Site-wide Bulk Earthworks Development Application, Menangle Park, NSW [EPBC 2024/10074]

Commonwealth Preliminary Documentation

Dahua Group Sydney Project 2 Pty Ltd

4 August 2025

Final

cumberland ecology

PART OF SLR

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Glossary

Term / Abbreviation	Definition
APZ	Asset Protection Zone
BAM	Biodiversity Assessment Method
BBAM	BioBanking Assessment Methodology
BC Act	NSW *Biodiversity Conservation Act 2016*
BCT	Biodiversity Conservation Trust
BDAR	Biodiversity Development Assessment Report
BEW	Bulk Earth Works
BOS	Biodiversity Offset Scheme
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environment Management Plan
CHAR	Cultural Heritage Assessment Report
Conservation Areas	Park K, Park L, the Howes Creek Conservation Area, the Northern Conservation Area, and the Stage 6B EBSF Conservation Area
Council	Campbelltown City Council, NSW
CPCP	Cumberland Plain Conservation Plan
CPW	Cumberland Plain Woodland
Development footprint	The areas within the Property proposed to be developed under the current proposed action
DA	Development Application
Commonwealth DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
EBSF	Elderslie Banksia Scrub Forest
EEC	Endangered Ecological Community
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
ESIS	Economic and Social Impact Statement
GIS	Geographic Information System
GPS	Global Positioning System
LGA	Local Government Area
MNES	Matters of National Environmental Significance
MPURA	Menangle Park Urban Release Area
NSW	New South Wales
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
PCT	Plant Community Type

Term / Abbreviation	Definition
project area	Location of the proposed action
proposed development works	Site-wide bulk earthworks to regrade the site, the associated clearing of native vegetation and enabling site works
proposed conservation works	The conservation and rehabilitation of native flora and fauna habitat within retention areas
retention area	Five separate conservation areas collectively that are being retained for conservation
RFEF	River-flat Eucalypt Forest
SIS	Species Impact Statement
TEC	Threatened Ecological Community
TSC Act	former NSW *Threatened Species Conservation Act 1995*
VMP	Vegetation Management Plan
VPA	Voluntary Planning Agreement

1. Introduction

1.1. Purpose

Dahua Group Sydney Project 2 Pty Ltd (Dahua) submitted a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) in December 2024. The referral relates to the proposed development and conservation works within specific areas of the Menangle Park Urban Release Area (MPURA), north of Menangle Road, Menangle Park NSW (the proposed action). The proposed action is referred to as the Site-wide Bulk Earthworks Development Application (BEW DA).

The proposed action comprises site-wide bulk earthworks to regrade the site, the associated clearing of native vegetation, enabling site works (hereafter referred to collectively as the 'proposed development works'), as well as the conservation and rehabilitation of native flora and fauna habitat within retention areas (hereafter referred to collectively as the 'proposed conservation works').

In March 2025, the DCCEEW determined the proposed action to be a Controlled Action that would be assessed via Preliminary Documentation. On 7 April 2025, the DCCEEW provided a Preliminary Documentation additional information request that specifies the information required by the Minister for the Environment and Water under Section 95A of the EPBC Act (**Appendix A**).

A Preliminary Documentation report was prepared to provide the requested additional information to enable the DCCEEW to assess the impacts of the proposed action and was submitted on 27 May 2025. The Preliminary Documentation report included the additional information requested by the DCCEEW, as well as 'high-level' information previously submitted in the original referral documentation, for context. The Species Impact Statement (SIS) prepared to support the NSW approval is attached in **Appendix B**.

The DCCEEW reviewed the Preliminary Documentation Report and provided comments in July 2025 (attached in **Appendix G**). The response document provided by the DCCEEW indicated that the Preliminary Documentation report submitted in May 2025 addressed most of the issues identified, and most items were identified with "No Action Required". However, some additional information was requested about the assessment of impacts on the Brown Treecreeper, buffers to Elderslie Banksia Scrub Forest (EBSF) patches being retained, and regarding details of offsets proposed for MNES.

This document provides an updated version of the Preliminary Documentation Report with the additional information requested by DCCEEW, and all changes to the document have been tracked to facilitate review and certify compliance.

1.2. Project Description

1.2.1. Location

The proposed action is located within several parcels of land within the MPURA between Menangle Road, Cummins Road and Glenlee Road in Menangle Park, NSW (hereafter referred to as the 'project area'). The project area is located entirely within the Campbelltown City Council Local Government Area (LGA) (**Figure 1**).

The layout of the project area is shown in **Figure 2**, which includes the extents of both the proposed development works (also referred to as the 'disturbance footprint') and proposed conservation works. A total of five separate conservation areas are proposed which include:

- Park K Conservation Area located to the south of the Howes Creek riparian corridor;
- Park L Conservation Area located to the south of the Howes Creek riparian corridor;
- Howes Creek Conservation Area located within the Howes Creek riparian corridor;
- Northern Conservation Area located in the northwest of the project area; and
- Stage 6B Elderslie Banksia Scrub Forest (EBSF) Conservation Area located to the south of the Howes Creek Riparian Corridor.

The locations of the proposed conservation areas are shown in **Figure 2** and are hereafter referred to collectively as the 'retention area'.

1.2.2. Description of the Project Area

The project area constitutes all land that will be directly impacted by both the proposed development works, comprising an area of ~150 ha, as well as the proposed retention area, comprising an area of ~59 ha (see **Figure 2**). The project area has historically been used for agricultural purposes, including cattle grazing, and continues to be for most of the site to the north of Howes Creek riparian corridor. Some of the land in the project area to the south of the Howes Creek Conservation Area, which is proposed for the development of a town centre, previously was the site of an old fireworks factory that has led to significant contamination of the land including the occurrence of heavy metals and friable asbestos in the soil. This area must be decontaminated prior to development and requires removal of all vegetation within this area, despite detailed investigations into the possibility of retaining that vegetation.

The project area is zoned as a mix of 'R5 Large Lot Residential', 'R4 High Density Residential', 'R3 Medium Density Residential', 'R2 Low Density Residential', 'RE1 Public Recreation', 'R5 Large Lot Residential', 'SP2 Infrastructure', 'RU2 Rural Landscape', 'E1 Local Centre', 'E4 General Industrial', 'C2 Environmental Conservation' and 'RU2 Rural Landscape' (see **Figure 3**).

The surrounding land use in adjacent lands is primarily agricultural with some patches of remnant vegetation. The project area is bounded by:

- Menangle Road to the south. On the south side of Menangle Park are existing and future stages of the Menangle Park master planned community;
- Hume motorway to the east;
- Rural residential lots, including Menangle Park village to the immediate west, with Menangle Park Train Station and rural lands further west. The existing rural residential lots are zoned low and medium density residential; and
- Mt. Annan Botanic Gardens to the north.

1.2.3. Current Project

The proposed action includes both the proposed development works (i.e. disturbance footprint), and the proposed conservation works (i.e. retention area) as shown in **Figure 2**. The proposed development works include site-wide bulk earthworks to regrade the site, the associated clearing of native vegetation and enabling site works. The proposed conservation works include the conservation and rehabilitation of native flora and fauna habitat within retention areas. The proposed development works include the clearing of all vegetation outside of retention areas, including two small, contaminated areas within conservation areas, to facilitate future subdivision works and the subsequent development of land in accordance with the Menangle Park Master Plan. The proposed development works are also necessary to support land remediation activities, and conservation works in accordance with the Vegetation Management Plans (VMPs) that are proposed for the retention areas. All VMPs to be implemented for the management of the retention areas have been approved as part of the project's NSW approval.

The legal subdivision of land is not proposed under the proposed development and conservation works, which is limited to bulk earthworks, vegetation clearance and vegetation management in the retention areas.

The retention of the Parks K and L Conservation Areas will be managed under a single VMP, the retention of the Howes Creek and Northern Conservation Areas will be managed under a separate VMP, and the retention of the Stage 6B EBSF Conservation Area will be managed under a separate VMP. All three VMPs have been prepared following the management requirements of a 20-year Biodiversity Stewardship Site as required by the NSW Biodiversity Offset Scheme (BOS), though the VMPs will be in place under a Voluntary Planning Agreement (VPA).

The proposed works will facilitate future development within the project area including but not limited to the construction of buildings and structures, associated infrastructure such as for sewage, electricity, gas or water, access routes and landscaping; however, all future development will be subject to subsequent DAs. Although this assessment applies to the proposed works as described above, this assessment has also considered impacts associated with the future residential development the proposed development works will facilitate (e.g. impacts associated with urbanisation).

The bulk earthworks and associated clearing of native vegetation proposed will be undertaken as a phased process where stages are progressively cleared and constructed. However, the construction of buildings, infrastructure (including for drainage, wastewater or erosions control) and access routes is not included in the proposed development works but will occur as a result of the proposed development works for subsequent DAs. Any future construction will occur in accordance with the Master Plan and the details will be provided within any relevant future DAs for the project area. Similarly, landscaping and wastewater disposal is not included in the proposed development works. All such works will be subject to subsequent DAs and will be in accordance with any relevant conditions of consent previously issued as part of the NSW approval for the project.

1.2.4. Assessment History

The BEW DA was first submitted to the Campbelltown City Council (Council) in November 2019 and a revised version was subsequently submitted in February 2023. This was approved by Council in 2024 and concurrence

provided by the NSW Department of Climate Change Energy, the Environment and Water (NSW DCCEEW) in 2024.

Council reviewed each version of the proposed action and provided detailed comments to each. Changes to the proposed action have been made in response to Council feedback including the following:

- The footprint of the proposed development works has been substantially reduced;
- Park K that will be subject to the conservation works has been modified to provide a uniform buffer around it to better protect retained threatened ecological communities (TEC);
- Baseline flora and fauna information has been increased by completion of extensive additional surveys during wetter conditions that occurred since the breaking of the drought in early 2020; and
- Baseline information about groundwater and groundwater dependent communities was provided.

Dahua submitted a referral under the EPBC Act to the DCCEEW in December 2024 in relation to the proposed action, and in March 2025, DCCEEW determined the proposed action to be a Controlled Action that would be assessed via Preliminary Documentation. On 7 April 2025, the DCCEEW provided a Preliminary Documentation additional information request that specifies the information required by the Minister for the Environment and Water under Section 95A of the EPBC Act. A Preliminary Documentation report was prepared to provide the requested additional information to enable the DCCEEW to assess the impacts of the proposed action.

1.3. Compliance Tables

The Preliminary Documentation additional information request from DCCEEW had several checklists of matters that are to be addressed in the Preliminary Documentation. **Table 1** provides confirmation of compliance with these checklists and identifies where each required component of the checklists is addressed in this document.

Table 1 Compliance with additional information request checklists

Preliminary Documentation Checklist	Where Addressed
Formatting and style checklist	
Present in a standard format – the document(s) will be published in hardcopy (e.g. A4/A3 hardcopies) and electronic formats (e.g. PDF or MS Word files).	This Report
Include all key claims, findings, conclusions, proposals and commitments in the main document.	This Report
Use maps, figures, diagrams and/or photographs where appropriate to support textual information.	This Report
Present all maps, figures and diagrams at an appropriate size and scale – see the department's Guide to providing maps and boundary data for EPBC Act projects (2021).	This Report
Reference all supporting documentation (including websites) clearly and consistently (e.g. table, figure, section, appendix).	This Report

Preliminary Documentation Checklist	Where Addressed
Ensure that other supporting documents (e.g. academic studies, regulatory standards, state permits/approvals) are publicly accessible, with electronic links provided where possible. If any information is not publicly available, it must be attached to the Preliminary Documentation as an appendix.	This Report
CPW TEC checklist	
Undertake vegetation surveys of Patches C15, C19 and C32 in accordance with relevant survey guidelines.	Section 2.2.2.1
Clearly assess the mapped areas of CPW TEC against the key diagnostic characteristics, condition thresholds or criteria, or patch definitions as set out in the Commonwealth Listing Advice on Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (2009). The department recommends a table which assesses the on-ground vegetation against the Commonwealth requirements.	***Section 3.1.1.1*** **Table 2**
If the proposed action is being assessed under the NSW Biodiversity Assessment Method (BAM), clearly identify the Plant Community Types and Vegetation Zones that align with CPW TEC in the project area and immediate surrounds.	***Section 3.1.1.1.*** Assessment is not utilising the BAM.
Provide the extent of CPW TEC within the areas labelled Patches C15, C19 and C32 in hectares.	The CPW in these patches does not comprise an MNES – see ***Section 3.1.1.1***
Provide the total area of CPW TEC in hectares, and if CPW TEC occurs in multiple distinct areas within and adjacent to the project area, provide the area (in ha) for each occurrence.	The total area of CPW in the project area is provided in **Table 2** in ***Section 3.1.1.1***, including the area of each occurrence.
Provide a map which identifies the total extent of CPW TEC within and adjacent to the project area.	**Figure 10**
Brown Treecreeper checklist	
Undertake on-ground surveys for the Brown Treecreeper and its habitat (e.g. targeted surveys, vegetation assessments, hollow-bearing tree assessments) in accordance with relevant survey guidelines (if required).	***Section 2.2.2.2***
Determine the type(s) of habitat available (e.g. foraging, nesting, roosting) based on a habitat assessment against the SPRAT Database and relevant statutory documents.	***Section 3.3.1***
Describe the quality of each habitat type.	***Section 3.3.1***
Describe and quantify key habitat features (e.g. water availability, hollow-bearing trees).	***Section 3.3.1***
Provide:	***Section 3.3.1***

Preliminary Documentation Checklist	Where Addressed
• The total amount of habitat (in ha) within and adjacent to the project area. • The amount of each habitat type (in ha) within and adjacent to the project area.	
Describe whether the habitat in the project area is habitat critical to the survival of the species as described in the BT Conservation Advice.	***Section 3.3.1***
Provide any other relevant information describing the species habitat.	***Section 3.3.1***
EPBC Act Environmental Offsets checklist	
The draft Offset Strategy must:	
• Identify and describe suitable area/s for the proposed environmental offsets, including location, size and environmental values for relevant listed threatened species and/or ecological communities.	***Section 5.3.1***, **Figure 9**
• Demonstrate how the proposed environmental offsets meet the principles specified in the Offsets Policy and the OAG, including clearly justifying the scores entered into the OAG.	***Section 5.6***
• Directly contribute to the ongoing viability of the relevant listed threatened species and/or ecological communities to deliver an overall conservation outcome that improves or maintains the viability of the protected matter in the region, as compared to what is likely to have occurred under the status quo (i.e. if neither the proposed action nor the offset had taken place).	***Section 5.3***
• Describe the proposed legal securing mechanism for the proposed environmental offsets.	***Section 5.3***
• Compensate for the residual significant impacts over the duration of the proposed action.	***Section 5.3***
• Apply the 'S.M.A.R.T' Principle (Specific, Measurable, Achievable, Relevant, Time-Bound).	***Section 5.3.2***
Economic and social matters checklist	
Consideration of negative impacts (e.g. disruption to existing community infrastructure, environmental features, and/or cultural and traditional activities).	***Section 7.2***, **Appendix F**
Consideration of positive impacts (e.g., increased housing, employment, social amenity).	***Section 7.3***, **Appendix F**
Consideration of different scales of impact (e.g. local, regional, state).	***Section 7.4***, **Appendix F**
Estimated capital value and ongoing economic value, using specific dollar or other numerical values where relevant.	***Section 7.5***, **Appendix F**
Discussion of relevant public consultation undertaken or to be undertaken since the lodgement of the referral documentation, including with First	***Section 7.6***

Preliminary Documentation Checklist	Where Addressed
Nations people and communities, including any issues raised in objection or support of the proposed action. Please refer to the department's First Nations engagement guidelines for more information on how and when to engage with First Nations people and communities.	
Discussion of any contributions for the proposed action (e.g. Commonwealth and/or State government funding).	***Section 7.7***, **Appendix F**

2. Methodology

2.1. Document Review

Cumberland Ecology (Part of SLR) has prepared several ecological assessments for parts of the MPURA, most of which have now been approved by the NSW Government, and information from these reports has been utilised in this Preliminary Documentation report (where relevant). Several additional studies have also been undertaken of the project area and surrounds by other ecological consultancies, and relevant information has been included from these. In addition, publicly available ecological information and databases have been accesses where relevant.

The following documents were reviewed to inform this Preliminary Documentation:

- OEH species profiles for 'subject' vegetation communities previously recorded within the local area (OEH 2018);
- Cumberland Plain Vegetation Mapping (DECCW 2007);
- Remnant Vegetation Mapping of the Cumberland Plain (OEH 2013);
- Preliminary and final determinations for TECs;
- Vegetation Information System (VIS) Classification Database (OEH 2017b);
- Menangle Park Ecological Constraints Assessment (Cumberland Ecology 2016a);
- Menangle Park Site-wide Bulk Earthworks SIS (Cumberland Ecology 2019b);
- Menangle Park Remediation SIS (Cumberland Ecology 2019a);
- Menangle Park Site Wide Bulk Earthworks Species Impact Statement (Cumberland Ecology 2024a);
- Menangle Park Structure Plan Review (Cumberland Ecology 2016a);
- Menangle Park Stage 1 Flora and Fauna Assessment (Cumberland Ecology 2017a);
- Menangle Park Stage 2A Flora and Fauna Assessment (Cumberland Ecology 2018c)
- Menangle Park Flora, Fauna and Aquatic Assessments (Eco Logical Australia 2009);
- Menangle Park Stage 1: Proposed Retirement of Ecosystem Credits for HN529 – Shale Hills Woodland (Derived Native Grassland) (Cumberland Ecology 2020)
- Menangle Park Stage 2B SIS (Cumberland Ecology 2018d);
- Menangle Park Stage 2B SIS Addendum (Ecology 2021);
- Menangle Park Stage 3A-2 Biodiversity Development Assessment Report (Cumberland Ecology 2023a);
- Menangle Park Stage 4 South Biodiversity Development Assessment Report (Cumberland Ecology 2022c);
- Menangle Park Southern Playing Fields Flora and Fauna Assessment Report (Cumberland Ecology 2023b);

- Menangle Park Nepean River VMP (Cumberland Ecology 2024b);
- Menangle Park Stage 3 North Biodiversity Development Assessment Report (Cumberland Ecology 2022b);
- Menangle Park Spine Road Biodiversity Development Assessment Report (Cumberland Ecology 2022a);
- Menangle Park Stage 3 South Biodiversity Development Assessment Report (Cumberland Ecology 2021a);
- Menangle Park Vegetation Assessment Report (Cumberland Ecology 2021b);
- Menangle Park Proposed Intersection at Cummins Road and Menangle Road Species Impact Statement (Cumberland Ecology 2018a);
- Menangle Park Proposed Vegetation Clearing within Menangle Park Urban Release Area Species Impact Statement (Cumberland Ecology 2018b);
- Report on Menangle Park – Offsetting Strategy (GHD 2010); and
- Ecological Assessment- Proposed Subdivision and infrastructure Delivery – Precinct 200 and Adjacent Bulk Earthworks (Travers Bushfire & Ecology 2013).
- Menangle Park Rezoning: *Pimelea spicata* Survey and Results (GHD 2009); and
- Menangle Park Flora, Fauna and Aquatic Assessments (Eco Logical Australia 2009).

In addition, as required by the DCCEEW, this Preliminary Documentation has taken into consideration relevant guidance documents for determining, avoiding, mitigating and managing likely impacts on listed threatened species and communities, and DCCEEW policy documents where appropriate. This includes but is not limited to consideration of the following:

- Department of the Environment, Water, Heritage and the Arts (2013) Significant Impact Guidelines 1.1: Matters of National Environmental Significance;
- DCCEEW Offsets Mitigation Hierarchy: available: https://www.dcceew.gov.au/environment/epbc/approvals/offsets/guidance/mitigation-hierarchy;
- Department of Sustainability, Environment, Water, Population and Communities (2012) Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy;
- Department of the Environment, Water, Heritage and the Arts (2009). *Approved Conservation Advice for Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community*. Canberra, ACT: Department of the Environment, Water, Heritage and the Arts;
- Threatened Species Scientific Committee (2009). *Commonwealth Listing Advice on Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest*. Department of the Environment, Water, Heritage and the Arts. Canberra, ACT: Department of the Environment, Water, Heritage and the Arts;
- Department of the Environment, Water, Heritage and the Arts (2010) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest EPBC Act policy statement 3.31;

- Department of Agriculture, Water and the Environment (2020). *Conservation Advice for the Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion*. Canberra: Department of Agriculture, Water and the Environment
- Department of Agriculture, Water and the Environment (2020). Conservation Advice for the River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria. Canberra: Department of Agriculture, Water and the Environment
- Department of Climate Change, Energy, the Environment and Water (2023). *Conservation Advice for Climacteris picumnus victoriae (brown treecreeper (south-eastern))*. Canberra: Department of Climate Change, Energy, the Environment and Water

2.2. Field Surveys

The project area and surrounds have been extensively surveyed by Cumberland Ecology (now part of SLR) to inform the preparation of the Species Impact Statement (SIS) completed to support the NSW approval, as well as other ecological assessments to support NSW approvals in areas of the MPURA surrounding the project area. The biodiversity values of the project area and surrounds are well documented as these areas have been extensively surveyed over the past 10+ years. Surveys completed in the project area and wider MPURA include detailed vegetation surveys, targeted threatened species surveys as well as general fauna habitat assessments. Further details of these surveys are provided in the subsections below.

Additional surveys undertaken specifically for the purpose of providing additional information for the Preliminary Documentation have also been conducted, and the details of these are presented in ***Section 2.2.2***.

2.2.1. Field Surveys for the NSW State Approval

Cumberland Ecology (now part of SLR) undertook vegetation and ecological community surveys within the project area and surrounds initially in September and October 2016, October 2017, April 2019, March and April 2020, and September 2020. Cumberland Ecology prepared a constraints assessment in 2016 (Cumberland Ecology 2016b) and submitted several ecological assessments to facilitate development applications (Cumberland Ecology 2017a, b, 2018b, a, 2020) within the MPURA.

In spring 2021 Cumberland Ecology resurveyed the MPURA in response to the break of the drought and return to wetter conditions and where necessary revised vegetation mapping within the project area and surrounds.

Threatened flora surveys were undertaken within the project area and surrounds in September and October 2016, October 2017, July 2018, March and September 2020, March and April 2021, and September to November 2021.

Fauna surveys were undertaken within the project area and surrounds in October and December 2017, March 2018, September 2020, and September, October and March 2021, as well as an updated habitat assessment in May 2020 in some areas to determine the number of hollow-bearing trees present within retention areas.

To further refine vegetation mapping, Stadia Metric Surveys were undertaken by Craig and Rhodes surveyors of all trees in the project area in July 2021. Survey information included the location and trunk diameter of

these trees. Cumberland Ecology then identified the species of these trees and recorded the presence of hollows and other habitat features in July and September 2021.

2.2.2. Field Surveys for the Preliminary Documentation

Below are the details of the survey methodologies implemented that specifically address the additional information requested from DCCEEW in relation to the extent of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW) and Brown Treecreeper habitat in the project area.

2.2.2.1. Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest Additional Surveys

DCCEEW has requested additional plot data for three patches of CPW in the project area (patches C15, C19 and C32) as well as the extent of CPW in these patches. Surveys of these three patches were undertaken on 27 March 2025 which included completing a floristic plot within each patch following the NSW BioBanking Assessment Methodology (BBAM) and Biodiversity Assessment Method (BAM). The location of these patches and the flora plots surveyed are provided in **Figure 4**.

The following data was collected at each of the BBAM plot locations:

- Native species richness recorded within each stratum of a 20 m x 20 m plot;
- Native over-storey projected foliage cover recorded at 10 points along a 50 m transect;
- Native mid-storey projected foliage cover recorded at 10 points along a 50 m transect;
- Native groundcover projected foliage cover recorded at 10 points along a 50 m transect for three life forms (shrubs, grasses and other);
- Weed species projective foliage cover expressed as a percentage of over-storey, mid-storey and ground cover along a 50 m transect;
- Number of trees with hollows where entrance width is over 5 cm and hollow is at least 1 m above ground within the 20 m x 50 m plot;
- The percentage of regenerating canopy species within the vegetation zone; and
- The total length in metres of fallen logs over 10 cm in diameter within the 20 m x 50 m plot.

In addition, native plant species richness within a 20 m x 20 m plot and full floristic data was also collected to enable classification of each vegetation zone to the best-fit PCT.

A total of three BBAM plots were surveyed within plots C15, C19 and C32, one in each patch.

The BAM plots included the establishment of a 20 x 50 m plot with an internal 20 m x 20 m plot. The following data was collected within each of the plots:

- Composition for each growth form group by counting the number of native plant species recorded for each growth form group within a 20 m x 20 m floristic plot;

- Structure of each growth form group as the sum of all the individual projected foliage cover estimates of all native plant species recorded within each growth form group within a 20 m x 20 m floristic plot;
- Cover of 'High Threat Exotic' weed species within a 20 m x 20 m floristic plot;
- Assessment of function attributes within a 20 x 50 m plot, including:
    - Count of number of large trees;
    - Tree stem size classes, measured as 'diameter at breast height (DBH)' over bark;
    - Regeneration based on the presence of living trees with stems <5 cm DBH;
    - The total length in metres of fallen logs over 10 cm in diameter;
- Assessment of litter cover within five 1 m x 1 m plots evenly spread within the 20 x 50 m plot; and
- Number of trees with hollows that are visible from the ground within the 20 x 50 m plot.

A total of three BAM plots were surveyed within plots C15, C19 and C32, one within each patch. The locations of the BAM plots were the same as the BBAM plots.

2.2.2.2. Brown Tree Creeper Surveys

DCCEEW has requested that on-ground surveys for the Brown Treecreeper and its habitat be undertaken in accordance with relevant survey guidelines, including targeted surveys, vegetation assessments and hollow-bearing tree assessments. Using these, the type(s) of habitat available (e.g. foraging, nesting, roosting) was required to be determined based on a habitat assessment using the Species Profile and Threats (SPRAT) Database and relevant statutory documents.

Targeted surveys for the Brown Treecreeper were undertaken following '*Survey Guidelines for Australia's Threatened Birds*' (DEWHA 2010b). Surveys included 20-minute area searches undertaken during mornings, over a period of eight days from 9-12 March 2021 and on 16, 17, 30 and 31 March 2021 at the locations identified in **Figure 5**.

Initial surveys for the species were conducted between 9-12 March 2021. Additional targeted surveys for the species were also conducted between 16, 17, 30 and 31 March 2021, with these later surveys repeated at each survey location (i.e., total of two surveys per site). This included surveys within patches of woodland within and surrounding the project area. Surveys targeted hollow-bearing trees and any tree stumps to improve detectability of the Brown Treecreeper. All species observed (heard calling/seen) were recorded.

A fauna habitat assessment was undertaken within the project area during field surveys that was used to identify areas of potential habitat for the Brown Treecreeper. This assessment included consideration of important indicators of habitat conditions and complexity as well as the occurrence of micro-habitats such as tree hollows, fallen logs, dam fringing vegetation and riparian areas. An assessment of the structural complexity of the vegetation, the age structure of the vegetation and the nature and extent of human disturbance was also undertaken. Notes were taken on specific habitat features that may be utilised by the Brown Treecreeper including the presence of understorey shrubs and coarse woody debris.

In addition to the habitat assessment, fauna habitat data was also collected throughout the project area within the BBAM and BAM plots, which included the number of trees with hollows, the total length of logs and composition of the ground stratum.

An assessment of all hollow-bearing trees within the project area was undertaken as part of the stadia metric surveys described in ***Section 4.3.2.3*** that were conducted for the NSW approval. All trees within the project area were inspected by a botanist and ecologist in July and September 2021 and notes were taken on hollow-bearing trees, including the location, tree species, and estimated hollow size.

3. Existing Biodiversity Values

This chapter presents the results of surveys conducted by Cumberland Ecology and describes the flora and fauna listed as Matters of National Environmental Significance (MNES) that are relevant to this Preliminary Documentation report.

3.1. MNES Vegetation Communities

Vegetation within the project area includes intact and modified patches of native woodland and forest as well as previously cleared land that is comprised primarily of exotic vegetation. The project area has a history of agricultural development, which resulted in the degradation and clearing of native vegetation across a high proportion of the project area. Intact and modified patches of native woodland and forest vegetation present typically occur as small, isolated patches that are surrounded by previously cleared areas, with the exception of the larger tract of vegetation within the Howes Creek Conservation Area as part of the larger retention area. Native vegetation within the project area consists primarily of woody vegetation on shale soils dominated by *Eucalyptus tereticornis* (Forest Red Gum), with *Eucalyptus moluccana* (Grey Box) and *Eucalyptus crebra* (Narrow-leaved Ironbark) also present. In areas comprising sandy substrates, *Angophora subvelutina* (Broad-leaved Apple) dominates. The surrounding land use in adjacent lands is primarily agricultural or recent residential development, with some patches of remnant vegetation.

The native vegetation communities recorded in the project area (see **Figure 6**) that conform to MNES listed under the EPBC Act include:

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW);
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria (RFEF); and
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion (EBSF).

Further descriptions of the MNES vegetation communities within the project area are provided in the subsections below.

3.1.1. Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest

Areas of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW) in the project area consist of two variants listed under the NSW *Biodiversity Conservation Act 2016* (BC Act): Shale Hills Woodland and Shale Plains Woodland. Not all the area of these two communities in the project area comprise the EPBC Act listed community CPW however, as they do not meet the condition thresholds to be considered a MNES. In total, approximately 10.07 ha of CPW conforming to an MNES is present in the project area (see **Figure 6**). This occurs as scattered patches throughout the project area. A description of both variants is presented below.

Shale Hills Woodland occurs in the southwest of the project area, along Cummins Road. The canopy of this community consists of mature *Eucalyptus crebra* (Narrow-leaved Ironbark) with a mid-storey comprised of regrowth *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus tereticornis* (Forest Red Gum) and *Acacia decurrens* (Black Wattle). The shrub layer contains regrowth of the canopy and mid-storey, along with the native *Bursaria spinosa* (Blackthorn), and the exotics *Olea europaea* subsp. *cuspidata* (African Olive) and *Lycium ferocissimum* (African Boxthorn). The groundcover of this community is dominated by exotic species with

scattered native species present scattered throughout. Native herbs and grasses present include *Cotula australis*, *Cyperus gracilis* (Slender Flat-sedge), *Dichondra repens* (Kidney Weed), *Lomandra filiformis subsp. Filiformis*, *Oxalis perennans,* and *Microlaena* stipoides. Dominant exotic groundcovers include *Sida rhombifolia* (Paddy's Lucerne), *Ehrharta erecta* (Panic Veldtgrass), *Lysimachia arvensis* (Scarlet Pimpernel) and *Asparagus asparagoides* (Bridal Creeper).

Shale Plains Woodland occurs as scattered patches of varying sizes within the project area, with the largest patches located around the Howes Creek Conservation Area and in the northwest corner of the project area. Within the project area, Shale Plains Woodland primarily occurs generally as isolated patches surrounded by exotic vegetation or derived native grasslands. The canopy of the community is comprised of mature *Eucalyptus tereticornis* (Forest Red Gum) and/or *Eucalyptus moluccana* (Grey Box) trees. The community lacks a substantial shrub layer in most areas but does contain scattered regrowth *Eucalyptus tereticornis* (Forest Red Gum) and/or *Eucalyptus moluccana* (Grey Box) trees, *Acacia decurrens* (Black Wattle) and the exotics *Olea europaea* subsp. *cuspidata* (African Olive) and *Lycium ferocissimum* (African Boxthorn). The groundcover of the community is comprised of exotic herbs and grasses interspersed within native grasses. The most prevalent native species present are *Microlaena stipoides* (Weeping Grass), *Sporobolus creber* (Slender Rat's Tail Grass), *Themeda triandra*, *Oxalis perennans, Einadia trigonos* (Fishweed) and *Cotula australis* (Common Cotula). Exotic species include *Cyclospermum leptophyllum* (Slender Celery), *Facelis retusa* (Annual Trampweed), (Fireweed), *Bromus catharticus* (Prairie Grass) and *Ehrharta erecta (*Panic Veldtgrass).

3.1.1.1. Cumberland Plain Woodland in Patches C15, C19 and C32

This section provides additional data for three separate patches of CPW (patches C15, C19 and C32) as requested by DCCEEW.

Detailed floristic surveys in accordance with the BBAM were undertaken with these areas (see ***Section 2.2.2*** and **Figure 4**) and the data collected has been assessed against the EPBC Act condition thresholds for patches that meet the description for CPW to determine if they conform to a TEC listed under the EPBC Act. The floristic surveys also included the collection of BAM plot/transect data; however, this was only done to collect additional information and not to identify/describe PCTs as per the BAM as the assessment was done under the BBAM, consistent with the NSW approval.

As identified in **Table 2** below, none of the vegetation within these patches meets listing criteria under the EPBC Act as the native perennial understorey is less than 30% within all patches. Therefore, they do not comprise MNES. A more detailed description of the vegetation in Patches C15, C19 and C32 is presented below in subsequent sections and the plot data collected is provided in **Appendix C**. It is noted that the DCCEEW's information request, required information on the extent of patches C15, C19 and C32; however, none of these areas are an MNES due to their degraded conditions and therefore the MNES extent within these areas is 0 ha.

Table 2 EPBC Assessment of patches C15, C19 and C32

Category	Threshold	Patch C15	Patch C19	Patch C32
A.	Minimum patch size is 0.5ha; AND ≥50% of the perennial understorey vegetation cover is made up of native species.	Condition not met. Patch is >.5 ha; however, perennial understory is <50%.	Condition not met. Patch is >.5 ha; however, perennial understory is <50%.	Condition not met. Patch is >.5 ha; however, perennial understory is <50%.
B.	The patch size is ≥5ha; AND ≥30% of the perennial understorey vegetation cover is made up of native species.	Condition not met. Patch is <5 ha.	Condition not met. Patch is <5 ha.	Condition not met. Patch is <5 ha.
C.	The patch size is ≥0.5 ha; AND ≥30% of the perennial understorey vegetation cover is made up of native species; AND The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥5ha in area.	Condition not met. Patch is >.5 ha; however, perennial understory is <30%.	Condition not met. Patch is >.5 ha; however, perennial understory is <30%.	Condition not met. Patch is >.5 ha; however, perennial understory is <30%.
D.	The patch size is ≥0.5 ha in size; AND ≥30% of the perennial understorey vegetation cover is made up of native species; AND The patch has at least one tree with hollows per hectare or at least one large tree (≥80 cm dbh) per hectare from the upper tree layer species outlined in the Description and Appendix A.	Condition not met. Patch is >.5 ha; however, perennial understory is <30%.	Condition not met. Patch is >.5 ha; however, perennial understory is <30%.	Condition not met. Patch is >.5 ha; however, perennial understory is <30%.

i. Patch C15

Patch C15 is 0.85 ha in area and contains very little native woody vegetation, with only two endemic trees present within the plot sampled. Only 0.08 ha of this patch is within the project area. As a result of its degraded condition, this patch does not meet the condition threshold requirements for the EPBC Act listed CPW as less than 30% of the native perennial understorey cover is comprised of native species (see **Table 2**). Perennial native understorey species cover for the patch is 17.6% (this excludes 5% comprising the non-endemic *Cynodon dactylon* (Common Couch) present). It is noted that *Cynodon dactylon* is currently recognised by the NSW

Herbarium as being native in NSW; however, its listing as native in NSW is the subject of much controversy amongst Australian botanists. This is highlighted by the fact that the NSW Herbarium is the only herbarium in Australia that considers the species to be native to Australia, and all other state herbaria describe it as introduced/naturalised (Department for Environment and Water SA 2021, Northern Territory Government 2021, Queenland Government 2021, Royal Botanic Gardens Victoria 2021, Salas and Baker 2021). For the purposes of this report *Cynodon dactylon* is not included as a native perennial species in the estimation of native perennial understorey cover. This is consistent with previous assessments done for the NSW approval, as well as all Australian herbaria (except for NSW) and is based on the advice presented in the Australian Flora (Barlow 2020) which states that *Cynodon dactylon* is an early introduction or possibly native to Norfolk Island and Lord Howe Island.

ii. Patch C19

Patch C19 is 0.58 in area and is dominated by the exotic weed species *Olea europeae* subsp. *cuspidata* (African Olive) in the shrub layer and *Cynodon dactylon* (Common Couch) in the ground layer. Only 0.17 ha of this patch is within the project area. As a result of its degraded condition, this patch does not meet the condition threshold requirements for the EPBC Act listed CPW as less than 30% of the perennial understorey cover is comprised of native species (see **Table 2**). Perennial native understorey species cover for the patch is 22.3% (this excludes 20% comprising the non-endemic *Cynodon dactylon* (Common Couch) present).

iii. Patch C32

Patch 32 is 1.87 ha in area and is characterised by a heavy infestation of the exotic weed species *Olea europeae* subsp. *cuspidata* (African Olive) in the sub-canopy and some areas of the groundcover. The groundcover is sparse and includes only a few native forbs and grasses. Large *Eucalyptus moluccana* (Grey Box) occur as emergent from the subcanopy of African Olive. Only 0.30 ha of this patch is within the project area. As a result of its degraded condition, this patch does not meet the condition threshold requirements for the EPBC Act listed CPW as less than 30% of the perennial understorey vegetation cover is comprised of native species (see **Table 2**). Perennial understorey native species cover for the patch is 3.3% (this excludes 1% comprising the non-endemic *Cynodon dactylon* (Common Couch) present).

3.1.2. Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion

Within the project area Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion (EBSF) is present as small, isolated patches that are surrounded mostly by previously cleared lands. The largest patch of the community is located in the centre of the project area, within the Park K Conservation Area (see **Figure 6**). Within the project area, this community either consists of a canopy and mid-storey comprised of mature and regrowth *Angophora subvelutina* (Broad-leaved Apple) or *Banksia integrifolia* (Coast Banksia), but not both. *Angophora floribunda* (Rough-barked Apple) occurs as an additional canopy species. The shrub layer is comprised of the native *Duboisia myoporoides* (Corkwood) and regrowth *Angophora subvelutina*. Dominant exotic shrubs include *Olea europaea* subsp. *cuspidata* (African Olive) and *Lycium ferocissimum* (African Boxthorn). The groundcover in areas is dominated by native species and in other areas is dominated by exotic species. Common native groundcover species include *Pteridium esculentum* (Common Bracken), *Hydrocotyle laxiflora (*Stinking Pennywort), *Einadia trigonos* (Fishweed), *Dichondra repens*, and *Microlaena stipoides*. Common exotic groundcovers include *Asparagus asparagoides*, *Sida rhombifolia, Ehrharta erecta*, *Lantana camara* (Lantana),

Gomphocarpus fruticosus (Narrow-leaved Cotton Bush), *Senecio madagascariensis* (Fireweed) and *Eragrostis curvula*.

3.1.3. River-flat Eucalypt Forest on Coastal Floodplains of Southern New South Wales and Eastern Victoria

River-flat Eucalypt Forest (RFEF) is present primarily within or adjacent to the riparian corridors of the Menangle Park Project Site. Areas of the community within riparian corridors also contain the largest patches of the community (see **Figure 6**).

Within the project area, this community exists primarily as a moderate-sized isolated patch surrounded by previously cleared areas and as small patches that adjoin other native vegetation communities. The canopy of this community within the project area is comprised of mature *Eucalyptus tereticornis* trees. The mid-storey contains mature *Casuarina glauca* (Swamp Oak) and the non-endemic *Grevillea robusta* (Silky Oak). Exotic shrubs include *Olea europaea* subsp. *cuspidata*. Common native groundcover species include *Microlaena stipoides*, *Pteridium esculentum*, *Solanum prinophyllum* (Forest Nightshade), *Cyperus polystachyos*, and the non-endemic *Cynodon dactylon*. Common exotic groundcover species includes and *Eragrostis curvula*, *Ehrharta erecta*, *Cirsium vulgare* (Spear Thistle), *Paspalum dilatatum*, *Conyza sumatrensis* (Tall Fleabane), and *Asparagus asparagoides*.

3.2. MNES Flora Species

No flora species listed as MNES under the EPBC Act were recorded during surveys of the project area. The vegetation present is too disturbed and is predominantly comprised of disturbed grassland, therefore no suitable habitat is present and threatened flora species are considered unlikely to occur.

3.3. MNES Fauna Species

The vegetation in the project area comprises intact and modified patches of native woodland and forest, as well as previously cleared land that is comprised primarily of exotic vegetation. The project area has a history of agricultural development, which resulted in the degradation and clearing of native vegetation across a high proportion of the project area.

Due to historical disturbance in the form of grazing and pasture improvement across large areas of the project area, fauna habitats for MNES species within the project area are largely limited to areas of remnant woody vegetation. Based on studies undertaken to date and a review of existing species records in the NSW BioNet Atlas and the Commonwealth Protected Matters Search Tool, the woodland and forest areas within the project area are considered to provide habitat for the following MNES species:

- Grey-headed Flying-fox (*Pteropus poliocephalus*): This species was recorded from the project area and the woodland and forest patches in the project area constitutes foraging habitat for this species as part of a broader foraging range. There is no breeding habitat present within the project area (i.e. no camps).
- Brown Treecreeper (south-eastern) (*Climacteris picumnus victoriae*): This species was recorded from the project area and the woodland and forest patches in the project area constitute foraging habitat for this

species as part of a broader foraging range. Potential breeding habitat also occurs in the form of hollow-bearing trees.

- Rufous Fantail (*Rhipidura rufifrons*): This species was recorded from the project area and the woodland and forest patches in the project area constitutes foraging habitat for this species as part of a broader foraging range.

Due to disturbed nature of the project area, with a long history of cattle grazing and pasture improvement, the understorey of the vegetation that occurs in the project area is degraded and lacks a dense native shrub layer or high diversity of native herbs and grasses. As a result, it is unlikely that the project area is important habitat for any threatened fauna species that are MNES.

Further details regarding habitat for Brown Treecreeper as requested in Section 3.2.1 of the further information request from DCCEEW are provided in the section below.

3.3.1. Brown Treecreeper

There are nine records of the Brown Treecreeper within 10 km of the MPURA, with only four of these records occurring within the last ten years. Two individuals of the species were recorded by Cumberland Ecology at two separate locations in the project area in 2018 (see **Figure 7**). One of these was in the south-west of the project area within a patch of native vegetation that will be removed, and the other was in the north-west of the project area, within the proposed Norther Conservation Area. However, subsequent targeted surveys for the species undertaken in 2020 and 2021 did not detect the species again.

Literature for the Brown Treecreeper identifies that the species is unable to maintain viable populations in remnants of native vegetation less than 200 ha and its abundance decreases as remnant size decreases (Barret & Ford, 1994). Further to this, a detailed study of woodland patches on the New England Tablelands indicated that the species was absent from woodland patches less than 6 ha (Barrett 1994). No patches of potential habitat for the species to be removed from the project area are larger than 3 ha.

The Brown Treecreeper is known to occur in dry open eucalypt forests and woodlands, usually with an open grassy understorey. The species usually does not occur in woodlands with a dense shrub layer and optimal habitat must be subject to an ongoing disturbance regime in order to keep the ground layer from becoming too dense (DCCEEW 2023). All areas to the south of the Howes Creek Conservation Area have been free from regular disturbance (e.g. fire, livestock) for several years and are not subject to ongoing disturbance, which has led to the formation of a dense weedy ground layer in most areas that is not suitable for the species. Areas to the north of the Howes Creek Conservation Area are still subject to livestock grazing; however, these areas still contain a dense weedy ground layer in most areas. Further to this, all potential habitat proposed to be removed is highly fragmented and collectively is significantly less than 200 ha, with the largest patch to be removed only measuring 2.87 ha. The species utilises hollows within dead or alive trees and tree stumps for breeding and these resources are essential for nesting. It is generally sedentary in nature with an average range of 4.4 ha; however, the species is known to disperse from its normal range after breeding (EHG 2024).

