaken. It is not known the relationship of the local population (if any) to other populations of the species, including the BioNet Atlas of NSW Wildlife Database record that is within 10 kilometres north west of the study area.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The OEH species profile for *G. baueri* identifies the European Rabbit as a possible threat. It states, 'browsing by swamp wallabies and possibly rabbits is known to have removed flowering and fruiting stems at the site in the Ku-Ring-Gai Wildflower Garden. Whilst this damage is not expected to kill plants it may adversely impact future recruitment potential' (OEH 2019). It is unknown if the Project would promote the spread of swamp wallabies or the European Rabbit through the potential *G. baueri* habitat. No diseases have been identified as a threat to *G. baueri*. No recovery plan has been developed for *G. baueri* under the EPBC Act. However, the Approved Conservation Advice for *G. baueri* acknowledges the need for a recovery plan to be developed. Advice for *G. baueri* outlines the following conservation objectives, required management actions and required information: Conservation objectives • Population increases so that the species is secure in the wild to the point of being delisted. • Expanded area of occupancy information required • All individuals located in intensive surveys of nearby potential habitat. • Status assessed across historical and potential new locations. • Design and implement a monitoring program or, if appropriate, support and enhance existing programs. Management actions required • Ensure sites where species occurrences are protected from disturbance by trail bike riding, rubbish dumping and track and road maintenance by barriers and/or fencing. • Maintain natural habitat of the species. • As the species exists in well-drained habitat types, any alteration to hydrology at all sites should be avoided. Potential habitat for the species will be impacted by alteration to hydrology. *i*.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	*G. baueri* has been allocated to the site-managed stream of the SoS program. This species requires site-based management in order to secure it from extinction in NSW for 100 years. There are no conservation sites for this species within the study area. There is no national recovery plan for *G. baueri*. The Conservation Advice (DoE, 2014b) does not detail any priority actions and threat abatement actions to support the recovery of the species. There are no threat abatement plans identified as being relevant to this species. Species credit species offsets are proposed to offset the potential loss of *G. baueri* habitat within the impact area in accordance with the BOS..

Appendix L
Multipage figures

Appendix L – Part 1: Broadscale vegetation mapping

Appendix L – Part 2: Hydrological features

Appendix L – Part 3: Plot-based floristic survey and plot and transect survey

Appendix L – Part 4: Plant community types

Appendix L – Part 5: Threatened ecological communities

Appendix L – Part 6: Vegetation zones

Appendix L – Part 7: Groundwater-dependent ecosystems

Appendix L – Part 8: Threatened species survey locations

Note: Mapping is based on a total of 85 map tiles. For some parts, map tiles have been omitted where they do not show any relevant information to minimise file size.

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SMEC is recognised for providing technical excellence and consultancy expertise in urban, infrastructure and management advisory. From concept to completion, our core service offering covers the life-cycle of a Project and maximises value to our clients and communities. We align global expertise with local knowledge and state-of-the-art processes and systems to deliver innovative solutions to a range of industry sectors.