No Critical Habitat as defined under section 207A of the EPBC Act has been identified for the species or included in the Register of Critical Habitat. However, the Conservation Advice for the species (DCCEEW 2023) identifies that habitat critical to the survival of the Brown Treecreeper includes areas that have:

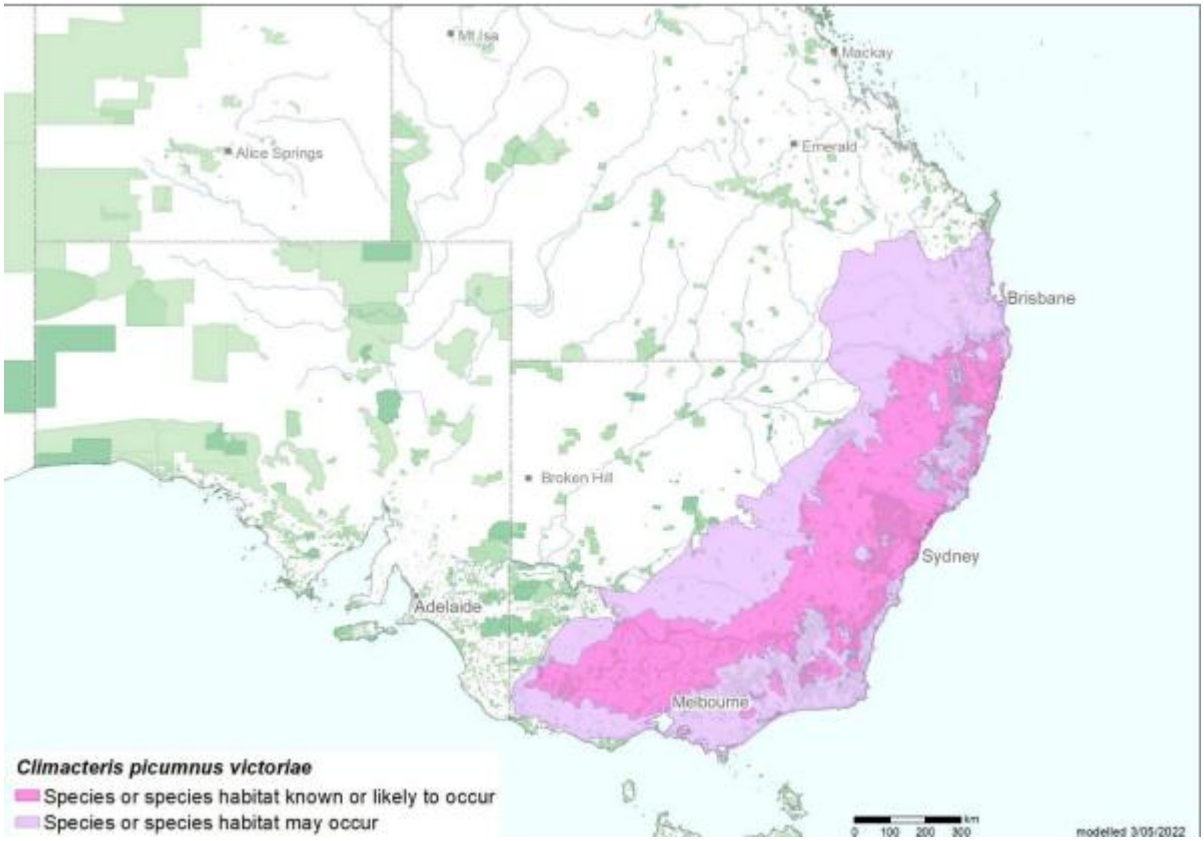
- Relatively undisturbed grassy woodland with native understorey that has an open habitat structure at ground level;
- Large living and dead trees which are essential for roosting and nesting sites and for foraging;
- Fallen timber which provides essential foraging habitat; and;
- Hollows in standing dead or live trees and tree stumps for nesting.

The habitat present within the project area is comprised of highly fragmented regrowth woodland/forest that was historically cleared for agricultural purposes. The vast majority of potential habitat proposed to be removed are isolated patches of native vegetation dominated by small, regrowth trees, beneath which there are levels of weed infestation that has reduced the native understorey and created a dense shrubby weed layer. This is not an open habitat structure that is preferred by the Brown Treecreeper. Further to this, the vast majority of the areas of habitat proposed to be removed lack substantial fallen timber which provides essential foraging habitat. Therefore, the majority of the habitat present in the project area does not meet the criteria specified in the species' Conservation Advice.

The Conservation Advice further identifies that "…any known or likely habitat (Map 1) should be considered as habitat critical to the survival of the subspecies. Additionally, areas that are not currently occupied by the subspecies due to recent disturbance (e.g. fire, grazing or human activity), but which could become suitable again in the future, should also be considered habitat critical to the survival of the subspecies".

Although the project area is within areas mapped in Map 1 of the Conservation Advice (DCCEEW 2023), it is considered that the Conservation Advice takes an extremely precautionary approach to identifying critical habitat for the species and Map 1 is merely a broad known and potential distribution map of the species. The map includes substantial areas that do not comprise suitable habitat for the species as the entire Sydney metropolitan area is mapped on Map 1. and Metropolitan areas do not support the species due to a lack of grassy woodland vegetation with large trees, tree hollows and fallen timber. Map 1 from the Conservation Advice is provided below in Map 1.

Map 1 Map 1 from the Conservation Advice



A precautionary approach has been taken to the mapping of Brown Treecreeper habitat within the project area whereby all woodland/forest patches, as well as patches of native shrubby regrowth, no matter how small or fragmented are mapped as potential habitat. The majority of the patches mapped as potential habitat are likely to be unsuitable because they are very small, do not have large trees, have very few hollows and are densely infested with woody weeds. Moreover, even if the total area of all potential habitat is added together, they form much less than the minimum 200 ha regarded as the minimum sized patch to support a viable population (Barret & Fort, 1994 and EHG 2024).

With consideration of the above, the habitat present is considered to be sub-optimal for the species. None of the habitat present within the project area is considered suitable to support a viable population of the species as it's comprised largely of small, isolated patches of regrowth vegetation that are collectively far less than 200 ha in area. That notwithstanding, advice from the DCCEEW indicates that the Department considers the woodland/forest habitat in the project area to be 'Critical Habitat' for the Brown Treecreeper. For this reason a detailed analysis of the potential habitat to be impacted versus those retained is provided in this report.

Approximately 46 ha of potential habitat (i.e. native woodland/forest) for the Brown Treecreeper occurs in the project area, of which approximately 17 ha will be removed, and approximately 29 ha retained and conserved in perpetuity. The 17 ha of potential habitat for the species within the project area that is proposed to be removed is comprised largely of small, isolated patches that are degraded and have little to no connectivity to larger areas of habitat. The largest patch of potential habitat to be removed is approximately 3 ha in area.

While areas of habitat to be removed are comprised of small, isolated patches, the potential habitat to be retained and conserved includes the largest patches present in the project area that do have connectivity to adjoining areas of potential habitat within and outside of the project area. Further to the retention of approximately 29 ha of potential habitat, an additional 23 ha of woodland/forest will be created within retention areas though the revegetation and regeneration of exotic grasslands. This revegetation will not only result in a greater area of potential habitat for the species to what is currently present, but will connect currently fragmented areas and improve connectivity across the project area, compared to current conditions.

Table 3 summarises the potential habitat for the species to be cleared and retained within the project area.

Table 3 Summary of Brown Treecreeper habitat to be cleared and retained within the project area

Total Area (ha) within Project Area	Total Area (ha) within Disturbance Footprint	Total Area (ha) within Retention Area	Total Area (ha) of Exotic Grassland to be Revegetated to Woodland/Forest	Total Area (ha) of Potential Habitat (including revegetation)
46	17	29	23	52

The total area of potential habitat for the species in the approved Master Plan area, which includes both the project area and areas adjacent to the project area, is approximately 96 ha. Of the 96 ha of potential habitat present within the Master Plan area, a total of approximately 52 ha will be removed and approximately 44 ha retained and conserved in perpetuity across the Master Plan area. This includes the proposed action, as well as separate DAs previously approved or DAs consistent with the Master Plan anticipated to be approved in the future. Similar to the project area, the areas of habitat proposed to be removed under the Master Plan are largely comprised of small, isolated patches while the areas to be retained are mostly larger patches with connectivity to adjoining areas of suitable habitat. Further to this, an additional 23 ha of grassland areas within retention areas to be managed under a VMP will be replanted as native woodland/forest, which will result in ~67 ha of suitable habitat for the species within the Master Plan area in the long-term.

It is also important to recognise that prior to implementation of the Master Plan, no areas within the MPURA were being managed for conservation in common with other habitats that remain in the region, and ongoing grazing would have likely resulted in continuing degradation of the remnant native vegetation present. As a result of the proposed action, a total of ~67 ha of woodland/forest will be retained/revegetated in conservation areas and conserved and managed in perpetuity to enhance and improve its biodiversity value.

Although suitable habitat for the Brown Treecreeper is present, most of the habitat is highly disturbed and fragmented, and has limited to no connectivity to larger patches of habitat. The species is likely to utilise the suitable habitat to be cleared primarily for foraging purposes only and is considered more likely to utilise habitat within the retained areas for nesting purposes as these areas include larger tracts of vegetation that are less exposed to edge effects, as well as more hollow-bearing trees. The most suitable roosting/nesting habitat for this species, is within the Howes Creek Conservation Area and Northern Conservation Area that

contain the largest patches of woodland/forest and highest number of tree hollows that are less exposed to edge effects.

The significance of the project area for this species in the locality and region is relatively low. The species has only been recorded at two locations in 2018 and has not been detected again through subsequent targeted surveys. The species appears unable to maintain viable populations in remnants less than 200 ha and its abundance decreases as remnant size decreases (Barret & Ford, 1994). The degraded patches in the project area are considerably less than 200 ha and are unlikely to be able to support a viable population of this species. Similar fragmented habitats occur outside the project area will remain, along with the substantial area of less fragmented woodland/forest within the Howes Creek Conservation Area and Northern Conservation Area that will be retained in perpetuity.

4. Impact Assessment

As per Section 3 of the further information request from DCCEEW, the department considers the proposed action is likely to have a significant impact on the three following critically endangered ecological communities and one threatened fauna species (vulnerable) listed under the EPBC Act:

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW);
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion (EBSF);
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria (RFEF); and
- Brown Treecreeper (south-eastern) (*Climacteris picumnus victoriae*).

This chapter provides an assessment of the direct and indirect impacts on these MNES as a result of the proposed action.

4.1. Direct Impacts

4.1.1. Impacts to MNES TECs

The proposed action will result in the full removal of some areas of the above listed MNES TECs as well as partial clearing/modification of some areas for Asset Protection Zone (APZ) purposes. Substantial areas will be protected within the conservation areas. **Table 4** identifies the extent of proposed impacts to extant MNES TECs within the project area as a result of the development works and areas proposed to be conserved in the retention area by the proposed conservation works. These areas are shown on **Figure 7** and **Figure 9**. Further details of the direct impacts anticipated to occur to these MNES TECs are provided in subsequent sections.

Table 4 Extent of impacts to extant MNES TECs within the project area

MNES Vegetation Community	Total Area (ha) in Proposed Conservation Works	Total Area (ha) in Proposed Development Works	Total Area (ha) in Project Area
Cumberland Plain Woodland	5.45	4.62	10.07
River-flat Eucalypt Forest	7.96	0.38	8.34
Elderslie Banksia Scrub Forest	1.72	0.77	2.49

4.1.1.1. Cumberland Plain Woodland

Based on the State Vegetation Type Mapping (or SVTM) prepared by the NSW Government, there is approximately 1,177 ha of CPW within 5km of the project area that is considered to be a TEC in NSW (**Figure 10**). The total area of this that is a MNES TEC cannot be accurately determined due to the survey effort that would be required as well as land access restrictions as the majority of these areas are privately owned. However, significant areas are likely to meet MNES thresholds. A conservative estimate of 10% of the 1,177 ha being a MNES TEC, equates to approximately 118 ha of the MNES present within 5 km of the project area, although the actual area is likely to be considerably more.

Approximately 10 ha of CPW comprising a MNES is present within the within the project area. As shown in **Figure 7** the largest, most continuous patches of woodland are in the Northern Conservation Area, while small to moderate sized patches of CPW that occur in the north and southwest of the project area are isolated and surrounded by previously cleared lands.

Approximately 4.62 ha of CPW MNES will be removed for the project, with approximately 5.45 ha being conserved and managed for conservation in retained areas (see **Table 4**).

4.1.1.2. Elderslie Banksia Scrub Forest

Approximately 2.49 ha of EBSF is present within the project area in the form of two larger patches, two small patches adjacent to other native vegetation communities and several small, isolated patches. In total ~ 0.77 ha are proposed to be removed for the proposed action, including removal of 0.02 ha for remediation within a very small part of the conservation area that will be replanted and managed under a VMP.

One of the two larger patches (Patch E4) will be conserved within Park K, with the exception of the ~0.02 to be removed due for remediation of contamination and then rehabilitated. The remediation is required to remove any future human health risks. Two smaller patches (Patch E1) adjacent to other native vegetation communities will be retained in Park L. Additionally, a moderately sized ~0.21 ha patch (Patch E7) in the Stage 6B EBSF Conservation Area will be conserved and retained. As a result, a total of 1.72 ha of extant EBSF MNES is proposed to be retained (this excludes the 0.02 ha to be removed for remediation that will be revegetated), with an additional 0.56 ha to be revegetated in Park K (this includes the 0.02 ha to be removed for remediation that will be revegetated). Therefore, a total of 2.28 ha of EBSF will be conserved in perpetuity and managed under VMPs. The locations of retained EBSF MNES are shown in **Figure 7**.

One of the larger patches (Patch E5) and one of the small, isolated patches (Patch E6) to be removed occur within land that was previously used as an old fireworks factory and subsequently has contaminated soils. The soils require excavation for remediation and so these patches cannot be avoided or retained. This remediation will also involve the removal of a small portion of the northern corner of Park K, which will then be subsequently rehabilitated under a VMP.

Some very small patches of EBSF MNES (Patches E2 and E3), which lack *Banksia integrifolia* and many other plant species typical of the community are isolated amid exotic grassland to the south of the remediation area (see **Figure 7**). Because of their size, isolation and low diversity these occurrences are not proposed to be retained and, like the vegetation in the remediation area, will be subject to offsetting.

4.1.1.3. River-flat Eucalypt Forest

This MNES TEC is widespread in the MPURA, with extensive mapped occurrences along the Nepean River, and along Howes Creek (**Figure 7**).

A small area of this community (~0.38 ha) will be removed for the proposed action. This includes the edges of a patch (Patch R5) to the east of Park L and the edges of a patch (Patch R7) to the south of the Howes Creek Conservation Area (**Figure 7**). Most of the RFEF MNES TEC within the project area is to be retained within the Howes Creek Conservation Area where it will be actively managed for conservation under a VMP that has been prepared for this area.

Within the project area the community occurs as isolated patches or on the periphery of larger patches that are generally bound by previously cleared lands. The community within the project area is substantially degraded from previous and current agricultural land uses.

4.1.2. Impacts on Brown Treecreeper Habitat

Two Brown Treecreeper individuals were recorded (see **Figure 7**) within the project area by Cumberland Ecology in 2018. Only nine individuals have been recorded within 10 km of the MPURA, with only four of these records occurring within the last ten years. It has not been detected again in the project area by subsequent detailed targeted surveys. As a result, it is considered unlikely that any individuals are reliant on the habitat present but may occur on occasion.

Despite a lack of recent records, the project area contains woodland/forest that is potentially suitable foraging and nesting habitat for the Brown Treecreeper (see ***Section 3.3.1***). The proposed action will remove patches of potential habitat totalling approximately 17 ha. As illustrated in **Figure 8,** the individual patches are small and lack connectivity to other larger woodland/forest areas. The largest patch being removed measures less than 3 ha.

The removal of these small areas of habitat is unlikely to be significant to the long-term survival of the species in the local context as larger areas of similar habitat will remain in the MPURA and beyond. Furthermore, the largest areas of woodland/forest habitat present within the project area will be conserved, rehabilitated and managed in perpetuity along the Howes Creek and Northern Conservation Areas (see **Figure 8**). The Howes Creek Conservation Area is part of an extensive, connected block of woodland/forest that connects off site to vegetation along the Nepean River, while the Northern Conservation Area provides connectivity off site to vegetation within the Mt Annan Royal Botanic Gardens to the north.

As part of the overall Master Plan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, approximately 23 ha of woodland/forest will be created within retention areas though the revegetation and regeneration of exotic grasslands, resulting in a cumulative long-term retention/management of ~67 ha of suitable habitat for the Brown Treecreeper. It is also important to note that prior to implementation of the Master Plan, no areas within the MPURA were being managed for conservation. As a result of the proposed action, a total of 52 ha of woodland/forest will be conserved and managed in perpetuity within the project area, which is greater than the 46 ha of potential habitat currently present in the project area.

Woody weeds including African Olive and Privet are prevalent across the woodland/forest of the project area, and in the locality. When unmanaged, these weeds dominate woodland/forest patches and exclude smaller native plants, particularly ground stratum. They are a major threat to Brown Treecreeper habitat and will be removed from the conservation areas in the long term under VMPs. The removal of woody weeds will increase the diversity of grassy ground cover within the conservation areas and will therefore increase the potential of such areas to be used by the Brown Treecreeper in the future. The conservation areas will be managed in perpetuity and are of a large enough scale to provide substantial habitat for the Brown Treecreeper because Howes Creek Conservation Area connects to woodland/forest along the Nepean River, while the Northern

Conservation area is adjacent to the Mt Annan Botanic Gardens where large areas of African Olive have been removed to provide for the restoration of Cumberland Plain Woodland.

The proposed removal of habitat in the project area is not expected to significantly affect the species' long-term viability as the habitat present already exists in a fragmented and degraded condition. Suitable habitat for the Brown Treecreeper to be removed within the project area is largely limited to small, isolated patches with no connectivity to larger patches of habitat. Further to this the habitats present in the MPURA are already highly fragmented. Although the proposed action will increase existing fragmentation of habitat to some extent by increasing the distance between fragments and reducing the ability for movement and gene flow, fragmentation of the largest areas of suitable habitat within retention areas will not occur. Rather, the proposed action requires clearing of already fragmented patches and will not create additional fragmented habitat patches. Further to this, retention areas will be managed under a VMP which includes the replanting of native vegetation which will improve habitat connectivity within retention areas in the long-term.

Although the Brown Treecreeper is considered to be a sedentary species, with distinct home territories, some birds disperse locally after breeding (OEH 2017a). The species disperses locally, with an average recorded dispersal distance of approximately one kilometre, but ranging up to over 2 km (Doerr, 2011). Accordingly, they are able to access other resources if required and are not dependent on the resources in a single patch.

Although some areas of sub-optimal habitat will be removed, larger areas of habitat will be retained in the MPURA and beyond, around Howes Creek and the Nepean River. The Brown Treecreeper is more likely be dependent on larger tracts of less disturbed vegetation located within the Howes Creek Conservation Area and Northern Conservation Area. Due to this, the proposed action will not likely affect habitat connectivity for this species as no existing connectivity to off-site reserves will be affected.

4.2. Residual Significant Impacts

As requested by the DCCEEW information request, this section provides a residual significant impact assessment, supported by justification and evidence, for CPW and the Brown Treecreeper after proposed avoidance, mitigation and management measures are considered. The residual significant impact assessment has been undertaken with consideration of the information requested in the DCCEEW information request and the Significant Impact Guidelines 1.1.

4.2.1. Cumberland Plain Woodland

This section provides an assessment of CPW against the Significant Impact Guidelines for Critically Endangered Ecological Communities.

An action is likely to have a significant impact on a critically endangered, or endangered ecological community if there is a real chance or possibility that it will:

a) reduce the extent of an ecological community;

The proposed action will result in the permanent clearing of ~4.62 ha of CPW MNES in the project area. This vegetation is in poor condition and the highest quality CPW MNES will be managed in areas of retained

vegetation within the retention area. That notwithstanding, the action will reduce the extent of this ecological community.

b) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

The CPW occurring within the project area and MPURA is already fragmented due to previous clearing and currently occurs as isolated patches. Habitat within the project area does not join onto any national parks or reserves or to any large remnant patch of native vegetation. Accordingly, the connectivity offered by these isolated patches is relatively low and limited to "stepping-stone" connectivity. The proposed action will clear two entire patches and the peripherals of two patches of CPW, however a greater area of CPW will be retained to what will be removed that will continue to provide connectivity between areas of retained vegetation, including in five retention areas referred to as Parks K and L, Howes Creek, the Northern Retention areas and Stage 6B Elderslie Banksia Scrub Forest (EBSF). As such, the proposed removal of the CPW within the project area would not significantly fragment this community further than current conditions.

c) adversely affect habitat critical to the survival of an ecological community;

Habitat critical to the survival of a listed ecological community (Department of the Environment 2013) includes areas that are necessary for the long-term maintenance of the ecological community; to maintain genetic diversity and long-term evolutionary development; or for the recovery of the ecological community. The occurrence of this community within the project area is not considered to be critical to the survival of the community given its history of disturbance from current and historic land uses. Further to this, the majority of the community within the project area will be retained and large areas of this community in a similar condition to that in the project area will remain in the locality.

d) modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;

The project is unlikely to reduce groundwater levels or alter surface water drainage patterns such that other occurrences of this community to be retained will be significantly affected. Appropriate mitigation measures will be implemented as part of the project's NSW approval to ensure groundwater and surface water are appropriately managed. Further to this, all retained areas of this community will be managed under a VMP to improve vegetation condition in the long-term. The project is not considered likely to modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the community's survival.

e) cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;

The project will result in the permanent clearing of ~4.62 ha of the MNES, and within this area there will be a substantial change in species composition as all species will be removed. However, a total of 5.45 ha of this MNES within the project area will be retained and managed in perpetuity under VMPs. These measures will

ensure that no substantial change will occur to the species composition of the occurrence of CPW in the project area in the long term.

f) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

i) assisting invasive species, that are harmful to the listed ecological community, to become established, or;

ii) causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or;

The project will result in the permanent clearing of ~4.62 ha of the ecological community, however it is not expected that the proposed action will result in a substantial reduction in the quality or integrity of the portions of the occurrence of this community within or beyond the project area.

The condition of the vegetation within the project area is currently being impacted as a result of previous and current land uses. Invasive flora and fauna species are known to occur and agricultural activities such as historic grazing have resulted in reduced species diversity. As a result of the proposed action, a total of 5.45 ha of extant CPW MNES will be retained and conserved in the long-term. A VMP will be implemented for all areas of retained vegetation which include measures to control weeds and therefore invasive species are unlikely to impact on retained areas of CPW. Appropriate management actions will be implemented to contain weed and feral animals to minimise the risks of invasive species. Furthermore, biodiversity credits will be used to offset any residual impact. A significant number of BBAM credits have already been purchased and remaining credits required will be either retired through the retirement of the proponent's existing BBAM credits, purchase of BBAM credits, or by obtaining an assessment of reasonable equivalence to convert these to BAM credits and paying into the Biodiversity Conservation Fund. These measures will ensure that no substantial reduction will occur to the quality or integrity of the occurrence of CPW in the project area or beyond in the long term.

g) interfere with the recovery of an ecological community

The impacts to CPW within the project area are not considered likely to interfere with the recovery of this community. The areas of this community to be impacted have been modified and are not actively managed and continue to be impacted by previous and current land uses. Areas of CPW will be retained and managed within the site with further revegetation of CPW within retention areas. Therefore, the proposed action is not considered to interfere with the recovery of CPW. Furthermore, biodiversity credits will be used to offset any residual impact. A significant number of BBAM credits have already been purchased and remaining credits required will be either retired through the retirement of the proponent's existing BBAM credits, purchase of BBAM credits, or by obtaining an assessment of reasonable equivalence to convert these to BAM credits and paying into the Biodiversity Conservation Fund. These measures will ensure that the project will not interfere with the recovery of CPW in the project area in the long term.

Conclusion

The project will result in a direct impact on CPW in the project area through the permanent clearing of ~4.62 ha of the ecological community. Nevertheless, a total of 5.45 ha of the ecological community in the project

area will be retained and managed for conservation in perpetuity, ensuring the long-term survival of the community in the long-term.

Furthermore, biodiversity credits will be used to offset any residual impact. A significant number of BBAM credits have already been purchased and remaining credits required will be either retired through the retirement of the proponent's existing BBAM credits, purchase of BBAM credits, or by obtaining an assessment of reasonable equivalence to convert these to BAM credits and paying into the Biodiversity Conservation Fund. These measures will ensure that no significant impact will occur to the occurrence of CPW in the project area in the long term.

4.2.2. Brown Treecreeper

This section provides an assessment of the Brown Treecreeper against the Significant Impact Guidelines for Vulnerable species. It is acknowledged that feedback on the draft Preliminary Documentation from DCCEEW indicates that the department considers that the proposed action will have a residual significant impact on the Brown Treecreeper, and this assessment has been revised to provide further detail of the avoidance, mitigation and management measures that are proposed for this species.

An action has, will have, or is likely to have a significant impact on a Vulnerable species if it does, will, or is likely to:

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

Two Brown Treecreepers were recorded in 2018 from the project area (see **Figure 7**). The species has not been subsequently recorded through targeted surveys. The project area is considered to provide sub-optimal habitat comprised largely of small (all less than 3 ha), isolated fragments that have a dense weedy understorey not suitable for the species. Further to this, the total area of all habitat (comprised largely of small, isolated patches) present within the project area (approximately 46 ha) is far less than the 200 ha requirement to maintain a viable population. Any individuals that occur are not considered to comprise or be part of an important population of the species, as the species is generally sedentary and has not been continually recorded.

The direct impact to potential foraging habitat for this species will occur in the permanent removal of several small, isolated patches that are not large enough to support a population, when considered individually or collectively. Collectively a total of approximately 17 ha of sub-optimal habitat will be removed, which is comprised of only three patches measuring greater than 1 ha in area, with the largest being less than 3 ha (see **Figure 8**). The remaining patches all measure less than 1 ha in area, with the majority of these comprising scattered trees surrounded entirely by grassland. Potential nesting/roosting habitat may also be impacted through the removal of hollow-bearing trees. Indirect impacts also have the potential to occur in areas of retained native vegetation. These indirect impacts are primarily related to edge effects such as weed incursion, light, and noise. These indirect impacts are anticipated to be appropriately mitigated through the implementation of the VMPs for all retention areas.

Although a total of approximately 17 ha of scattered patches of foraging habitat and potential nesting/roosting habitat for the Brown Treecreeper will be removed, these areas are small, isolated patches with no connectivity to other areas on- or off-site. Approximately 29 ha of intact bushland will be retained in Parks K and L, the

Stage 6B EBSF Conservation Area, and the Howes Creek and the Northern Conservation Area (see **Figure 8**) that will continue to provide suitable foraging and nesting/roosting habitat for the species. Further to this, approximately 23 ha of grassland and cleared land will be regenerated in the conservation areas in accordance with a VMP to provide additional habitat for the Brown Treecreeper in the long-term.

Woody weeds including African Olive and Privet are prevalent across the woodland/forest of the project area, and in the locality. When unmanaged, these weeds dominate woodland/forest patches and exclude smaller native plants, particularly ground stratum. They are a major threat to Brown Treecreeper habitat and will be removed from conservation areas in the long term. The removal of woody weeds will increase the diversity of grassy ground cover within the conserved woodland/forest areas and will therefore increase the potential of such areas to be used by the Brown Treecreeper. The conservation areas will be managed in perpetuity under VMPs and are of a large enough scale to provide substantial habitat for the Brown Treecreeper because the Howes Creek Conservation Area connects to woodland/forest along the Nepean River, while the Northern Conservation Area is adjacent to the Mt Annan Botanic Gardens where large areas of African Olive have been removed to provide for the restoration of Cumberland Plain Woodland.

In addition, the Howes Creek and Northern Conservation Areas currently contain areas of grassland and cleared land that will be regenerated to woodland and open forest under a VMP. Approximately 23 ha of grassland and cleared land will be regenerated in these two conservation areas in accordance with a VMP to provide habitat for the Brown Treecreeper. Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River. Revegetation of currently degraded land in the Northern Conservation Area will form proximal habitat to other Cumberland Plain Woodland that is being regenerated at Mount Annan Botanic Gardens to the north of the project area. These measures will benefit the Brown Treecreeper, as Cumberland Plain Woodland is known to be utilised by this species.

No important population of the Brown Treecreeper is considered to occur in the project area and with consideration of the extensive conservation areas that are being provided, the loss of the relatively small, isolated patches of habitat for this species is not considered likely to lead to a long-term decrease in the size of the population that may occur.

b) reduce the area of occupancy of an important population

An important population is defined as one that is necessary for a species' long-term survival and recovery. Given the few records of this species on or near the project area, the potential habitat available is not considered as supporting an important population. Accordingly, although the area of occupancy of this species may be reduced, the proposed action will not reduce the area of an important population of this species.

As outlined previously, approximately 29 ha of suitable habitat for this species will be retained in Parks K and L, the Stage 6B EBSF Conservation Area, and the Howes Creek and the Northern Conservation Area (see **Figure 9**). These conservation areas contain the highest quality habitat for the Brown Treecreeper and other native species that currently exists in the project area. In addition, approximately 23 ha of grassland and cleared land in the Howes Creek and Northern Conservation Areas will be regenerated to woodland and open forest under a VMP. Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of

native vegetation extending from Howes Creek to the Nepean River, providing opportunities for the Brown Treecreeper to disperse and access a variety of habitat resources. The Northern Conservation Area will also be revegetated and will form proximal habitat to other Cumberland Plain Woodland that is being regenerated at Mount Annan Botanic Gardens to the north of the project area. As these areas of woodland/forest revegetation mature, they will add to the existing areas of habitat for the Brown Treecreeper and provide large areas of suitable habitat for this species that will be protected and managed in perpetuity.

No important population of the Brown Treecreeper is considered to occur in the project area and with consideration of the extensive areas of high-quality habitat that are being protected in conservation areas and created through revegetation, the loss of the relatively small area of habitat for this species is not considered likely to reduce the area of occupancy of an important population.

c) fragment an existing important population into two or more populations

No important population of the Brown Treecreeper is considered likely to occur in the project area. Furthermore, although the species is quite sedentary, it can be highly mobile and is known to disperse over 2 km (Doerr, 2011). The ability of any birds to move through the landscape will not be impeded by the proposed development due to the retention of habitat corridors in Howes Creek and Northern Conservation Areas and therefore the existing population, although not considered to be an important population will not be fragmented into two or more populations by the proposed development.

d) adversely affect habitat critical to the survival of a species

The potential habitat for the Brown Treecreeper in the project area that will be removed is not considered to be critical to the survival of the species (refer to ***Section 3.3.1***). Large areas of similar habitat will remain in the locality, including approximately 29 ha to be retained in Parks K and L, the Stage 6B EBSF Conservation Area and the Howes Creek and Northern Conservation Areas that will be managed for conservation in the long term. These conservation areas contain the highest quality habitat for the Brown Treecreeper and other native species that currently exists in the project area. In addition, approximately 23 ha of grassland and cleared land in the Howes Creek and Northern Conservation Areas will be regenerated to woodland and open forest under a VMP. Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River. providing opportunities for the Brown Treecreeper to disperse and access a variety of habitat resources. The Northern Conservation Area will also be revegetated and will form proximal habitat to other Cumberland Plain Woodland that is being regenerated at Mount Annan Botanic Gardens to the north of the project area. As these areas of woodland/forest revegetation mature, they will add to the existing areas of habitat for the Brown Treecreeper and provide large areas of suitable habitat for this species that will be protected and managed in perpetuity. Further to this, nest boxes specifically designed for the Brown Treecreeper will be installed within the conservation areas to ensure sufficient nesting habitat for the Brown Treecreeper is available. Accordingly, the action is unlikely to adversely affect habitat critical to the survival of this species.

e) disrupt the breeding cycle of an important population

No important population of the Brown Treecreeper is considered likely to occur in the project area. Although potential nesting habitat may be impacted through the removal of hollow-bearing trees, large areas of intact

bushland directly adjoining the project area on the western boundary will be retained areas as well as approximately 29 ha of high quality habitat in Parks K and L, the Stage 6B EBSF Conservation Area and the Howes Creek and Northern Conservation Areas that will continue to provide high quality nesting habitat for the species. In addition, approximately 23 ha of grassland and cleared land in the Howes Creek and Northern Conservation Areas will be regenerated to woodland and open forest under a VMP. Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River, providing opportunities for the Brown Treecreeper to disperse and access a variety of habitat resources. The Northern Conservation Area will also be revegetated and will form proximal habitat to other Cumberland Plain Woodland that is being regenerated at Mount Annan Botanic Gardens to the north of the project area. As these areas of woodland/forest revegetation mature, they will add to the existing areas of habitat for the Brown Treecreeper and provide large areas of suitable habitat for this species that will be protected and managed in perpetuity. Further to this, nest boxes specifically designed for the Brown Treecreeper will be installed within the conservation areas to ensure sufficient nesting habitat for the Brown Treecreeper is available. Therefore, the project will not disrupt the breeding cycle of an important population of this species.

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

Although approximately 17 ha of scattered patches of foraging habitat and potential nesting/roosting habitat will be removed from the project area, large areas of intact bushland directly adjoining the project area on the western boundary will be retained in the retention areas. Approximately 29 ha of the highest-quality foraging and nesting/roosting habitat for the species will be conserved in Parks K and L, the Stage 6B EBSF Conservation Area and the Howes Creek and Northern Conservation Areas. In addition, approximately 23 ha of grassland and cleared land in the Howes Creek and Northern Conservation Areas will be regenerated to woodland and open forest under a VMP. Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River, providing opportunities for the Brown Treecreeper to disperse and access a variety of habitat resources. The Northern Conservation Area will also be revegetated and will form proximal habitat to other CPW that is being regenerated at Mount Annan Botanic Gardens to the north of the project area. As these areas of woodland/forest revegetation mature, they will add to the existing areas of habitat for the Brown Treecreeper and provide large areas of suitable habitat for this species that will be protected and managed in perpetuity. Further to this, nest boxes specifically designed for the Brown Treecreeper will be installed within the conservation areas to ensure sufficient nesting habitat for the Brown Treecreeper is available.

It is also important to note that prior to implementation of the Master Plan, no areas within the MPURA were being managed for conservation, and threatening processes such as grazing were progressing unchecked, resulting in ongoing degradation of the native vegetation present. As a result of the proposed action, a total of 52 ha of woodland/forest will be conserved and managed in perpetuity. Therefore, when balanced against the gains in biodiversity value realized by protection and management of existing habitat, and the creation of additional habitat through revegetation, the reduction of small areas of potential habitat for this species is not considered likely to cause the species to decline.

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

The project area currently contains many invasive weed species, some of which are recognised as high threat weeds which pose a threat to the habitat of native species including the Brown Treecreeper. The VMPs to be implemented in the retention areas contain detailed measures for the control of weed species, and their implementation will reduce the threat of invasive weed species, particularly woody weeds such as African Olive and Privet, which are degrading habitat for Brown Treecreeper.

No invasive fauna species are likely to become established in areas of Brown Treecreeper habitat as a result of the action. Therefore, it is unlikely that the action will result in the establishment of an invasive species in areas of habitat for the Brown Treecreeper.

h) introduce disease that may cause the species to decline, or

The action is considered unlikely to introduce disease that may cause this species to decline.

i) interfere substantially with the recovery of the species.

The proposed action will not interfere substantially with the recovery of the Brown Treecreeper as only relatively small and isolated patches of degraded habitat will be removed. Furthermore, the retention and management of approximately 29 ha of high-quality habitat in Parks K and L, the Stage 6B EBSF Conservation Area and the Howes Creek and Northern Conservation Areas will ensure that the highest quality areas of foraging and nesting habitat for this species will remain. In addition, approximately 23 ha of grassland and cleared land in the Howes Creek and Northern Conservation Areas will be regenerated to woodland and open forest under a VMP. Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River, providing opportunities for the Brown Treecreeper to disperse and access a variety of habitat resources. The Northern Conservation Area will also be revegetated and will form proximal habitat to other CPW that is being regenerated at Mount Annan Botanic Gardens to the north of the project area. As these areas of woodland/forest revegetation mature, they will add to the existing areas of habitat for the Brown Treecreeper and provide large areas of suitable habitat for this species that will be protected and managed in perpetuity. Further to this, nest boxes specifically designed for the Brown Treecreeper will be installed within the conservation areas to ensure sufficient nesting habitat for the Brown Treecreeper is available.

Conclusion

The proposed action will result in the removal of approximately 17 ha of potential habitat for the Brown Treecreeper, comprising several small, isolated patches of regrowth woodland/forest with a degraded understorey that is not optimal for the species. Furthermore, the species has only been recorded twice from the project area in 2018, and it has not been recorded since through targeted surveys. Accordingly, it is unlikely that there is a resident population of the Brown Treecreeper present in the project area, and the habitat present is not extensively used by this species. Notwithstanding, taking a precautionary approach, the woodland/forest patches to be removed are considered to comprise critical habitat for the Brown Treecreeper. Comprehensive mitigation measures have been developed to compensate for the removal of the potential habitat to be

removed, including the retention and in-perpetuity management of approximately 29 ha of the best condition habitat available for the species within the retention areas, comprising Parks K and L, the Stage 6B EBSF Conservation Area and the Howes Creek and Northern Conservation Areas.

The retention areas will be managed in accordance with a VMP, including weed management and supplementary planting of native species and they are expected to improve in ecological condition over time. The Howes Creek and Northern Conservation Areas have areas of grassland and cleared land, and approximately 23 ha will be regenerated to woodland and open forest under a VMP. Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River, providing opportunities for the Brown Treecreeper to disperse and access a variety of habitat resources. The Northern Conservation Area will also be revegetated and will form proximal habitat to other Cumberland Plain Woodland that is being regenerated at Mount Annan Botanic Gardens to the north of the project area. As these areas of woodland/forest revegetation mature, they will add to the existing areas of habitat for the Brown Treecreeper and provide large areas of suitable habitat for this species that will be protected and managed in perpetuity. Further to this, nest boxes specifically designed for the Brown Treecreeper will be installed within the conservation areas to ensure sufficient nesting habitat for the Brown Treecreeper is available.

The conservation of the highest quality areas of existing habitat for the Brown Treecreeper in the project area, and the proposed creation of large areas of habitat through revegetation, will, in the long term, lead to the conservation of 52 ha of suitable habitat for the species, or over three times the area being removed by the proposed action. This habitat will be managed in perpetuity and will provide a permanent conservation outcome for the species. Accordingly, the loss of the relatively small, isolated patches of habitat for this species as a result of the action is not considered likely to result in a significant impact to the Brown Treecreeper.

4.3. Cumulative Impacts with Consideration of the CPCP

As requested in the DCCEEW information request, this section of the Preliminary Documentation outlines the cumulative impacts of the project with consideration of the CPCP. It is noted that the project area is located entirely within the CPCP's nominated area and is mapped as 'excluded land' under the CPCP. **Table 5** below identifies the total areas of impact and retention proposed by the CPCP and proposed action for the MNES CPW, EBSF, RFEF and the Brown Treecreeper.

Table 5 Summary of cumulative impacts associated with the CPCP and project area

MNES	CPCP Total Area (ha)*	CPCP Impact Area (ha)	CPCP Avoided Area (ha)	CPCP % Avoided Area (ha)o	Project Area Impact Area (ha)	Project Area Retention Area (ha)	Project Area % Avoided Area
CPW	247	135	112	45	4.62	5.45	50
RFEF	259	114	145	56	0.38	7.96	95
EBSF	9.4	0	0	100	0.77	1.72	69

MNES	CPCP Total Area (ha)*	CPCP Impact Area (ha)	CPCP Avoided Area (ha)	CPCP % Avoided Area (ha)o	Project Area Impact Area (ha)	Project Area Retention Area (ha)	Project Area % Avoided Area
Brown Treecreeper*	3,272	720	2,552	78	17	29	63

Note: CPCP Area calculations exclude areas mapped as excluded land under the CPCP.
**Detailed habitat assessment areas for the Brown Treecreeper are not included in the CPCP report. The Cumberland Plain Land Snail has been utilised as a 'best-fit' surrogate due to habitat similarities (e.g. CPW and RFEF).*

4.4. Indirect Impacts

There is the potential for the proposed action to indirectly impact on adjacent areas which contain habitat for MNES, particularly the conservation areas, through the following indirect effects:

- Sedimentation and Erosion;
- Edge effects;
- Weeds;
- Physical damage;
- Noise, vibration, air quality and light; and
- Habitat fragmentation

These are addressed further in the following sections.

4.4.1. Sedimentation and Erosion

During the construction stage of the proposed action, there is potential for retained vegetation in the conservation areas to be impacted by sedimentation, erosion and runoff from development in adjacent areas. Eroded sediment can smother retained vegetation if appropriate control measures are not implemented. Smothering can cause dieback of herbs and shrubs and reduce regeneration of groundcover species. Sediment and eroded material can also contain weed matter and nutrients, and movement of this material into the retained vegetation in the MPURA can facilitate the spread of weeds.

Draft consent conditions issued by Council require the preparation of a Construction Environmental Management Plan (CEMP) to detail the environment management and control measures which will be implemented to ensure the works are managed in a manner to reduce adverse impacts on the environment (see ***Section 5.2.1***). This will include appropriate sediment and erosion control and reduction measures to avoid sediment runoff into retained areas of native vegetation in the conservation areas and outside the MPURA. Further details of requisite management plans, in accordance with Council's draft consent conditions, are provided in ***Section 5.2***.

4.4.2. Edge Effects

Edge effects are impacts that occur at the interface between natural habitats, especially forests and disturbed or developed land (Yahner 1988). When an edge is created between woodland and a cleared area, changes to ecological processes within the vegetation can extend between 10 m and 100 m from the edge. These changes include; invasion by weeds, increase in feral animals, reduction in tree health, and barriers to dispersal or distribution (Yahner 1988).

The native vegetation to be retained within the conservation areas are already subject to a high degree of edge effects as a result of previous clearing and agricultural activity within and surrounding the MPURA. The proposed works will increase the edge effects to some minor degree due to clearing, however, the conservation areas are mostly discrete areas of native vegetation surrounded by cleared land and therefore are already highly impacted by existing edge effects. Accordingly, the project is not likely to significantly increase edge effects relative to current conditions. The highest quality areas of native vegetation in the conservation areas will be managed and enhanced into perpetuity, in accordance with Vegetation Management Plans (VMP) prepared as part of Council development consent conditions thus reducing the extent of edge effects from the development.

Further details of requisite management plans, in accordance with Council's draft consent conditions, are provided in ***Section 5.2***.

4.4.3. Weeds

Alterations to habitat conditions often favour introduced and/or hardy native plant species that can proliferate in disturbed conditions. Such species have potential to impact upon the original local native plant species. Weeds such as exotic grasses and other introduced plants have potential to outcompete regenerating native plant species.

The native vegetation within the MPURA currently have significant weed infestations, and a total of seven Weeds of National Significance (WoNS) have been recorded including *Lantana camara* (Lantana), *Lycium ferocissimum* (African boxthorn), *Nassella neesiana* (Chilean needle grass), *Nassella trichotoma* (Serrated tussock), *Opuntia stricta* (Common Prickly Pear), *Rubus fruticosus* (Blackberry) and *Senecio madagascariensis* (Fireweed).

There is a risk that seeds or other propagules from these weeds could be dispersed while the proposed works are being undertaken, either on vehicles or clothing of the workers involved. These risks will be mitigated in accordance with approved management plans, such as the VMP and Construction Environment Management Plan (CEMP). Further details of requisite and approved management plans, in accordance with Council's draft consent conditions, are provided in ***Section 5.2***.

4.4.4. Physical Damage

The native vegetation and associated habitat outside the development footprint have potential to be damaged physically by human activities. This can include trampling of vegetation, soil compaction and disturbance, especially during transport of materials. These activities can alter regeneration of species within the vegetation

communities and result in an alteration to community composition and structure. These impacts are likely to occur if access is not restricted.

The risk of physical damage from inadvertent access will be negated by clear delineation and fencing of vegetation to be retained and managed. Furthermore, all physical works in close proximity to vegetation/habitat will be conducted under ecological supervision.

Further details of requisite and approved management plans, in accordance with Council's draft consent conditions, are provided in ***Section 5.2***.

4.4.5. Noise, Vibration, Air Quality and Light

Noise and vibration can affect animal physiology and behaviour, and if it becomes an ongoing stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. There are other potential impacts due to noise that include habitat loss through avoidance, reduced reproductive success and a retreat away from favourable habitats (AMEC 2005).

Noise also affects the way that animal-created sounds are heard and interpreted by other animals. This can include mating calls, territorial calls and alarm calls. Interference with these calls by noise created by the mine, has the potential to disrupt the species relying on these calls with deleterious results including reduced reproductive success and mortality (AMEC 2005).

The proposed works have the potential to generate noise and vibration during construction works. Notwithstanding this, background noise levels already exist in the locality of the MPURA given its location within an urbanised area and proximity to major roads.

It is unlikely that the proposed action will exacerbate these impacts significantly above current background levels and the proposed works will continue to comply with regulatory standards. Furthermore, the proposed works will be very short-term i.e. restricted to the construction period, and noise and vibration impacts will not be sustained in the long term. Therefore, potential indirect impacts on native fauna within the MPURA are not likely to be significant.

The major source of air pollution from works associated with the proposed works will be dust created by the construction works, particularly if climatic conditions are dry. Dust emissions from vehicles during ingress and egress are also likely during construction works. However, the works will be short-term, and it is not anticipated that the proposed development will create any air quality problems. Dust has the potential to smother plants and inhibit growth, if excessive building up occurs on vegetation adjoining the construction zones. However, the impact of dust on air quality and plant health is managed in accordance with approved management plans.

The residential development has the potential to increase the level of artificial night light in the natural environment, through the installation of street lighting and residential lighting. Increased night light levels may adversely impact wildlife by direct glare, chronic or periodic increased illumination and temporary unexpected fluctuations in light levels (Saleh 2007, Longcore and Rich 2010). However, the impacts of artificial lighting can be mitigated through the installation of fauna sensitive lighting, and the impacts from night light pollution are likely to remain close to the immediate boundary of the development. In accordance with Council

consent conditions, outdoor lighting has been designed to be fauna friendly and reduce light spill into areas of retained/managed vegetation.

Further details of requisite management plans, in accordance with Council's draft consent conditions, are provided in ***Section 5.2***.

4.4.6. Habitat Fragmentation

Fragmentation is the process where habitats that were once continuous become divided into separate fragments isolated from each other by non-forest land (Primack 1993, Fahrig 2003, Lindenmayer and Fischer 2006). This process, together with habitat loss, is a major cause of biodiversity loss and a threat to native species (Rand et al. 2006, Laurance et al. 2007).

The proposed works involve removal and/or modification of native vegetation that is already highly fragmented, and although some areas of vegetation will be removed, the project will not increase fragmentation relative to current levels. The most significant existing patches of native vegetation will be retained in the retention area. Accordingly, the existing "stepping stone" connectivity that currently exists between patches of native vegetation that occur in a predominantly cleared landscape will be retained, and the proposed development works will not result in any fragmentation native vegetation.

5. Avoidance, Mitigation and Offset Measures

This chapter provides information on specific and enforceable measures proposed to avoid, mitigate and offset each identified impact from the proposed action on MNES TECs and the Brown Treecreeper. This includes avoiding impacts by changing the layout to avoid areas of TEC and threatened species habitat, preparing and implementing relevant management plans, conserving areas of TEC and habitat, and retiring biodiversity credits. Since the submission of the original Preliminary Documentation, the DCCEEW requested further discussion of any measures specific to the Brown Treecreeper, and identification of whether any updated measures to avoid or mitigate impacts to this species have been identified. No updated measures for further avoidance have been identified; however, it is now proposed that 25% of all nest boxes to be installed in order to mitigate/offset the loss of hollow-bearing trees will be nest boxes specifically designed for occupation by the Brown Treecreeper. This section has been revised to clarify the mitigation measures proposed specific to the Brown Treecreeper, including the new commitment to install nest boxes specifically designed for the Brown Treecreeper, as well as provide further explanation of the extensive habitat restoration measures proposed (and have been commenced) that are likely to benefit the Brown Treecreeper in the long-term.

At the end of this chapter, sections are provided which identify the Development Consent Conditions that have been issued by Council for the project (***Section 5.4***) and demonstrate that the project is compliant. ***Section 5.5*** identifies the commitments of the CPCP and provides evidence that the project is compliant where relevant.

5.1. Avoidance Measures

5.1.1. Changes to the Layout

Avoidance of ecological impacts has been achieved through a lengthy iterative design process in consultation with Council and NSW Government including during:

- The original rezoning of Menangle Park in 2017;
- The preparation and finalisation of the Planning Proposal in 2020 to revise the location of Menangle Park Centre; and
- The preparation and assessment of the BEW DA by the NSW Government.

This has resulted in significant changes to the layout of the proposed action to avoid impacts on areas of high conservation value including the following:

- Changes to the location of Spine Road and the proposed school site and town centre to avoid areas of EBSF and habitat for the Brown Treecreeper;
- The creation of Parks K and L to conserve EBSF and RFEF and habitat for the Brown Treecreeper; and
- Substantial reductions to the footprint of the action.

A number of initiatives have been implemented to avoid impacts to MNES, most significantly being realigning the Spine Road to avoid EBSF and RFEF and creating two new parks, Park K and Park L to retain and conserve high quality examples of EBSF and adjoining RFEF (Park L only) that were previously zoned residential/school and which had been identified to be removed under the 2017 rezoning. These areas also provide some of the highest quality habitat in the project area for the Brown Treecreeper.

The Spine Road was relocated to avoid an area of EBSF and facilitated the creation of Park L for conservation. Park L is approximately 1.66 ha, comprising 0.49 ha in conservation zoning including RFEF retention, EBSF retention/ revegetation and 1.17 ha of open space in a RE1 recreation zoning. The school was relocated as its previous location conflicted with EBSF that is subsequently now identified for conservation within Park K. Park K is approximately 3.44 ha, comprising 2.13 ha in conservation zoning including EBSF retention/ revegetation and 1.31 ha of open space in a RE1 recreation zoning. Furthermore, Park K has been modified to provide a buffer around the entire area that ranges from 29 m at its nearest point and 60 m at its furthest point to better protect EBSF.

Through implementing the above initiatives, the project has avoided impacts to significant areas of EBSF compared to the original rezoning, with the avoidance of 1.72 ha of ESBF, and commitments to revegetate 0.56 ha of ESBF, resulting in a total increase of 2.28 ha of ESBF to be retained compared to the original 2017 zoning of the project area. As this community also provides habitat for the Brown Treecreeper, these amendments have resulted in an increase in the area of habitat for this species that will be retained and created in the project area. In addition, the footprint of the proposed development works has been substantially reduced and revised design of developable areas has been undertaken to maximise the avoidance of MNES.

5.1.2. MNES Removal Rationale

5.1.2.1. Rationale for Removing TECs

Table 6 below provides a rationale for the removal of all patches of MNES TECs proposed within the project area. **Figures 11** – **15** show each patch(es) of TEC overlayed with the current zoning illustrating the areas to be removed and retained.

Table 6 MNES removal rationale

Patch ID	MNES TEC	Impact Area (ha)	Retention Area (ha)	Impact Rational	Figure
C42	CPW	0.21	4.73	Moderate condition example of the MNES.A small area of the MNES to be removed is within a future section of the Spring Farm Parkway alignment. The alignment cannot be changed. A small area of the MNES to be removed is within areas zoned for future development as per the Master Plan. MNES to be removed forms the peripherals of a larger patch of the MNES to be retained and the majority of the patch will be retained.	11
C39	CPW	0.81	0.72	Moderate condition example of the MNES. A small area of the MNES to be removed is within a future section of the Spring Farm Parkway alignment. The alignment cannot be changed. The western area of the MNES to be removed is within areas zoned for future development as per the Master Plan. The areas of MNES to be removed forms the peripherals of a larger patch of the MNES to be retained and will not result in isolation or fragmentation of the community. Further to	11

Patch ID	MNES TEC	Impact Area (ha)	Retention Area (ha)	Impact Rational	Figure
				this, grassland areas between this patch and patch C42 to the north will be revegetated under a VMP to improve connectivity.	
C30	CPW	1.73	0	Moderate condition example of the MNES. The entire patch of this MNES is proposed to be cleared. This patch is within an area zoned for development as per the Master Plan. MNES present is an isolated patch with no connectivity to additional areas of habitat.	12
C12	CPW	1.87	0	Moderate condition example of the MNES. The entire patch of this MNES is proposed to be cleared. This patch is within a location designated to be a public school. The proponent is required to include a State Primary School within the Master Plan under an executed State VPA between Dahua and NSW Government. The school was originally planned to be within Park K, but following negotiations with Council and the NSW Government it was relocated to Patch C12 as part of the Planning Proposal to facilitate the conservation of EBSF within Park K. The MNES present is an isolated patch with no connectivity to additional areas of habitat.	15
R7	RFEF	0.11	2.25	Moderate condition example of the MNES. A small area of this patch will be cleared that forms the peripherals of a larger patch of the MNES to be retained. The small areas to be removed are either within contaminated lands that require remediation or are within the Spine Road, road reserve. The alignment of the road reserve cannot be amended as it aligns with the already constructed Spring Farm Parkway to the north. The majority of this patch of MNES will be retained.	13
R5	RFEF	0.27	0.34	Moderate condition example of the MNES. A small area of this patch will be cleared that forms the peripherals of a larger patch of the MNES to be retained. The area of this patch of MNES to be cleared is within location of Spine Road, which cannot be amended as it aligns with the already constructed Spring Farm Park Way further to the north. The Spine Road location was previously moved as far east as possible to facilitate the creation of Park L and the retention of the EBSF MNES present.	14
E2	EBSF	0.03	0	Poor condition example of the MNES comprised of scattered trees over exotic dominated grassland. This patch is within an area zoned for development as per the Master Plan.	13

Patch ID	MNES TEC	Impact Area (ha)	Retention Area (ha)	Impact Rational	Figure
E3	EBSF	0.07	0	Poor condition example of the MNES comprised of scattered trees over exotic dominated grassland. This patch is within an area zoned for development as per the Master Plan.	13
E4	EBSF	0.02	1.29	Good condition example of the MNES. Comprised of canopy, shrubs and native groundcovers. A very small area of this patch is within contaminated land that requires remediation to remove human health risks. The area to be removed forms the edge of the largest patch of EBSF present within the project area. All areas of the patch to be removed within Park K will be replanted under a VMP.	13
E5	EBSF	0.56	0	Patch E5 is the second largest patch of EBSF in the project area and is considered to be in relatively good condition. However, this patch is within contaminated land that requires remediation to remove human health risks. This patch is within designated to be a town centre as negotiated with Council and consistent with the Master Plan.	13
E6	EBSF	0.09	0	Patch E6 is comprise of scattered canopy trees over exotic dominated grasslands and is in poor condition. This patch is within contaminated land that requires remediation to remove human health risks and is within an area zoned for development as per the Master Plan.	13

5.1.2.2. Rationale for Removing Brown Treecreeper Habitat

Figure 8 shows the extent of all Brown Treecreeper habitat proposed to be retained and removed within the project area. Each patch of Brown Treecreeper habitat has been assigned a unique identifier and **Table 7** below provides the total area of each patch proposed to be removed, as well as a rationale for the removal of Brown Treecreeper habitat proposed within the project area. As many patches are very small, and in many instances comprise a single tree or shrubby regrowth that does not comprise a TEC, in some instances, several adjacent smaller patches have been amalgamated into a larger patch as can be seen on **Figure 8**. Two areas of Brown Treecreeper habitat proposed to be removed are with contaminated lands requiring remediation. The extent of the vegetation removal within these areas will be confirmed once remediation works have commenced. If during remediation works it is determined that the vegetation can be retained, it will be retained. If the vegetation within these areas must be removed, the areas will be replanted with native vegetation as required by the project's VMPs. These areas are identified on **Figure 8**.

Appendix H includes further details of each patch of Brown Treecreeper habitat proposed to be removed, including engineering plans demonstrating why further avoidance cannot be achieved.

Table 7 Brown Treecreeper habitat removal rationale

Patch ID	Area Removed (ha)	Impact Rational
T1	1.83	Moderate condition example of habitat. The patch is isolated with minimal connectivity to additional areas of habitat. The entire patch of habitat is proposed to be cleared. This patch is within a location designated to be a public school. The proponent is required to include a State Primary School within the Master Plan under an executed State VPA between Dahua and NSW Government. The school was originally planned to be within Park K, but following negotiations with Council and the NSW Government it was relocated to Patch C12 as part of the Planning Proposal to facilitate the conservation of EBSF within Park K. Furthermore, there are steep existing grades that require substantial cut and regrading.
T2	3.35 (2.87 woodland + 0.49 scattered shrubby regrowth)	The 2.87 ha of woodland is a moderate condition example of habitat, while the 0.49 ha of nearby patches of shrubby regrowth are a poor condition example of habitat. The entire patch of habitat is proposed to be cleared. This area is required to be cleared as there are steep existing grades that require regrading and between 1-4 m cut to make it level.
T3	1.02 (0.92 forest + 0.10 scattered shrubby regrowth)	The 0.92 ha of forest is a moderate condition example of habitat, while the 0.10 ha of nearby patches of shrubby regrowth are a poor condition example of habitat. A small area of this patch will be cleared that forms the peripherals of a larger patch of habitat to be retained. The area of this patch of habitat to be cleared is within the Spine Road, which cannot be amended as it aligns with the already constructed Spring Farm Park Way further to the north. The Spine Road location was previously moved as far east as possible to facilitate the creation of Park L and the retention of the EBSF MNES present.
T4	1.34	This patch consists of several very small patches in low condition. The entirety of these patches are proposed to be cleared as there are currently steep existing grades that require regrading.
T5	0.02	This is a good quality patch of habitat in the south-east of the project area. A very small area (0.02 ha) of this habitat is proposed to be removed for remediation purposes and will be replanted and managed under a VMP for Park K. All other areas are not proposed to be removed and will be retained and managed for conservation under a VMP.
T6	0.64	Good condition example of habitat. Comprised of canopy, shrubs and native groundcovers. The area to be removed forms the edge of a larger patch of habitat that is proposed to be retained and managed under a VMP. This area is required to be cleared to allow for fill on perimeter roads to remain above flood level.
T7	1.73 (0.94 habitat permanently removed + 0.79 habitat removed and replanted or	T7 forms the peripherals of a larger patch of relatively good condition habitat. Vegetation removal is proposed as the patch is within contaminated land that requires remediation to remove human health risks. The soil will be tested and if it is contaminated, the trees will be

Patch ID	Area Removed (ha)	Impact Rational
	retained)	removed. Following remediation works, the area will be replanted with native vegetation and managed under a VMP. Therefore the proposed 1.73 ha removal of T7 is a worst-case scenario as vegetation may be able to be retained and will be replanted if removal is required.
T8	0.84	T8 includes the second largest patch of EBSF in the project area, as well as scattered patches of nearby habitat. T8 is considered to be in relatively good condition. However, this patch is within contaminated land that requires remediation to remove human health risks. This patch is within designated to be a town centre as negotiated with Council and consistent with the Master Plan.
T9	0	This is a moderate quality patch of habitat adjacent to the Howes Creek corridor. This area is not proposed to be removed and will be retained and managed for conservation under a VMP.
T10	0.15	Relatively good condition example of habitat. A small area of this patch will be cleared that forms the peripherals of a larger patch of habitat to be retained.. The alignment of the road reserve cannot be amended as it aligns with the already constructed Spring Farm Parkway to the north. The majority of this patch of habitat will be retained.
T11	0.17	Poor condition example of habitat comprised of scattered trees over exotic dominated grassland. Steep existing grades in this area require regrading. The lots/road require a 3-4 m cut. Levels will be dictated by provision of water quality basin and restriction of batter lengths to avoid encroachment to TfNSW land.
T12	0.45	Moderate condition example of habitat, comprising a cluster of trees on the edge of the project area. This area is required to be cleared due to the presence of steep existing grades (10%) that require regrading. The lots/road require a 3-4 m cut.
T13	0.33	Poor condition example of habitat comprised of scattered trees over exotic dominated grassland. This area is required to be cleared due to the presence of steep existing grades up to 20% that require regrading. The roads/lots will require up to 3-4 m fill.
T14	0.52	Moderate condition example of habitat. The entire patch of habitat is proposed to be cleared. This area is proposed to be cleared as regrading is required for water quality basin and trunk drainage. Fill required for residential areas to be above flood levels is between 2-4 m.
T15	0.11	Poor condition example of habitat comprised of scattered trees over exotic dominated grassland. This area is proposed to be cleared as steep grades require fill and the construction of retaining walls.
T16	1.73	Moderate condition example of habitat. The entire patch of habitat is proposed to be cleared. This patch is within an area zoned for development as per the Master Plan. It is an isolated patch with no connectivity to additional areas of habitat.

Patch ID	Area Removed (ha)	Impact Rational
T17	0.59	Poor condition example of habitat comprised of scattered trees over exotic dominated grassland. This area is proposed to be cleared as the trees occur in an existing depression/creekline that is to be filled. Site regrading is required to allow trunk drainage along Spine Rd. Steep existing grades require regrading and the construction of retaining walls for residential lots.
T18	0.04	Poor condition example of habitat comprised of a very small patch of trees over exotic dominated grassland. This area is proposed to be cleared to facilitate the widening of Glenlee Road from 10 m to 20.4 m collector road. In this area there are steep existing grades requiring regrading.
T19	0	This is a good quality patch of habitat in the Howes Creek corridor. This area is not proposed to be removed and will be retained and managed for conservation under a VMP.
T20	0	This is a good quality patch of habitat adjacent to the Nepean River in the west of the project area. This area is not proposed to be removed and will be retained and managed for conservation under a VMP.
T21	0.92	Moderate condition example of habitat. Some of this patch is to be removed as it is within a future section of the Spring Farm Parkway alignment. TfNSW are responsible for delivering Spring Farm Parkway and the proponent will not be doing any clearing in TfNSW land. The alignment cannot be changed. The western area of the habitat to be removed is within areas proposed for Employment land where the lots are required to be flat. Existing grades at 4% will require regrading. The areas of habitat to be removed forms part of a larger patch of habitat to be retained and will not result in isolation or fragmentation of habitat. Further to this, grassland areas between this patch and the patch to the north will be revegetated under a VMP to improve connectivity.
T22	0.29	Moderate condition example of habitat. This area is required to be removed as it is within proposed Employment land where the lots are required to be flat. Existing grades at 4% will require regrading.
T23	0.21	Moderate condition example of habitat. The majority of this patch is in the Northern Conservation Area and will be retained. A small area of this patch to be removed is within a future section of the Spring Farm Parkway alignment. The alignment cannot be changed. A small area of the habitat to be removed is within areas zoned for future development as per the Master Plan. Habitat to be removed forms the peripherals of a larger patch of habitat to be retained and the majority of the patch will be retained.
T24	0.30	Poor condition example of habitat comprised of scattered trees over exotic dominated grassland. This area is required to be removed as it is within proposed Employment land where the lots are required to be flat. Existing grades at 4% will require regrading.

Patch ID	Area Removed (ha)	Impact Rational
Total	**16.59***	

**Includes 0.81 ha of habitat that will either be retained, or replanted following removal associated with remediation works. Total may not exactly match sum of all areas as a result of rounding.*

5.1.3. Ecological Buffers

This section provided details of the buffers that are proposed to be implemented around retained areas of MNES TECs in the project area to minimise indirect impacts on retained vegetation. Although the focus of this section is on the areas of TECs, it should be noted that each TEC comprises a native vegetation community that has potential to provide habitat for the Brown Treecreeper. Accordingly, the buffers around the TECs will directly benefit this species through minimising impacts on areas of retained habitat. Each TEC is considered individually in subsections below.

5.1.3.1. Cumberland Plain Woodland

Review of the EPBC Act Conservation Advice (Threatened Species Scientific Committee 2008a), the EPBC Act Listing Advice (Threatened Species Scientific Committee 2008b) and the EPBC Act Policy Statement (DEWHA 2010a) for this community indicates no requirement or recommendation for the provision of buffers around conserved examples of this community. All areas of CPW MNES to be retained have not had a buffer applied. Nevertheless, all areas of CPW to be retained will be managed under a VMP, which includes detailed management actions to minimise indirect impacts on retained vegetation. This includes the installation of fencing to restrict access, ongoing weed management and plantings, as well as feral animal monitoring and associated controls (where required). Therefore, in the absence of buffers, the implemented VMPs are considered appropriate to ensure the long-term viability and improved condition of all retained CPW MNES within the project area. This will also benefit the Brown Treecreeper through ensuring the long term viability of suitable habitat in the project area.

5.1.3.2. River Flat Eucalypt Forest

The EPBC Act Conservation Advice (TSSC 2020) for this community recommends the implementation of buffers around areas of RFEF that are being retained in a development area. The application of buffer zones, particularly areas of other native vegetation around remnants of RFEF to minimise adverse off-site impacts is included as one of the Priority conservation and research actions. The Conservation Advice notes that the buffer zone must encompass an area large enough to protect the root zone of the outermost trees from damage and edge effects. No specifications are provided regarding the size of the buffers required, and it states that judgement should be exercised to determine an appropriate buffer distance, depending on circumstances and how a patch may be detrimentally impacted.

RFEF MNES to be retained within the project area are located within Park L and Howes Creek Riparian Corridor conservation areas. During design of the Master Plan, buffers to these conservation areas were applied to the furthest extent possible, with consideration of the overall Master Plan. The buffer zones applied to these areas have been zoned as either RE1: Public Recreation or C2: Environmental Conservation. Areas zoned as RE1 will be impacted to some degree as part of a DA(s); however, no substantial construction of permanent

dwelling/structures will occur in such areas, consistent with the zoning's objectives. As such, RE1 zoned areas surrounding MNES to be retained will serve as a buffer to this retained habitat. Areas zoned As C2 will not be directly impacted as the sole purpose of this zoning is for environmental conservation purposes. Therefore, any areas of C2 zoned land adjacent to retained MNES will act as a buffer to future development and associated indirect impacts.

Figures 16 and **18** illustrate the buffers applied to this MNES within the conservation areas. As shown in **Figure 16**, RFEF MNES within the Howes Creek Conservation Area have a varying degree of buffers applied, ranging from 10m along the eastern extent of the MNES and 324 m along the western extent of the MNES. These buffers are considered to provide adequate space between future development and the outermost root zones of any remnant trees.

As shown in **Figure 18**, RFEF MNES within the Park L Conservation Area have a varying degree of buffers applied, ranging from 10m along the eastern and northern extents, approximately 25 m along the western extent and greater than 70 m along the southern extent. These buffers are considered to provide adequate space between future development and the outermost root zones of any remnant trees.

In addition to the buffers, all areas of RFEF MNES to be retained will be managed under a VMP. The management actions associated with each VMP alone is considered adequate to ensure the long-term survival of the MNES with an improved condition in the long-term. The buffers applied further ensure their long-term viability in the project area as well as the long-term viability of suitable habitat for the Brown Treecreeper.

5.1.3.3. Elderslie Banksia Scrub Forest

The EPBC Act Conservation Advice (DAWE 2020) for this community recommends the implementation of buffers around areas of EBSF that are being retained in a development area. The application of buffer zones, particularly areas of other native vegetation around remnants of ESBF to minimise adverse off-site impacts is included as one of the Priority conservation and research actions. The Conservation Advice states that the recommended minimum buffer zone is 30 m from the outer edge of the patch as this distance accounts for likely influences upon the root zone. Activities that damage vegetation or habitat should not occur in this area. Where it is not feasible to apply a wide buffer, the Conservation Advice (DAWE 2020) states that other means should be used to minimise impacts of activities in the vicinity of patches (for example by moderating the use of pesticides, herbicides and fertilisers or sprinklers or applying them using more closely controlled methods and in consultation with ecological experts).

Where possible, buffers have been applied to all areas of EBSF MNES to be retained in order to protect the community and the habitat for the Brown Treecreeper that is provides.

During design of the Master Plan, buffers to the Parks K and L Conservation Areas were applied to the furthest extent possible, with consideration of the overall Master Plan. The buffer zones applied to these areas have been zoned as either RE1: Public Recreation or C2: Environmental Conservation. Areas zoned as RE1 will be impacted to some degree as part of a DA(s); however, no substantial construction of permanent dwelling/structures will occur in such areas, consistent with the zoning's objectives. As such, RE1 zoned areas surrounding MNES to be retained will serve as a buffer to this retained habitat. Areas zoned As C2 will not be directly impacted as the sole purpose of this zoning is for environmental conservation purposes. Therefore,

any areas of C2 zoned land adjacent to retained MNES will act as a buffer to future development and associated indirect impacts.

Figures 17 and **18** illustrate the buffers applied to this MNES within the Parks K and L Conservation Areas. As shown in **Figure 17**, EBSF MNES within the Park K conservation area have a varying degree of buffers applied, ranging from 29-34 m along the northern extent of the MNES, 31-44 along the western extent, 45 m along the southern extent and 31-41 m along the western extent of the MNES. Although the applied buffers are less than the 30 m recommended in the Conservation Advice, other 'means' have been applied to the retained MNES, being the implementation of a VMP in perpetuity. Further to this, although the applied buffers are slightly less than the recommended 30 m, the implementation of a buffer with a minimum distance of 29m is considered to provide adequate space between future development and the outermost root zones of any remnant trees.

As shown in **Figure 18**, EBSF MNES within the Park L conservation area have a varying degree of buffers applied, ranging from approximately 8-31 m along the western extents, approximately 33 m along the northern extent, no less than 31 m along the eastern extent and greater than 71 m along the southern extent. These buffers are considered to provide adequate space between future development and the outermost root zones of any remnant trees. The closest encroachment on retained EBSF MNES within Park L is located along the northwestern extent (see **Figure 18**). Development associated with a temporary drainage basin along the western extent has been previously carried out under a separate approval. As part of that approval, quarterly monitoring of the retained EBSF was carried out as a condition of consent to ensure the development had no indirect impacts on the retained EBSF within Park L. The quarterly monitoring concluded that the retained EBSF was not impacted. Further to this, the 8 m buffer appropriately avoided any impacts to root zones as no trees were observed to die-back during the monitoring. The final monitoring report is located in **Appendix D**.

EBSF within the Stage 6B conservation area is not currently zoned as either RE1 or C2 as is the case for Parks K and L, and is instead currently zoned for medium density residential development. The EBSF within the Stage 6B conservation area was not originally intended to be retained and therefore was not included in the rezoning under the Master Plan. The EBSF present within the Stage 6B conservation area was eventually proposed to be retained following negotiations with Council and the State.

The intention of the proponent for the Stage 6B conservation area and surrounding area is to dedicate the land to Council who will rezone the Stage 6B conservation area to C2: Environmental Conservation and the surrounding land as RE1: Public Recreation. As shown in **Figure 19**, EBSF MNES within the Stage 6B conservation area have a varying degree of buffers applied, ranging from greater than 30 m along the northern extent, approximately 27-45 m along the eastern extent, approximately 2-11 m along the southern extent and approximately 5-13 m along the western extent. 30 m buffers along the southern and western extents of the EBSF cannot be achieved due to the existing Fitzpatrick Street to the south and private land holding to the west. A 30 m buffer along the eastern extent is achieved for the largest patch of EBSF present, with a 27 m buffer achieved for the smaller patch of EBSF present. Although a 30m buffer isn't met for all areas of EBSF along the eastern extent, the adjoining land is proposed to be a shared access path under the Master Plan.

Although the 30 m recommended buffer included in the Conservation Advice is not met for all edges of the extant EBSF, it is not achievable due to the aforementioned reasons. Nevertheless, other 'means' have been applied to the retained MNES, being the implementation of a VMP in perpetuity. Further to this, although the

applied buffers are less than the recommended 30 m in areas, the proposed buffers are considered to provide adequate space between future development and the outermost root zones of any remnant trees. This is demonstrated by the fact that EBSF is persisting within very close proximity of Fitzpatrick Street to the south.

In addition to the buffers, all areas of EBSF MNES to be retained will be managed under a VMP. The management actions associated with each VMP alone is considered adequate to ensure the long-term survival of the MNES with an improved condition in the long-term. The buffers applied further ensure their long-term viability in the project area as well as the long-term viability of suitable habitat for the Brown Treecreeper.

5.2. Mitigation Measures

This section provides details of the mitigation measures that have been developed for the proposed action to mitigate the impacts that are unable to be avoided. Potential impacts to flora and fauna occurring in the construction phase and which can be managed include, but are not limited to runoff, sedimentation, erosion, spread of weeds and pollution. Sediment control and reduction measures will be implemented to reduce sediment runoff into adjacent habitat to be retained in the conservation areas and within the waterways present in the MPURA. Adjacent communities of particular importance includes CPW, EBSF and RFEF to be retained and the associated habitat for the Brown Treecreeper that they provide.

One of the key mitigation measures for the proposed action is the preparation of a CEMP for the proposed development works to provide management guidelines to minimise impacts on the environment, including biodiversity values (see ***Section 5.2.1***). Ameliorative measures included in the CEMP will include pre- and during-construction mitigation measures including pre-clearance surveys to check for any nesting or roosting fauna, in particular the Brown Treecreeper, and moving any recorded individuals to the closest areas of habitat to be retained. During development, precautions will be taken to ensure that no pollution escapes the construction site, Pollution traps and regular removal of pollution to an offsite location will assist to minimise pollution impacts. A Waste Management Plan will be developed to mitigate waste and pollution entering the surrounding development.

In addition to the measures included in the CEMP, long-term management strategies, and compensation measures will also be implemented. Compensation measures for the proposed action include the following:

- Purchase and retirement of biodiversity credits for all native vegetation within the project area;
- Implementation of 20-year VMPs for the TECs occurring within Parks K and L, the Howes Creek and Northern Conservation Areas, and the Stage 6B EBSF Conservation Area - Cumberland Plain Woodland, River-flat Eucalypt Forest, and EBSF.

Further information about the proposed compensation measures is provided in ***Section 5.3***.

5.2.1. Construction Environment Management Plan

A CEMP will be developed by the contractor engaged to do the construction works to provide management guidelines to minimise impacts on the environment, including biodiversity values. The production of the CEMP is anticipated to become a condition of consent for the DA that will require approval by Council prior to issuing a construction certificate for the DA. The CEMP will include the following details at a minimum:

- Measures to delineate clearing areas and protect native vegetation that is to be retained, including EBSF directly north of the project area;
- Pre-clearance and clearance survey requirements;
- Measures to prevent the spread of priority and environmental weeds and *Phytophthora cinnamonii*;
- Required Sediment and Erosion Control Measures/stockpile management as per Managing Urban Stormwater: Soils and Construction (Landcom, 2004) - The Blue Book;
- Noise control measures;
- Air quality control measures (dust);
- Hazardous material management protocols (i.e. fuel etc) addressing storage, use, refilling etc;
- Incident and emergency response protocols;
- Competence, training and awareness procedures (i.e. Environmental inductions, Toolbox talks, training and awareness);
- Roles and responsibilities for implementing, monitoring and reviewing CEMP requirements;
- An overview of relevant Environmental management documentation;
- Waste Management procedures as per the submitted Waste Management Plan; and
- Inspection, monitoring and auditing requirements for all environmental controls and adaptive management to ensure environmental mitigation measures remain effective.

The measures relevant to biodiversity are discussed in more detail below.

5.2.1.1. Vegetation Clearance and Fauna Management Protocols

i. Inductions/ Toolbox Talks

Prior to undertaking any works within the project area, inductions are to be given by the civil contractor to ensure all site workers and visitors are aware of any no-access areas. The inductions should also include details of the adjoining vegetation present (e.g. types and listing status), potential fauna species present such as the Brown Treecreeper, as well as any penalties (e.g. termination of employment) associated with damaging such areas. In addition to the site inductions, daily toolbox talks will be provided by the civil contractor that reiterate the above to all site workers.

ii. Delineation of Clearing Areas

To avoid unnecessary removal or damage to native vegetation to be retained adjacent to the project area, the clearing area will be clearly demarcated and signed, where appropriate, to ensure no vegetation beyond these boundaries is removed. In areas adjacent to woodland/forest located outside of the project area (i.e. extent of clearing), temporary fencing and signage will be installed to provide a physical barrier between machinery and nearby vegetation to be retained. Furthermore, any tree protection fencing recommended by the project

arborist will also be installed, where required. Fencing is required to be installed prior to the commencement of any works.

No machinery will be parked on areas beyond the temporary fencing and no access will be allowed during construction. Ancillary facilities such as stockpile sites, site compounds and construction zones must be located within the limits of clearing or within lands approved to be cleared under a previously approved DA. Access to and from the project area will only be from existing roads, or areas subject to an approved DA.

iii. Clearance Timing

Clearing of vegetation will be timed to avoid key lifecycle stages, such as breeding periods, of the likely affected species that have the potential to roost within the project area, including woodland birds such as the Brown Treecreeper and microbat species. A pre-clearance survey by a qualified ecologist will be undertaken within two weeks prior to the clearing of vegetation within the project area, and should any threatened species be identified as breeding within the clearance areas then clearing will be timed to avoid the specified breeding periods for those species.

Clearing will preferably be undertaken during late autumn or early winter, as these times are the least likely to coincide with the breeding periods of the likely affected species with the potential to breed within the project area. However, if microbats are found to be roosting on site during the pre-clearance survey, clearance would occur in warmer months (spring, summer and autumn) and no clearance will occur in winter (i.e. June, July, August) when bats are inactive and in torpor.

iv. Pre-clearance Surveys and Clearance Supervision

Pre-clearance surveys and clearance supervision will be conducted in the project area as detailed below.

a. Pre-clearance Surveys

Prior to the commencement of any works, fauna pre-clearance surveys must be undertaken by a suitably qualified ecologist to avoid impacts to any individuals that may be present. Pre-clearance surveys will include the following:

- Detect any roosting and/or nesting threatened and non-threatened fauna;
- Be carried out within two weeks prior to native vegetation being cleared;
- Include targeted surveys for microchiropteran bats using harp traps for a minimum of four nights without heavy rain, with the age, sex and reproductive status of captured bats being assessed and recorded;
- Include roost searches for microchiropteran bats by using a torch to shine in holes, cracks and crevices, and by using a handheld bat detector to locate and identify bats that may call;
- Include spotlighting, stag watching and hollow watching on the evening before the woodland vegetation will be cleared, for a minimum of one hour prior to dusk, and for at least one hour after dusk;
- Include roost watches using bat detectors undertaken prior to the demolition of existing buildings;
- Safely relocate non-threatened fauna to nearby woodlands before vegetation is cleared;

- Preparation of a detailed Threatened Species Relocation Plan (TSRP), if threatened species such as the Brown Treecreeper are roosting and/or nesting in any habitat to be removed; and
- Include the demarcation of all hollow-bearing trees and fallen logs (with the latter being >10cm diameter), along with any other key habitat features.

In addition, surveys for environmental weeds will be undertaken within the project area in order to identify weed infestations to ensure they are dealt with appropriately (e.g. not reused as mulch). Any additional weed control requirements will be incorporated into a pre-clearance assessment letter (as required).

Upon the completion of preclearance surveys a report outlining all of the preclearance surveys carried out, including survey effort, results and outcomes must be submitted to Council's Executive Manager Urban Release and Engagement (or equivalent).

If threatened species such as the Brown Treecreeper are roosting and/or nesting in any habitat to be removed, a detailed threatened species relocation plan must be developed and submitted to Council's Executive Manager Urban Release and Engagement (or equivalent). This plan must be approved in writing by Council's Executive Manger Urban Release and Engagement (or equivalent) prior to the issuing of a construction certificate or the commencement of any on ground works.

As part of the preclearance survey work, and following clearing, an appropriately qualified ecologist must identify any trees and logs or parts thereof, that would be appropriate for use as fauna habitat within the proposed conservation areas. Where relevant, specifications for felling/removal (to enable retention of features for fauna habitat) must also be specified.

b. Clearance Supervision

To minimise impacts to native fauna species, clearing must be undertaken in the following two staged process under the supervision of a suitably qualified ecologist:

- The initial phase of clearing will involve clearing around the habitat features demarcated in a) i) above and leaving these habitat features overnight to encourage any resident fauna to self-relocate; and
- The second stage will involve clearing of the habitat features left overnight followed by an inspection. Prior to felling, habitat trees will be nudged using an excavator to promote any resident fauna to self-relocate. No habitat tree is to be felled without the attending ecologist providing approval to the excavator/machine operator.

During any vegetation clearing, no habitat tree is to be felled without the attending ecologist providing approval to the excavator/machine operator. Any confirmed microchiropteran bat roost trees identified during the targeted microchiropteran bat surveys undertaken as part of the pre-clearance surveys will be removed carefully in sections under ecologist supervision to minimise harm to roosting individuals. Where possible, any confirmed microchiropteran bat roost trees will be removed last so that they are isolated as long as possible to encourage bats to self-relocate.

All fallen trees should be investigated by the attending project ecologist for the presence of hollows not detected prior to clearing. Inspections should be undertaken of these hollows for native fauna, in particular

bats and the Brown Treecreeper. Any bats recovered from felled trees will be captured and identified by the attending ecologist and will be kept in a calico bag in a dark, quiet place until nightfall and then relocated according to the TSRP. To minimise impacts to microchiropteran bat species, the demolition of existing buildings identified as potential habitat during pre-clearance surveys will be supervised by an ecologist.

Provisions to protect any native fauna encountered during clearing activities are to include:

- Briefing all people involved in the clearing works about the possibility of fauna being present;
- Any animals disturbed or dislodged during clearance but not injured should be assisted to move into the adjacent bushland or other specified locations; and
- If any animals are injured during vegetation clearance, appropriate steps must be taken to humanely treat the animal under the advice of the attending ecologist (either taken to the nearest veterinary clinic for treatment, or if the animal is unlikely to survive taken to the vet to be humanely euthanized).

Salvaged material suitable for use in proposed conservation areas as per above must be stockpiled in an appropriate place with appropriate signage, to ensure it can be reused at a later date. A report outlining how salvaged material has been/will be reused must be prepared and submitted to Council's Executive Manager Urban Release and Engagement (or equivalent) prior to the principal certifying authority issuing an occupation (Final compliance) certificate.

It is recommended that the removal of hollow-bearing trees not be undertaken during the colder winter months (June to August) when microchiropteran bats may be in torpor and are less likely to successfully relocate during clearing activities, and when the Brown Treecreeper is unlikely to be using hollows for nesting.

v. Hollow Offset Replacement Strategy

Among other species, the Brown Treecreeper is known to utilise hollows for breeding, and a hollow-offset replacement strategy will be developed that outlines the number and type of nest boxes/salvaged hollows required to be installed within retained areas to appropriately offset the removal of hollow-bearing trees. The hollow-offset replacement strategy will also include details regarding on-going monitoring requirements.

A total of 49 hollow-bearing trees and 175 tree hollows are to be removed by the proposed development works. Section 11.2.2 of the *Campbelltown (Sustainable City) DCP 2015* as well as the draft Conditions of Consent identify a 2:1 replacement ratio of nest boxes/salvaged hollows to the number of hollows removed. Accordingly, 372 nest boxes/salvaged hollows are required and will be installed to meet the DCP's offset ratio. In order to meet the commitment of 25% of the nest boxes being installed being designed specifically for the Brown Treecreeper, a total of 93 Brown Treecreeper nest boxes will be installed within the conservation area. It is noted that a total of 123 nest boxes have already been installed within areas of vegetation to be retained, which includes a total of six nest boxes designed specifically for the Brown Treecreeper. Therefore, an additional 87 Brown Treecreeper nest boxes will be installed.

Areas of vegetation where nest boxes/salvaged hollows can be installed include areas proposed to be conserved under a VMP (i.e. Howes Creek, Parks K and L, Northern and Stage 6B Conservation Areas). These areas are known to provide suitable habitat for the Brown Treecreeper and the placement of nest

boxes/salvaged hollows in these areas will ensure that these important components of breeding habitat for the species are available in areas of protected habitat. A preference for the salvage of hollows over nest boxes is recommended and will be included in the hollow-offset replacement strategy.

The BEW DA nest box replacement works will be monitored for five years, consistent with the terms granted for other approved DAs in the MPURA. Such mitigation works will be part of an overall hollow offset replacement strategy.

vi. Weed Management

Woody weeds including African Olive and Privet are prevalent across the woodland/forest of the project area, and in the locality. When unmanaged, these weeds dominate woodland/forest patches and exclude smaller native plants, particularly ground stratum. They are a major threat to Brown Treecreeper habitat and will be removed from conservation areas in the long term. The removal of woody weeds will increase the diversity of grassy ground cover within the conservation areas and will therefore increase the potential of such areas to be used by the Brown Treecreeper. The conservation reserves will be managed in perpetuity and are of a large enough scale to provide substantial habitat for the treecreeper because the Howes Creek conservation area connects to woodland along the Nepean River, while the Northern conservation area is adjacent to the Mt Annan Botanic Gardens where large areas of African Olive have been removed to provide for the restoration of Cumberland Plain Woodland.

To minimise the spread of weeds throughout the project area and into adjoining areas, appropriate weed control activities will be undertaken. This will mitigate one of the key risks to the survival and integrity of native vegetation communities and the habitat they provide to native fauna species, including the Brown Treecreeper.

Prior to construction, environmental weeds present in the project area will be identified during pre-clearing surveys. Due to the known presence of priority weeds occurring in high abundances within the project area, no vegetation removed should be re-used as mulch within the site or offsite. Dense infestations of weeds reduce the suitability of habitat for the Brown Treecreeper that prefers a more open vegetation structure, and therefore any areas of dense environmental weeds recorded during pre-clearing surveys will be removed and disposed of according to the following protocols:

- Areas of dense environmental weeds will not be mulched on-site, but will be removed;
- All weed material will be taken to an appropriate waste facility; and
- All weed material transferred off-site must be covered.
- A wash-down station will be established and all construction vehicles entering and leaving the site will be required to be washed down to prevent weed seeds entering or leaving the site. It is expected that the details of the wash-down station will be included in the CEMP. These procedures will also assist in preventing the introduction of *Phytophthora cinnamomi*, which is a pathogen of native vegetation that is carried in contaminated soil.

vii. Erosion, Sedimentation and Pollution Control

Potential impacts to flora and fauna habitat occurring in the construction phase that can be managed include: run-off, sedimentation, erosion and pollution. To reduce sedimentation on the construction site, erosion control measures will be implemented. This includes minimising the amount of exposed soils on the project area at any given time. All soil stockpiles will be adequately covered when not in use to prevent erosion from heavy rainfall.

Sediment fences will be established around the perimeter of the clearing areas to prevent the impacts of sedimentation on any adjoining vegetation and habitat. This is particularly important in areas adjacent to woodland/forest in the southeast and north of the project area. During development, precautions will be taken to ensure that no pollution, such as petrochemical substances or water containing suspended solids, escapes the construction site. Pollution traps and efficient removal of pollution to an off-site location will be used to minimise pollution impacts.

viii. Other Relevant Measures

The following general construction mitigation measures are proposed to be undertaken during the construction phase and will be included in the CEMP for the project:

- Dust management - to minimise the impacts to vegetation and habitat quality;
- Noise management - to minimise impacts to fauna species; and
- Light management – to minimise impacts to fauna species.

In addition to the above measures, no clearing of vegetation will be undertaken during periods of heavy rain to minimise the risk of erosion/sediment controls failing.

Post-construction it is considered that light pollution may have the potential to impact on fauna species such as the Brown Treecreeper utilising areas of adjacent retained vegetation. It is recommended that all lighting associated with development be restricted to prevent light entering areas of retained vegetation. It is anticipated that Council will provide final approval on future dwellings and that appropriate light restrictions will be placed on buildings in close proximity to retained vegetation (e.g. no bright lights directed towards vegetation) to avoid impacts on resident fauna species.

5.2.1.2. Protection of Conservation Area Boundaries during Construction

Edges between the proposed Parks K and L, Stage 6B EBSF Conservation Area, and the Howes Creek and Northern Conservation Areas will be protected from impacts from adjacent development by a suite of measures, including:

- Installation of sediment fencing;
- Installation of protective fencing with signage; and
- Monitoring of vegetation condition.

Further details are provided below.

i. Sediment Fencing

Installation of sediment fencing along all borders of the areas of retained EBSF will be undertaken under a Council approved sediment control plan. All sediment fencing is to be installed prior to issuing a Construction Certificate for the DA.

ii. Protective Fencing and Signage

Installation of protective fencing around all borders of the EBSF proposed to be retained will be undertaken under a Council approved fencing plan. Fencing will also be installed along the top-of-bank of the proposed temporary drainage line to provide an additional buffer to EBSF. Fencing will be either Australian Temporary Fencing or semi-permanent chain wire fencing. All fencing will also include signage identifying that the fenced vegetation is 'ecological sensitive' and no trespassing is permitted. All protective fencing and associated signage is to be installed prior to commencement of construction. This fencing will assist in preserving the ecological integrity of the EBSF to be retained and the habitat for native species including the Brown Treecreeper, that it provides.

iii. Monitoring of Vegetation Condition

The integrity of conservation areas will be subject to regular monitoring during the development works to check that erosion and deposition are prevented in conservation areas, to monitor weed invasion and to ensure the integrity of the TECs within the conservation areas.

5.3. Compensation Measures (Offsets)

This section outlines the measures proposed to offset any residual impacts of the proposed action after avoidance and mitigation measures have been implemented (see ***Sections 5.1*** and ***5.2***).

Details are provided of how appropriate offsets will be achieved for each protected matter identified in the additional information request from DCCEEW and specifies the expected timeframe for the legal security of the offsets. The protected matters which require consideration are:

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest threatened ecological community (CPW);
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion threatened ecological community (EBSF);
- River-flat Eucalypt Forest on Coastal Floodplains of Southern New South Wales and eastern Victoria threatened ecological community (RFEF); and
- Brown Treecreeper (south-eastern) (*Climacteris picumnus victoriae*)

The proposed offset strategy for the project area includes a combination of the following methods:

- Conservation of areas of TEC or threatened species habitat in on-site conservation areas to be managed in accordance with VMPs attached to a VPA. The VPA and VMPs will be approved and implemented prior to issuing a Construction Certificate.

- As part of the NSW approval, additional offsets will be provided through the purchase and retirement of BBAM credits following DA approval. A number of credits are currently owned by the client and all credits will be retired prior to issuing the Construction Certificate; and
- If the requisite BBAM credits are not available, reasonable equivalency will be requested based on BBAM offset liability and payment of the requisite amount will be made for any outstanding offset liability into the Biodiversity Conservation Trust (BCT). Payment into the BCT will occur prior to issuing a Construction Certificate

Further details of the conservation areas that form the basis of the offsetting strategy are provided below in ***Section 5.3.1***. Details of the proposed use of BBAM/BAM credits for CPW, EBSF and RFEF are provided in ***Section 5.3.2***. Subsequently, details of the offset package proposed for each of the threatened entities identified above is provided, comprising a combination of conservation and credit retirement.

5.3.1. Conservation Areas

The primary offset mechanism proposed for the project involves the establishment of conservation areas for the in-perpetuity protection of viable, representative occurrences of flora and fauna, including the MNES assessed in this report. Conservation areas include Parks K and L, the Stage 6B EBSF Conservation Area, and the Howes Creek and the Northern Conservation Area (**Figure 9**). These will conserve viable representative areas of all MNES TECs that occur at Menangle Park as follows:

- Howes Creek and the Northern Conservation Areas will conserve areas of CPW and RFEF;
- The Stage 6B EBSF Conservation Area will conserve areas of EBSF; and
- Parks K and L will retain and revegetate areas of EBSF.

These areas contain the highest quality native woodland vegetation in the project area and also provide the highest quality habitat for the Brown Treecreeper, thereby ensuring large areas of viable habitat are retained, providing a good conservation outcome for this species.

In addition to protecting high quality areas of native vegetation, the Howes Creek and Northern Conservation Areas have areas of grassland and cleared land that will be regenerated to woodland and open forest under the VMP. Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River, providing opportunities for native fauna species including the Brown Treecreeper to disperse and access a variety of habitat resources. The Northern Conservation Area will also be revegetated and will form proximal habitat to other areas of CPW that are being regenerated at Mount Annan Botanic Gardens to the north of the project area. As these areas of woodland revegetation mature, they will add to the existing areas of habitat for native fauna species including the Brown Treecreeper and provide large areas of suitable habitat that will be protected and managed in perpetuity.

The conservation areas will be secured under a legal mechanism to ensure that they are managed and funded in perpetuity, with details set out within a Voluntary Planning Agreement (VPA). Under the former NSW *Threatened Species Conservation Act 1995* (TSC Act), the legal mechanism for permanently funding conservation areas was via the creation of a BioBanking site utilising the BBAM. However, the TSC Act is now

repealed and the creation of a BioBanking site is no longer an option. As a result, the five conservation areas are proposed to be conserved under 20-year VMPs, prepared with due consideration to requirements for the establishment of Biodiversity Stewardship Sites, included within a VPA. The primary purpose of the VMPs will be to guide the reconstruction, regeneration and management of all native vegetation associated with each conservation area including CPW, EBSF and RFEF, and the habitat for species such as the Brown Treecreeper these communities provide. In addition to managing the existing vegetation, the VMPs prescribe reconstruction of the areas currently mapped as Exotic Grassland/Cleared Land to original TEC communities, using bushland regeneration techniques and appropriate weed control techniques.

The aims of the VMPs are:

- To improve the biodiversity values of the conservation areas;
- To re-establish native vegetation that is broadly representative of the original plant communities of the conservation areas, including canopy, understorey, small trees, shrubs and groundcovers;
- To establish and enhance habitat for local fauna species with the potential to occur or known to occur within the conservation areas including the Brown Treecreeper; and
- To enhance the ecological character of the conservation areas by removal and routine control of weed and exotic species present.

All VMPs have been included in the conditions of consent for the project as part of the NSW approval. Further to this, management of the conservation areas according to the relevant VMP is scheduled to commence in May/June 2025.

5.3.2. Retirement of Biodiversity Credits

As specified in Section 3.2.5 of the Preliminary Documentation additional information request from DCCEEW, any identified residual significant impacts must be offset in accordance with the EPBC Act Environmental Offsets Policy 2012 (Offsets Policy) and Offsets Assessment Guide (OAG), or other endorsed offset framework such as the NSW Biodiversity Offset Scheme (BOS). The proposed offsets for the project are compliant with the EPBC Act Environmental Offsets Policy, and **Table 14** in ***Section 5.6*** demonstrates compliance with each of the principles. However, the main offset framework utilised for the project is the NSW BOS. As the DCCEEW has endorsed the BOS, which includes the BAM, the biodiversity credit system, and the offset rules set out in the NSW *Biodiversity Conservation (Savings and Transitional) Regulation 2017* (the Biodiversity Conservation Regulation), offsetting outcomes under the EPBC Act can be achieved through the BAM provided that they are 'like-for-like' in relation to listed threatened communities under the EPBC Act. Payment into the Biodiversity Conservation Trust (BCT) is also considered acceptable to offset impacts to MNES.

Under transitional arrangements established by the Biodiversity Conservation Regulation, existing BBAM credits can be converted to BAM credits via an "assessment of reasonable credit equivalence". The Environment Agency Head can determine the reasonable credit equivalence of the BBAM credits or credit obligations to the new BOS credit numbers and classes. As the BAM provides for the use of BBAM credits via the assessment of reasonable equivalency, the retirement of BBAM credits for the proposed action is appropriate to mitigate impacts on MNES, given that the DCCEEW has endorsed the BOS, which includes the BAM.

Credit calculations were conducted for the SIS which accompanied the DA that was approved by the NSW Government (Cumberland Ecology 2024), and a BBAM credit liability was calculated to offset the impacts to all TECs listed under the NSW BC Act (formerly the TSC Act), including CPW, EBSF and RFEF. These communities are also listed under the EPBC Act and are considered in this Preliminary Documentation. Although the BC Act listing criteria for these TECs is different to the EPBC Act listing advice, in every case, the areas comprising the BC Act listed community include the areas that are listed under the EPBC Act, and in the case of CPW, includes far greater areas. This is because the EPBC Act has stricter requirements regarding the area thresholds and native species composition of a community for it to be recognised as a TEC under the EPBC Act. In the case of CPW, the BC Act listed TEC includes areas of shrubby regrowth and derived native grassland as CPW, even if the canopy is absent, however these areas are not considered to comprise the EPBC Act listed community. Accordingly, the area of each EPBC Act listed community in the project area is smaller the area of the BC Act listed community. This means that the number of BBAM credits that have been calculated based on the larger BC Act listed community is either equivalent to or greater than that required to offset the area of the EPBC Act listed community in the project area.

No credit liability for the Brown Treecreeper was included in the NSW approval. The Brown Treecreeper is an Ecosystem Credit Species under the BAM, but was a species credit under the BBAM. A review of the BioBanking public register identifies that no BBAM species credits are available for the species, nor has a species credit for the species ever been retired under the BBAM. With consideration of the above, even if a BBAM species credit liability was required for the Brown Treecreeper, there is no way that the credit obligation could be met as no BBAM credits exist. Reasonable equivalence under the BAM is also not feasible as the species is an ecosystem credit. As all the TECs occurring in the project area potentially provide suitable habitat for the Brown Treecreeper, all the offsets established for these TECs will also directly benefit the Brown Treecreeper, which is consistent with the BAM and the project's NSW approval. As such, the retirement of ecosystem credits required under the project's approval appropriately offset the residual impacts to the Brown Treecreeper, consistent with the BAM considering it is an ecosystem species credit under the BAM.

Table 8 below provides a comparison of the area of each BC Act listed community in the project area to the area comprising the EPBC Act community, together with details of the BBAM credit liability that has been calculated for each community. The BBAM credit liability identified does not include proposed onsite offsetting which resulted in a significant reduction in the overall BBAM credit liability identified in the NSW approval, which is also shown in **Table 8**. The BC Act listed TEC is listed first, and underneath, the EPBC Act listed TEC is presented. This demonstrates that for each community, more or equal BBAM credits are identified as being required than are needed to offset the smaller or equal area of the EPBC Act listed TECs (i.e. MNES TECs). **Table 8** does not include a BBAM credit liabilities for the Brown Treecreeper explained in the previous paragraph.

Table 8 Comparison of BC Act listed TEC areas and MNES TECs in the project area and their BBAM credit liabilities

MNES	Total Area (ha) in Proposed Development Works	BBAM Credit Liability (excluding proposed conservation area)	Total Area (ha) in Proposed Conservation Works	NSW Approval BBAM Credit Liability
CPW (BC Act)	44.77	796	12.02	454

MNES	Total Area (ha) in Proposed Development Works	BBAM Credit Liability (excluding proposed conservation area)	Total Area (ha) in Proposed Conservation Works	NSW Approval BBAM Credit Liability
CPW (EPBC Act)	4.62		5.45	
RFEF (BC Act)	1.68	68	11.22	0
RFEF (EPBC Act)	0.38		7.96	
EBSF (BC Act)	0.77	22	1.72	15
EBSF (EPBC Act)	0.77		1.72	

As explained previously, the BBAM credits that will be retired for the NSW approval will be converted to the equivalent number of BAM credits if appropriate BBAM credits are not available. This approach has been accepted by the NSW Government and impacts to BC Act listed TECs have been assessed as being adequately offset in the NSW Government approval of the DA. Therefore, as the use of the BAM is endorsed by the DCCEEW, it is considered that it is appropriate to use these to offset MNES within the project area using the same mechanism.

Following their review of the first version of the Preliminary Documentation, the DCCEEW requested that the revised version would demonstrate that BBAM credits for relevant MNES are available in full, and if not, to clearly outline the available BBAM credits for each MNES and the outstanding offset liability for each MNES for payment into the BCT. **Table 9** below provides the details of the number of BBAM credits available for the relevant MNES entities as per the BioBanking Public Register as of 29 July 2026. Note that the MNES CPW comprises two separate communities listed under the BC Act: Shale Plains Woodland and Shale Hills Woodland, and the BBAM credits available for both variants of CPW are provided below in **Table 9**.

Table 9 BBAM credits available to offset impacts to MNES

MNES	BVT	BC Act listed Community	No. BBAM Credits Available*
CPW	HN529	Shale Hills Woodland	4,197
CPW	HN528	Shale Plains Woodland	1,783
RFEF	HN526	River Flat Eucalypt Forest	1,062
EBSF	HN635	Elderslie Banksia Scrub Forest	0
Brown Treecreeper	-	-	0

**Number of BBAM credits available as per the BioBanking public register as of 29 July 2026.*

Specific details of the offset package for each MNES are provided in ***Section 5.3.4***, including any outstanding offset liability (to be satisfied via payment to the BCT) that would remain if the credits identified in **Table 9** were purchased.

5.3.3. Timing

As required by the proposed action's consent condition 24 issued for the NSW approval, all required biodiversity credits for each stage of development will be retired prior to carrying out of any works that could directly or indirectly impact the biodiversity values requiring offset. Further to this, implementation of all VMPs for all retention areas will have commenced prior to any works commencing within the proposed works area of the project area.

5.3.4. MNES Offset Strategy

Further details on the offsetting proposed for the specific MNES predicted to be impacted by the project is presented in subsequent sections. This strategy has been developed in accordance with the 'S.M.A.R.T' Principles (Specific, Measurable, Achievable, Relevant, Time-Bound) and includes a combination of conservation of the highest quality examples in the project area within the conservation areas, and the retirement of BBAM credits.

5.3.4.1. Cumberland Plain Woodland

Approximately 4.62 ha of CPW is proposed to be removed by the project, and a total of 5.45 ha of existing CPW is proposed to be protected and managed in the conservation areas (**Table 4**). In addition, and consistent with the proposed action's conditions of consent for the NSW approval, a total of 454 BBAM credits will be retired to compensate for the BC Act listed examples of CPW, comprising Shale Hills Woodland and Shale Plains Woodland. A total of 302 Shale Hills Woodland (HN529) BBAM credits and 152 Shale Plains Woodland (HN528) BBAM credits will be retired to compensate for impacts to the two variants of the BC Act listed community. As identified previously, these offsets will also directly benefit other species such as the Brown Treecreeper, which is known to utilise CPW.

The proponent has already acquired 227 Shale Hills Woodland (HN529) credits and 130 Shale Plains Woodland (HN528) credits. The remaining 75 Shale Hills Woodland (HN529) credits and 22 Shale Plains Woodland (HN528) credits will be purchased and retired either through the retirement of the proponent's existing BBAM credits, purchase of further BBAM credits, or by obtaining an assessment of reasonable equivalence to convert these to BAM credits and paying into the BCF. As indicated in **Table 9**, there are 4,197 Shale Hills Woodland BBAM credits available and 1,783 Shale Plains Woodland BBAM credits available (as of the 29 July 2025). Accordingly, it is expected that the entire credit liability can be satisfied through the retirement of existing credits and the purchase and retirement of additional credits (75 Shale Hills Woodland credits and 22 Shale Plains Woodland credits). As outlined previously, given that the impacts to vegetation conforming to the definition of the EPBC Act listed CPW are far exceeded by the impacts to the BC Act listed community (see **Table 8**), it is considered that impacts to CPW have been appropriately offset.

5.3.4.2. Elderslie Banksia Scrub Forest

The proposed development works require the removal of 0.77 ha of EBSF from the project area (see **Table 10** below). An area of 0.56 ha of the community within the project area was previously proposed to be removed under a separate remediation DA, which has now been incorporated into the BEW DA impact area. The areas of the community proposed to be removed consist of small, isolated patches that are generally degraded. To compensate for the proposed removal of this community associated with this DA, extant areas of the

community present within the project area (1.72 ha) are proposed to be conserved and managed under VMPs. The VMP for Park K and L will also include the revegetation of 0.56 ha of the community within areas with deep sandy soils surrounding the extant vegetation. The proposed area of the community to be managed under a VMP has been developed in consultation with Council. As a result, the implementation of the VMP will result in more than twice the area of the community being retained/revegetated and managed in perpetuity as what is proposed to be removed within the project area under this DA (see **Table 10**).

Currently, none of the EBSF present within the project area is managed and is susceptible to further degradation because of surrounding land uses. The implementation of the VMP will ensure that all retained areas of the community are managed and conserved in perpetuity. Furthermore, the area of the community proposed to be conserved includes the largest patch present within the project area, which will be further increased through revegetation under the VMP resulting in a patch that will be less exposed to edge effects through having a decreased perimeter to total area ratio.

Table 10 Details of EBSF MNES to be impacted and managed under a VMP

Vegetation Community	Extant Area within the Project Area (ha)	Proposed Impact (ha)	Extant Area Managed by VMP	Revegetation Area Managed by VMP	Total Area to be managed by VMP
EBSF	2.49	0.77	1.72	0.56	2.28

In addition, a total of 15 BBAM credits have been calculated as being required as part of the NSW assessment and approval. As indicated in **Table 9**, no EBSF BBAM credits are currently available, and therefore this credit liability will be retired in its entirety by obtaining an assessment of reasonable equivalence to convert these to BAM credits and paying the appropriate amount into the BCF.

With consideration of the above, the proposed retention and management of EBSF present is considered to adequately compensate for the proposed impacts to the community.

5.3.4.3. River-flat Eucalypt Forest

The offsetting strategy for this community is the protection of the vast majority of it within the conservation areas in the MPURA. Approximately 0.38 ha of River Flat Eucalypt Forest will be cleared from the project area, however approximately 7.96 ha will be protected from within the conservation areas (see **Table 4**). No BBAM credits have been calculated as being required as part of the NSW assessment and approval, due to the substantial amount of retention of this MNES within conservation areas (see **Table 8**). Potential indirect impacts on this community and others in the conservation areas are anticipated and are proposed to be appropriately ameliorated by the mitigation measures proposed and the implementation of the VMPs.

The impacts to vegetation conforming to the definition of the EPBC Act listed RFEF are included in and are exceeded by the impacts to the BC Act listed community (see **Table 8**). Due to the substantially larger quantum of on-site offsets proposed for the MNES (and RFEF listed under the BC Act), it is considered that impacts to the smaller area of MNES RFEF have been appropriately offset.

5.3.4.4. Brown Treecreeper

The proposed development works require the removal of approximately 17 ha of potential habitat for the Brown Treecreeper from the project area (see **Table 11** below). The areas of potential habitat proposed to be removed consist of small, isolated patches of native vegetation that are generally degraded due to previous land clearing and weed invasion.

The primary offset strategy for the Brown Treecreeper involves the establishment of the conservation areas for the in-perpetuity protection of viable, representative occurrences of suitable habitat for this species, including Parks K and L, the Stage 6B EBSF Conservation Area, and the Howes Creek and the Northern Conservation Area (see **Figure 8**). Areas of habitat in the conservation areas are proposed to be conserved and managed under VMPs. Currently, none of the potential habitat for this species present within the project area is managed and is susceptible to further degradation because of surrounding land uses. The implementation of the VMPs will ensure that all retained areas of habitat are managed and conserved in perpetuity.

As part of the overall Masterplan, approximately 44 ha of existing native vegetation suitable for the Brown Treecreeper will be retained and managed in perpetuity under a VMP. This includes approximately 15 ha of vegetation located outside of the project area to the south, along the Nepean River.

Within the project area, approximately 46 ha of extant habitat for the Brown Treecreeper is present. Approximately 17 ha of this habitat will be removed within the project area, while the remaining 29 ha will be retained and managed in perpetuity. Further to this, approximately ~23 ha of native woodland and open forest vegetation will be replanted in conservation areas and managed in the long-term under a VMP, resulting in the cumulative long-term retention of ~52 ha of native vegetation within the project area (see **Table 11**). This is over three times the area to be impacted (17 ha), resulting in the long term net gain of a substantial area of permanently conserved habitat for the Brown Treecreeper that will be protected for conservation in perpetuity.

Table 11 Details of Brown Treecreeper habitat to be impacted and managed under a VMP

Extant Area within the Project Area (ha)	Proposed Impact (ha)	Extant Area Managed by VMP	Revegetation Area Managed by VMP	Total Area to be managed by VMP
~46	~17	~29	~23	~52

Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River, providing opportunities for the Brown Treecreeper to disperse and access a variety of habitat resources. Revegetation of the Northern Conservation Area will form proximal habitat to other Cumberland Plain Woodland that is being regenerated at Mount Annan Botanic Gardens to the north of the project area. This will benefit the Brown Treecreeper, as Cumberland Plain Woodland is known to be utilised by this species. As the revegetated areas of woodland revegetation mature, they will add to the existing areas of habitat for the Brown Treecreeper and in total this would result in approximately 52 ha of suitable habitat for this species that will be protected and managed in perpetuity. The conservation areas will be secured under a legal mechanism to ensure that they are managed and funded in perpetuity, with details set out within a VPA.

The habitat values contained in proposed Parks K and L, Stage 6B EBSF Conservation Area, and the Howes Creek and Northern Conservation Areas will be protected from impacts from adjacent development by a suite of measures, including:

- Installation of sediment fencing;
- Installation of protective fencing with signage; and
- Monitoring of vegetation condition.

These measures are detailed within the VMPs that have been prepared for the retention areas.

Taking into consideration the proposed conservation of approximately 29 ha of existing habitat in the conservation areas and the creation of approximately 23 ha of additional habitat (total of approximately 52 ha of habitat being protected), no additional offsets are considered to be required to compensate for the 17 ha of potential Brown Treecreeper habitat being removed.

No credit liability for the Brown Treecreeper was included in the NSW approval. The Brown Treecreeper is an Ecosystem Credit Species under the BAM, but was a species credit under the BBAM. A review of the BioBanking public register identifies that no BBAM species credits are available for the species, nor has a species credit for the species ever been retired under the BBAM. With consideration of the above, even if a BBAM species credit liability was required for the Brown Treecreeper, there is no way that the credit obligation could be met as no BBAM credits exist. Reasonable equivalence under the BAM is also not feasible as the species is an ecosystem credit. As all the TECs occurring in the project area potentially provide suitable habitat for the Brown Treecreeper, all the offsets established for these TECs will also directly benefit the Brown Treecreeper, which is consistent with the BAM and the project's NSW approval. As such, the retirement of ecosystem credits required under the project's approval appropriately offset the residual impacts to the Brown Treecreeper, consistent with the BAM considering it is an ecosystem species credit under the BAM.

5.4. Development Consent Conditions

Draft Development Consent conditions have been provided by Campbelltown City Council. As requested in the DCCEEW information request, this section of the Preliminary Documentation provides an outline of the draft conditions of the Development Consent relevant to avoiding, mitigating and minimising the potential impacts of the proposed action on relevant listed threatened species and ecological communities. Each development consent condition relevant to MNES is either reproduced in italics or summarised below and the Draft Development Consent in its entirety is attached in **Appendix E**.

Condition 24: Biodiversity Offsetting Requirement

This condition contains a table that identifies the number of credits requiring to be retired prior to carrying out any development that could directly or indirectly impact the biodiversity values requiring offset. This includes credits for CPW and EBSF.

Details of the credits proposed to be retired in accordance with this condition of consent are provided in ***Section 5.3.2***.

Condition 25: Vegetation Management Plans

a. A Vegetation Management Plan for the Stage 6 Conservation area (VMP 3) is to be prepared and submitted to Council for written approval by Council's Manger Development Assessment (or equivalent) prior to the commencement of any on ground works.

b. The VMP's numbered 1, 2 and 3 are to include the Nest Box Plan within the documents.

c. VMP's 2 and 3 are to include the seed collection and propagation plan for the Elderslie Banksia Scrub Forest (EBSF) within the documents, and include species associated with EBSF, including *Duboisia myoripoides* – Corkwood, as a species within the revegetation zones for these VMP's.

d. The BAM plots to be undertaken for the length of time that is stated within the VMP's are to be within the EBSF restoration and revegetation / rehabilitation areas. These BAM plots will designate if the Vegetation Integrity Score (VIS) is increasing over time with the VMP implementation and set up a baseline dataset for EBSF within the Campbelltown LGA.

Details of VMPs that have already been prepared and approved by Council are provided in ***Section 5.3.1***.

Condition 32: Pre-clearance Surveys

a. Prior to the commencement of any works, pre-clearance surveys are to be conducted in all areas of vegetation to be cleared and undertaken within two weeks of clearing of vegetation. Habitat features appropriate for relocation are to be marked during the pre-clearance survey.

b. Fauna pre-clearance surveys are to be undertaken by a suitably qualified ecologist in accordance with Section 7.2.1.1 (iv) (a) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024.

c. Upon completion of pre-clearance surveys, a report outlining the pre-clearance surveys carried out, including survey effort, results and outcomes will be completed and submitted to Council.

d. If threatened species are roosting in any habitat to be removed, a detailed threatened species relocation plan is to be developed and submitted to Council's Manger Development Assessment (or equivalent) for approval prior to the commencement of any on ground works.

e. If any habitat features (trees, logs or parts thereof) are identified to be appropriate for relocation to the proposed conservation areas in the Menangle Park Urban Release Area, the felling/removal procedures and storage is to be specified to personnel undertaking vegetation removal.

f. If any breeding threatened species are detected during the pre-clearance surveys, then clearance will be postponed until breeding is complete and hollows are vacant.

Details of the pre-clearance surveys that will be conducted in the project area are specified in ***Section 5.2.1.1***.

Condition 33: Hollow Offset Replacement

Prior to the commencement of any works, a Hollow Offset Replacement Strategy and associated monitoring / maintenance program must be prepared and submitted to Council's Manager Development Assessment (or

equivalent) for approval in accordance with Section 11.2.2 of the Campbelltown (Sustainable City) DCP 2015. The nest box replacement ratio is to be 2:1. Should the applicant not be able to accommodate these within their own landholdings, they are to liaise with Council's Manager Development Assessment (or equivalent) about alternative locations.

Details of the Hollow Offset Replacement Strategy are provided in ***Section 5.2.1.1v***.

Condition 34: Threatened Species Relocation Plan

A Threatened Species Relocation Plan is to be prepared that includes the methodology to be employed to capture and relocate threatened species recorded from the subject land during pre-clearance surveys and/or clearance supervision, as set out in section 7.2.1.1 (iv)(a) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024.

Details of pre-clearance surveys to be implemented are provided in ***Section 5.2.1.1iv***.

Condition 35: Construction Environmental Management Plan

Prior to the commencement of any works a Construction Environmental Management Plan (CEMP) shall be prepared to the satisfaction of the Principal Certifier. The CEMP must detail the environment management and control measures which will be implemented in association with the proposed construction activities to ensure the works are managed in a manner to reduce adverse impacts on the environment. At a minimum the CEMP must address:

- *Measures to delineate clearing areas and protect native vegetation that is to be retained, as set out in Section 7.2.1 of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024.*
- *Preclearance survey requirements as outlined in Section 7.2.1.1 (iv) (a) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024.*
- *Measures to prevent the spread of priority and environmental weeds as set out in section 7.2.1.1 (viii) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024.*
- *Measures to prevent the transport and spread of Phytophthora cinnamoni and other plant pathogens (for example myrtle rust) into areas of conservation value within the Menangle Park Urban release Area.*
- *Required Sediment and Erosion Control Measures/stockpile management as per Managing Urban Stormwater: Soils and Construction (Landcom, 2004) – The Blue Book and as set out in Section 7.2.1.1 (ix) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024.*
- *Noise control measures.*
- *Air quality / dust control measures.*
- *Hazardous material management protocols (i.e., fuel etc.) addressing storage, use, refuelling etc.*
- *Incident and emergency response protocols.*

- *Competence, training and awareness procedures (i.e., environmental inductions, toolbox talks, training and awareness)*
- *Roles and responsibilities for implementing, monitoring and reviewing CEMP requirements.*
- *An overview of relevant environmental management documentation.*
- *Waste Management procedures as per the submitted Waste Management Plan.*
- *Inspection, monitoring and auditing requirements for all environmental controls and adaptive management to ensure environmental mitigation measures remain effective.*

Details of the CEMP are provided in ***Section 5.2.1***.

Condition 36: Dam Dewatering Plan

A Dam Dewatering Plan is to be prepared that includes the methodology to be employed to dewater the dam, capture and relocate aquatic species, and relevant licences as set out in section 7.2.1.1 (vi) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024.

This plan shall be prepared to the satisfaction of the Principal Certifier prior to the commencement of any on ground works.

Condition 37. Inductions/ Toolbox Talks

The civil contractor is to ensure that during the site induction process and site toolbox talks, all site workers and visitors are aware of the no-access areas within the site, as per section 7.2.1.1 (i) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024.

Details of the inductions/toolbox talks are provided in ***Section 5.2.1***.

Condition 38: Tree Protection Measures

The Conservation Areas – Parks K and L, Howes Creek and Northern Conservation Area and the Stage 6B EBSF Conservation Area, are required to be protected by fencing prior to the commencement of any works, as set out in section 7.2.1.2 of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024, including: -

i. Sediment fencing
ii. Protective fencing and signage
iii. Monitoring of vegetation condition

Site Inductions are to include communication on tree protection measures, and a siting of where the delineation of conservation areas and associated fencing is located.

Fences are to be installed around specified tree protection zones and conservation areas prior to any works being undertaken.

All tree work is to be supervised by a suitably qualified and insured Arborist; as set out in sections 7.2.1 (ii) and 7.2.1.2 of the Species Impact Statement by Cumberland Ecology dated 30 July 2024.

A Conservation Area Fencing Plan is to be prepared and approved in writing by Council's Manger Development Assessment (or equivalent) prior to the commencement of any on ground works.

Details of the tree protection measures are provided in ***Section 5.2.1.2ii***.

Condition 39: Delineation of Clearing Limits

Clearing limits are to be marked either by high visibility tape on trees or metal/wooden pickets, fencing or an equivalent boundary marker. Disturbance, including stockpiling, is restricted to the clearing limits: as set out in section 7.2.1.1(ii) of the Species Impact Statement by Cumberland Ecology dates 30 July 2024.

Details of delineation of clearing limits are provided in ***Section 5.2.1.1ii***.

Condition 40: Native Seed Collection (Elderslie Banksia Scrub Forest)

A native plant seed collection and propagation plan is to be prepared; This plan must be approved in writing by Council's Manger Development Assessment (or equivalent) prior to the commencement of any on ground works.

The collection of native seed for the future rehabilitation/regeneration purposes within Parks K and L and the Stage 6B Conservation Area (and the associated Vegetation Management Plans) is to be undertaken with procedural advice from the Mount Annan Botanic Gardens plant bank personnel. The collection of seed is to be undertaken prior to the commencement of any on ground works.

The native plant seed collection and propagation plan is to include (but not limited to) the:

- *Methodology to be employed, for seed collection and propagation*
- *Seed storage*
- *Permits and licences required*
- *Propagation techniques*
- *Where the propagation area is sited*
- *Personnel involved*

for the collection and propagation of native species collected from the Elderslie Banksia Scrub Forest areas to be removed.

Reference to the Vegetation Management Plans for the areas to be conserved (Parks K and L and Stage 6B Conservation Area) is to be made in the seed collection and propagation plan.

Condition 43. Erosion and Sediment Control

Erosion and sediment control measures shall be provided and maintained throughout the construction period in accordance with the applicable requirements of Landcom's Managing Urban Stormwater: Soils and Construction,

Volume 1 (the Blue Book), the approved plans, Council specifications, Section 7.2.1.1 (ix) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024, and to the satisfaction of the principal certifier. The erosion and sediment control devices shall remain in place until the site has been stabilised and fully revegetated.

Condition 48: Clearing Supervision and Protocols:

To minimise impacts to native fauna species, clearing is to be undertaken under the supervision of a suitably qualified ecologist, in a two staged process, as set out in section 7.2.1.1 (iv) (b) of the Species Impact Statement by Cumberland Ecology dated 30 July 2024.

a. *All fallen trees to be inspected by the attending ecologist for hollows not detected previously.*
b. *Any fauna residing in the felled hollows to be captured and housed safely, to be released in the conservation areas.*
c. *All personnel involved in the clearing works to be inducted about the possibility of fauna being present.*
d. *Any animals disturbed or dislodged during clearance but not injured should be assisted to move into the adjacent bushland or other specified locations; and*
e. *If any animals are injured during vegetation clearance, appropriate steps must be taken to humanely treat the animal under the advice of the attending ecologist, and WIRES or local VET to be contacted at the discretion of attending ecologist.*
f. *Salvaged material suitable for use in proposed conservation areas, must be stockpiled in an appropriate place with appropriate signage, to ensure it can be reused at a later date.*
g. *A report outlining how salvaged material has been/will be reused must be prepared and submitted to Council's Manager Development Assessment (or equivalent) prior to the principal certifying authority issuing a Final Compliance Certificate.*
h. *The removal of hollow-bearing trees is not to be undertaken during the months of June, July and August.*

Details of the proposed clearing supervision are provided in ***Section 5.2.1.1.iv.b***.

5.5. CPCP Commitments

The CPCP has 26 commitments and 131 actions designed to improve ecological resilience and protect biodiversity in western Sydney by 2056. A further 8 ecological biodiversity enhancements were announced jointly by the NSW ministers for planning and environment in March 2024.

As requested in the DCCEEW information request, this section of the Preliminary Documentation provides detail on how the establishment of the conservation areas compare to the commitments in the CPCP for conservation areas and management actions to achieve environmental outcomes for relevant listed threatened species and ecological communities. Each commitment of the CPCP is reproduced in **Table 12** below, and a summary of how the project compares with each commitment.

Table 12 Comparison with CPCP commitments

Commitment	Comparison with Proposed Action
1): Development will be undertaken in accordance with the CPCP and any conditions of approval.	The proposed development has been undertaken in accordance with the CPCP and in accordance with the draft consent conditions issued by Council. The proposed action will be compliant with any consent conditions imposed by the Commonwealth DCCEEW.
2): Avoid and minimise impacts of up to 4,510 hectares of high biodiversity value area (the avoided land) through strategic conservation planning in the nominated areas.	Not relevant. This commitment relates to essential infrastructure. The project area is not listed as avoided land under the CPCP.
3): Avoid and minimise impacts to threatened ecological communities, species and their habitat within certified-major transport corridors through detailed planning and design.	Not relevant. This commitment relates to certified major transport corridors.
4): Avoid and minimise impacts on threatened ecological communities, species and their habitat within major transport corridors (strategically assessed only), including the Outer Sydney Orbital and Metro Rail Future Extension tunnel sections	Not relevant. This commitment relates to certified major transport corridors.
5): Mitigate indirect and prescribed impacts from urban and industrial development; infrastructure; and intensive plant agriculture on threatened ecological communities, species and their habitat. This includes meeting specific mitigation requirements for threatened ecological communities, species and their habitat in accordance with Appendix E of the CPCP	Relevant entities identified in the CPCP include the Grey-headed Flying Fox,
6): Mitigate indirect and prescribed impacts on threatened ecological communities, species and their habitat within major transport corridors, including the Outer Sydney Orbital and Metro Rail Future Extension tunnel sections	Not relevant. This commitment relates to certified major transport corridors.
7): Mitigate indirect and prescribed impacts from urban, industrial, infrastructure development on the Southern Sydney koala population to best-practice standards and in line with advice from the Office of the NSW Chief Scientist & Engineer, and in accordance with Appendix E of the CPCP	Not relevant. No impacts are predicted to occur to the Koala. This species has not been recorded and is considered unlikely to occur.
8): Protect a minimum of 5,325 hectares of native vegetation in the Cumberland subregion to conserve biodiversity values in perpetuity in accordance with the conservation land selection steps, which may require up to 11,900 hectares of conservation land.	Approximately 15 ha of MNES vegetation will be protected in the project area, thereby contributing to this target.

Commitment	Comparison with Proposed Action
9): Protect threatened species likely to be at risk of residual adverse impacts from development under the CPCP (target species) in accordance with the plan's conservation land selection steps. This includes securing offsets to protect known locations for the following target threatened species…	Not relevant. The target species identified in the CPCP have not been recorded from the project area and are unlikely to occur.
10): Establish a reserve to protect the north–south koala movement corridor along the Georges River between Appin and Long Point.	Not relevant. Area is outside the project area.
11): Establish at least 2 new reserves in addition to the Georges River Koala Reserve that will protect threatened communities, species and habitats that are targeted for protection through the CPCP.	Not relevant.
12): Protect koala corridors in the Cumberland subregion, including those along the Nepean River, Georges River, Cataract River and Ousedale Creek.	Not relevant. Project area is not located in these areas.
13): Deliver and support ecological restoration activities in conservation land including ecological reconstruction of up to a maximum of 25% of the plan's offset target for native vegetation	The proposed action is consistent with this objective due to the proposed implementation of VMPs within retention areas.
14): Minimise impacts from development on biodiversity values in the strategic conservation area.	Not relevant. Project area is not in the strategic conservation area.
15): Manage priority weeds in strategic locations in the Cumberland subregion to reduce threats to land secured within the strategic conservation area.	Not relevant. Project area is not in the strategic conservation area. That notwithstanding, weeds in the project area will be managed in accordance with a VMP to reduce threats on retained native vegetation.
16): Manage priority pest animals in strategic locations in the Cumberland subregion to reduce threats to land protected within the strategic conservation area.	Not relevant. Project area is not in the strategic conservation area. Pest animals have not been identified as a major threat in this area.
17): Manage fire in strategic locations in the Cumberland subregion to support the maintenance of biodiversity values on conservation land.	Not relevant. Fire management is not proposed as it is not appropriate for the areas of retained vegetation in the retained area.
18): Support new or existing programs to control key diseases affecting threatened species and ecological communities in the Cumberland subregion.	Not relevant.
19): Support existing or new programs to help threatened species and ecological communities adapt to the impacts of climate change in the CPCP Area.	The protection of native vegetation in the retained area will assist the ecological communities and species they support to adapt to the impacts of climate change.

Commitment	Comparison with Proposed Action
20): Provide opportunities for the residents of Western Sydney to learn about and actively participate in biodiversity conservation including koala conservation.	The conservation areas will be accessible to future residents and interpretive signage will provide opportunities for learning about conservation.
21): Partner with Aboriginal groups and community to help maintain a distinctive cultural, spiritual, physical and economic relationships with their land and waters in Western Sydney	Engagement with Aboriginal groups and community have been appropriately undertaken with reference to the proposed action (refer to **Chapter 7**).
22): Invest in research priorities that will support the implementation of the CPCP and help to deliver the plan's outcomes.	Not relevant. No research will be funded as part of the project.
23): Support rehabilitation measures to help maintain koala health and welfare.	Not relevant. The Koala has not been recorded from the project area and is considered unlikely to occur.
24); Establish governance arrangements including roles, responsibilities and funding to ensure the efficient and effective implementation of the CPCP.	Not relevant.
25): Implement an evaluation program for the CPCP that sets out requirements for monitoring, evaluation, reporting and adaptive management.	Not relevant
26): Implement a compliance program to ensure compliance with the CPCP and conditions of approval.	Not relevant

Appendix E of the CPCP provides mitigation measures to address residual risks to specific threatened fauna and TECs in several tables. Threatened species and TECs identified in Appendix E that are relevant to the project are identified in **Table 13**, together with mitigation measures identified in the CPCP for each entity. **Table 13** also provides detail of how the project meets these requirements.

Table 13 Assessment of CPCP mitigation measures for relevant MNES TECs and species

Relevant Entity	Requirements of CPCP	Project Compliance
Grey-headed Flying-fox	Retain large trees (including dead trees but excluding noxious weeds) (≥50cm DBH) during precinct planning where possible and avoid impacts to soil within the dripline of these trees during construction.	Significant areas of native vegetation containing large trees have been retained and will be managed under a VMP.
Grey-headed Flying-fox	Establish a 100 m minimum setback for development around flying fox camps.	No flying fox camps are present in the project area

Relevant Entity	Requirements of CPCP	Project Compliance
Cumberland Plain Woodland	Incorporate best-practice site hygiene protocols to manage the potential spread of pathogens, such as Phytophthora and myrtle rust adjacent to potential habitat for relevant TECs	Site hygiene protocols will be included in the CEMP for the project (see ***Section 5.2***).

5.6. Compliance with EPBC Act Offsets Policy Principles

As required by the DCCEEW information request, **Table 14** demonstrates how the proposed environmental offsets meet the principles specified in the EPBC Act Offsets Policy. Each Offsets Policy principle is reproduced in **Table 14** below, and compliance is demonstrated in the column adjacent.

Table 14 Compliance with EPBC Act Offsets Policy Principles

Offsets Policy Principles	Evidence of Compliance
Suitable offsets must:	
deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action	The MNES affected by the proposed action are identified in this report (see **Chapter 3** and subsequent chapters). The conservation outcome proposed by the DA will improve the viability of these MNES through a combination of protecting existing habitat, creating new habitats, and retirement of biodiversity credits (See ***Sections 5.2*** and ***5.3***)
be built around direct offsets but may include other compensatory measures *be in proportion to the level of statutory protection that applies to the protected matter*	The proposed offsets are based around the protection and conservation of existing habitat (direct offsets) as outlined in ***Section 5.3.1***). They are in proportion to the level of protection that applies to each MNES, and substantial offsets (including retirement of biodiversity credits) for TECs listed as CEECs under the EPBC Act.
be of a size and scale proportionate to the residual impacts on the protected matter	The size of the proposed conservation areas, and the areas proposed to be revegetated are proportionate to the impacts on MNES. Larger areas of offsets will be provided than will be impacted, and in addition, biodiversity credits will be retired for CPW, EBSF and RFEF.
effectively account for and manage the risks of the offset not succeeding	Monitoring is proposed to be undertaken for a minimum of 20 years which will identify if the offset areas are not succeeding in providing the expected biodiversity values. This will enable alternative offsets to be provided, or alternative management measures

Offsets Policy Principles	Evidence of Compliance
	to be implemented to ensure the success of the offsets.
be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action)	The proposed offsets are agreed to under the BC Act. While they have not been used to offset other impacts on MNES, the use of biodiversity credits within NSW is recognised as a suitable method for offsets under the EPBC Act for the same action.
be efficient, effective, timely, transparent, scientifically robust and reasonable	The management measures proposed are efficient, effective, timely, transparent, scientifically robust and reasonable. The protection and enhancement of existing habitat, and the creation of additional habitat are measures that are known to be effective in conserving endangered species and communities.
have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	Monitoring measures are proposed for the conservation areas to enable the biodiversity values provided by these areas to be measured, audited and enforced.

6. Principles of Ecologically Sustainable Development

The EPBC Act (Section 3A) defines principles of ecologically sustainable development as:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- The principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations
- The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making
- Improved valuation, pricing and incentive mechanisms should be promoted.

Project implementation of the ecologically sustainable development principles are reviewed in **Table 15**.

Table 15 Compliance with Ecologically Sustainable Development Principles

Principle	Measures
Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations	Project planning has been ongoing for since 2014 to enable comprehensive engagement with local Council, the community and Traditional Custodians. This has allowed for environmental impacts to be fully quantified and the development footprint to be revised in response to environmental constraints, ensuring that values are protected to the greatest extent possible through development and into the future. *Environment* The proponent acknowledges that there will be environmental impacts from the project such as clearing of native vegetation. However, these have been avoided to the extent feasible in the design stage of the project, and a comprehensive suite of mitigation measures has been developed to address any remaining impacts. This includes the protection of the highest quality examples of native vegetation and TECs in the conservation areas and the proposed rehabilitation of degraded areas. The protection and enhancement of retained vegetation and habitat restoration including rehabilitation of degraded areas and ongoing weed and pest animal management will benefit the local environment in both the short and longer term. Additional offsets will be provided through the retirement of BBAM biodiversity credits. Indirect impacts may occur, and these will be managed through such plans as a CEMP and associated subplans. *Economic* The Project is economically feasible and will facilitate urban development consistent with the current zoning, the Urban Structure Plan contained in the Campbelltown City Council (Council) *Development Control Plan Part 8 – Menangle Park*, and with reference to the proponent's Master Plan (the

Principle	Measures
	'Master Plan') for the MPURA. The Project will also see the delivery of much needed homes on a vacant site in the Greater Sydney metropolitan area in a location close to existing and proposed public transport and infrastructure. The Project will utilise a large, skilled, local workforce and acquire local goods and services for the construction phase of the Project. *Social* Construction activities have the potential to cause temporary disruptions to the local community, for example, through increased traffic, construction noise and heavy and long vehicle movements through the area. The proponent has been working with relevant stakeholders throughout Project planning to determine the potential impacts and develop appropriate management responses. Neighbouring landholders, Council and other stakeholders have been and will continue to be notified of specific works/impacts in line with approved local consent conditions. A complaints and issues management procedure has been integrated into the CEMP and these impacts will not be ongoing. The Project will result in new community infrastructure including pocket parks, open space and a recreation facility which will all play a part in enabling community building and social interaction. *Equity* Consultation activities have been inclusive and extensive, providing a range of avenues and opportunities for stakeholders to understand the proposed action and engage with the Project team.
If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation	A precautionary approach informed field surveys and data interpretation, and it has been assumed that threatened species are present and may be impacted by the Project unless there is clear evidence to preclude its use of the site. Subsequently, appropriate mitigation measures have been identified for all confirmed and potential species, and their habitat, as well as any overall environmental impacts of the Project.
The principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations	The highest quality areas of native vegetation in the project area will be retained and managed in perpetuity thus enhancing the vegetation beyond current conditions for the benefit of future generations.

Principle	Measures
The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making	The highest quality remnant bushland within the project area is to be retained in the conservation areas and managed in perpetuity to maintain and improve their ecological value. Additional areas that currently do not contain native vegetation will be revegetated to further increase conserved areas within the project area. Impacts have been avoided through a lengthy iterative design process in consultation with Council and NSW Government which has resulted in significant changes to the layout of the proposed action to avoid impacts on areas of high conservation value including the following: • Changes to the location of Spine Road and the proposed school site and town centre to avoid areas of EBSF; • The creation of Parks K and L to conserve EBSF; and • Substantial reductions to the footprint of the action to maximise the avoidance of TECs. In addition, as part of the NSW approval, additional offsets will be provided through the purchase and retirement of BBAM credits following DA approval, or by obtaining an assessment of reasonable equivalence to convert these to BAM credits and paying into the BCF.
Improved valuation, pricing and incentive mechanisms should be promoted	The environmental assessments undertaken have examined the environmental consequences of the proposed action and identified mitigation measures for areas which have the potential to be affected adversely. Alternatives have also been assessed during development of the detailed design options for each of the sections of work, aiming first to avoid impacts and then to minimise or mitigate any unavoidable impacts. Consistent with the 'polluter pays' principle, the costs associated with environmental commitments have been incorporated into the overall Project planning and operation costs. This includes procedures, equipment and resources required to manage and monitor specific environmental risks such as discharge, air quality chemical risk and erosion and sediment control; Provisions for rehabilitation/revegetation, engagement with indigenous parties and other stakeholders and provisions for implementing negotiated agreements; and Implementation of a range of mitigation measures to ensure that, during construction and operation, waste is avoided, reused or recycled wherever possible.

7. Economic and Social Considerations

7.1. Economic and Social Impact Statement

Urbis Ltd have prepared an Economic and Social Impact Statement (ESIS) for the MPURA. Below are the key findings of the ESIS, and the entire ESIS is provided in **Appendix F**.

7.2. Consideration of Negative Impacts

The identified potential negative impacts of the proposed action includes:

- Increase pressure on existing public transport and the road network;
- Increased pressure on existing social infrastructure, depending on the timely provision of new social infrastructure;
- Potential disruption to sites of Aboriginal significance;
- Increased urban heat through a loss of green space;
- Amenity impacts during construction due to increased noise, dust, and potential vibration;
- Potential risk of flooding impacting the safety of residents;
- Change to local character and potential community concerns around impacts to environmental values, including the Nepean River;
- A perceived lack of communication and communication channels between Dahua Group and the incoming community; and
- Potential construction and community consultation fatigue.

7.3. Consideration of Positive Impacts

The identified potential positive impacts of the proposed action includes:

- Increased access to social infrastructure for current and future residents, workers and visitors;
- Increased opportunities for precinct activation and the realisation of state strategic plans;
- Increased access to a diversity of housing types;
- Increased opportunity to provide a range of housing price options;
- Change to the demographic profile of Menangle Park and associated change to community character and cohesion, including increased diversity associated with new residents;
- Increased vehicular access and connectivity;
- Increased opportunities to celebrate local Aboriginal history and culture through the built environment;

- Enhanced social amenity via healthier built environments, which would, in turn, promote healthy lifestyles (via enhanced footpaths and active transport opportunities); and
- Increased access to employment opportunities, local development, and upskilling opportunities.

7.4. Consideration of Different Scales of Impact

The scales of impact considered in the ESIS includes:

- Local social locality: The local social locality encompasses the suburb of Menangle Park, including the project area and its immediate surrounding areas, such as landholdings, property owners, and residents of associated dwellings. For the economic impact assessment, Campbelltown LGA is considered as part of the local social locality to provide a holistic picture of the development's local impact on housing and employment needs in the neighbouring suburbs and broader LGA.
- Regional social locality: The regional social locality encompasses Greater Sydney, specifically including Campbelltown LGA and the Greater Macarthur Priority Growth Area, where the project area is located. The regional social locality provides insights into the development's contribution to broader impacts being experienced in the regional area, particularly concerning increasing demand for social infrastructure, open space, public transport, and other essential services and facilities as the region's population continues to grow across Greater Sydney.
- State social locality: The state social locality encompasses the population of NSW to provide a broader and comparative social context for the development.

7.5. Estimated Capital Value and Ongoing Economic Value

The total estimated capital investment value of the entire development is approximately $3,779 million, representing direct expenditure (Economic Output), inclusive of GST. The project is estimated to have a nine-year construction period, concluding in 2033.

7.6. Public Consultation

Kelleher Nightingale Consulting Pty Ltd have prepared an Aboriginal cultural heritage assessment report (CHAR) for MPURA holdings, with specific impact assessment for the project area. This section and the subsections below present the finding of the CHAR, which included an archaeological test excavation program conducted under the Heritage NSW Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW and a comprehensive program of Aboriginal community consultation undertaken in accordance with the Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010. The CHAR was prepared in accordance with the Heritage NSW Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW and Clause 61 of the National Parks and Wildlife Regulation 2019.

7.6.1. Summary of CHAR Findings

Background research and previous archaeological assessment including field survey and a test excavation program have been undertaken for the project and identified numerous Aboriginal archaeological sites and Aboriginal cultural areas within the wider MPURA. Sites include open artefact scatters and isolated finds and

subsurface archaeological deposit of varying density and integrity. Impact assessment and recommendations specific to the site-wide bulk earthworks and vegetation clearing DA have been undertaken with Aboriginal stakeholders. Thirteen extant Aboriginal archaeological sites are situated at least partially within the proposed impact area. Archaeological significance of the identified Aboriginal sites was defined by the information exhibited by each site and ranges from low to moderate-high. A mitigation program comprising archaeological salvage, undertaken prior to construction, is required where at least moderately significant Aboriginal archaeology would be impacted by the proposed action. Surface artefact collection is also recommended for all sites prior to impact. An Aboriginal Heritage Impact Permit (AHIP) is therefore being sought under S90 of the National Parks and Wildlife Act 1974 for the lands subject to the proposed action (outside of existing AHIP areas).

7.6.2. Aboriginal Community Consultation

The aim of consultation is to integrate cultural and archaeological knowledge and ensure registered stakeholders have information to make decisions on Aboriginal cultural heritage. Aboriginal people who hold knowledge relevant to determining the cultural heritage significance of Aboriginal objects and Aboriginal places in the study area were invited to register interest in a process of community consultation (ongoing since 2018). Investigations for the current project have included consultation with 20 Aboriginal community groups and individuals. A full consultation process has been undertaken with these Aboriginal stakeholders specific to the proposed action.

All consultation has been undertaken in accordance with the Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 and the requirements of Clause 60 of the National Parks and Wildlife Regulation 2019. The formal consultation process and all timeframes have been in accordance with the relevant NSW legislative processes and guidelines, including the following actions:

- Notification of Aboriginal persons, including register of native title determinations search and government agency notification letters (early 2018);
- advertising for registered stakeholders in local print media (early 2018);
- notification of closing date for registration and provision of registration records to Heritage NSW (formerly Office of Environment and Heritage) and the Local Aboriginal Land Council (April 2018);
- provision of project information and proposed cultural heritage assessment methodology, inviting stakeholder review and comments (May 2018);
- provision of proposed test excavation methodology for comment and review (May 2018) and invitations to participate in field program;
- invitation to advise on Aboriginal cultural values of the study area and identified sites;
- provision of initial MPURA draft CHAR for review (January 2019);
- provision of draft CHARs specific to various individual development Stages and DAs (2019 - 2024);

- provision of updated draft CHAR related specifically to the site-wide bulk earthworks and vegetation clearing DA area (June-July 2022); and
- ongoing consultation with the local Aboriginal community including regular project updates through 2019-2025.

Stakeholders have expressed traditional family connections to the local area and the importance of maintaining this connection and responsibility for Aboriginal cultural heritage in the region. This includes care of the physical manifestations of Aboriginal heritage (archaeological sites, plants and animals, riparian areas and landscape features) and also of the social, spiritual and cultural elements including stories, songlines, traditional knowledge and the promotion of Aboriginal cultural heritage and education. The connectivity of landforms and sites across the area has been emphasised, with community noting that sites do not exist in isolation but are part of a complex cultural landscape.

Previous assessments of MPURA have included investigation of Aboriginal cultural values (separate to archaeological values). Specific areas of cultural value were identified by the Aboriginal community during these assessments including areas directly adjacent to the Nepean River, landforms along Howes Creek, and an elevated knoll cut by Menangle Road, to the south of the project area.

During the draft CHAR review period for the proposed action, all Aboriginal stakeholders were invited to comment on the findings of the assessment, the proposed impacts, the proposed mitigation measures and management of Aboriginal cultural heritage matters. Responses were received from six stakeholder groups. All stakeholder responses expressed support and agreement with the findings of the assessment and the management recommendations.

7.7. Contributions

The proposed development has support from Campbeltown City Council and the local community with a Development Contribution Plan adopted for the redevelopment area and a VPA outlining a variety of community needs that have been agreed upon. These community infrastructure needs include open space and recreational areas, land dedication, bioretention facilities and monetary contributions toward community needs.

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APPENDIX A :

Menangle Park Site Wide Bulk Earthworks Preliminary Information Request

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Ref: 2024/10074

Mr Robert Fischer
Associate Development Manager
Dahua Group Sydney Project 2 Pty Ltd

robert.fischer@dahuaaustralia.com.au

Dear Mr Fischer

Further information required for preliminary documentation for the Site-wide Bulk Earthworks Development Application, Menangle Park, NSW

I am writing to you about the proposal to undertake development works and conservation works within the Menangle Park Urban Release Area in Menangle Park, NSW.

On 17 March 2025, a delegate of the Minister for the Environment and Water decided that the proposed action is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and that it will be assessed by preliminary documentation. Further information was required to assess the relevant impacts of the proposed action on listed threatened species and communities. In accordance with section 95A(2) of the EPBC Act, please find attached details of the further information to enable a robust assessment of the proposed action under the EPBC Act.

Details on the assessment process for the proposed action and the responsibilities of the proponent are set out in the EPBC Act — Environment Assessment process fact sheet. Further information on the referral and assessment process can be found on the department's website.

If you have any questions about the process, please contact the project manager, Andy Groom, by email to andy.groom@dcceew.gov.au, and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely,

Sarah Reachill
Director
Canberra and Sydney Assessments Section
Commonwealth Department of Climate Change, Energy, the Environment and Water

7 April 2025

Preliminary documentation additional information request

Site-wide Bulk Earthworks Development Application, Menangle Park, NSW (EPBC 2024/10074)

On 17 March 2025, the proposed action was determined to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) due to likely significant impacts to listed threatened species and communities (sections 18 and 18A).

It was also determined that the proposed action will be assessed by preliminary documentation (further information required). This document specifies the information required by the Minister for the Environment and Water under section 95A of the EPBC Act, combined with the referral documentation, to adequately assess the impacts of the proposed action (the 'preliminary documentation').

Overview and formatting

1 Overview

The preliminary documentation consists of the referral documentation and the additional information requested in this document.

The preliminary documentation must enable the Minister (or delegate) and any other interested stakeholders to understand the impacts of the proposed action on relevant listed threatened species and ecological communities. The preliminary documentation must be able to be read as a stand-alone document (the 'main document') and include a table which clearly identifies where the requirements of this document have been addressed in the preliminary documentation and its appendices.

Any assumptions made in the main document must be clearly explained and justified. The extent to which the limitations, if any, of available information may influence the conclusions of the environmental assessment should be clearly stated.

If it is necessary to rely on any confidential material, please consult with the project manager on the handling of that material before submitting the draft preliminary documentation to the department for publication for public comment.

1.1 Relevant policies

The preliminary documentation must take into consideration:

- *Significant Impact Guidelines 1.1: Matters of National Environmental Significance* (Significant Impact Guidelines 1.1).
- Other relevant EPBC Act policy statements and guidelines: EPBC Act publications and resources - DCCEEW.
- All relevant guidance documents for determining, avoiding, mitigating and managing likely impacts on listed threatened species and communities.

- The department's offsets mitigation hierarchy: Offsets mitigation hierarchy - DCCEEW.

2 Format and style

The preliminary documentation must be published by the proponent and made available for public comment. It is therefore important to the integrity of the EPBC Act assessment process that the preliminary documentation is presented in a way that is intelligible to the general public, who may not be familiar with the history of the proposed action or with the technical aspects of its assessment. **Table 1** provides a checklist for appropriate formatting and style.

The main document can include specific references to relevant sections within the appendices to avoid duplication (e.g. referral documentation). However, it should only be contextual information to support key claims, conclusion and commitments. Clear referencing must be used.

Table 1 Formatting and style checklist

Present in a standard format – the document(s) will be published in hardcopy (e.g. A4/A3 hardcopies) and electronic formats (e.g. PDF or MS Word files).	☐
Include all key claims, findings, conclusions, proposals and commitments in the main document.	☐
Include key supporting documents (e.g. referral, survey data, technical reports) as appendices	☐
Explain (or avoid) technical jargon and acronyms.	☐
Use maps, figures, diagrams and/or photographs where appropriate to support textual information.	☐
Present all maps, figures and diagrams at an appropriate size and scale – see the department's *Guide to providing maps and boundary data for EPBC Act projects* (2021).	☐
Reference all supporting documentation (including websites) clearly and consistently (e.g. table, figure, section, appendix).	☐
Ensure that other supporting documents (e.g. academic studies, regulatory standards, state permits/approvals) are publicly accessible, with electronic links provided where possible. If any information is not publicly available, it must be attached to the preliminary documentation as an appendix.	☐

Controlling provisions

3 Listed threatened species and communities (s18 & s18A)

Under this controlling provision, any listed threatened species or ecological community is potentially relevant to the assessment of the proposed action. However, based on the information provided in the referral, the department requires additional information in relation to the listed threatened species and ecological communities listed in section 3.1 below.

Relevant guidance material (e.g. survey guidelines, conservation advices, recovery plans, threat abatement plans and policy statements) is available through the department's Species Profile and

Threats (SPRAT) Database. It is the responsibility of the proponent to ensure that all relevant documents have been identified and considered in the assessment of the proposed action.

Further, it is the proponent's responsibility to ensure that any listed threatened species and ecological communities at the time of the controlled action decision (17 March 2025), which will or are likely to be impacted by the proposed action, are assessed for the Minister's consideration. Some listing events (e.g. the listing or uplisting of a species) that occur after the controlled action decision do not affect the assessment and approval process.

3.1 Listed threatened species and ecological communities likely to be significantly impacted

Based on the information provided in the referral documentation, the department considers the following listed threatened species and ecological communities are likely to be significantly impacted by the proposed action:

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest threatened ecological community – Critically endangered
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion threatened ecological community – Critically endangered
- River-flat Eucalypt Forest on Coastal Floodplains of Southern New South Wales and eastern Victoria threatened ecological community – Critically endangered
- Brown Treecreeper (south-eastern) (*Climacteris picumnus victoriae*) – Vulnerable

3.2 Further information required

3.2.1 Extent

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest threatened ecological community (CPW TEC)

Based on section 4.1.4.2 of the referral, there is a further 0.55 hectares (ha) of vegetation that has the potential to conform to the EPBC Act-listed CPW TEC and that additional plot data is required to confirm if the Commonwealth criteria are met.

Therefore, the department requires information on the CPW TEC's extent within the areas labelled Patches C15, C19 and C32 within and adjacent to the project area (see **Table 2**).

Table 2 CPW TEC checklist

Undertake vegetation surveys of Patches C15, C19 and C32 in accordance with relevant survey guidelines.	☐
Clearly assess the mapped areas of CPW TEC against the key diagnostic characteristics, condition thresholds or criteria, or patch definitions as set out in the *Commonwealth Listing Advice on Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* (2009). The department recommends a table which assesses the on-ground vegetation against the Commonwealth requirements.	☐

If the proposed action is being assessed under the NSW Biodiversity Assessment Method (BAM), clearly identify the Plant Community Types and Vegetation Zones that align with CPW TEC in the project area and immediate surrounds.	☐
Provide the extent of CPW TEC within the areas labelled Patches C15, C19 and C32 in hectares.	☐
Provide the total area of CPW TEC in hectares, and if CPW TEC occurs in multiple distinct areas within and adjacent to the project area, provide the area (in ha) for each occurrence.	☐
Provide a map which identifies the total extent of CPW TEC within and adjacent to the project area.	☐

Brown Treecreeper

Section 5.3.2 of the Species Impact Statement states that the Brown Treecreeper has been recorded in the south of the project area and section 4.1.4.2 of the referral states that the project area includes foraging and potential nesting/roosting habitat (i.e. hollow-bearing trees).

The department considers that the project area contains habitat critical to the survival of the species as described in the *Conservation Advice for* Climacteris picumnus victoriae *(brown treecreeper (south-eastern)* (2023) (BT Conservation Advice). A detailed assessment of the suitable habitat in and adjacent to the project area for the Brown Treecreeper is therefore required (see **Table 3**).

Table 2 Brown Treecreeper checklist

Undertake on-ground surveys for the Brown Treecreeper and its habitat (e.g. targeted surveys, vegetation assessments, hollow-bearing tree assessments) in accordance with relevant survey guidelines (if required).	☐
Determine the type(s) of habitat available (e.g. foraging, nesting, roosting) based on a habitat assessment against the SPRAT Database and relevant statutory documents.	☐
Describe the quality of each habitat type.	☐
Describe and quantify key habitat features (e.g. water availability, hollow-bearing trees).	☐
Provide: • The total amount of habitat (in ha) within and adjacent to the project area. • The amount of each habitat type (in ha) within and adjacent to the project area.	☐
Describe whether the habitat in the project area is habitat critical to the survival of the species as described in the BT Conservation Advice.	☐
Provide any other relevant information describing the species habitat.	☐

3.2.2 Impact assessment

The preliminary documentation must include an updated assessment of the impacts on CPW TEC and the Brown Treecreeper with consideration of the information requested in section 3.2.1 above, and any new information which arises in the preparation of the preliminary documentation.

The impact assessment must identify and provide an analysis of the nature and extent of the likely short-term and long-term impacts to CPW TEC and the Brown Treecreeper from the proposed action,

quantify the total area of direct and indirect impacts (in ha), and provide justification and evidence for any conclusions reached about the impacts.

The impact assessment must also consider the potential for the proposed action to impact on adjacent areas which contain habitat for relevant listed threatened species and ecological communities, particularly the conservation areas if no buffers are proposed to minimise long-term edge effects (see section 3.2.3 below).

The impact assessment must also outline the cumulative impacts of the proposed action with the impacts of the endorsed Cumberland Plain Conservation Plan (CPCP) on relevant listed threatened species and ecological communities, and how they have been considered at the planning stage for the proposed action.

3.2.3 Avoidance, mitigation and management measures

In addition to the measures described within the referral documentation, the preliminary documentation must provide updated information on specific and enforceable measures proposed to avoid, mitigate and manage each identified impact from the proposed action on CPW TEC and the Brown Treecreeper. This includes amending relevant vegetation and construction environmental management plans as required.

Buffer requirements

The department notes that the referral did not propose to implement buffers to minimise long-term edge effects on retained habitat for all relevant listed threatened species and ecological communities, including the proposed conservation areas.

Therefore, the preliminary documentation must outline whether buffers will be implemented for the proposed action, especially for the threatened ecological communities identified in section 3.1 above. Any proposed buffers must be quantified (e.g. in metres) and supported by suitable justification (e.g. Commonwealth statutory document/s, expert advice, research articles, local/state policies and approvals, etc.).

The preliminary documentation must include updated maps that include any proposed buffers.

Development Consent conditions

Section 134 of the EPBC Act states that in deciding whether to attach a condition to an approval, the Minister must consider any relevant conditions that have been imposed, or are considered likely to be imposed, by a state or territory or under another law of the Commonwealth. The department notes that section 1.2.6 of the referral states that draft Development Consent conditions have been provided by Campbelltown City Council.

The preliminary documentation must outline any draft or approved conditions of the Development Consent relevant to avoiding, mitigating and minimising the potential impacts of the proposed action on relevant listed threatened species and ecological communities. The Development Consent must be attached to the preliminary documentation as an appendix.

CPCP commitments

The preliminary documentation must provide detail on how the establishment of the conservation areas compare to the commitments in the CPCP for conservation areas and management actions to achieve environmental outcomes for relevant listed threatened species and ecological communities.

3.2.4 Residual significant impacts

At a minimum, the preliminary documentation must include a residual significant impact assessment, supported by justification and evidence, for CPW TEC and the Brown Treecreeper after proposed avoidance, mitigation and management measures are considered. The residual significant impact assessment must be undertaken with consideration of the information requested in this document and the Significant Impact Guidelines 1.1.

3.2.5 Compensation measures (offsets)

Any identified residual significant impact (including any other MNES that may be identified) must be offset in accordance with the department's *EPBC Act Environmental Offsets Policy 2012* (Offsets Policy) and Offsets Assessment Guide (OAG), or other endorsed offset framework (e.g. the NSW Biodiversity Offset Scheme [BOS]).

Based on section 4.1.4.11 of the referral, an assessment was undertaken in accordance with the BioBanking Assessment Methodology 2014 (BBAM) under the NSW *Threatened Species Conservation Act 1995* to determine the offset credit requirements for the impacts of the proposed action on listed threatened species and ecological communities. The department notes that this assessment method was superseded by the BOS when the NSW *Biodiversity Conservation Act 2016* commenced on 25 August 2017.

Section 7.4.1.2 of the Species Impact Statement states that the implementation of the conservation areas does not adequately offset the impacts and that additional credits will need to be purchased and retired, or by making payment into the Biodiversity Conservation Fund.

The preliminary documentation must describe the proposed Offset Strategy which outlines how the offsets will be achieved for each protected matter listed in section 3.1 above (at a minimum) and specifies the expected timeframe for the legal security of the offsets.

The preliminary documentation must provide detail on how the proposed offsets compare with the environmental outcomes of the CPCP for relevant listed threatened species and ecological communities.

Offsets do not need to be secured before the decision on whether to approve the proposed action. However, if approved, the department's policy is that offsets must be legally secured prior to the commencement of the proposed action.

Endorsed offset frameworks

In the interests of streamlining regulatory requirements for proponents, the Commonwealth has endorsed some state government policies, as reflected in the department's *EPBC Act Condition-setting Policy 2016*.

The department has endorsed the BOS, which includes the BAM, the biodiversity credit system, and the offset rules set out in the Biodiversity Conservation Regulation. This means that offsetting outcomes achieved through the BAM will be accepted for the purposes of the EPBC Act, provided that they are 'like-for-like' in relation to listed threatened species and communities as defined for the purposes of the EPBC Act. Payment into the Biodiversity Conservation Fund is also considered acceptable.

If you are proposing offsets developed using the BAM, the preliminary documentation must include a summary of the proposed offsets for the residual significant impacts on relevant listed threatened species and ecological communities. The preliminary documentation must also include indicative

timeframes for securing and retiring offset credits. All relevant BAM documentation (including a Biodiversity Development Assessment Report) must be appended to the preliminary documentation.

EPBC Act Environmental Offsets

If offsets are to be secured in accordance with the Offsets Policy, the preliminary documentation must demonstrate that the proposed Offset Strategy meets the criteria outlined in **Table 4** below.

Table 4 EPBC Act Environmental Offsets checklist

The draft Offset Strategy must:	
• Identify and describe suitable area/s for the proposed environmental offsets, including location, size and environmental values for relevant listed threatened species and/or ecological communities.	☐
• Demonstrate how the proposed environmental offsets meet the principles specified in the Offsets Policy and the OAG, including clearly justifying the scores entered into the OAG.	☐
• Directly contribute to the ongoing viability of the relevant listed threatened species and/or ecological communities to deliver an overall conservation outcome that improves or maintains the viability of the protected matter in the region, as compared to what is likely to have occurred under the status quo (i.e. if neither the proposed action nor the offset had taken place).	☐
• Describe the proposed legal securing mechanism for the proposed environmental offsets.	☐
• Compensate for the residual significant impacts over the duration of the proposed action.	☐
• Apply the 'S.M.A.R.T' Principle (Specific, Measurable, Achievable, Relevant, Time-Bound).	☐

Other considerations

4 Principles of ecologically sustainable development (ESD)

The preliminary documentation must provide information about how the proposed action is consistent with each of the principles of ESD. The principles of ESD are outlined in section 3A of the EPBC Act and specified below.

Section 3A Principles of Ecologically Sustainable Development

a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;

b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;

c) the principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;

d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and

e) improved valuation, pricing and incentive mechanisms should be promoted.

5 Economic and social matters

The preliminary documentation must provide information about the expected long- and short-term economic and social impacts of the proposed action, both positive and negative. This must include, but not necessarily be limited to, the points outlined in **Table 5** below.

Table 5 Economic and social matters checklist

Consideration of negative impacts (e.g. disruption to existing community infrastructure, environmental features, and/or cultural and traditional activities).	☐
Consideration of positive impacts (e.g., increased housing, employment, social amenity).	☐
Consideration of different scales of impact (e.g. local, regional, state).	☐
Estimated capital value and ongoing economic value, using specific dollar or other numerical values where relevant.	☐
Discussion of relevant public consultation undertaken or to be undertaken since the lodgement of the referral documentation, including with First Nations people and communities, including any issues raised in objection or support of the proposed action. Please refer to the department's First Nations engagement guidelines for more information on how and when to engage with First Nations people and communities.	☐
Discussion of any contributions for the proposed action (e.g. Commonwealth and/or State government funding).	☐

APPENDIX B :

Menangle Park Site Wide Bulk Earthworks Species Impact Statement

Menangle Park Site Wide Bulk Earthworks

Species Impact Statement: DA 3574/2019/DA-CW

Dahua Group Australia

30 July 2024

Final

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Report No. 17072RP37

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or commendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology.

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Approved by:	**Dr David Robertson**
Position:	Director
Signed:	
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Glossary

Term / Abbreviation	Definition
BBAM	BioBanking Assessment Methodology
BC Act	*Biodiversity Conservation Act 2016*
BSA	Biodiversity Stewardship Agreement
BVT	Biometric Vegetation Type
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
CER	Chief Executive Requirements
Conservation Areas	Park K, Park L, the Howes Creek Conservation Area, the Northern Conservation Area, and the Stage 6B EBSF Conservation Area
CPW	Cumberland Plain Woodland
DA	Development Application
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
EBSF	Elderslie Banksia Scrub Forest
EEC	Endangered Ecological Community
EHG	Environment and Heritage Group
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic Information System
GPS	Global Positioning System
ha	Hectares
LGA	Local Government Area
Locality	As defined in the Threatened Species Assessment Guidelines (DECC 2007)
Local Area	The area within a 5 km radius of the study area
NSW	New South Wales
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
MNES	Matters of National Environmental Significance
OEH	NSW Office of Environment and Heritage (now EHG)
PCT	Plant Community Type
Proposed conservation works	Conservation and rehabilitation of native flora and fauna within proposed conservation areas as shown in **Figure 1**.

Term / Abbreviation	Definition
Proposed development works	Clearing of all vegetation within proposed development areas as shown in **Figure 1** to facilitate the subdivision and subsequent development. The legal subdivision of land is not proposed under this DA.
Proposed works	the combined development and conservation works that comprise the BEW DA as shown in **Figure 1.**
Campbelltown DCP 2015	*Campbelltown (Sustainable City) Development Control Plan 2015*
Campbelltown LEP 2015	*Campbelltown Local Environment Plan 2015*
SEE	Statement of Environmental Effects
SEPP 19	*State Environmental Planning Policy 19 – Bushland in Urban Areas*
SEPP 44	*State Environmental Planning Policy 44 – Koala Habitat Protection (repealed)*
SREP 20	*Sydney Regional Environmental Plan No 20 – Hawkesbury-Nepean River*
SIS	Species Impact Statement
study area	The area including the subject site and any areas affected by the proposal, either directly or indirectly (see **Figure 1**).
subject site	The area subject to the proposed works, including development and conservation measures, as shown in **Figure 1**
Sydney Region Growth Centres SEPP	*State Environmental Planning Policy – Sydney Region Growth Centres 2006*
TEC	Threatened ecological community
TSC Act	NSW Threatened Species Conservation Act 1995 (repealed)
VMP	Vegetation Management Plan
VMP 1	VMP for the Howes Creek and Northern Conservation Area
VMP 2	VMP for Parks K and L
VPA	Voluntary Planning Agreement
Wider locality	The area within a 10 km radius of the study area
WONS	Weed of National Significance

Executive Summary

S1 Purpose

Cumberland Ecology has been commissioned by Dahua Group Australia (the 'proponent') to prepare a revised Species Impact Statement (SIS) to support a submitted development application (DA) (DA 3574/2019/DA-CW) for site-wide bulk earthworks.

The **proposed works** that are the subject of this SIS comprise both development and conservation works within the Menangle Park Urban Release Area north of Menangle Road. They include:

- the **proposed development works** that entail bulk earthworks to regrade the site, the associated vegetation clearance, and enabling site works within proposed development areas as shown in **Figure 1** to facilitate future subdivision works and subsequent development of land in accordance with the Menangle Park Master Plan; and
- the **proposed conservation works** that entail conservation and rehabilitation of native flora and fauna within five proposed conservation areas as shown in **Figure 1**.

The proposed conservation works are summarised in this SIS, which also refers to detailed information in the vegetation management plan (VMP) for Parks K and L (Cumberland Ecology 2022), and the VMP for the Howes Creek and the Northern Conservation Areas (Cumberland Ecology 2022). The VMP for the Stage 6B Elderslie Banksia Scrub Forest (EBSF) Conservation Area is proposed to be prepared as a Condition of Consent for the project and include management consistent with the VMPs for Parks K and L, and the Howes Creek and Northern Conservation Area. The SIS should be read in conjunction with the VMPs.

The land on which the proposed works will occur is referred to as the 'subject site', which is in the Campbelltown Local Government Area (LGA). A small portion of the Northern Conservation Area in the far north of the subject site occurs within the Camden LGA; however, no proposed development works will occur in this area and works will be restricted to the conservation and management of vegetation under a VMP.

The purpose of the proposed development works is to facilitate future urban development as permitted by the current zoning, the Urban Structure Plan contained in the Campbelltown City Council (Council) *Development Control Plan Part 8 – Menangle Park*, and with reference to the proponent's Master Plan (the 'Master Plan') for the Menangle Park Urban Release Area (URA) (see **Figure 2**). Although the proposed development works do not include future urban development, which will be covered by subsequent development applications (DAs), the anticipated impacts of such developments are considered within this SIS.

The purpose of the proposed conservation works is to provide guidance for the in-perpetuity management of the conservation areas of the URA, including guidance to:

- Reconstruct areas of the subject site currently mapped as exotic vegetation communities to native vegetation, using bushland regeneration and revegetation techniques; and

- Promote regeneration of areas of the subject site currently mapped as remnant native vegetation through appropriate weed control techniques.

The purpose of this SIS is to assess the impacts of the proposed development works on threatened species and communities, and provide appropriate amelioration measures for adverse impacts. This SIS has been prepared in accordance with Section 109 and 110 of the NSW *Threatened Species Conservation Act 1995* (repealed) (TSC Act) and the requirements of the Chief Executive of the NSW Office of Environment and Heritage (OEH) (Chief Executive Requirements (CERs)), which are provided in **Appendix A**. Note that OEH is now referred to as the Environment and Heritage Group (EHG). This document refers to both OEH and EHG where relevant. For example, CERs were issued by OEH and species databases are currently published by EHG.

This report was previously updated from the version submitted to Council in June 2022 to account for:

- updates requested by Council requested in December 2022;
- to address vegetation removal within contaminated land on Lot 59 DP 10718 (**Figure 3**); and
- the removal of Spring Farm Parkway lands from the proposed works.

These changes are consistent with the Remediation DA submitted with the BEW DA.

This report has subsequently been updated a second time from the version submitted to Council and EHG in February 2023 to account for:

- updated Lot/DP numbers;
- the newly proposed conservation of an additional ~0.21 hectare (ha) EBSF patch within Stage 6B. This new area of retained EBSF will be conserved under a new VMP that is separate from the VMPs for Parks K and L (VMP 2) and Howes Creek / Northern Conservation Area (VMP 1). The VMP for the retained area of EBSF at Stage 6B will be prepared in accordance with a condition of consent
- additional discussion and inclusion of vegetation patches considered EBSF by EHG;
- clarifying the conservation mechanisms for the five areas within the proposed conservation works will be under VMPs supported by a Voluntary Planning Agreement (VPA); and
- updates agreed with Council and EHG during ongoing discussions held in 2023-2024.

S2 Background

S2.1 Location

The subject site is comprised of several parcels of land located between Menangle Road, Cummins Road and Glenlee Road in Menangle Park. It is zoned as a mix of 'R3 – Medium Density Residential', 'R2 Low Density Residential', 'RE1 Public Recreation', 'R5 Large Lot Residential', 'SP2 Infrastructure', 'RU2 Rural Landscape', 'B2 – Local Centre' and 'IN1 General Industrial' (**Figure 4**).

The surrounding land use in adjacent lands is primarily agricultural with some patches of remnant vegetation. The site is immediately bounded by:

- Menangle Road to the south. On the south side of Menangle Park are existing and future stages of the Menangle Park master planned community.
- Hume motorway to the east.
- Rural residential lots, including Menangle Park village to the immediate west, with Menangle Park Train Station and rural lands further west. The existing rural residential lots are zoned low and medium density residential.
- Australian Botanic Gardens to the north.

Council, supported by Dahua, has prepared a planning proposal to amend *Campbelltown Local Environment Plan 2015* (LEP) in relation to the Menangle Park URA. This amendment builds upon the site's previous rezoning and associated Structure Plan including additional dwellings with varying densities, a new major town centre, neighbourhood centre and a revised road network.

S2.2 Previous Ecological Assessments

Earlier versions of this SIS have been submitted to, and reviewed by Council. Council provided detailed comments to the previously submitted versions and this revised SIS responds to all Council comments. Modifications to the revised SIS include:

- the footprint of the proposed development works has been substantially reduced;
- one of the parks that will be subject to the conservation works has been modified to provide a uniform 30 m wide buffer around it to better protect the threatened ecological community (TEC) EBSF;
- additional retention of a 0.21 ha patch of EBSF to be managed in perpetuity under a VMP;
- baseline flora and fauna information has been increased by completion of extensive additional surveys during wetter conditions that occurred since the breaking of the drought in early 2020; and
- baseline information about groundwater and groundwater dependent communities is included.

The biodiversity values of the study area and subject site are well known as these areas have been extensively surveyed. Cumberland Ecology has prepared a series of ecological assessments in the Menangle Park URA and these are summarised and used in the SIS.

S3 Description of the Subject Site, Study Area and Local Area

S3.1 The Subject Site

For the purposes of this SIS, the subject site constitutes all land that will be directly impacted by the proposed development works, including:

- APZs, comprising an area of ~152 ha;
- The proposed conservation works, comprising an area of ~60 ha. All of this land is subject to the *Campbelltown DCP 2015 Volume 1 Section 11 (Vegetation and Wildlife Management) and Volume 2 Part 8 Section 1.11 (Environmental Management)*. As mentioned, three VMPs will apply across this land; and
- Vegetation that will be cleared which is not sited on land that will be subject to a VMP.

The subject site also contains land mapped as 'Terrestrial Biodiversity' under Clause 7.20 'Terrestrial Biodiversity' of the *Campbelltown Local Environment Plan (LEP) 2015* map (BIO_003) (see **Figure 5**).

S3.2 Description of the Study Area

The "study area" is a formal term used in an SIS to refer to the area of land that is both subject to direct impacts of a proposed development, and any indirect impacts. Indirect impacts can include changes to surface and groundwater flow, impacts to wildlife corridors and overall habitat connectivity, weed invasion, changes to lighting, noise levels and air quality in adjacent areas. For the purposes of this SIS the study area encompasses a wide area around the proposed development works area of ~988 ha, as shown on **Figure 1**. This has been set to provide a conservative assessment of areas that could be subject to indirect impacts from the project.

S3.3 Topography, Geology and Soils

The topography of the study area is gently undulating with the flattest areas located alongside the Nepean River and Howes Creek. The land is relatively low altitude and ranges from 60 metres (m) asl beside the Nepean River and 190 m asl on hilltops (see **Figure 7**). Low lying areas of the study area contain ephemeral creek/drainage lines that are periodically inundated after heavy rain. Most of the study area is underlain by Bringelly Shale with low infiltration rates comprising shale, carbonaceous claystone, laminite, fine to medium grained lithic sandstone and rarely coal.

S3.4 Vegetation

Despite past clearing for agriculture, fourteen native vegetation communities and one exotic vegetation community were recorded within the study area by Cumberland Ecology and/or have been mapped by the OEH as part of the Remnant Vegetation of the Western Cumberland Subregion mapping project (OEH 2013b). Where possible, vegetation community names follow names within DECCW (2007).

The exotic vegetation community present is separated based on grassland or woody condition states, with the later dominated by exotic woody species. These vegetation communities are present throughout the study area within open and generally tree-less areas, in dense woody conditions states in riparian areas, and include cleared areas currently occupied by existing structures, roads and infrastructure. The exotic vegetation communities include Exotic Grassland/Cleared Land, Privet Dominated Exotic Woody Vegetation, African Olive Dominated Exotic Woody Vegetation, and Other Exotic Dominated Woody Vegetation.

The native vegetation communities recorded in the study area all have the potential to conform to TECs listed under the TSC Act and are described in detail in **Chapter 4** of the SIS. TECs listed under the TSC Act present include:

- Shale Plains Woodland, Shale Plains Woodland derived native grassland, Shale Hills Woodland and Shale Hills Woodland derived native grassland conform to Cumberland Plain Woodland (CPW) in the Sydney Basin Bioregion (critically endangered ecological community (CEEC) TSC Act);
- River-Flat Eucalypt Forest conforms to River-flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (endangered ecological community (EEC) TSC Act);
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion (CEEC TSC Act);
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act); and
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act).

S4 Methodology

S4.1 Desktop Study

A detailed desktop study was undertaken to collate and assess available information to determine the species and vegetation communities that are known or considered likely to be present in the study area.

Various sources were utilised in undertaking the desktop assessment, including previous ecological assessments, the vegetation mapping of the Cumberland Plains (OEH 2013a), the Atlas of NSW Wildlife database (EES 2020), the EPBC Protected Matters Search Tool (DAWE 2020) and relevant recovery plans for threatened species.

S4.2 Field Studies

Field studies were undertaken and were guided by the results of the desktop assessment, Council comments on the previous SIS, and agency survey guidelines. In particular, the following threatened species and communities were targeted through detailed field survey.

Vegetation Communities – all the previously listed native vegetation communities.

Threatened flora species:

- *Allocasuarina glareicola* - Endangered TSC Act and EPBC Act;
- *Cynanchum elegans* (White-flowered Wax Plant) – Endangered TSC Act and EPBC Act;
- *Eucalyptus benthamii* (Camden White Gum) – Vulnerable TSC Act and EPBC Act;
- *Genoplesium baueri* (Bauer's Midge Orchid) – Endangered TSC Act and EPBC Act;
- *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) – Vulnerable TSC Act and EPBC Act;

- *Gyrostemon thesioides* – Endangered TSC Act;
- *Maundia triglochinoides* – Vulnerable TSC Act;
- *Persicaria elatior* (Tall Knotweed) – Vulnerable TSC Act and EPBC Act;
- *Pimelea spicata* (Spiked Rice-flower) – Endangered TSC Act and EPBC Act;
- *Pomaderris brunnea* (Brown Pomaderris) – Endangered TSC Act and Vulnerable EPBC Act;
- *Pterostylis saxicola* (Sydney Plains Greenhood) – Endangered TSC Act and EPBC Act;
- *Pultenaea pedunculata* (Matted Bush-pea) – Endangered TSC Act; and
- *Thesium australe* (Austral Toadflax) – Vulnerable TSC Act and EPBC Act.

Threatened fauna species:

- Arboreal mammals including gliders and the Koala (*Phacolarctos cinereus*);
- Threatened and listed migratory birds;
- Microchiropteran bats;
- Grey-headed Flying-fox (*Pteropus poliocephalus*); and
- Cumberland Plain Land Snail (*Meridolum corneovirens*).

Endangered populations

- *Marsdenia viridiflora* R. Br subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas.

S5 Results

S5.1 Vegetation

A mixture of native and exotic plant communities occurs in the study area, ranging from native woodland, to derived native grassland to a suite of plant communities wholly dominated by exotic plants. These are mapped in **Figure 15** in the SIS. **Table 1** below lists the vegetation communities occurring within the study area, the equivalent DECCW (2007) map unit, the PCT and associated Biometric Vegetation Type (BVT), and the area of occupancy.

Cumberland Plain Woodland (Shale Hills Woodland and Shale Plains Woodland) is the most widespread native woodland which occurs as scattered patches of woodland amid grasslands. There are also patches of EBSF, River-flat Eucalypt Forest, Shale Hills Woodland shrubby regrowth, and Swamp Oak Floodplain Forest. Within the EBSF, several small, scattered patches have been identified by EHG that were not previously incorporated into the mapping and are not considered to conform to the ecological community as per its final determination;

therefore, these have been referred to as comprising a non-TEC form of the community and are provided as distinct from the existing mapping of EBSF.

The remaining areas are generally comprised of derived native grasslands, varying condition states of exotic vegetation, along with areas of Freshwater Wetland and artificial farm dams with or without fringing vegetation.

Table 1 Approximate areas of vegetation communities occurring within the study area and subject site

Vegetation Community	DECCW (2007) Map Unit	PCT/BVT	TSC Act Status	Proposed Development Works Area (ha)	Proposed Conservation Works Area (ha)	Study Area (ha)*	Subject Site (ha)*
Shale Plains Woodland	10 – Shale Plains Woodland	849/ HN528	CEEC	5.94	11.59	30.41	17.53
Shale Plains Woodland (derived native grassland)	10 – Shale Plains Woodland	849/ HN528	CEEC	8.67	0.43	23.01	9.09
Shale Hills Woodland	9 – Shale Hills Woodland	850/ HN529	CEEC	4.80	0.00	20.75	4.80
Shale Hills Woodland (derived native grassland)	9 – Shale Hills Woodland	806/ HN627	CEEC	3.28	0.00	3.48	3.28
Shale Hills Woodland (shrubby regrowth)	9 – Shale Hills Woodland	806/ HN627	-	0.49	0.00	1.49	0.49
Moist Shale Woodland	14 - Moist Shale Woodland	830/ HN524	EEC	0.00	0.00	12.16	0.00
Elderslie Banksia Scrub Forest	37 – Elderslie Banksia Scrub Forest	774/ HN635	CEEC	0.77	1.74	2.50	2.49
Elderslie Banksia Scrub Forest (non-TEC)	37 – Elderslie Banksia Scrub Forest	774/ HN635	-	0.10	0.00	0.12	0.10

Vegetation Community	DECCW (2007) Map Unit	PCT/BVT	TSC Act Status	Proposed Development Works Area (ha)	Proposed Conservation Works Area (ha)	Study Area (ha)*	Subject Site (ha)*
River-flat Eucalypt Forest	12 – Riparian Forest 11 – Alluvial Woodland	835/ HN526	EEC	1.51	8.44	58.52	9.96
River-flat Eucalypt Forest (derived native grassland)	12 – Riparian Forest 11 – Alluvial Woodland	835/ HN526	-	0.00	0.00	0.19	0.00
Swamp Oak Floodplain Forest	11 – Alluvial Woodland	1800/ HN674	EEC	3.39	7.16	11.12	10.55
River Oak Riparian Woodland	12 – Riparian Forest	1105/ HN574	-	0.00	0.01	4.62	0.01
Freshwater Wetlands	36 – Freshwater Wetlands	1071/ HN630	EEC	0.37	6.15	6.86	6.52
Exotic Grassland/ Cleared Land	-	-	-	119.80	19.68**	398.91	138.68
African Olive Dominated Exotic Woody Vegetation	-	-	-	1.32	0.01	1.46	1.33
Privet Dominated Exotic Woody Vegetation	-	-	-	0.00	3.46	6.62	3.46
Other Exotic Dominated Woody Vegetation	-	-	-	0.05	0.06	3.08	0.11
Dam	-	-	-	1.01	0.84	3.29	1.86

Vegetation Community	DECCW (2007) Map Unit	PCT/BVT	TSC Act Status	Proposed Development Works Area (ha)	Proposed Conservation Works Area (ha)	Study Area (ha)*	Subject Site (ha)*
Unmapped Areas	-	-	-	0.00	0.00	398.79	0.00
Total				**151.58**	**59.59**	**987.32**	**210.33**

**Total includes rounding and may be different to the sum of the individual areas*

***Includes 0.77 ha where Swamp Oak Floodplain Forest and 0.02 ha where Shale Plains Woodland will be removed as part of the proposed development works*

S5.2 Threatened Species

S5.2.1 Threatened Flora

Despite repeated, extensive surveys, including recent surveys in optimal conditions, no threatened plant species have been found within the subject site. The vegetation present, particularly the ground stratum, is heavily modified by historic clearing, livestock grazing and weed invasion. No threatened flora species are considered likely to occur or be impacted by the project.

S5.2.2 Threatened Fauna

The SIS provides a detailed analysis of the species most likely to be affected by the proposed development works. The following fauna species are considered most likely to be affected by the proposal and are considered to be "affected species": Black-necked Stork (*Ephippiorhynchus asiaticus*); Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*); Dusky Woodswallow (*Artamus cyanopterus cyanopterus*); Eastern Cave Bat (*Vespadelus troughtoni*); Eastern False Pipistrelle (*Falsistrellus tasmaniensis*); Eastern Coastal Free-tailed Bat (*Mormopterus norfolkensis*); Greater Broad-nosed Bat (*Scoteanax rueppellii*); Grey-headed Flying-fox (*Pteropus poliocephalus*); Large Bent-winged Bat (*Miniopterus schreibersii oceanensis*); Little Bent-winged Bat (*Miniopterus australis*); Little Eagle (*Hieraaetus morphnoides*), Little Lorikeet (*Glossopsitta pusilla*), Powerful Owl (*Ninox strenua*), Southern Myotis (*Myotis macropus*); Varied Sittella (*Daphoenositta chrysoptera*); and White-bellied Sea-Eagle (*Haliaeetus leucogaster*).

S6 Impacts

S6.1 Direct Impacts

S6.1.1 Vegetation Clearance

Vegetation clearance will have the most significant ecological impact out of all works that are proposed under this DA. The proposed scope of vegetation clearance under this DA comprises:

- Ecologically harmful clearing of native vegetation in the development areas; and

- Ecologically beneficial clearing of exotic vegetation and replanting of native vegetation in the conservation areas in accordance with the proposed VMPs.

Table 2 gives the areas of each vegetation community to be cleared within the study area and subject site. The distribution of these communities is shown in **Figure 15.**

The proposed development works will clear ~152 ha of woodland and grassland vegetation and ~ 1.01 ha of old farm dams. Most of the vegetation cleared is exotic grassland and shrubland. Approximately 29.3 ha of native vegetation will be cleared and this is comprised of about 17.3 ha of woodland or intact vegetation and 11.9 ha of derived native grassland. Impacts (indirect and direct) to these native vegetation communities are discussed further in **Chapter 6**.

The proposed conservation works will clear exotic-dominated vegetation. The five conservation areas comprise about 60 ha of which ~22 ha is currently infested by exotic woody weeds and grasses. These will be progressively cleared and replaced with native woodland, forest, and freshwater wetland species; along with the areas that will be cleared as part of the contaminated land remediation works. This ecologically beneficial clearing is explained below in **S8**, and within **Chapter 7** of the SIS. Currently, there is a substantial break in connectivity between the train line in the west and the vegetation further to the south east. While the proposed development footprint includes a road break further east in the Howes Creek riparian corridor, the width of this break is less than what currently exists and therefore the proposed conservation works will likely assist in increasing the habitat connectivity for threatened species and TECs long-term.

Table 2 Vegetation to be cleared within the study area

Vegetation Community	PCT/BVT	TSC Act	Proposed Development Works Area (ha)	Subject Site (ha)	% Retained in Subject Site
Shale Plains Woodland	849/ HN528	CEEC	5.94	17.53	66.08
Shale Plains Woodland (derived native grassland)	849/ HN528	CEEC	8.67	9.09	4.62
Shale Hills Woodland	850/ HN529	CEEC	4.80	4.80	0.00
Shale Hills Woodland (derived native grassland)	806/ HN627	CEEC	3.28	3.28	0.00
Shale Hills Woodland (shrubby regrowth)	806/ HN627	-	0.49	0.49	0.00
Moist Shale Woodland	830/ HN524	EEC	0.00	0.00	-

Vegetation Community	PCT/BVT	TSC Act	Proposed Development Works Area (ha)	Subject Site (ha)	% Retained in Subject Site
Elderslie Banksia Scrub Forest	774/ HN635	CEEC	0.77	2.49	69.08
Elderslie Banksia Scrub Forest (non-TEC)	774/ HN635	-	0.10	0.10	0.00
River-flat Eucalypt Forest	835/ HN526	EEC	1.51	9.96	84.84
River-flat Eucalypt Forest (derived native grassland)	835/ HN526	-	0.00	0.00	-
Swamp Oak Floodplain Forest	1800/ HN674	EEC	3.39	10.55	67.87
River Oak Riparian Woodland	1105/ HN574	-	0.00	0.01	-
Freshwater Wetlands	1071/ HN630	EEC	0.37	6.52	94.33
Exotic Grassland/Cleared Land	-	-	119.80	138.68	13.61
African Olive Dominated Exotic Woody Vegetation	-	-	1.32	1.33	0.90
Privet Dominated Exotic Woody Vegetation	-	-	0.00	3.46	100.00
Other Exotic Dominated Woody Vegetation	-	-	0.05	0.11	52.55
Dam	-	-	1.01	1.86	45.70
Unmapped Developed, Exotic and Cleared Land	-	-	0.00	0.00	-
Total			**151.58**	**210.33**	-

S6.1.2 Removal of Fauna Habitat

The vegetation occurring within the subject site provides marginal potential habitat for a range of flora and fauna, including species that are listed as threatened under the TSC Act and/or EPBC Act. The vegetation communities also support specific habitat features that provide foraging, shelter and breeding opportunities for fauna. The proposal will remove these habitats and features within the subject site.

Fauna habitat features that will be removed because of the proposed development works include:

- Terrestrial habitat features such as ground and shrub layer vegetation, leaf litter, coarse woody debris;
- Hollow bearing trees;
- Blossom-producing trees and shrubs;
- Stick nests;
- Farm dams; and
- Freshwater wetlands.

The removal of these habitat features also has the potential to directly impact the fauna species utilising the habitats during the clearing process. Although some species, including diurnal species and highly mobile species may relocate during this period, there is potential for fauna to remain within the habitat features, such as hollows.

Although the habitat features listed above within the subject site will be removed, mitigation measures are proposed during the clearing process to ameliorate any impacts on resident fauna, including, birds, roosting microchiropteran bats, frogs and small reptiles.

S6.2 Indirect Impacts

The proposed development works may have indirect impacts on the ecological values of remaining vegetation and habitat within the study area, including edge effects, shading, alteration to hydrological regimes and changes to weed occurrences.

Additionally, some construction and operational impacts, such as those relating to dust, noise and light, will also impact the remaining vegetation and habitat. Indirect impacts relevant to the project are summarised below and considered in detail in **Chapter 5** and **Chapter 6**.

S6.2.1 Habitat Fragmentation

The proposed development works involve clearing of ~1.01 ha of dams and ~152 ha of vegetation, of which ~29.3 ha is native. The proposal clears habitat that is already isolated and degraded within the study area. As a result, the proposed clearing of vegetation will reduce remaining habitat but will not isolate habitat patches. As such, the proposed removal of the vegetation and associated habitat within the subject site would not add to fragmentation further than current conditions. It is worth noting that the proposed development works have

avoided most areas of habitat that provide connectivity within the study area (e.g. riparian corridors). The areas of conservation and retention are identified at ***Section 6.4.2***.

S6.2.2 Edge Effects

The vegetation within the subject site consists of patches of vegetation that are currently considered to be subject to a high degree of edge effects because of being bounded by previously cleared areas. The proposed development works will increase the edge effects within the study area; however, these effects are likely to have minor impacts on the flora and fauna present as they currently utilise habitat experiencing these effects due to the large areas of Exotic Vegetation already present in the study area. The SIS provides detailed descriptions of such edge effects.

S6.2.3 Alterations to Hydrological Regimes and Groundwater

Groundwater flows beneath parts of the subject site and supports a suite of presumed groundwater dependent ecosystems (GDEs). These plant communities rely at least in part for their survival on groundwater.

GDEs are most likely to occur on site where groundwater is found within deeper, more permeable soil substrates including deep sandy soils and gravels. Across Menangle Park the following relevant geological settings occur:

- Quaternary aged quartz and lithic fluvial sand, silt and clay;
- Tertiary aged alluvial;
- Alluvium gravel, swamp deposits and sand dunes; and
- Triassic aged Wianamatta Group Shale and Sandstone.

The Bringelly Shallow (Wianamatta Group) is present along the elevated southern portion of the site and to the northeast of Howes Creek. The central portion of the site is dominated by Tertiary Alluvium while the north-west portions of Howes Creek are present in an area of Quaternary Alluvium.

The analysis within the SIS found the most likely GDEs include:

- River-flat Eucalypt Forest – Terrestrial Ecosystem;
- Elderslie Banksia Scrub Forest – Terrestrial Ecosystem;
- Swamp Oak Floodplain Forest – Terrestrial Ecosystem; and
- Freshwater Wetlands – Aquatic Ecosystem.

Some limited areas of groundwater dependent ecosystems will be cleared within the subject site. However, most groundwater dependent ecosystems will be conserved within Parks K and L, and the Howes Creek and Northern Conservation Areas.

As development takes place in the subject site there is potential to change groundwater resources available to groundwater dependent ecosystems within the conservation areas. To minimise potential impacts to groundwater levels a range of mitigation strategies have been recommended and will be implemented. While there is potential for indirect impacts to groundwater and groundwater dependent ecosystems, these will continue to be monitored as development proceeds Further detail about groundwater is provided in ***Section 5.1.3.2***.

S6.2.4 Increased Sedimentation, Erosion and Runoff

Sediment and erosion control and reduction measures will be implemented prior to the clearing phase of the proposed development works to reduce sediment runoff into retained habitat, with particular focus on the retained areas of vegetation identified above. Additionally, a management plan will be developed that will outline measures to mitigate potential impacts on retained vegetation (including impacts associated with sedimentation, erosion and runoff) within the study area from the commencement of the proposed development works to the completion of future development within the subject site. If controls prescribed within **Chapter 7** of this report and within the management plan are implemented, it is expected that these indirect impacts will be appropriately mitigated.

S6.2.5 Weeds

There are 31 species of weeds listed as priority weeds or weeds of concern in the Greater Sydney area under the *Biosecurity Act 2015* currently occurring within parts of the study area. There is a risk that seeds or other propagules from these weeds could be dispersed while the proposed works are being undertaken, either on vehicles or clothing of the workers involved, and from the time the proposed works are completed until future development is completed, which may be several years. To mitigate the risk of weed dispersal, a monitoring plan will be implemented as specified in the VMPs prepared for the conservation areas that will include the monitoring of any weed dispersal into areas of retained vegetation and provide appropriate mitigation measures and/or management actions to minimise any significant weed dispersal found to occur.

S6.2.6 Construction and Operational Impacts

Several indirect impacts relevant to the construction and operational phases of the proposed development works have the potential to impact the ecological values of the study area, such as those relating to dust, noise, light, shading and urbanisation. The potential for such indirect impacts is discussed in detail in the SIS and a suite of appropriate mitigation measures for these indirect impacts is proposed in **Chapter 7**.

S7 Feasible Alternatives

S7.1 Do Nothing

If nothing is done and no development occurs, the areas of vegetation within the subject site are likely to survive in the long term *in situ*, however the condition and structure of the vegetation is expected to continue to degrade and be further modified due to its current isolation and exposure to edge effects. If nothing is done, it is expected over time the exotic species will increase in abundance and continue to provide competition for

native species in the long term. Better conservation outcomes would eventuate from protecting and enhancing areas of higher condition native vegetation that provide connectivity to areas of habitat located outside of the study area.

The subject site is within the 'Menangle Park Urban Release Area', which is a priority release area in the NSW Department of Climate Change, Energy, the Environment and Water's (NSW DCCEEW) Greater Macarthur Priority Area. The objective of the 'Menangle Park Urban Release Area' is to support the Campbelltown-Macarthur Regional City through land release, new infrastructure and urban renewal. Therefore, the proposed works is in alignment with the aims of the NSW DCCEEW's Greater Macarthur Priority Area, and to do nothing would not support the Campbelltown-Macarthur Regional City. Further to this, the proposed works build upon previously approved development in surrounding areas that also aim to meet the needs of the Greater Macarthur Priority Area.

S7.2 Alternative Development Layout

Any number of alternative development layouts could be developed within the study area; however, the proposed works form part of larger development within the Menangle Park URA as identified in the Menangle Park Structure Plan, which has been developed with consideration to Cumberland Ecology's 'Menangle Park Structure Plan Review' (2016a), along with a proposed Concept Plan for all lands within the 'Menangle Park Release Area' owned by the proponent. A significant amount of survey work and planning has been undertaken to identify areas most appropriate for development (exotic grassland and small isolated patches of woodland) as well as conservation (larger areas of woodland such as the Howes Creek Riparian Corridor) to minimise impacts on threatened entities.

The current proposed development works design has avoided areas considered to have the highest biodiversity value as far as practicable while still delivering future development consistent with the needs of the priority growth area. All areas of native vegetation and associated threatened species habitat proposed to be removed will be appropriately offset for through one of the following mechanisms:

- the purchase and retirement of ecosystem and species credits; and
- In-perpetuity management of conservation areas under a VMP attached to a VPA.

This provides for a sustainable ecological outcome as the fragmented and degraded areas of the communities to be removed will be balanced by conservation and restoration of areas of native vegetation that will be managed in perpetuity.

The Howes Creek Conservation area currently links to the Nepean River and the connectivity of habitat will be improved by revegetation works in the future. Similarly, the Northern Conservation Area is located adjacent to the Mount Annan Botanic Gardens and woodland vegetation that is being restored within it will complement and form a steppingstone habitat link to woodlands being restored at Mount Annan.

The current development layout maximises residential development within the subject site, while providing for sustainable conservation outcomes, which is in alignment with the aims of the NSW DCCEEW's Greater

Macarthur Priority Area which is to provide land release, new infrastructure and urban renewal in order to support the Campbelltown-Macarthur Regional City.

S7.3 Reduced Scale

Reductions to the scale of the development could occur, which would entail setting aside some additional areas of woodland, and this has in fact occurred in the latest version of this report with the additional conservation of the EBSF patch occurring in Stage 6B. However, the remaining patches of woodland and scattered shrubs currently proposed for clearing and development are comprised of relatively young regrowth vegetation and have disturbed ground stratum vegetation. Moreover, they are currently isolated from other patches of woodland and if retained would become further isolated as development proceeds around them. Retention of some additional patches of woodland would substantially reduce the financial incentives of development as fewer or smaller lots would be required, while the overall ecological benefits would be limited by the isolation of these patches.

Furthermore, the proposed development works are consistent with the proposed Concept Plan that has been submitted to Council. Therefore, a reduction in scale would not be consistent with the proposed Concept Plan or the aims of the Greater Macarthur Priority Area.

S8 Ameliorative and Compensatory Measures

S8.1 Mitigation Measures

A range of mitigation measures have been developed for the proposed development works to mitigate the impacts that are unable to be avoided using the measures outlined previously, including the preparation of a Construction Environment Management Plan (CEMP) that is to be subsequently approved by Council prior to issuing a construction certificate (CC) for the DA. The CEMP is to include the following details at a minimum:

- Measures to delineate clearing areas and protect native vegetation that is to be retained, including EBSF. The area of retained EBSF has increased under the amended scope for the BEW DA;
- Pre-clearance and clearance survey requirements;
- Measures to prevent the spread of priority and environmental weeds and *Phytophthora cinnamonii*;
- Required Sediment and Erosion Control Measures/stockpile management as per Managing Urban Stormwater: Soils and Construction (Landcom, 2004) - The Blue Book;
- Noise control measures;
- Air quality control measures (dust);
- Hazardous material management protocols (i.e. fuel etc) addressing storage, use, refilling etc;
- Incident and emergency response protocols;

- Competence, training and awareness procedures (i.e. Environmental inductions, Toolbox talks, training and awareness);
- Roles and responsibilities for implementing, monitoring and reviewing CEMP requirements;
- An overview of relevant environmental management documentation;
- Waste Management procedures as per the submitted Waste Management Plan; and
- Inspection, monitoring and auditing requirements for all environmental controls and adaptive management to ensure environmental mitigation measures remain effective.

S8.2 Compensatory Measures

To compensate for the proposed impacts on the TECs, non-TEC vegetation, and threatened species associated with the proposed development works, the following measures will be implemented:

- Provision of on-site conservation areas within the subject land to compensate for impacts to the TECs Cumberland Plain Woodland (Shale Plains Woodland), River-flat Eucalypt Forest, Freshwater Wetlands and Swamp Oak Floodplain Forest;
- Purchase and retirement of biodiversity credits to compensate for impacts to the TEC Cumberland Plain Woodland (Shale Hills Woodland and Shale Plains Woodland) and EBSF, including for the non-TEC EBSF;
- Purchase and retirement of species credits to compensate for impacts to the Southern Myotis; and
- Retention and revegetation of the TEC EBSF within the proposed conservation works area that will be managed in perpetuity under VMPs (VMP 2: 17072 RP29 and the Stage 6B EBSF Conservation Area to be prepared as a Condition of Consent).

A BioBanking Assessment was undertaken to determine the credit requirements for the Cumberland Plain Woodland, Shale Hills Woodland shrubby regrowth, River-flat Eucalypt Forest, Freshwater Wetlands, EBSF and Swamp Oak Floodplain Forest, and Southern Myotis habitat proposed to be impacted, as well as the credits generated within the proposed conservation areas.

Impacts to EBSF will be partially offset through the retention and revegetation of areas to be managed under VMP 2. The proposed area to be managed under the VMP has been developed in consultation with Council, and therefore not all impacts on EBSF and associated offsets have been assessed utilising the BBAM.

The BioBanking Assessment was undertaken according to the BioBanking Assessment Methodology 2014 (BBAM) (OEH 2014a) under the TSC Act. The BioBanking Assessment is provided in **Appendix G** and a summary of the BioBanking Assessment results are presented in **Table 3**.

This assessment indicated that the provision of the onsite conservation areas including retained vegetation (extant areas) and revegetation areas will adequately offset the impacts to the following TECs and associated Biometric Vegetation Type (BVT):

- River-flat Eucalypt Forest (BVT HN526);

- Swamp Oak Floodplain Forest (HN674); and
- Freshwater Wetlands (BVT HN630).

However, the provision of the onsite conservation areas does not offset the impacts to Shale Plains Woodland (HN528), Shale Plains Woodland derived native grassland (HN528), Shale Hills Woodland (HN529), Shale Hills Woodland derived native grassland (HN529), Shale Hills Woodland shrubby regrowth (HN529), and EBSF (HN635) as these communities will not be retained within offset areas or areas in the offset areas have only generated part of the credits required for the proposed impact to these communities. No species credits have been calculated for the offset areas and accordingly, no on-site offsets for the Southern Myotis occur. Remaining impacts to these communities will be offset by the purchase of ecosystem credits.

Table 3 BBAM credit summary

Vegetation Community	BVT	Impact		Offset Extant Area (CA)		Offset Revegetation Area (CA)		Offset Combined (CA)		Credit Surplus/ Deficit
	BVT	Area (ha)	Ecosystem Credits	Area (ha)	Ecosystem Credits	Area (ha)	Ecosystem Credits	Area (ha)	Ecosystem Credits	Ecosystem Credits
River-flat Eucalypt Forest	HN526	1.51	68	8.44	102	3.84	39	12.28	141	73
Shale Hills Woodland	HN529	4.80	237	0	0	0	0	0	0	-237
Shale Hills Woodland (shrubby regrowth)	HN529	0.49	10	0	0	0	0	0	0	-10
Shale Hills Woodland (derived native grassland)	HN529	3.28	55	0	0	0	0	0	0	-55
Shale Plains Woodland	HN528	5.94	271	11.57	132	11.55	127	23.12	259	-12
Shale Plains Woodland (derived native grassland)	HN528	8.67	146	0.43	6	0	0	0.43	6	-140

Vegetation Community	BVT	Impact		Offset Extant Area (CA)		Offset Revegetation Area (CA)		Offset Combined (CA)		Credit Surplus/ Deficit
Freshwater Wetlands	HN630	0.37	10	6.15	86	1.62	18	7.77	104	94
Swamp Oak Floodplain Forest	HN674	3.39	161	7.16	104	5.68	58	12.84	162	1
Elderslie Banksia Scrub Forest	HN635	0.87*	47	0.21	2	0.56**	30**	0.21	2	-15
Total		**29.32**	**1,005**	**34.83**	**432**	**23.25**	**242**	**58.73**	**674**	**-301**

**0.56 ha of Elderslie Banksia Scrub removal has already been negotiated with Council based on the proposed retention in Parks K and L. Therefore, credit calculations only considered the additional 0.31 ha of removal proposed in this updated SIS. This 0.56 ha was not included in total calculations for the "Offset Combined (CA)" area.*

***These credits were not calculated based on BBAM, these are based on the change in credit liability calculated for the removal of 0.87 ha compared to 0.31 ha of EBSF.*

S8.2.1 Southern Myotis credit calculations

BBAM credit calculations have been undertaken for impacts to the Southern Myotis as this species is not a predicted ecosystem species, it has been recorded within the subject site and breeding habitat for the species occurs within the subject land in the form of woodland with hollow-bearing trees within 200 m of waterbodies with a width of 3m or greater. The species polygon for the Southern Myotis shown in **Figure 18** and is ~6.17 ha comprising the following vegetation areas:

- 3.04 ha of Shale Plains Woodland (HN528);
- 2.63 ha of Swamp Oak Floodplain Forest (HN674);
- 0.29 ha of Elderslie Banksia Scrub Forest (HN635); and
- 0.23 ha of River-flat Eucalypt Forest (HN526).

A total of 136 species credits will be purchased and retired to offset impacts to the Southern Myotis.

S8.2.2 Retention and revegetation of Elderslie Banksia Scrub Forest

The proposed development works require the removal of about 0.77 ha of EBSF from the subject site and an additional 0.10 ha of EBSF (non-TEC). The non-TEC EBSF includes several small, scattered vegetation patches identified by EHG; however, these are not considered to conform to the ecological community and have been mapped separately in this report; regardless, they have been included in the BBAM calculations as part of the TEC and will be offset accordingly through the purchase and retirement of biodiversity credits.

An area of 0.56 ha of the community within the subject land was previously proposed to be removed under a separate remediation DA (REF. 17072RP10), which has now been incorporated into this BEW DA impact area. The areas of the community proposed to be removed consists of small, isolated patches that are generally degraded, and three of the four highest quality and largest patches will be retained and conserved in perpetuity, with the patch to be removed only occurring due to significant land contamination making retention unviable.

To compensate for the proposed removal of this community associated with this DA, extant areas of the community present within the subject land (1.73 ha) are proposed to be conserved and managed under two VMPs (REF. VMP 2 - 17072RP29 and a VMP to be prepared for the Stage 6B EBSF as a Condition of Consent). The VMP 2 will also include the revegetation of 0.56 ha of the community within areas with deep sandy soils surrounding the extant vegetation, including the 0.02 ha that will be cleared in Park K as a requirement for land decontamination works. The proposed areas of the community to be managed under a VMP has been developed in consultation with Council, with an additional ~0.21 ha patch of EBSF now being retained within the Stage 6B area.

As a result, the implementation of the VMPs will result in more than twice the area of the community being retained/revegetated and managed in perpetuity as what is proposed to be removed within the subject land under this DA. The additional 0.42 ha that has been mapped as part of Cumberland Ecology's updated 2021 mapping for this updated SIS, and the 0.10 ha as part of the non-TEC form of the community, was not included

within these negotiations for the VMP area with Council and will be subject to credit liabilities calculated using BBAM (see **Table 3**)

S9 Conclusion

Vegetation clearance will have the most significant ecological impact out of all works that are proposed under this DA.

The proposed scope of vegetation clearance under this DA comprises:

- Harmful clearing of native vegetation in the development areas; and
- Ecologically beneficial clearing of exotic vegetation and replanting of native vegetation in the conservation areas in accordance with the proposed VMPs.

The proposed development works will clear ~150.47 ha of land that comprises woodland and grassland vegetation and ~ 1.01 ha of old farm dams. Most of the vegetation cleared is exotic grassland and shrubland. Approximately 29.3 ha of native vegetation will be cleared and this is comprised of about 17.34 ha of woodland and 11.94 ha of derived native grassland.

The proposed conservation works will clear exotic-dominated vegetation. The five conservation areas comprise about 60 ha of which ~22 ha is currently infested by exotic woody weeds and grasses. These will be progressively cleared and replaced with native woodland, forest and freshwater wetland species.

Within the native vegetation to be cleared, no threatened flora species are likely to occur or be impacted by the proposed development works. Sixteen threatened fauna species may be affected by the works including:

- **Birds**: Black-necked Stork, Brown Treecreeper, Dusky Woodswallow, Varied Sittella and White-bellied Sea-Eagle;
- **Microchiropteran bats**: Eastern Cave Bat, Eastern False Pipistrelle, Eastern Coastal Free-tailed Bat, Greater Broad-nosed Bat, Large Bent-winged Bat, Little Bent-winged Bat, Little Eagle, Little Lorikeet, Powerful Owl, Southern Myotis; and
- **Grey-headed Flying-fox**.

Impacts to some TECs and threatened species have been reassessed by completing seven-part tests and the development will technically have significant impacts on local occurrences of some species and TECs. However, in the long term such impacts will be addressed and ameliorated in three ways:

- by the implementation of a suite of mitigation measures within the development areas;
- by the establishment of conservation reserves and restoration of habitats within them; and
- by the purchase and retirement of ecosystem and species credits to address any potential residual impacts of the proposed development.

Permanent conservation areas will protect viable, representative occurrences of flora and fauna including areas of all TECs and threatened species habitats that occur at Menangle Park as follows:

- Howes Creek and the Northern Conservation Areas will conserve areas of Cumberland Plain Woodland (Shale Plains Woodland), River-flat Eucalypt Forest, Freshwater Wetlands and Swamp Oak Floodplain Forest (REF. VMP 17072RP36);
- Parks K and L will retain and revegetate areas of EBSF, and smaller areas of River-flat Eucalypt Forest, Shale Plains Woodland and Swamp Oak Floodplain Forest (REF. VMP 17072RP29); and
- Stage 6B EBSF Conservation Area will retain a patch of EBSF as part of a VMP to be prepared as a Condition of Consent.

Howes Creek and the Northern Conservation Areas will link to offsite areas and will contribute to substantial corridors of flora and fauna habitat within the locality.

Compensatory measures include the purchase and retirement of ecosystem and species credits.

The proposed combined avoidance, mitigation and compensatory measures are likely to ameliorate the impacts of the proposed development works.

1. Introduction

1.1. Purpose

Cumberland Ecology has been commissioned by Dahua Group Australia (Dahua Group Sydney Project 2 Pty Ltd and Dahua Group Sydney Project 3 Pty Ltd) (the 'proponent') to prepare a revised Species Impact Statement (SIS) to support a submitted development application (DA) (DA 3574/2019/DA-CW) for site-wide bulk earthworks.

The **proposed works** that are the subject of this SIS comprise both development and conservation works within the Menangle Park Urban Release Area (URA) north of Menangle Road. They include:

- the **proposed development works** that entail bulk earthworks to regrade the site, the associated vegetation clearance, and enabling site works within proposed development areas as shown in **Figure 1** to facilitate future subdivision works and the subsequent development of land in accordance with the Menangle Park Master Plan; and
- the **proposed conservation works** that entail conservation and rehabilitation of native flora and fauna within proposed conservation areas (referred to individually as 'Park K', 'Park L', the 'Howes Creek Conservation Area' and 'Northern Conservation Area' and 'Stage 6B Elderslie Banksia Scrub Forest (EBSF)'; referred to collectively as the 'conservation areas'), as shown in **Figure 1**.

Details of the proposed conservation works are summarised in this SIS, and provided in detail in the vegetation management plan (VMP) for Parks K and L (VMP 2) (Cumberland Ecology 2022c), the VMP for the Howes Creek and the Northern Conservation Areas (VMP 1) (Cumberland Ecology 2022d), and the VMP for the Stage 6B EBSF. The SIS should be read in conjunction with VMP 1 and VMP 2. The VMP for the Stage 6B EBSF will be prepared as a condition of consent and include management consistent with VMP 1 and VMP 2.

Due to the potential for the proposed development works to significantly impact on threatened ecological communities (TECs), Chief Executive Requirements (CERs) were sought from the former New South Wales (NSW) Office of Environment and Heritage OEH for the preparation of an SIS. This SIS has been prepared in accordance with Sections 109 and 110 of the NSW *Threatened Species Conservation Act 1995* (repealed) (TSC Act), which describes the form and content of a SIS, except for those matters limited or modified in the CERs as listed in ***Section 1.6***.

The land on which the proposed works (both proposed development works and proposed conservation works) will occur is referred to as the 'subject site', which is in Campbelltown Local Government Area (LGA). A small portion of the Northern Conservation Area in the far north of the subject site occurs within the Camden LGA; however, no proposed development works will occur in this area and works will be restricted to the conservation and management of vegetation under VMP 1.

The purpose of the proposed development works is to facilitate urban development consistent with the current zoning, the Urban Structure Plan contained in the Campbelltown City Council (Council) *Development Control Plan Part 8 – Menangle Park*, and with reference to the proponent's Master Plan (the 'Master Plan') for the Menangle Park URA (see **Figure 2**). Although the development works do not include future urban development, which will be covered by subsequent DAs, the anticipated ecological impacts of such developments are considered within this SIS.

The purpose of the proposed conservation works is to provide a framework and prescriptions for the in-perpetuity management of the conservation areas of the Menangle Park URA, including guidance to:

- Reconstruct areas of the subject site currently mapped as exotic vegetation communities to native vegetation, using bushland regeneration and revegetation techniques; and
- Promote regeneration of areas of the site currently mapped as remnant native vegetation through appropriate weed control techniques.

The proposed development works will require the clearing of TECs that are listed under both the TSC Act and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The proposed works fit the required transitional arrangement criteria for the NSW *Biodiversity Conservation Act 2016* (BC Act), as outlined in the *Biodiversity Conservation (Savings and Transitional) Regulation 2017,* to be assessed under the now repealed TSC Act. Therefore, this report refers to the TSC Act instead of the BC Act.

The purpose of this SIS is to assess the impacts of the proposed works on threatened species and communities and provide appropriate amelioration measures for adverse impacts resulting from the proposed works. This SIS has been prepared in accordance with Section 109 and 110 of the TSC Act and the requirements of the Chief Executive of the former OEH. As of 1 July 2019, OEH was dissolved and is now included in the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW). However, as the CERs were issued by the former OEH, the former agency is referred to throughout this SIS. The CERs are provided in **Appendix A**.

Although this SIS has been prepared primarily to meet the requirements of the TSC Act, the impacts to threatened flora and fauna listed under the EPBC Act have also been assessed. Within this document, reference to threatened flora and fauna includes populations, species and communities listed by the TSC Act and/or the EPBC Act.

The objectives of this SIS are to:

- Identify threatened species issues and provide appropriate amelioration measures for adverse impacts resulting from the proposed works;
- Provide an appropriate level of background information and assessment to facilitate determinations and licensing processes;
- Assist consent and determining authorities in the assessment of the development application under Part 4 or request for Part 5 approval under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act);
- Assist the Chief Executive of the OEH in deciding whether concurrence should be granted for the purposes of Parts 4 or 5 of the EP&A Act; and
- Assist the Chief Executive of the OEH or the Minister for the Environment when consulted for the purposes of Parts 4 or 5 of the EP&A Act.

This document has been structured to comply precisely with the CERs. Throughout the SIS at the start of each major section the relevant parts of the CERs are reproduced in italics to demonstrate how each SIS section complies with statutory requirements.

1.1.1. Report Updates

1.1.1.1. Round 1

This report was initially updated from the version submitted to Council in June 2022 to account for

- updates requested by Council requested in December 2022;
- to address vegetation removal within the 'remediation lot' Lot 59 DP 10718; and
- the removal of Spring Farm Parkway lands from the proposed works.

These changes were consistent with the Remediation DA submitted with the BEW DA, at that time.

In relation to the areas of contaminated land proposed to be cleared, JBS&G has completed contamination assessments of Lot 59 DP 1078. These noted the location of a burial pit (BP7) occurring within the south eastern corner, which overlaps with the north eastern corner of future Park K. Additional contaminated lands, including copper contamination, occur in the north eastern corner of the lot that overlaps with an area included within the Howes Creek riparian corridor (**Figure 3**). Ultimately, both of these areas would be dedicated to Council, and are zoned for E2 / RE1 use.

JBS&G advise the vegetation must be removed in order to complete investigations and ultimately remediation of the future town centre. It is understood that Council would not accept dedication of the E2 / RE1 lands until such time they are remediated at the cost of the developer. Should the vegetation not be removed, an Environmental Management Plan (EMP) would need to be prepared and implemented in perpetuity. This would also mean the balance of the future town centre lot would not be able to be signed off as remediated, as a partial site audit statement would not be issued by a site auditor.

Given the vegetation within contaminated land will require removal, and the land must be remediated, these areas are now included as part of the total extent of vegetation removal proposed under this DA and are incorporated into the 'proposed development works' for the purposes of assessing vegetation clearing. The area of contaminated land will be rehabilitated under VMP 2 relevant to Parks K and L (REF. 17072 RP29) and VMP 1 for the Howes Creek and Northern Conservation Area VMP (REF. 17072 RP36), following remediation works. They are therefore still included within the total 'proposed conservation works' for the purposes of determining future conservation areas.

The total additional area of upfront vegetation removal proposed within the Howes Creek and Northern Conservation Area is ~0.80 ha, comprising ~0.77 ha of Swamp Oak Floodplain Forest, ~0.02 ha of Shale Plains Woodland and ~0.01 ha of Exotic Grassland/Cleared Land. The total additional area of upfront vegetation removal proposed within the Parks K and L Conservation Areas is ~0.04 ha, comprising ~0.02 ha of EBSF and ~0.02 ha of Exotic Grassland/Cleared Land. Both these areas will be entirely rehabilitated to native vegetation in the long term.

1.1.1.2. Round 2

This report has subsequently been updated a second time from the version submitted to Council and EHG in February 2023 to account for:

- updated Lot/DP numbers;
- the newly proposed conservation of the ~0.21 hectare (ha) EBSF patch within Stage 6B, to be conserved under a new VMP to be prepared as a condition of consent;
- additional discussion and inclusion of vegetation patches considered EBSF by EHG;
- clarifying the conservation mechanisms for the five areas within the proposed conservation areas will be under VMPs supported by a Voluntary Planning Agreement (VPA); and
- updates agreed with Council and EHG during discussions held in 2023-24.

As part of ongoing negotiations with EHG, clarification over areas of EBSF mapping and retention / removal has been undertaken.

The additional retention of the ~0.21 ha patch of EBSF occurring within Stage 6B is now proposed and this would be retained as part of a low-use park within the 'residual lot' of Stage 6B, with the EBSF fenced and signed to prevent public access. The park would provide a grassed buffer zone to the patch of EBSF on the northern and eastern sides; though it is noted a full 30 m buffer surrounding the patch is not feasible due to the presence of an existing Council-owned road to the south and the lot to the west being sold as a future school site along with the majority of the western boundary being adjacent to an existing residential lot and dwelling not owned by the proponent. There is also a road to the west that will provide access to the Howes Creek open spaces area, and water and stormwater infrastructure to occur within 30 m of the patch. Nevertheless, this patch of EBSF will further the areas of the Critically Endangered Ecological Community (CEEC) to be retained in perpetuity and the patch will be managed under a VMP prepared to the standards of the Park K and L VMP (REF. 17072 RP29) and the Howes Creek and Northern Conservation Area VMP (REF. 17072 RP36).

There are several small patches of vegetation surrounding Park L that EHG considers to conform to EBSF listed under the TSC Act. Cumberland Ecology has completed a detailed investigation of each of the patches and prepared a letter (REF. 17072 Let50_31.08.2023) outlining the justification for these patches not conforming to the vegetation community or the TEC. This letter was peer reviewed and the peer reviewer agreed with Cumberland Ecology's conclusions. Regardless, to address these areas they have been included within this round of updates to the SIS and mapped as EBSF (non-TEC), which is included within the BBAM calculations and will be offset accordingly. Therefore, while the mapping of these small scattered patches remains disputed on whether or not they conform to EBSF, and it is agreed by EHG that the patches individually are not viable in the long-term in their current state, they will be appropriately offset through the purchase and retirement of biodiversity credits and their removal considered within this report.

Further information on each patch of EBSF mapped within the subject site is included within the Avoidance Memo that is being submitted alongside this SIS. This document identifies the current unique patch identifications and ranks the patches according to their conservation significance. Importantly, three of the

four 'good' and 'moderate' condition patches will be conserved and managed under VMPs, with removal of EBSF restricted to 'poor' and 'very poor' quality patches, or those that must be removed as part of contaminated land remediation works. Management of the retained EBSF will be directed through the three VMPs under a VPA; and will be in line with the requirements of management under a Biodiversity Stewardship Agreement (BSA), despite the Biodiversity Conservation Trust conducting a site inspection of the vegetation and determining that the vegetation is not suitable for a BSA due to the small size and condition.

Several further updates have been made in the second round of updates to the SIS. Firstly, the Lot/DP numbers previously included are outdated, the Addendum Statement of Environmental Effects (SEE) provides the latest accurate information for these. Secondly, the far northern corner of the Northern Conservation Area occurs in the Camden LGA and this area has been removed from the DA documentation as it is not an area impacted by the project; though it is included within the subject site in the ecology reports as it will be subject to conservation works under VMP 2 (REF. 17072 RP36). Finally, the Menangle Park Stage 3A-2 Biodiversity Development Assessment Report submitted in December 2023 overlaps with the BEW DA subject site and includes the assessment of some areas of vegetation communities assessed under this SIS, including the EBSF (non-TEC) which did not generate a biodiversity credit liability under the Biodiversity Assessment Methodology 2020 (BAM) due to the low vegetation integrity score. However, those areas remain assessed under this SIS and are proposed to be offset, even though no offsetting is required under the BAM.

1.2. Background

1.2.1. Local Context

Menangle Park is a rural-residential suburb located in Sydney's south-west within the Greater Macarthur Priority Growth Area. It is approximately 5.5 km to the south-west of Campbelltown, 23 km from the Liverpool Strategic Centre and 65 km from Sydney Central Business District.

Menangle Park is within the Menangle Park URA which covers a total area of approximately 958 ha and is bounded by the Nepean River to the south and west, the Hume Highway (M31) to the east and the Mt. Anan Botanic Gardens to the north (see **Figure 2**). The Main Southern Railway Line dissects the area in a north / south direction.

Dahua (the 'proponent') own and control a significant portion of the Menangle Park URA consisting of approximately 364 ha of gross site area, and approximately 184 ha of net developable area. The proponent's land includes the central and eastern parts of the area to the east of Cummins Road. Their holdings are positioned to the north and south of Menangle Road and include proposed residential lands under the current rezoning. Their holdings include land in the north-west corner of the URA which has been earmarked as future employment lands.

1.2.2. Location of the Subject Site

For the purposes of this SIS, the subject site constitutes all land that will be directly impacted by the proposed development works, including asset protection zones (APZs), comprising an area of ~151.58 ha, as well as the proposed conservation works, comprising an area of ~59.59 ha

The subject site is comprised of several parcels of land located between Menangle Road, Cummins Road and Glenlee Road in Menangle Park.

The subject site is zoned as a mix of 'R3 – Medium Density Residential', 'R2 Low Density Residential', 'RE1 Public Recreation', 'R5 Large Lot Residential', 'SP2 Infrastructure', 'RU2 Rural Landscape', 'B2 – Local Centre', 'IN1 General Industrial', 'RE1 Public Recreation' and 'RU2 Rural Landscape' (**Figure 4**).

The surrounding land use in adjacent lands is primarily agricultural with some patches of remnant vegetation. The subject site is bounded by:

- Menangle Road to the south. On the south side of Menangle Park are existing and future stages of the Menangle Park master planned community;
- Hume motorway to the east;
- Rural residential lots, including Menangle Park village to the immediate west, with Menangle Park Train Station and rural lands further west. The existing rural residential lots are zoned low and medium density residential; and
- Mt. Annan Botanic Gardens to the north.

Surrounding lands that are considered to have the potential to be indirectly impacted by the proposed works comprise the 'study area'. The study area was determined by named roads that act as barriers between habitat of the subject site and the surrounds, the boundary of the Campbelltown LGA in the north, the extent of Dahua owned lands adjacent to the Nepean River in the south, or areas that are well outside (>300 m) of the subject site. **Figure 1** shows the extent of the study area. Throughout this report, the extent of the study area is synonymous with the 'locality'.

The Campbelltown DCP 2015 Volume 1 Section 11 (Vegetation and Wildlife Management) and Volume 2 Part 8 Section 1.11 (Environmental Management) apply to the subject site as it is located entirely within the Campbelltown LGA. The subject site also contains land mapped as 'Terrestrial Biodiversity' under Clause 7.20 'Terrestrial Biodiversity' of the Campbelltown Local Environment Plan (LEP) 2015 map (BIO_003) (see **Figure 5**).

1.2.3. Previous Ecological Assessments

Earlier versions of this SIS were submitted to Council in November 2019 and February 2023. Council reviewed each version and provided detailed comments to each. This revised SIS responds to all Council comments. Updates covered in this revised SIS include:

- the footprint of the proposed development works has been substantially reduced;
- one of the parks that will be subject to the conservation works has been modified to provide a uniform 30 m wide buffer around it to better protect the TEC EBSF;
- baseline flora and fauna information has been increased by completion of extensive additional surveys during wetter conditions that occurred since the breaking of the drought in early 2020; and
- baseline information about groundwater and groundwater dependent communities is included.

The biodiversity values of the study area and subject site are well documented as these areas have been extensively surveyed over the past 12 years. Cumberland Ecology prepared many ecological assessments for parts of the Menangle Park URA, most of which have now been approved, and information from these reports is used in the preparation of this SIS. They include, but are not limited to:

- Menangle Park Stage 3A-2 Biodiversity Development Assessment Report (Cumberland Ecology 2023a);
- Menangle Park Stage 4 South Biodiversity Development Assessment Report (Cumberland Ecology 2022e);
- Menangle Park Southern Playing Fields Flora and Fauna Assessment Report (Cumberland Ecology 2023b);
- Menangle Park Nepean River VMP (Cumberland Ecology 2024a);
- Menangle Park Stage 3 North Biodiversity Development Assessment Report (Cumberland Ecology 2022b);
- Menangle Park Spine Road Biodiversity Development Assessment Report (Cumberland Ecology 2022a);
- Menangle Park Stage 3 South Biodiversity Development Assessment Report (Cumberland Ecology 2021a);
- Menangle Park Vegetation Assessment Report (Cumberland Ecology 2021b);
- Menangle Park Stage 2B SIS Addendum (Ecology 2021);
- Stage 2A Flora and Fauna Assessment (Cumberland Ecology 2020c);
- Menangle Park Site-wide Bulk Earthworks SIS (Cumberland Ecology 2019b);
- Menangle Park Remediation SIS (Cumberland Ecology 2019a);
- Menangle Park Vegetation Clearing Species Impact Statement (Cumberland Ecology 2018c);
- Menangle Park Stage 2B SIS (Cumberland Ecology 2018f);
- Cummins and Menangle Road Intersection Species Impact Statement (Cumberland Ecology 2018b);
- Stage 1 Flora and Fauna Assessment (Cumberland Ecology 2017a, 2018d); and
- Menangle Park Ecological Constraints Assessment (Cumberland Ecology 2016a).

Several additional studies of the study area and surrounding areas have been undertaken by other ecological consultancies and include the following:

- Ecological Assessment – Proposed Subdivision and Infrastructure Delivery – Precinct 200 and Adjacent Bulk Earthworks (Travers Bushfire & Ecology 2013a);
- Report on Menangle Park Offsetting Strategy (GHD 2010);
- Menangle Park Rezoning: *Pimelea spicata* Survey and Results (GHD 2009); and
- Menangle Park Flora, Fauna and Aquatic Assessments (Eco Logical Australia 2009a).

Recent assessments are summarised below.

1.2.3.1. Stage 3A-2 North Biodiversity Development Assessment Report

This Biodiversity Development Assessment Report was prepared in 2023 to support the Stage 3A-2 North DA and includes some land overlapping with the BEW DA surrounding Park L. The DA includes the removal of Cumberland Plain Woodland (Shale Plains Woodland), River-flat Eucalypt Forest, Swamp Oak Floodplain Forest, and non-TEC EBSF, as well as areas of additional non-TECs comprised of exotic dominated grasslands and farm dams. To compensate for impacts on all native vegetation the DA proposed to purchase and retire ecosystem credits where the vegetation integrity is sufficiently high to create a credit liability, as well as species credits for the Southern Myotis as required under the BAM. This DA has been submitted to Council and is currently being assessed.

1.2.3.2. Stage 4 South Biodiversity Development Assessment Report

This Biodiversity Development Assessment Report was prepared in 2022 to support the Stage 4 South DA. The DA includes the removal of Cumberland Plain Woodland (Shale Plains Woodland), derived native grasslands, and areas comprised of exotic dominated grasslands. To compensate for impacts on all native vegetation the DA proposed to purchase and retire ecosystem credits, as well as species credits for the Southern Myotis and Large-eared Pied Bat (both assumed present) as required under the BAM. This DA has been approved and is currently under development.

1.2.3.3. Southern Playing Fields Flora and Fauna Assessment Report

This Flora and Fauna Assessment Report was submitted in 2022 and updated in 2023. The DA includes the removal of a small area of Cumberland Plain Woodland (Shale Plains Woodland) and large swaths of exotic dominated grassland and exotic dominated woody vegetation. This DA has been submitted to Council and is currently being assessed.

1.2.3.4. Nepean River VMP

This VMP supports the Stage 4 South and Southern Playing Fields DAs, and provides for the maintenance and enhancement of the riparian corridor vegetation along the Nepean River, including a smaller riparian corridor around a tributary running between the two DAs and flowing out to the Nepean River to the south. This VMP has been submitted and is currently being assessed.

1.2.3.5. Stage 3 North Biodiversity Development Assessment Report

This Biodiversity Development Assessment Report was prepared in 2022 to support the Stage 3 North DA. The DA includes the removal of Cumberland Plain Woodland (Shale Hills Woodland), River-flat Eucalypt Forest, Freshwater Wetlands and exotic dominated grasslands. To compensate for impacts on all native vegetation the DA proposed to purchase and retire ecosystem credits, as well as species credits for the Large-eared Pied Bat as required under the BAM. This DA has been approved and is currently under development.

1.2.3.6. Spine Road Biodiversity Development Assessment Report

This Biodiversity Development Assessment Report was prepared in 2022 to support the Spine Road DA. The DA includes the removal of Cumberland Plain Woodland (Shale Hills Woodland), River-flat Eucalypt Forest, and exotic dominated grasslands. To compensate for impacts on all native vegetation the DA proposed to purchase

and retire ecosystem credits, as well as species credits for the Large-eared Pied Bat as required under the BAM. This DA has been approved and is currently under development.

1.2.3.7. Stage 2B Species Impact Statement and Addendum Reports

This Species Impact Statement and supporting addendum reports were prepared between 2018 and 2021 to support a proposed development referred to as 'Stage 2B'. The Stage 2B area is comprised of the TEC Cumberland Plain Woodland (both Shale Hills Woodland and Shale Plains Woodland), as well as areas of non-TECs comprised of Shale Plains Woodland shrubby regrowth, one farm dam, exotic vegetation and cleared lands. To compensate for impacts on all native vegetation, the DA proposes to purchase and retire ecosystem credits as well as species credits for the Southern Myotis. This DA was approved by Council in September 2022.

1.2.3.8. Stage 3 South Biodiversity Development Assessment Report

This Biodiversity Development Assessment Report was prepared in 2021 to support the Stage 2 South DA. The DA included the removal of Cumberland Plain Woodland (both Shale Hills Woodland and Shale Plains Woodland), as well as areas of non-TECs comprised of exotic dominated grasslands and farm dams. To compensate for impacts on all native vegetation the DA proposed to purchase and retire ecosystem credits as well as species credits for the Southern Myotis as required under the BAM. This DA was approved by Council in November 2021.

1.2.3.9. Stage 2A Flora and Fauna Assessment – Cumberland Ecology

This Flora and Fauna Assessment was originally prepared in 2018 and updated to include modifications to the development footprint as well as bushfire asset protection zones in 2020. The Stage 2A area is comprised entirely of Exotic Vegetation. No threatened flora species were recorded or were considered likely to occur, and only highly marginal potential foraging habitat is present for fauna. This report concluded that no significant impact would occur because of the proposed works. This DA was approved by Council in July 2020.

1.2.3.10. Remediation Species Impact Statement – Cumberland Ecology

This SIS was prepared in 2019 for a Remediation DA that included the removal of the TECs EBSF, River-flat Eucalypt Forest, Swamp Oak Floodplain Forest and Freshwater Wetlands. This SIS is not yet approved. The SIS determined that no TECs or threatened species were likely to be significantly impacted by the DA. To compensate for the impacts on EBSF the DA proposes to conserve and manage areas of the community within conservation areas that will result in areas of the TEC being conserved in perpetuity. This DA is currently with Council for assessment; however, this SIS now includes the area subject to this previously submitted DA, deeming its status irrelevant.

1.2.3.11. Cummins and Menangle Road Intersection Species Impact Statement – Cumberland Ecology

This SIS was prepared in 2018 to support a DA for a proposed intersection located to the south of the existing Cummins Road and Menangle Road intersection. The DA required the removal of CPW. All impacts to CPW are proposed to be offset through the purchase and retirement of ecosystem credits. A significant impact to CPW is expected to occur because of the DA, but no significant impacts to threatened flora or fauna species were found likely. This DA was approved by Council in July 2019.

1.2.3.12. Stage 1 Flora and Fauna Assessment – Cumberland Ecology

This Flora and Fauna Assessment was prepared in 2017 for Stage 1 and an addendum letter was prepared in 2018. The Stage 1 Flora and Fauna Assessment determined that the DA will result in the removal of 0.12 ha of the TEC Cumberland Plain Woodland (Shale Hills Woodland only), 1.37 ha of Acacia Regrowth, and 32.27 ha of Exotic Vegetation.

Council reviewed the submitted ecological assessments and requested that further information be provided regarding the retirement of credits for Shale Hills Woodland as well as areas mapped as Exotic Vegetation and whether they should be mapped as Shale Hills Woodland derived native grassland. Further flora surveys were undertaken and additional supporting ecological assessments (Cumberland Ecology 2020a, b) were prepared to provide Council with the further information requested.

As a result, the vegetation mapping was revised and it was determined that the Stage 1 DA would result in the removal of 0.15 ha of Shale Hills Woodland derived native grassland, which also comprises the CPW TEC. An additional adjoining area of 0.01 ha of Shale Hills Woodland derived native grassland not subject to the Stage 1 DA was also identified. As a result, the Stage 1 DA included the retirement of three (3) ecosystem credits for all 0.16 ha of Shale Hills Woodland derived native grassland. All 0.16 ha of the community offset under the Stage 1 DA are located within the Stage 2B DA subject site (i.e. the DA this SIS supports) and have therefore been offset appropriately. The Stage 1 DA included the retirement of three (3) ecosystem credits for 0.081 ha of Shale Hills Woodland that falls within the Stage 2B DA subject site and therefore this 0.081 ha of the community have been offset appropriately. In addition to the above, the Stage 1 DA includes the removal of 0.74 ha of Acacia Regrowth and 0.01 ha of Scattered Native Trees that are already approved and are within the Stage 2B subject site being assessed by this SIS. Further details of the offsetting measures implemented for the current DA are provided in ***Section 7.1.2*** and **Appendix G**.

In addition to the direct impacts identified above, the Stage 1 DA is considered to have the potential to result in indirect impacts on TECs located outside of the development footprint. TECs with potential to be indirectly impacted by the Stage 1 DA include EBSF, Freshwater Wetlands, Swamp Oak Floodplain Forest and River-flat Eucalypt Forest. No threatened flora or fauna species were recorded during field surveys or considered likely to be impacted by the Stage 1 DA. This DA was approved by Council in May 2020.

1.2.3.13. Ecological Constraints Assessment – Cumberland Ecology

In 2016, an Ecological Constraints Assessment was prepared for an area of 500 ha within the Menangle Park URA, including the subject site. Seven TECs were recorded in the area. No threatened flora were recorded or were considered highly likely to occur, but habitat is present for threatened fauna.

Both the Biodiversity Certification Assessment Methodology and BioBanking Assessment Methodology were utilised to conduct a preliminary assessment of the quantum of impacts and the potential offset value of retained vegetation.

1.2.3.14. Ecological Assessment – Proposed Subdivision and Infrastructure Delivery – Precinct 200 and Adjacent Bulk Earthworks – Travers Bushfire and Ecology

In 2013, an ecological assessment was undertaken by Travers Bushfire and Ecology which included parts of the study area. The assessment recorded the three following TECs: CPW, River-flat Eucalypt Forest and EBSF. The

assessment also recorded the following six threatened fauna species within the study area: Greater Broad-nosed Bat (*Scoteanax rueppellii*), Eastern Coastal Free-tailed Bat (*Mormopterus norfolkensis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-footed Myotis (*Myotis macropus*), Varied Sittella (*Daphoenositta chrysoptera*) and Large Bent-winged Bat (*Miniopterus schreibersii oceanensis*). All species were recorded outside of the subject site.

1.2.3.15. Report on Menangle Park Offsetting Strategy – GHD

In 2010, GHD developed a vegetation 'Offset Strategy' for a proposed works within the Menangle Park Urban Release Area. The Offset Strategy recorded the following TECs within the Menangle Park Urban Release Area: CPW and River-flat Eucalypt Forest. The Offset Strategy identified areas within the Howes Creek riparian corridor to be utilised as 'on-site' offsets as these areas contained the best condition vegetation that has connectivity to off-site habitat. None of the Howes Creek riparian corridor will be directly impacted by the proposed works.

1.2.3.16. Menangle Park Rezoning: Pimelea spicata Survey and Results – GHD

Targeted surveys for the threatened plant *Pimelea spicata* were undertaken by GHD within four separate areas of the Menangle Park Urban Release Area, three of which are located within the study area. Reference sites of known populations located outside of the study area were visited as part of the surveys; however, no individuals were recorded.

1.2.3.17. Flora, Fauna and Aquatic Assessments – Eco Logical Australia

The study area for this report encompassed 890 ha and included the Menangle Park residential area and designated surrounding rural areas. This report concluded that although the area is overall highly degraded, EECs and threatened species occur. The following TECs were recorded within the study area: River-flat Eucalypt Forest, CPW and Sydney Freshwater Wetlands. This report recommended five areas with high ecological values that should be retained and managed. The subject site does not include any of these five areas.

The study also included targeted threatened flora and fauna surveys within the Menangle Park Urban Release Area. No threatened flora were recorded within the study area and the Greater Broad-nosed Bat (*Scoteanax rueppellii*) was the only threatened fauna species recorded with the study area. The species was recorded within Howes Creek which is not proposed to be directly impacted by the proposed works.

1.3. Legislative Requirements for SIS

All fauna and flora work was carried out under the NSW OEH Scientific Licence number SL100103 and the NSW Department of Primary Industries Animal Research Authority Trim File No. 14/3039.

1.4. Relevant Legislation

Legislation relevant to this SIS includes:

- NSW *Environmental Planning and Assessment Act 1979*;
- NSW *Threatened Species Conservation Act 1995*;
- NSW *Biosecurity Act 2015*; and

- *Environment Protection and Biodiversity Conservation Act 1999*;

Although this SIS has been prepared primarily to meet the requirements of NSW legislation, the impact to threatened flora and fauna listed by the Commonwealth EPBC Act has also been assessed.

1.4.1. Environmental Planning and Assessment Act 1979

The EP&A Act is the principal planning legislation for NSW, providing a framework for the overall environmental planning and assessment of development proposals. Various legislation and instruments, such as the TSC Act, are integrated with the EP&A Act and have been reviewed separately.

1.4.2. Threatened Species Conservation Act 1995

The TSC Act was repealed and replaced by the BC Act in August 2017; however, the associated *Biodiversity Conservation (Savings and Transitional) Regulation 2017* includes a transitional period for the Campbelltown LGA which allows for developments to be assessed under the former planning provisions for a period of 18 months, starting 25 August 2017 and ending November 2019. As the DA for subject site was submitted to Council within the transitional period, this report has assessed the proposed works under the former planning provisions, including the TSC Act.

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

The TSC Act requires consideration of whether a development (Part 4) or an activity (Part 5) is likely to significantly impact threatened species, populations, communities or their habitat. The potential impacts of any developments, land use changes or activities are subject to an "Assessment of Significance" under Section 5A of the EP&A Act.

Schedule 1 of the TSC Act lists threatened species, populations and ecological communities that are endangered or presumed extinct. Schedule 2 lists vulnerable species and Schedule 3 lists key threatening processes. The TSC Act is administered by NSW DCCEEW, which has issued guidelines for the assessment of threatened flora and fauna.

1.4.3. Biosecurity Act 2015

Under the NSW *Biosecurity Act 2015* (Biosecurity Act) all weeds are required to be controlled by all persons under a "General Biosecurity Duty". The General Biosecurity Duty means that all public and private land owners or managers and all other people who deal with weed species (biosecurity matters) must use the most appropriate approach to prevent, eliminate, or minimise the negative impact (biosecurity risk) of those weeds (DPI 2017).

State-wide management of weeds under the new legislation is directed by the NSW Invasive Species Plan (Local Land Services 2019). This assigns weed responses to four categories:

- Prevention of new weeds establishing;

- Eradication of small and localised infestations where feasible;
- Containment of larger infestation to stop wider spread; and
- Protection of key assets such as threatened plants and agricultural land, to prevent their damage or degradation by weed invasion.

Under the Biosecurity Act some weed species have been prioritised for management by specific regulations and controls under the act. These are known as State Level Priority Weeds.

The state has been divided into 11 regions (each covering several LGAs) under the act, with each region managed by a Regional Weeds Committee. Management actions for weeds within a region are detailed within a Regional Strategic Weed Management Plan. Within each region, additional weed species to the State Level Priority Weeds have been prioritised for management. These species are known as Regional Priority Weeds.

A further set of weeds are identified within the Regional Strategic Weed Management Plans as being "other weeds of regional concern". The Biosecurity Act provides powers to Local Control Authorities to take action in relation to these weeds in particular circumstances, for example where a weed threatens a high value asset, and prevention, elimination or reduction of the risk is feasible and reasonable. Examples of high values assets include the Environment, Human Health, and Agriculture.

All land within the study area occurs within the Greater Sydney Local Land Services region, and weed management within the region is be undertaken under the direction of the Greater Sydney Regional Strategic Weed Management Plan (LLS: Greater Sydney 2023). The appendices of the Greater Sydney Weed Management Plan outlines the State Listed Priority Weeds and Regional Priority Weeds..

1.4.4. Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's key piece of environmental legislation and is administered by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW). It is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES), which include threatened species of flora and fauna, TECs, 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.

Under the EPBC Act, any action (which includes a development, project or activity) that is considered likely to have a significant impact on MNES must be referred to the Commonwealth Minister for the Environment and Water. This SIS has determined that significant impacts on MNES listed under the EPBC Act are predicted to occur and referral to the Commonwealth is required.

1.5. State and Local Government Planning Instruments

Planning Instruments that relate to the proposed works include:

- State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44);
- State Environmental Planning Policy (Precincts – Western Parkland City) 2021;

- Campbelltown Local Environment Plan 2015; and
- Campbelltown (Sustainable City) Development Control Plan 2015.

1.5.1. SEPP 44 – Koala Habitat Protection

SEPP 44 was repealed and replaced by SEPP (Koala Habitat Protection) 2019 on 1 March 2020. In November 2020, SEPP (Koala Habitat Protection) 2020 replaced and repealed the 2019 Koala Habitat Protection SEPP. The 2020 Koala Habitat Protection SEPP 2019 was in turn replaced by the 2021 Koala Habitat Protection SEPP in March 2021. This SEPP reinstates Koala Habitat Protection SEPP 2019. However, savings provisions identified within the new SEPP states that " *A development application made in relation to land, but not finally determined before this Policy applied to the land, must be determined as if this Policy had not commenced in its application to the land"*. Therefore, this report assesses the proposed works against the former SEPP 44 as required.

SEPP 44 aims to maintain a permanent free-living population of the species over their current range and reverse the current trend of koala population decline. Campbelltown LGA is identified as being an LGA to which SEPP 44 applied. Any lands that contain primary and/or secondary Koala feed trees may constitute Potential Koala Habitat or Core Koala Habitat. Any areas identified as Core Koala Habitat must have a plan of management prepared for the land in accordance with the SEPP. A Comprehensive Koala Plan of Management (CKPoM) (Phillips 2016) has been prepared for the Campbelltown LGA that may be utilised as a plan of management for the proposed works if Core Koala Habitat is to be impacted.

1.5.2. State Environmental Planning Policy (Precincts – Western Parkland City) 2021: Growth Centres

Chapter 3 of State Environmental Planning Policy (SEPP) (Precincts – Western Parkland City) 2021 transfers provisions of the now repealed Sydney Regional Growth Centres State Environmental Planning Policy 2006 (Sydney Region Growth Centres SEPP). The purpose of this SEPP is to co-ordinate the release of lands within growth centres for development that allows for comprehensive planning to ensure that controls are implemented to improve outcomes associated with sustainability, infrastructure, waterways, heritage and biodiversity.

The Sydney Regional Growth Centres SEPP is applicable to the DA as the subject site is located within the Menangle Park Precinct of the Greater Macarthur Growth Area. Chapter 3, Part 3.6 of the SEPP (Precincts – Western Parkland City) 2021 is applicable to this report as it relates to consent for clearing native vegetation.

1.5.3. Campbelltown Local Environment Plan (LEP) 2015

The Campbelltown LEP 2015 aims to make local environmental planning provision for land within the Campbelltown LGA. The proposed works is subject to this LEP. The subject site also includes areas mapped as 'Terrestrial Biodiversity' under Clause 7.20 'Terrestrial Biodiversity' of the Campbelltown LEP 2015 map (BIO_003) (see **Figure 5**).

1.5.4. Campbelltown (Sustainable City) Development Control Plan 2015

Campbelltown DCP 2015 Volume 1 Section 11 (Vegetation and Wildlife Management) and Volume 2 Part 8 Section 1.11 (Environmental Management) apply to the subject site as it is located entirely within Council's LGA.

A site specific DCP applies to the subject site, within Part 8 – Menangle Park (Campbelltown City Council 2016). This DCP has been prepared to enable a mix of housing types within the context of environmental, social and economic sustainability.

1.6. CER Matters Which Have Been Limited or Modified

The following Section 110 matters need not be addressed within this SIS:

- Section 110(2)(g) and 110(3)(d). The matters raised in these sections of the TSC Act have been clarified by the requirements provided here.

The following Section 110 matters need only be addressed where relevant:

1.6.1.1. Recovery Plans and Management Plans

The following Recovery and/or Management Plans may be relevant to the proposed works:

- Recovery Plan for the Bush Stone-Curlew (*Burhinus grallarius*);
- *Pimelea spicata* R. Br. Recovery Plan;
- Cumberland Plain Recovery Plan; and
- Grey-headed Flying-fox Draft Recovery Plan.

1.6.1.2. Key Threatening Processes

The following examples of Key Threatening Processes are relevant to the proposed works. Further details are provided in **Chapter 5**.

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Bushrock removal;
- Clearing of native vegetation;
- Loss of hollow-bearing trees;
- Invasion and establishment of exotic vines and scramblers;
- Invasion and spread of Lantana (*Lantana camara* L. Sens lat);
- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*);
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants; and

- Removal of dead wood and dead trees.

1.6.1.3. Threat Abatement Plans

No Threat Abatement Plans are relevant to the proposed works.

1.6.1.4. Critical Habitat

At this time, no areas of declared critical habitat are relevant to the proposed works.

2. Contextual Information

This chapter covers the following CERs:

CER 2. CONTEXTUAL INFORMATION

2.1. Description of the Proposal, Subject Site and Study Area

CER 2.1 Description of the proposal, subject site and study area.

A species impact statement must include a **full** description of the action proposed, including its nature, extent, location, timing and layout (Section 110 (1)).

2.1.1. Description of the Proposal

2.1.1.1. Nature

The proposed works include site-wide bulk earthworks to regrade the site, the associated clearing of native vegetation, and enabling site works, and the conservation and rehabilitation of native flora and fauna habitat within proposed conservation areas, as shown in **Figure 1**. The proposed development works include the clearing of all vegetation within proposed development areas and the two contaminated conservation areas to facilitate future subdivision works and the subsequent development of land in accordance with the Menangle Park Master Plan. The proposed development works are also necessary to support land remediation activities, and conservation works in accordance with the VMPs that are proposed under this DA.

The legal subdivision of land is not proposed under the scope for this DA, which is limited to bulk earthworks, vegetation clearance and vegetation management.

The retention of the Parks K and L Conservation Areas will be managed under VMP 2 (REF. 17072 RP29) and the retention of the Howes Creek and Northern Conservation Areas will be managed under a separate VMP (VMP 2) (REF. 17072 RP36). Both of these VMPs have been prepared following the management requirements of a 20-year Biodiversity Stewardship Site, though the VMPs will be in place under a VPA. A third VMP for the retained Stage 6B EBSF Conservation Area will be prepared as a Condition of Consent and include management consistent with VMP 1 and VMP 2.

The proposed development works will facilitate future development within the subject site; however, all future development will be subject to subsequent DAs. Although this DA technically applies to the proposed works as described above, this SIS has appropriately also considered impacts associated with the future residential development the proposed development works will facilitate.

The bulk earthworks and associated clearing of native vegetation proposed will be undertaken as a phased process. A detailed description of the proposed development works is provided within the SEE prepared for the DA.

i. Buildings or other structures

The construction of buildings or other structures is not included in the proposed development works but will occur because of the proposed development works for subsequent DAs. The future construction of buildings or other structures will occur in accordance with the Master Plan submitted by the client; however, the details of future construction are unknown, but will be provided within any relevant future DAs for the subject site.

ii. Associated infrastructure such as for sewage, electricity, gas or water

The construction of infrastructure is not included in the proposed development works but will take place because of the proposed development works for subsequent DAs. The future construction of infrastructure is expected to occur generally in accordance with the Master Plan (see **Figure 2**). The details of any future infrastructure will be provided within any relevant future DAs for the subject site.

iii. Access routes

The construction of access routes is not included in the proposed development works but will take place because of the proposed development works for subsequent DAs. Access routes are expected to be located generally in accordance with the Master Plan. The details of any future access routes will be provided within any relevant future DAs for the subject site.

iv. Infrastructure for drainage, wastewater/ effluent management or erosion control

Construction associated with infrastructure for drainage, wastewater/ effluent management or erosion control is not included in the proposed development works. All infrastructure will be installed (where required) in accordance with any relevant requirements and be subject to a subsequent DA(s).

v. Structure or activity that may change surface or subterranean water movements

The proposed development works are the physical works associated with the bulk earthworks and associated clearing of vegetation, which have the potential to change surface water movements. Changes to surface water movements may result in increased waterflows and associated sedimentation into areas of vegetation proposed to be retained under the Master Plan. Mitigation measures including sedimentation/erosion controls are proposed within this SIS to minimise the potential impacts of increased surface water movements having deleterious impacts on vegetation proposed to be retained. The implementation of the mitigation measures provided in ***Section 7.1.1*** are considered adequate to appropriately mitigate the increase in surface water movement within the study area.

vi. Wastewater disposal

Wastewater disposal is not included in the proposed development works. All wastewater disposal works will be subject to a subsequent DA(s) and will be in accordance with any relevant requirements.

vii. Bush fire hazard reduction and protection measures

No bush fire hazard reduction and protection measures have been developed for the proposed development works. A Bushfire Assessment (Peterson Bushfire Expert Consulting Services 2019) was undertaken to support the proposed development works which identifies that the DA complies with *Planning for Bushfire Protection 2018*. An APZ is proposed for future development stages that occurs entirely within the proposed development works area. Accordingly, future DAs for the staged development will not require APZs to be located within the proposed conservation works areas.

viii. Landscaping

Landscaping is not included in the proposed development works. All landscaping associated with future development will be subject to a subsequent DA(s).

2.1.2. Description of the Subject Site

For the purposes of this SIS, the subject site constitutes all land that will be directly impacted by the proposed development works and the proposed conservation works, which together make up an area of ~210 ha. The proposed development works would occur across ~152 ha and the proposed conservation works comprise an area of ~ 60 ha (**Figure 6**). As part of this DA, a VMP has been prepared for the Howes Creek and Northern Conservation Areas (REF. 17072 RP36) that combined total ~56.60 ha, and a separate VMP has been prepared for the Parks K and L Conservation Area (REF. 17072 RP29) that combined cover ~2.78 ha. A third VMP is to be prepared as a Condition of Consent for the new Stage 6B EBSF Conservation Area that covers ~0.21 ha. As such, despite complete clearance of native vegetation within the proposed development works area for this SIS, retention and management of viable, representative areas of native vegetation in perpetuity has been undertaken and incorporated into the overall strategy for this DA.

The subject site contains land subject to the Campbelltown DCP 2015 Volume 1 Section 11 (Vegetation and Wildlife Management) and Volume 2 Part 8 Section 1.11 (Environmental Management). The subject site also contains land mapped as 'Terrestrial Biodiversity' under Clause 7.20 'Terrestrial Biodiversity' of the Campbelltown LEP 2015 map (BIO_003) (see **Figure 5**).

The general description of the subject site within the local area is provided within ***Section 1.2***.

Vegetation within the subject site includes intact and modified patches of native woodland and forest as well as previously cleared land that is comprised primarily of exotic vegetation. The subject site has a history of agricultural development, which resulted in the degradation and clearing of native vegetation across a high proportion of the subject site. Intact and modified patches of native woodland and forest vegetation present typically occur as small, isolated patches that are surrounded by previously cleared areas, with the exception of the larger tract of vegetation within the Howes Creek Conservation Area. Native vegetation within the subject site consists primarily of woody vegetation on shale soils dominated by *Eucalyptus tereticornis* (Forest Red Gum), with *Eucalyptus moluccana* (Grey Box) and *Eucalyptus crebra* (Narrow-leaved Ironbark) also present. In areas comprising sandy substrates, *Angophora subvelutina* (Broad-leaved Apple) dominates.

2.1.3. Description of the Study Area

The study area is defined in ***Section 1.2.2*** and is shown in **Figure 1**.

The "study area" is a formal term used in an SIS to refer to the area of land that is both subject to direct impacts of a proposed development, and any indirect impacts. Indirect impacts can include changes to surface and groundwater flow, impacts to wildlife corridors and overall habitat connectivity, weed invasion, changes to lighting, noise levels and air quality in adjacent areas. For the purposes of this SIS the study area encompasses a wide area around the proposed works area as shown on **Figure 1**. This has been set to provide a conservative assessment of areas that could be subject to indirect impacts from the project.

Zoning of the subject site and study area under the Campbelltown LEP 2015 is identified in **Figure 4** and described below.

- R3 – Medium Density Residential

An area located along Cummins Road in the southwest of the subject site is zoned as R3 – Medium Density Residential. The overall objectives of this zoning are:

- To provide for the housing needs of the community within a medium density residential environment;
- To provide a variety of housing types within a medium density residential environment;
- To enable other land uses that provide facilities or services to meet the day to day needs of residents;
- To provide for a wide range of housing choices in close proximity to commercial centres, transport hubs and routes;
- To enable development for purposes other than residential only if that development is compatible with the character and scale of the living area; and
- To minimise overshadowing and ensure a desired level of solar access to all properties.

- R2 – Low Density Residential

The majority of the subject site is zoned as R2 – Low Density Residential. The overall objectives of this zoning are:

- To provide for the housing needs of the community within a low density residential environment;
- To enable other land uses that provide facilities or services to meet the day to day needs of residents;
- To enable development for purposes other than residential only if that development is compatible with the character of the living area and is of a domestic scale;
- To minimise overshadowing and ensure a desired level of solar access to all properties; and
- To facilitate diverse and sustainable means of access and movement.

- R5 – Large Lot Residential

An area in the east of the subject site located adjacent to the Hume Motorway is zoned as R5 – Large Lot Residential. The overall objectives of this zoning are:

- To provide residential housing in a rural setting while preserving, and minimising impacts on, environmentally sensitive locations and scenic quality;
- To ensure that large residential lots do not hinder the proper and orderly development of urban areas in the future;
- To ensure that development in the area does not unreasonably increase the demand for public services or public facilities;
- To minimise conflict between land uses within this zone and land uses within adjoining zones;

- To enable development for certain purposes other than residential only if that development is compatible with the character and scale of the living area; and
- To minimise overshadowing and ensure a desired level of solar access to all properties.

- RE1 – Public Recreation

Numerous sections of the subject site are zoned as RE1 – Public Recreation, particularly within and surrounding the Howes Creek Corridor Conservation Area and in small pockets to the east of Cummins Road. The overall objectives of this zone are:

- To enable land to be used for public open space or recreational purposes;
- To provide a range of recreational settings and activities and compatible land uses;
- To protect and enhance the natural environment for recreational purposes;
- To provide for land uses compatible with the ecological, scientific, cultural or aesthetic values of land in the zone;
- To facilitate the multiple use of certain open space areas;
- To facilitate development that is ancillary or incidental to the special land uses provided for in this zone;
- To provide for the sufficient and equitable distribution of public open space to meet the needs of the local community;
- To preserve and rehabilitate bushland, wildlife corridors and natural habitat, including waterways and riparian lands, and facilitate public enjoyment of these areas;
- To provide for the retention and creation of view corridors;
- To protect and enhance areas of scenic value and the visual amenity of prominent ridgelines; and
- To preserve land that is required for public open space or recreational purposes.

- SP2 – Infrastructure: Gas Well and Future Road Corridor

One small area located in the northeast of the subject site is zoned as SP2 – Infrastructure: Gas Well, while an additional area extending along the northern border of the Howes Creek Conservation Area is zoned as SP2 – Infrastructure: Future Road Corridor. The overall objectives of this zone are:

- To provide for infrastructure and related uses;
- To prevent development that is not compatible with or that may detract from the provision of infrastructure;
- To encourage activities involving research and development;

- To optimise value-adding development opportunities, particularly those associated with research;
- To provide for the retention and creation of view corridors;
- To preserve bushland, wildlife corridors and natural habitat; and
- To maintain the visual amenity of prominent ridgelines.

- RU2 – Rural Landscape

Two areas in the north of the subject site are zoned RU2 – Rural Landscape, one is south of Glenlee Road. to the other is the land west of the rail corridor. The objectives of this zone are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base;
- To maintain the rural landscape character of the land;
- To provide for a range of compatible land uses, including extensive agriculture;
- To preserve and enhance bushland, wildlife corridors, natural habitat and water resources, including waterways, ground water and riparian land;
- To protect and enhance areas of scenic value, and the visual amenity of prominent ridgelines, by minimising development and providing visual contrast to nearby urban development; and
- To promote healthy lifestyles by ensuring land is available for the local production and consumption of fresh food.

- IN1 – General Industrial

One area in the northern portion of the subject site to the west of the rail corridor is zoned IN 1 – General Industrial. The objectives of this zone are:

- To provide a wide range of industrial and warehouse land uses;
- To encourage employment opportunities;
- To minimise any adverse effect of industry on other land uses;
- To support and protect industrial land for industrial uses;
- To provide for a range of facilities and services to meet the day-to-day needs of workers in the area;
- To enable non-industrial land uses that are compatible with and do not detract from industrial and warehouse uses or impact on the viability of existing centres;
- To ensure that any commercial, retail or other non-industrial development is not likely to adversely affect employment generating activities or opportunities;

- To facilitate diverse and sustainable means of access and movement; and
- To maximise public transport patronage and encourage walking and cycling.

- B2 – Local Centre

One area adjacent to Cummins Road in the south west of the subject site is zoned B2 – Local Centre. The objectives of this zone are:

- To provide a range of retail, business, entertainment and community uses that serve the needs of people who live in, work in and visit the local area.
- To encourage employment opportunities in accessible locations.
- To maximise public transport patronage and encourage walking and cycling.
- To achieve an accessible, attractive and safe public domain.
- To provide for appropriate residential development in the form of shop top housing to support the vitality of the local area.
- To provide healthy, attractive, vibrant and safe local centres.

2.1.3.1. Topography, Geology and Soils

The topography is generally of gently undulating terrain with the flattest areas located alongside the Nepean River and Howes Creek (see **Figure 7**). Outside of the Nepean River, the low lying areas of the study area contain riparian areas that are only periodically inundated after periods of heavy rain.

The geology is dominated by clay-based soils originating form Wianamatta Shale. Areas of alluvial and sandy soils are also present in small pockets, primarily around the southern side of the Howes Creek riparian area in the centre of the study area.

The Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet (Hazelton and Tille 1990) shows the study area has soils of the Blacktown landscape group.

A groundwater assessment undertaken by Geotechnique (2019) for the Cumberland Ecology Stage 2B SIS determined that the eastern portion of the study area is '*underlain by Bringelly Shale, with low infiltration rates comprising shale, carbonaceous claystone, laminite, fine to medium grained lithic sandstone and rare coal. A portion of the site could belong to the Theresea Group, which is Tertiary and Quaternary flood plain and terraces of the Nepean River south of Cobbitty Creek with gently undulating slopes (<5%), almost completely cleared, low open woodland, with grass. Soils in this landscape are highly variable and include poorly structured silty loams and sandy loams*'.

2.1.3.2. Vegetation

Much of the vegetation within the study area has been extensively cleared because of historical agricultural practices. Nevertheless, twelve separate native vegetation communities and one exotic vegetation community

were either recorded within the study area by Cumberland Ecology or have been mapped by OEH as part of the Remnant Vegetation of the Western Cumberland Subregion mapping project (OEH 2013b).

Ten of the native vegetation communities that were either recorded or previously mapped in the study area conform to a TEC listed under the TSC Act. Some of the vegetation also conforms to TECs listed under the EPBC Act. TECs listed under the TSC Act and/or the EPBC Act that have been mapped or recorded within the study area include:

- Shale Plains Woodland, Shale Plains Woodland (derived native grassland), Shale Hills Woodland and Shale Hills Woodland (derived native grassland) conform to Cumberland Plain Woodland in the Sydney Basin Bioregion (CEEC TSC Act and EPBC Act);
- EBSF in the Sydney Basin Bioregion (CEEC TSC Act and EPBC Act);
- Moist Shale Woodland in the Sydney Basin Bioregion (CEEC TSC Act and EPBC Act);
- Riparian Forest, Alluvial Woodland and River-Flat Eucalypt Forest conform to River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered Ecological Community (EEC) TSC Act and EPBC Act);
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act and EPBC Act); and
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act).

Three (3) additional native vegetation communities (Shale Hills Woodland (shrubby regrowth), River Oak Riparian Woodland) and EBSF (non-TEC) were also recorded. Shale Hills Woodland (shrubby regrowth) was historically likely to be Cumberland Plain Woodland; but does not conform to this TEC due to its current degraded nature as a result of agricultural land practices. River Oak Riparian Woodland is not listed as a TEC. EBSF (non-TEC) includes 0.10 ha of scattered isolated patches of degraded vegetation that are not considered to conform to the TEC EBSF due to a lack of species diversity and structural components, though have been included based on EHG comments and will be offset along with the intact patches of EBSF.

The non-native vegetation community present is exotic vegetation that occurs in one grassland condition state and several woody condition states. The grassland condition state is present throughout the study area within open, predominately tree-less areas, and around existing structures that have all been extensively cleared for agricultural or residential purposes. The exotic woody condition states are present predominantly as scattered occurrences throughout the exotic grasslands and in dense patches along the riparian areas.

Several artificial farm dams are present and scattered throughout the study area. The Nepean River is present along the southern and western borders of the study area, and a creek line known as Howes Creek is also present in the centre of the study area.

Further details of the vegetation within the study area are provided in **Chapter 4,** whilst descriptions of the vegetation communities occurring within the local area are provided in ***Section 2.3***.

2.1.4. Description of the Local Area

The local area is defined here as all areas within a 5 km radius of the study area. Within terrestrial areas, the local area is comprised of a matrix of land uses typical of both urban and rural areas. This includes residential, commercial, agricultural recreation and conservation land uses (see **Figure 8**).

Conservation areas in the local area include William Howe Reserve located approximately 1.5 km to the northwest and Mt. Annan Botanical Gardens located approximately 500 m to the north. Within the greater locality (10 km radius from subject site), Dharawal National Park is located approximately 7 km to the southeast. The vegetation within the study area has little connectivity to the Mt. Annan Botanical Gardens, as the areas are separated by a train line.

2.2. Identification of the Development/Activity and Land to which SIS Applies

CER 2.2 Identification of the development/activity and land to which SIS applies

The subject site is owned by Dahua Group Australia who have submitted a DA (3574/2019/DA-CW) to undertake bulk earthworks, the associated clearing of native vegetation, and the retention and rehabilitation of the proposed conservation works areas (see **Figure 6**). The subject site is entirely within the Campbelltown LGA and includes all or part of numerous lots, as identified in the Addendum SEE prepared by Urbis for this DA.

2.3. Provision of Relevant Plans and Maps

CER 2.3 Plans and maps

The following maps are provided at the end of this report:

- **Figure 1**. Aerial photograph of the Menangle Park Urban Release Area, subject land, study area and subject site
- **Figure 2**. Menangle Park Master Plan
- **Figure 3.** JBS&G contaminated land assessment
- **Figure 4**. Zoning of the study area
- **Figure 5**. Campbelltown LEP 2015 Biodiversity Mapping
- **Figure 6**. The proposed development works
- **Figure 7**. Topography of the study area
- **Figure 8**. Land uses zoning in the local area (5 km radius of the subject site)
- **Figure 9**. Vegetation communities in the local area
- **Figure 10**. Threatened flora species recorded within the local area

- **Figure 11**. Threatened fauna species recorded within the local area
- **Figure 12**. Flora survey locations
- **Figure 12a**. Flora survey locations – north
- **Figure 12b**. Flora survey locations - south
- **Figure 13**. Pimelea spicata reference sites
- **Figure 14**. Fauna survey locations
- **Figure 14a**. Fauna survey locations – north
- **Figure 14b**. Fauna survey locations - south
- **Figure 15**. Vegetation communities in the study area
- **Figure 16**. Potential GDEs of the subject site
- **Figure 17**. Location of habitat features and threatened fauna recorded within the study area
- **Figure 18**: Identification of BBAM Assessment Area
- **Figure 19**. BBAM Impact Assessment
- **Figure 20**. BBAM Offset Assessment

3. Initial Assessment

This chapter covers the following CERs:

CER 3 INITIAL ASSESSMENT

A general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action (Section 110 (2)(a)); and

A general description of the ecological community present in the area that is the subject of the action and in any area that is likely to be affected by the action (Section 110 (3)(a)).

3.1. Assessment of Available Information

CER 3.1 Assessment of available information

Mapping prepared by OEH (2013b) was reviewed to assist in determining ecological communities to be included within the list of subject communities. This included identifying all threatened ecological communities (TECs) mapped by OEH in the locality (see **Figure 9**). Vegetation mapping of the Menangle Park URA by Cumberland Ecology (Cumberland Ecology 2016a), and mapping provided within the Flora, Fauna and Aquatic Assessment (Eco Logical Australia 2009b) and by the Ecological Assessment (Travers Bushfire & Ecology 2013a), were also consulted.

Refined vegetation mapping of OEH's broadscale mapping of the study area is presented within **Figure 15** of this document. There is necessarily a difference between **Figure 9** and **Figure 15,** as **Figure 15** is based on detailed studies by Cumberland Ecology and OEH's mapping is broadscale only.

Database analyses and review of the current literature for records of threatened species occurring within the local area (5 km radius of the subject site) were examined to determine the likelihood of threatened species to occur in the study area. Database analysis was undertaken using the EHG BioNet Atlas database (EHG 2023), the BioBanking Credit Calculator and the EPBC Protected Matters Search Tool (DAWE 2021). The BioNet Atlas database search was used to generate records of threatened flora and fauna species and populations listed under the TSC Act and EPBC Act within the local area. Migratory avifauna protected under the EPBC Act were also included in the BioNet Atlas database search. The BioBanking Credit Calculator was used to generate a list of species that are predicted to occur based on Plant Community Types (PCTs). The Protected Matters Search Tool generated a list of potentially occurring MNES listed under the EPBC Act within the wider locality of the study area.

Local area records of threatened flora and fauna from the BioNet Atlas database are shown in **Figure 10** and **Figure 11**, respectively. It is noted that the scale that Cumberland Ecology can present the locations of threatened fauna species provided by the BioNet Atlas database is determined by the 'Sensitive Species Data Policy' issued by EHG and the scale of the relevant figures has been adjusted accordingly (1:250,000) to be compliant with the 'Sensitive Species Data Policy' requirements. Migratory and/or marine species listed under the EPBC Act were also considered. The abundance, distribution and age of records generated within the search area also provided supplementary information for the assessment of likelihood of occurrence of those threatened species within the study area. Consideration was also given to those threatened species listed in the CERs.

Appendix B lists all communities, species and populations considered within this assessment and indicates those which are subject entities. The determination of whether a community, species or population is considered a subject entity is based on records, habitat types present in the study area and species distributions.

To identify the potential cumulative impacts of the proposal, a summary of all impacts already carried out (i.e., approved DAs) and impacts proposed within the proponent's land holdings (i.e., submitted DAs yet to be approved) were collated and assessed. Details of cumulative impacts are provided in ***Section 6.4***. This addresses Council comments and provides further assessment of cumulative impacts associated with the proposed development works. Note that ecological impacts of future DAs are estimates only and assume that areas zoned for development will be cleared of native vegetation. Such estimates therefore represent the maximum footprint that could be cleared.

3.2. Identifying Subject Threatened Species, Populations and Ecological Communities

CER 3.2 Identifying subject threatened species, population and ecological communities

3.2.1. Threatened Ecological Communities

The following TECs listed under the TSC Act have been recorded within the local area:

- Shale Sandstone Transition Forest in the Sydney Basin Bioregion (CEEC TSC Act);
- Cumberland Plain Woodland in the Sydney Basin Bioregion (CEEC TSC Act);
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act);
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion (CEEC TSC Act);
- Moist Shale Woodland in the Sydney Basin Bioregion (EEC TSC Act);
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act); and
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act).

Of these communities, only the following are known to occur within the study area and are each considered as a subject community:

- Cumberland Plain Woodland in the Sydney Basin Bioregion (CEEC TSC Act);
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act);
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion (CEEC TSC Act);

- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act);
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC TSC Act); and
- Moist Shale Woodland in the Sydney Basin Bioregion (EEC TSC Act).

3.2.2. Threatened Species and Populations

A suite of threatened flora and fauna species and populations have been recorded within the search area or are predicted to occur. The threatened species and populations considered as subject species for this SIS are as follows in **Table 4**:

Table 4 Threatened Species and Populations

Scientific Name	Common Name
Threatened flora species	
Allocasuarina glareicola	
Cynanchum elegans	
Eucalyptus benthamii	Camden White Gum
Genoplesium baueri	Bauer's Midge Orchid
Grevillea parviflora subsp. *parviflora*	
Gyrostemon thesioides	
Maundia triglochinoides	
Persicaria elatior	Tall Knotweed
Pimelea spicata	Spiked Rice-flower
Pomaderris brunnea	Brown Pomaderris
Pterostylis saxicola	Sydney Plains Greenhood
Pultenaea pedunculata	Matted Bush-pea
Thesium australe	Austral Toadflax
Threatened fauna species	
Botaurus poiciloptilus	Australasian Bittern
Melithreptus gularis gularis (eastern subspecies)	Black-chinned Honeyeater
Falco subniger	Black Falcon
Ephippiorhynchus asiaticus	Black-necked Stork
Climacteris picumnus victoriae (eastern subspecies)	Brown Treecreeper
Phascogale tapoatafa	Brush-tailed Phascogale
Burhinus grallarius	Bush Stone-curlew

Scientific Name	Common Name
Meridolum corneovirens	Cumberland Plain Land Snail
Stagonopleura guttata	Diamond Firetail
Artamus cyanopterus cyanopterus	Dusky Woodswallow
Vespadelus troughtoni	Eastern Cave Bat
Falsistrellus tasmaniensis	Eastern False Pipistrelle
Mormopterus norfolkensis	Eastern Coastal Free-tailed Bat
Petroica phoenicea	Flame Robin
Stictonetta naevosa	Freckled Duck
Callocephalon fimbriatum	Gang-gang Cockatoo
Calyptorhynchus lathami	Glossy Black-Cockatoo
Scoteanax rueppellii	Greater Broad-nosed Bat
Litoria aurea	Green and Golden Bell Frog
Pteropus poliocephalus	Grey-headed Flying-fox
Melanodryas cucullata cucullata (south-eastern form)	Hooded Robin
Phascolarctos cinereus	Koala
Chalinolobus dwyeri	Large-eared Pied Bat
Miniopterus schreibersii oceanensis	Large Bent-winged Bat
Miniopterus australis	Little Bent-winged Bat
Hieraaetus morphnoides	Little Eagle
Glossopsitta pusilla	Little Lorikeet
Tyto novaehollandiae	Masked Owl
Ninox strenua	Powerful Owl
Petroica boodang	Scarlet Robin
Myotis macropus	Southern Myotis
Chthonicola sagittata	Speckled Warbler
Circus assimilis	Spotted Harrier
Lophoictinia isura	Square-tailed Kite
Petaurus norfolcensis	Squirrel Glider
Lathamus discolor	Swift Parrot
Neophema pulchella	Turquoise Parrot
Daphoenositta chrysoptera	Varied Sittella
Haliaeetus leucogaster	White-bellied Sea-Eagle
Saccolaimus flaviventris.	Yellow-bellied Sheathtail-bat

Scientific Name	Common Name
Endangered Populations	
Marsdenia viridiflora R. Br subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas	

4. Survey

This chapter covers the following CERs:

CER 4 SURVEY

4.1. Requirement to Survey Vegetation and Ecological Communities

CER 4.1 Requirement to survey vegetation and ecological communities

CER 4.1.1 General survey requirements

CER 4.1.2 Additional survey requirements for specific ecological communities or vegetation types

Cumberland Ecology undertook vegetation and ecological community surveys in the study area and subject site initially in September and October 2016, October 2017, April 2019, March and April 2020, and September 2020 Cumberland Ecology prepared a constraints assessment in 2016 (Cumberland Ecology 2016b) and submitted several ecological assessments to facilitate development applications (Cumberland Ecology 2017a, b, 2018c, b, 2020b) within the Menangle Park URA; including the original SIS supporting this DA prepared in 2019.

In spring 2021 Cumberland Ecology resurveyed the Menangle Park URA and where necessary has revised vegetation mapping within the subject site. The 2021 surveys were completed in optimal conditions following average or above average rainfall.

Threatened flora surveys were undertaken within the study area and subject site in September and October 2016, October 2017, July 2018, March and September 2020, March and April 2021, and September to November 2021.

Fauna surveys were undertaken within the study area in October and December 2017, March 2018, September 2020 and March 2021, as well as an updated habitat assessment in May 2020 in some areas. To provide additional data requested by Council for this SIS, further fauna surveys were undertaken in the study area in September and October 2021.

Stadia Metric Surveys were undertaken by Craig and Rhodes surveyors of all trees in the proposed development works area in July 2021. Survey information included the location and trunk diameter of these trees. Cumberland Ecology then identified the species of these trees and recorded the presence of hollows and other habitat features in July and September 2021.

Additional studies conducted within the study area and local area provided a useful database of information which has supplemented the surveys undertaken for this DA. The methods utilised by Cumberland Ecology are described in detail in ***Section 4.3*** and survey effort is described within ***Section 4.4***.

4.2. Requirement to Survey for Species

CER 4.2.1 General survey requirements for species

CER 4.2.2 Additional survey requirements for specific species

Cumberland Ecology undertook flora and fauna surveys, including targeted threatened species surveys, within the study area and subject site in September and October 2016, October and December 2017, March and July 2018, March and September 2020, March and April 2021, July 2021 and September – November 2021. An updated habitat assessment was undertaken in May 2020 and as part of the Stadia Metric Surveys in July and September 2021. Additionally, previous studies conducted within the study area and surrounds provided a useful database of information which has supplemented the surveys undertaken within the study area and subject site.

The design of the flora and fauna surveys was determined in consideration of the Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities (Working Draft) (DEC (NSW) 2004) and/or the NSW Guide to Surveying Threatened Plants (OEH 2016a). The methods utilised by Cumberland Ecology are described in detail in ***Section 4.3*** and survey effort is described within ***Section 4.4***.

Additional surveys for the cryptic species *Pimelea spicata* were recommended in the CERs. Targeted threatened flora surveys for this species were undertaken within the study area and subject site in 2016, 2017 and 2020. Although an appropriate level of survey was undertaken for the species during the 2016 and 2017 surveys, Council requested that additional surveys be undertaken for the Stage 2B SIS that utilised a reference site where the species was in flower to improve the species detectability. The surveys undertaken in September 2020 were in response to Council's request and included a survey of a reference site (undertaken on the same day of targeted surveys within the study area) which is a nearby population (located along the M7 near Quakers Hill, NSW) that was flowering at the time of survey to ensure the targeted surveys of the study area were within the species' flowering period, and thus increasing the likelihood of any individuals within the study area being detected Subsequently, EHG comments on a previous draft of the Stage 2B SIS indicated that they considered the survey effort conducted to date on this species to be inadequate and that the reference site previously surveyed was inappropriate. To address EHG comments relating to *Pimelea spicata*, additional targeted surveys were undertaken in March 2021, including surveys of additional geographically closer reference sites and a grid-based targeted survey approach (see ***Section 4.3.2.4***)., This approach was deemed sufficient by EHG to adequately survey for the species.

The reference sites utilised are considered to be appropriate and consistent with the species' Environmental Impact Assessment Guidelines (NPWS 2000) as they are nearby and has very similar climatic conditions of the study area being located on the Cumberland Plain and within the same IBRA subregion. It is acknowledged that there are closer populations of the species to the study area that may have been surveyed; however, Cumberland Ecology did not have knowledge of their exact locations or if access was available at the time of the surveys. These surveys were conducted throughout the entirety of the subject site.

Targeted surveys for this species were also previously undertaken within the study area by GHD (2009), Travers Bushfire and Ecology (2013b) and Eco Logical (2009a).

4.3. Survey Techniques

CER 4.3 Documentation

CER 4.3.1 Description of survey techniques and survey locations

4.3.1. Vegetation Mapping

The following documentation and databases were reviewed to assist vegetation mapping within the study area:

- OEH species profiles for 'subject' vegetation communities previously recorded within the local area (OEH 2018i);
- Cumberland Plain Vegetation Mapping (DECCW 2007);
- Remnant Vegetation Mapping of the Cumberland Plain (OEH 2013a);
- Preliminary and final determinations for TECs;
- Vegetation Information System (VIS) Classification Database (OEH 2017m);
- Menangle Park Structure Plan Review (Cumberland Ecology 2016a);
- Menangle Park Stage 1 Flora and Fauna Assessment (Cumberland Ecology 2017a);
- Menangle Park Stage 2A Flora and Fauna Assessment (Cumberland Ecology 2018e)
- Menangle Park Flora, Fauna and Aquatic Assessments (Eco Logical Australia 2009a);
- Menangle Park Stage 1: Proposed Retirement of Ecosystem Credits for HN529 – Shale Hills Woodland (Derived Native Grassland) (Cumberland Ecology 2020b)
- Menangle Park Stage 2B SIS (Cumberland Ecology 2018f);
- Menangle Park Stage 2B SIS Addendum (Ecology 2021);
- Menangle Park Vegetation Assessment Report (Cumberland Ecology 2021b);
- Menangle Park Proposed Intersection at Cummins Road and Menangle Road Species Impact Statement (Cumberland Ecology 2018b);
- Menangle Park Proposed Vegetation Clearing within Menangle Park Urban Release Area Species Impact Statement (Cumberland Ecology 2018c);
- Report on Menangle Park – Offsetting Strategy (GHD 2010); and
- Ecological Assessment- Proposed Subdivision and infrastructure Delivery – Precinct 200 and Adjacent Bulk Earthworks (Travers Bushfire & Ecology 2013a).

Broad-scale vegetation mapping conducted by OEH (2013a) includes the study area. This mapping project identified all native vegetation within the study area. Unmapped areas within the study area are based on the unmapped areas within this OEH mapping, including areas of buildings, infrastructure, roads and cleared land. The vegetation mapping by OEH (2013a) was considered to closely align to the vegetation within the study area. However, the existing mapping was conducted at a subregional level and not at a local scale. For this reason, Cumberland Ecology conducted vegetation surveys within the study area in 2016, 2017, 2019, and 2020 to provide detailed, site-specific vegetation mapping that could be used for impact assessment purposes.

Following this, a comprehensive re-mapping of all areas within the subject site was conducted by Cumberland Ecology in September – November 2021 to update all existing vegetation mapping to reflect current on site conditions for this revised SIS with up-to-date data.

Vegetation mapping undertaken within the subject site and study area by Cumberland Ecology has included ground-truthing to examine and verify the condition and extent of the different vegetation communities occurring within the study area. Furthermore, heavily degraded areas were assessed for their recovery potential, based on the community type and evidence of native species in the seed bank. A combination of flora survey techniques was utilised to assist with refining the vegetation mapping and are outlined in ***Section 4.3.2***.

Mapping of scattered native trees utilised a stadia metric detailed survey of trees within the proposed development works area undertaken for the Menangle Park Vegetation Assessment Report (VAR) (Cumberland Ecology 2021b). The location of all native trees obtained during the preparation of Menangle Park VAR was overlain on the revised vegetation mapping to ensure individual scattered trees throughout the development works area were incorporated into vegetation community polygons.

Where vegetation community boundaries were found to differ from existing vegetation mapping, or where communities were degraded, records were made of proposed new boundaries using a hand-held Global Positioning System (GPS) and mark-up of aerial photographs. Areas that could not be surveyed due to access restrictions were mapped by extrapolating ground-truthed vegetation mapping in adjacent areas. The resultant information was synthesised using GIS. Mapping was completed using ArcGIS©.

Derived Native Grasslands within the subject site were mapped based on areas appearing to comprise >40% native vegetation cover, where the dominant native species was not *Cynodon dactylon* (Couch) as this has been planted within or invaded the pasture lands as a grazing species. The threshold of 40% native cover was utilised to conservatively identify grassland areas that have the potential to be considered as derived native grassland, as identified in the 'Expert Report – *Pimelea spicata*' (Teresa James 2018) that was commissioned by Council.

BBAM plots were completed throughout the Derived Native Grasslands, and in nearby adjacent exotic dominated grasslands to provide a comparison of the percentage native vegetation cover; thus, confirming the boundaries between the two vegetation communities.

4.3.2. Flora Survey

Flora surveys were undertaken within the study area by a botanist in September and October 2016, October 2017, July 2018, April 2019, March and April 2020, September 2020, March 2021 and April, July 2021 and September – November 2021. Flora surveys undertaken in 2016 were to support the Menangle Park Structure Plan Review, while the flora surveys undertaken in 2017 to 2019 were done to support six separate development applications along with the previous version of this SIS. Flora surveys undertaken in March and April 2020 were to support the Stage 2B SIS as well as ecological assessments to support the Stage 1 and 2A DAs. The flora surveys undertaken in September 2020 were specifically for targeting *Pimelea spicata* surveys for the Stage 2B SIS and this SIS. Cumberland Ecology undertook additional targeted threatened flora searches for *Pimelea spicata* (Spiked-rice Flower) in March 2021. Surveys conducted in July 2021 were to support the Menangle Park VAR (Cumberland Ecology 2021b) and surveys between September – November 2021 were to support this

revised SIS. The flora survey methods are described in detail in subsequent sections and included the following components:

- BioBanking Assessment Methodology (BBAM) (DECC 2009) plot and transects to obtain information on species composition and community structure;
- Random meander surveys, to detect additional flora species not recorded during plot sampling;
- Targeted searches for threatened flora; and
- Stadia metric surveys to identify trees occurring within the subject site.

4.3.2.1. BioBanking Assessment Methodology (BBAM) Plot and Transects

A total of 37 BBAM plots were conducted within the study area in 2016 and 2017 to inform the previous version of this SIS. However, these plots were completed during extremely dry conditions and they are now over five years old.

To replace the older plots and collect data during wetter seasonal conditions, 65 BBAM plots and transects were completed in the study area between September to November 2021. Many of the new plots were at the same or similar locations to provide comparable data. Of the 65 BBAM plots surveyed, 32 were within the proposed development works area, 21 were within the Howes Creek Conservation Area, three (3) were within the areas subject to Parks K and L (Cumberland Ecology 2020d) and nine (9) were within other parts of the study area outside of the aforementioned areas.

Within the subject site, the number of plots required to be completed for each vegetation community is provided in **Table 5**. Thirty-five (35) BBAM plots were required to be completed for the vegetation zones within the subject site, however 65 plots were completed.

Table 5 Summary of BBAM Plot Requirements

Vegetation Community	Location	Area (ha)	Plots Required	Plots Completed
Proposed Development Works Area				
African Olive Dominated Exotic Woody Vegetation	Proposed Development Works Area	1.32	0	0
Dam	Proposed Development Works Area	1.01	0	0
Elderslie Banksia Scrub Forest	Proposed Development Works Area	0.75	1	1
Elderslie Banksia Scrub Forest (non-TEC)*	Proposed Development Works Area	0.10	1	0
Freshwater Wetlands	Proposed Development Works Area	0.37	1	1
Other Exotic Dominated Woody Vegetation	Proposed Development Works Area	0.05	0	0
River Flat Eucalypt Forest	Proposed Development Works Area	1.51	1	1

Vegetation Community	Location	Area (ha)	Plots Required	Plots Completed
Shale Hills Woodland	Proposed Development Works Area	4.80	3	3
Shale Hills Woodland Derived Native Grassland	Proposed Development Works Area	3.28	3	3
Shale Hills Woodland Shrubby Regrowth	Proposed Development Works Area	0.49	1	2
Shale Plains Woodland	Proposed Development Works Area	5.94	3	5
Shale Plains Woodland Derived Native Grassland	Proposed Development Works Area	8.67	3	6
Swamp Oak Floodplain Forest	Proposed Development Works Area	3.39	2	3
Exotic Grassland/Cleared Land	Proposed Development Works Area	119.80	0	6
	Total	**151.58**	**18**	**31**
Howes Creek and Northern Conservation Area (existing areas*)**				
African Olive Dominated Exotic Woody Vegetation	Howes Creek and Northern Conservation Area	0.01	0	0
Dam	Howes Creek and Northern Conservation Area	0.84	0	0
Freshwater Wetlands	Howes Creek and Northern Conservation Area	6.15	3	4
Other Exotic Dominated Woody Vegetation	Howes Creek and Northern Conservation Area	0.06	0	0
Privet Dominated Exotic Woody Vegetation	Howes Creek and Northern Conservation Area	3.46	0	1
River Flat Eucalypt Forest	Howes Creek and Northern Conservation Area	8.10	3	3
Shale Plains Woodland	Howes Creek and Northern Conservation Area	11.51	3	5
Shale Plains Woodland Derived Native Grassland	Howes Creek and Northern Conservation Area	0.43	1	1
Swamp Oak Floodplain Forest	Howes Creek and Northern Conservation Area	7.65	3	4
Exotic Grassland/Cleared Land	Howes Creek and Northern Conservation Area	18.37	0	3
	Total	**56.60**	**13**	**21**
Parks K and L Conservation Area (existing areas*)**				
Elderslie Banksia Scrub Forest	Parks K and L Conservation Area	1.54	1	1

Vegetation Community	Location	Area (ha)	Plots Required	Plots Completed
River Flat Eucalypt Forest	Parks K and L Conservation Area	0.34	1	1
Shale Plains Woodland	Parks K and L Conservation Area	0.08	1	0
Swamp Oak Floodplain Forest	Parks K and L Conservation Area	0.28	1**	0
Exotic Grassland/Cleared Land	Parks K and L Conservation Area	0.54	0	1
	Total	**2.78**	**4**	**3**
Stage 6 EBSF Conservation Area				
Elderslie Banksia Scrub Forest	Stage 6 EBSF Conservation Area	0.21	1	1
	Total	**0.21**	**1**	**1**

**This vegetation is included within the TEC EBSF for BBAM calculations and therefore the plot undertaken within the community is suitable for use in the non-TEC form as it includes better condition scores to what is actually present.*

Plots were recorded within this patch of vegetation, however just outside the boundaries of the Park K and L VMP Area due to size restrictions influencing plot locations. See* ***Figure 12*.*

****These areas include the total current area of each vegetation community mapped within the proposed conservation works areas, not including the areas proposed to be removed due to land contamination in Lot 59 DP 10718.*

The locations of BBAM plots and transects were recorded using a GPS and the coordinates are provided in **Table 6**. The location and orientation of BBAM plots and transects are shown in **Figure 12**. Plot locations were selected to either match up with existing plots conducted in 2016 and 2017 or were located randomly in areas representative of the varying conditions of the vegetation within the study area. Following initial vegetation mapping in September 2021, a secondary site inspection was conducted in November 2021 to confirm the boundaries of the DNG within the subject site.

The following data was collected at each of the BBAM plot and transect locations:

- Native species richness recorded within each stratum of a 20 m x 20 m plot;
- Native over-storey projected foliage cover recorded at 10 points along a 50 m transect;
- Native mid-storey projected foliage cover recorded at 10 points along a 50 m transect;
- Native groundcover projected foliage cover recorded at 10 points along a 50 m transect for three life forms (shrubs, grasses and other);
- Weed species projective foliage cover expressed as a percentage of over-storey, mid-storey and ground cover along a 50 m transect;
- Number of trees with hollows where entrance width is over 5 cm and hollow is at least 1 m above ground within the 20 m x 50 m plot;

- The percentage of regenerating canopy species within the vegetation zone; and
- The total length in metres of fallen logs over 10 cm in diameter within the 20 m x 50 m plot.

In addition, native plant species richness within a 20 m x 20 m plot and full floristic data was also collected to enable classification of each vegetation zone to the best-fit PCT.

A copy of the survey proformas used in the surveys is attached in **Appendix C**.

Table 6 Location of BBAM plots and transects

Plot Name	Date	Size (m)	Zone	Start (Easting)	Start (Northing)	End (Easting)	End (Northing)
1	22/09/2021	20 x 50	56	292823	6226466	292811	6226501
2	22/09/2021	20 x 50	56	292637	6226241	292680	6226240
3	22/09/2021	20 x 50	56	292695	6225938	292652	6225923
5	22/09/2021	20 x 50	56	292578	6225671	292566	6225718
6	22/09/2021	20 x 50	56	293447	6225519	293414	6225533
7	23/09/2021	20 x 50	56	292503	6225481	292474	6235453
8	24/09/2021	20 x 50	56	293634	6225370	293684	6225379
10	24/09/2021	20 x 50	56	292994	6225176	293034	6225179
11	23/09/2021	20 x 50	56	291822	6225173	291809	6225216
12	24/09/2021	20 x 50	56	292882	6225081	292857	6225726
13	24/09/2021	20 x 50	56	293201	6224948	293157	6224978
14	29/09/2021	20 x 50	56	293104	6224789	293065	6224766
15	23/09/2021	20 x 50	56	293507	6224707	293474	6224745
16	23/09/2021	20 x 50	56	293441	6224699	293419	6224746
17	29/09/2021	20 x 50	56	293198	6224535	293213	6224487
18	23/09/2021	20 x 50	56	293538	6224431	293541	624444
19	29/09/2021	20 x 50	56	293019	6224325	292996	6224284
21	29/09/2021	20 x 50	56	293023	6224244	293050	6224283
22	30/09/2021	20 x 50	56	292649	6224095	292607	6224107
23	30/09/2021	20 x 50	56	292477	6223865	292479	6223912
25	30/09/2021	20 x 50	56	292434	6223457	292407	6223430
26	05/10/2021	20 x 50	56	293067	6222821	293114	6222804
27	30/09/2021	20 x 50	56	292323	6222669	292364	6222692
28	30/09/2021	20 x 50	56	292647	6222615	292601	6222619
29	05/10/2021	20 x 50	56	292953	6222494	292909	6222507
30	22/09/2021	20 x 50	56	293085	6226382	293049	6226356

Plot Name	Date	Size (m)	Zone	Start (Easting)	Start (Northing)	End (Easting)	End (Northing)
31	22/09/2021	20 x 50	56	293115	6226197	293164	6226196
32	22/09/2021	20 x 50	56	292816	6226079	292846	6226108
33	22/09/2021	20 x 50	56	293553	6226027	293558	6226077
34	22/09/2021	20 x 50	56	293177	6225437	293135	6225407
35	23/09/2021	20 x 50	56	292250	6225492	292201	6225494
36	23/09/2021	20 x 50	56	291582	6225163	291587	6225207
37	24/09/2021	20 x 50	56	293007	6225053	293020	6225012
38	29/09/2021	20 x 50	56	292797	6224945	292770	6224986
39	23/09/2021	20 x 50	56	293244	6224829	293206	6224856
40	29/09/2021	20 x 50	56	293000	6224562	293023	6224605
41	30/09/2021	20 x 50	56	262612	6224198	262577	6224211
42	30/09/2021	20 x 50	56	292723	6224023	292729	6224070
43	30/09/2021	20 x 50	56	292644	6224014	292626	6223968
1a	22/09/2021	20 x 50	56	292619	6226034	292651	6226078
2a	29/09/2021	20 x 50	56	293602	6225445	293651	6225446
3a	05/10/2021	20 x 50	56	292843	6222819	292854	6222869
1b	22/09/2021	20 x 50	56	293958	6225897	294002	6225912
2b	08/10/2021	20 x 50	56	293549	6225936	293594	6225948
3b	09/10/2021	20 x 50	56	293818	6225791	293818	6225843
4b	09/10/2021	20 x 50	56	293891	6225847	293872	6225893
5b	08/10/2021	20 x 50	56	293131	6226291	293180	6226274
6b	08/10/2021	20 x 50	56	292819	6226361	292867	6226350
7b	08/10/2021	20 x 50	56	292888	6226414	292939	6226403
4a	05/11/2021	20 x 50	56	292804	6226101	-	-
5a	05/11/2021	20 x 50	56	292468	6225464	-	-
6a	05/11/2021	20 x 50	56	292738	6226435	-	-
7a	05/11/2021	20 x 50	56	292795	6226275	-	-
8a	05/11/2021	20 x 50	56	292972	6226259	-	-
9a	05/11/2021	20 x 50	56	293127	6226172	-	-
10a	05/11/2021	20 x 50	56	222496	6293098	222501	293048
11a	15/11/2021	20 x 50	56	291800	6225606	291853	6225603
12a	15/11/2021	20 x 50	56	292311	6225588	292340	6225546
13a	15/11/2021	20 x 50	56	292523	6225919	292574	6225931
14a	15/11/2021	20 x 50	56	293562	6224638	293514	6224623

Plot Name	Date	Size (m)	Zone	Start (Easting)	Start (Northing)	End (Easting)	End (Northing)
15a	15/11/2021	20 x 50	56	293288	6224565	293296	6224515
16a	15/11/2021	20 x 50	56	292788	6225376	292758	6225419
17a	15/11/2021	20 x 50	56	292646	6224076	-	-
18a	15/11/2021	20 x 50	56	292569	6223984	-	-
19a	15/11/2021	20 x 50	56	292528	6224073	-	-

4.3.2.2. Random Meander Surveys

To provide extra flora data, 'random meander' surveys were undertaken throughout the study area in conjunction with vegetation mapping surveys in order to maximise the number of vascular plant species recorded. Additional species not recorded within the BBAM plots were noted during the random meander surveys and included in the total species list, which is provided in **Appendix D**. The locations of the random meander surveys are shown in **Figure 12**.

4.3.2.3. Stadia Metric Surveys

Stadia Metric Surveys were undertaken within the development works area of trees by Craig and Rhodes in July 2021. A tree was defined in accordance with the definition from Section 11.1 of the *Campbelltown (Sustainable City) Development Control Plan 2015* as a perennial plant with at least one self-supporting stem which:

- Has a height of more than three (3) metres, or
- Has an outside circumference of at least 500mm at ground level; or
- Has a branch and foliage crown spread of at least 4 metres.

Craig & Rhodes undertook detailed survey of trees using RTK GPS and Robotic Total Stations. All trees were surveyed using the Craig & Rhodes site-wide survey control network that is based on GDA94 Zone 56 MGA coordinates and AHD height datum.

Surveyed tree data was then downloaded, decoded & reduced using Landmark Survey Software.

The data was then provided to Cumberland Ecology in the following files; CSV, DXF & KML containing tree data in the following format: Tree Number/Easting/Northing/Height/Canopy spread/Trunk diameter (ground)/Trunk diameter (chest)/Multi stem status.

Cumberland Ecology botanists and ecologists resurveyed each tree and identified the species on the 13th to 16th, and the 20th to the 21st of July 2021, and 22 September 2021. The dataset from Craig & Rhodes included instances of exotic species and dead trees along with native trees. For the purposes of this assessment the term "native" was defined as per the NSW *Local Land Services Act 2013* (LLS Act), i.e. *"A plant is native to New South Wales if it was established in New South Wales before European settlement. The regulations may authorise*

conclusive presumptions to be made of the species of plants native to New South Wales by adopting any relevant classification in an official database of plants that is publicly accessible".

4.3.2.4. Targeted Threatened Flora Surveys

Targeted threatened flora surveys were undertaken in September and October 2016, October 2017, July 2018, March and September 2020, March 2021 and September to November 2021. To guide the threatened species searches, a list of candidate species was determined through analysis of database records and consideration of available habitat. The candidate species are equivalent to the subject species identified within ***Section 3.2.2*** and includes: *Allocasuarina glareicola*, *Cynanchum elegans* (White-flowered Wax Plant), *Eucalyptus benthamii* (Camden White Gum), *Genoplesium baueri* (Bauer's Midge Orchid), *Grevillea parviflora subsp. parviflora* (Small-flower Grevillea), *Gyrostemon thesioides*, *Maundia triglochinoides*, *Persicaria elatior* (Tall Knotweed), *Pimelea spicata* (Spiked Rice-flower), *Pomaderris brunnea* (Brown Pomaderris), *Pterostylis saxicola* (Sydney Plains Greenhood), *Pultenaea pedunculata* (Matted Bush-pea) and *Thesium australe* (Austral Toadflax).Cumberland Ecology undertook the additional targeted threatened flora searches for *Pimelea spicata* (Spiked-rice Flower) in 2020 and 2021 to respond to Council comments provided previously. When searches are made for this plant, it is appropriate to verify that it is flowering at reference sites, as it can then be assumed that it would be likely to be flowering at the subject site if present, and so be detectable. Surveys undertaken for this species in September 2020 included the survey of a reference site of a nearby population ((located along the M7 near Quakers Hill, NSW) that was flowering, on the same day of targeted surveys within the study area to ensure surveys were undertaken within the species' known flowering period. The *Guide to Surveying Threatened Plants* (OEH 2016a) was referenced to guide the targeted surveys which included random meanders through suitable habitat for all subject threatened species that were considered to have the potential to occur within the subject site. Areas of potential habitat for the targeted species were identified as occurring within areas of native vegetation. This habitat and additional areas, including exotic vegetation were surveyed concurrently with vegetation mapping ground-truthing, random meander surveys, and BBAM plot and transect surveys.

To address EHG comments relating to *Pimelea spicata* for the Stage 2B SIS (REF. 17072 RP15 and 17072 RP22) additional targeted surveys were undertaken in March 2021 that encompassed the entirety of the subject site, including surveys of additional reference sites and a grid-based targeted survey approach. These surveys are described below.

i. Reference Sites

Potential reference sites were identified from the NSW BioNet Atlas as well as from Council. A total of four publicly accessible reference sites were visited on 11 March 2021 prior to undertaking targeted surveys for the species within the study area. The reference sites are located near the M7 in Quakers Hill as well as Henrietta Drive, Richardson Road and Mt Annan Drive within the Camden LGA. Three additional reference sites within the Campbelltown LGA were attempted to be visited, including one near the study area, but all locations were within private property and inaccessible. The locations of reference sites surveyed are shown in **Figure 13**. All reference sites recorded flowering individuals confirming that the timing of targeted surveys within the study area was appropriate.

Photograph 1 Flowering *Pimelea spicata* during March 2021 within the four reference sites

1: Quakers Hill	Site 2: Henrietta Drive
	
Site 3: Richardson Road	Site 4: Mt Annan Drive
	

ii. Survey Grid

Additional targeted surveys for *Pimelea spicata* were conducted on 17 and 18 March 2021 following the 'Two-phase grid-based systematic survey approach for large areas' identified in the '*Surveying threatened plants and their habitats*' (NSW Government 2020).

Prior to undertaking targeted surveys for the species within the study area, a 100 m grid was nested within a one-square-kilometre grid from a topographic map image and then overlayed onto the study area using a

Geographic Information System (GIS). Surveys were undertaken where the 100 m gridlines intersect within suitable habitat for a target species and where the land is within Dahua Group Australia ownership. The majority of the study area is not considered to provide suitable habitat for the species as it contains soils with a sandy influence that is not considered to be 'well-structured' clay soils' required to support the species (OEH 2019d). Nevertheless, the entire study area was initially considered as 'potential habitat'.

At each survey location (grid intersect), the following two-stage assessment process was undertaken within a 40-metre diameter area pre-loaded onto a Global Positioning System unit:

0. Potential habitat inspected to determine if suitable habitat present; and

1. Targeted surveys where suitable habitat detected.

Suitable habitat was defined as any woodland areas, or any grassland areas that had greater than 40% native species cover. Any areas confirmed to have less than 40% native cover or were within inundated areas not suitable for the species, were not surveyed.

The threshold of 40% native cover was utilised to conservatively identify grassland areas that have the potential to be considered as derived native grassland. As identified in the 'Expert Report – *Pimelea spicata*' (Teresa James 2018), suitable habitat for the species within the study area (and Greater MacArthur Growth Area) is limited to Cumberland Plain Woodland, Moist Shale Woodland, Shale Sandstone Transition Forest and Derived Native Grasslands. Therefore, the conservative 40% native cover threshold for grassland areas utilised was appropriate.

Once suitable habitat was confirmed, the 40-metre diameter area was systematically surveyed for *Pimelea spicata*. The locations of targeted surveys within the study area are provided in **Figure 12**. The targeted threatened surveys undertaken by Cumberland Ecology supplemented previous targeted threatened surveys undertaken by Travers (2013b), Eco Logical (2009b) and GHD (2009).

4.3.3. Fauna Survey

Cumberland Ecology conducted fauna surveys within the study area in September 2016, October 2017, March 2018, September 2020, March 2021, and September to November 2021. Fauna surveys were conducted, where appropriate, in accordance with the survey guidelines provided in the Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities (Working Draft) (DEC (NSW) 2004) and included the following surveys:

- General habitat assessment;
- Hollow-bearing tree assessment;
- Targeted searches for Cumberland Plain Land Snail;
- Targeted searches for the Green and Golden Bell Frog;
- Diurnal bird census;
- Microchiropteran bat surveys;

- Spotlighting and call playback;
- Spot Assessment Technique surveys;
- Infra-red camera surveys;
- Roost watches;
- Koala detection dog surveys; and
- Incidental fauna observations.

A detailed description of the survey methodologies undertaken for each of the survey types performed within the study area is provided below. The survey effort undertaken for each survey type is provided in ***Section 4.4***.

4.3.4. General Habitat and Site Condition Assessment

A general fauna habitat assessment was undertaken within subject site during field surveys. This assessment included consideration of important indicators of habitat conditions and complexity as well as the occurrence of micro-habitats such as tree hollows, fallen logs, dam fringing vegetation and riparian areas. An assessment of the structural complexity of the vegetation, the age structure of the forest and the nature and extent of human disturbance was also undertaken. Notes were taken on specific habitat features that may be utilised by threatened fauna species known to occur in the local area.

In addition to the general habitat assessment, fauna habitat data was also collected throughout the study area within the BioBanking plots, which included the number of trees with hollows, the total length of logs and composition of the ground stratum.

4.3.4.1. Hollow-bearing Tree Assessment

An assessment of all hollow-bearing trees within the subject site was undertaken as part of the stadia metric surveys described in ***Section 4.3.2.3*** that were conducted for the Menangle Park VAR (REF. 17072 RP23). All trees within the subject site were inspected by a botanist and ecologist in July and September 2021 and notes were taken on hollow-bearing trees, including the location, tree species, and estimated hollow size.

4.3.5. Targeted Threatened Fauna Surveys

4.3.5.1. Cumberland Plain Land Snail

Targeted searches were undertaken within the subject site and surrounding area for the Cumberland Plain Land Snail (*Meridolum corneovirens*) which is listed as endangered under the TSC Act. Searches for the Cumberland Plain Land Snail were undertaken at the base of trees characteristic of CPW (e.g. *Eucalyptus tereticornis*, *Eucalyptus crebra*, *Eucalyptus moluccana*) as well as around the base of logs, log piles and other woody debris. Searches consisted of checking within 1 m of the base of all suitable trees that had a diameter at breast height greater than 10 cm and had leaf litter present at the base, and at the base of logs/log piles with a diameter of greater than 10 cm. These were undertaken in conjunction with the SAT surveys described in ***Section 4.3.10*** on 24, 28 and 30 September 2021. Nocturnal surveys for the Cumberland Plain Land Snail were undertaken

via spotlighting using high-powered handheld torches over several nights on 30 September 2021 and 5, 6 and 7 October 2021.

4.3.5.2. Green and Golden Bell Frog

A diurnal habitat assessment of waterbodies and dams within the study area was undertaken on 30 September 2021, including inspection of the fringing vegetation, vegetative cover, basking areas, connectivity and surrounding habitat type. A diurnal search was simultaneously conducted around each suitable waterbody to record any amphibian species present. Nocturnal surveys for the Green and Golden Bell Frog (*Litoria aurea*) were conducted on 30 September 2021 and 5, 6 and 7 October 2021 and involved a combination of spotlighting on foot around suitable waterbodies and call playback using a pre-recorded call of the Green and Golden Bell Frog.

4.3.6. General Diurnal Bird Census

Eighteen (18) 20-minute area surveys were undertaken within the study area over six days in set locations. Surveys were undertaken by two ecologists just after sunrise on 11, 12 and 13 December 2017 and 14, 19, and 23 March 2018. Bird species that were observed or heard calling were recorded.

4.3.7. Targeted Threatened Bird Surveys

4.3.7.1. Diurnal Bird Census

Targeted surveys for the Brown Treecreeper, Little Lorikeet and Little Eagle, were undertaken following '*Survey Guidelines for Australia's Threatened Birds*' (DEWHA 2010b). Surveys included 20-minute area searches undertaken during mornings, over a period of eight days from 9-12 March 2021 and on 16, 17, 30 and 31 March 2021 at the locations identified in **Figure 14**.

A total of 8 locations were surveyed between 9-12 March 2021. A further eight location were surveyed between 16, 17, 30 and 31 March 2021, with these later surveys were repeated at each survey location (i.e., total of two surveys per site). This included surveys within patches of woodland within the subject site, and woodland areas located within the study area. Surveys targeted hollow-bearing trees and any tree stumps to improve detectability of the Brown Treecreeper and Little Lorikeet. During the area search surveys, any large stick nests deemed suitable for the Little Eagle were recorded. Any nests identified were also targeted during the survey to improve detectability of the species. All species observed (heard calling/seen) were recorded.

4.3.8. Microchiropteran Bat Surveys

Microchiropteran bat surveys have been conducted in the study area between 2017 and 2021, utilising a range of methods including ultrasonic call detection, roost watches and harp trapping. Further details of these survey methods is provided below in subsequent sections.

4.3.8.1. Echolocation Call Detection

Three echolocation call detection units (one SM2 and two Anabat Units) were deployed within the study area over a period of seven consecutive nights. Units were set up on 11 December 2017 and retrieved on 18 December 2017. Two units were also deployed within the study area from 19 March 2018 to 23 March 2018 and the other unit deployed from 23 March 2018 to 26 March 2018. All units were deployed overnight for a

period of 12 hours from 6:00pm to 6:00am. As microchiropteran bats are generally most active between October and March, the survey was undertaken when the weather was warm during the optimum survey period, thereby increasing the likelihood of detecting microchiropteran bats.

The identification of bat echolocation calls recorded during surveys was undertaken by Dr Anna McConville from Echo Ecology using AnalookW software (Echo Ecology, 2018). Full spectrum calls (.WAV files) were first converted to zero crossings using Kaleidoscope. The identification of calls was undertaken with reference to Pennay et al. (2004) and through the comparison of recorded reference calls from the Sydney Basin. Reference calls were obtained from the NSW database and from the personal collection of Dr McConville.

4.3.8.2. Roost Watches

Targeted surveys were undertaken in 2021 following the '*Species credit' threatened bats and their habitats: NSW survey guide for the Biodiversity Assessment Method*' (NSW Government 2018) and '*Survey Guidelines for Australia's Threatened Bats*' (DEWHA 2010a). Surveys included roost watches with an echolocation recording device (e.g. Anabat/Anabat Swift) and harp trapping. Further details of these surveys are provided below and in ***Section 4.3.8.3***.

Roost watch surveys using an echolocation recording device were carried out at dusk from 8-11 March 2021 and 15, 16, 29 and 30 March 2021. Roost watches were carried out by two ecologists in eight locations within the study area(see **Figure 14**). Roost watches included watching tree hollows (each ecologist watched a separate hollow(s)) from approximately 30 minutes prior to dusk and 30 minutes after dusk (i.e., minimum of one hour) using an echolocation recording device to identify potential bat roosts as well as the species roosting. During roost searches, the time and location of any bats detected (either seen or recorded on echolocation device were recorded. All bat recordings were sent to Dr Anna McConville of Echo Ecology for species identification.

Additional roost watches without the use of an echolocation device were carried out on 30 September and 5, 6, and 7 October 2021. Roost watches were carried out by two ecologists in eight locations within the study area and watches included watching tree hollows (each ecologist watched a separate hollow(s)) from approximately 15 minutes prior to dusk and 15 minutes after dusk (i.e., minimum of half hour).

During roost watch surveys, spotlighting was also undertaken to determine if hollows were being used by other fauna, including arboreal mammals and owls (including the Powerful Owl). Any fauna recorded during spotlighting was recorded on the roost watch survey proformas (see **Appendix C**).

4.3.8.3. Harp Trapping

Harp trapping was carried out over a period of four nights from 8-12 and 15-16 March 2021 within four patches of woodland containing tree hollows located in the study area (see **Figure 14**). All captured bats were identified to species level and subsequently released either the morning or evening of capture.

4.3.9. Spotlighting and Call Playback

Fifteen 20-50 minute area surveys were undertaken within accessible areas of the study area over six nights in 2017 and 2018. Two ecologists undertook these surveys on 18, 19 and 21 December 2017, and 26-28 March 2018. Eight walking transect surveys were undertaken over four nights on 30 September and 5, 6 and 7 October

2021, with two ecologists walking each transect for between 0.5-1.5 hours (1-3 person hours). Not all eight transects were surveyed on each of the four nights; however, each was surveyed on at least three nights. Surveys consisted of undertaking spotlighting/ call playback targeting nocturnal birds and mammals, as well as recording any incidental species.

Surveys consisted of a random meander through each survey point or along the transect using a high-powered hand-held torch to search for evidence of nocturnal birds and mammals. Call playback for the Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*) and Masked Owl (*Tyto novaehollandiae*) was undertaken in 2017 and 2018. Call playback for the Bush Stone-curlew (*Burhinus grallarius*) and Koala (*Phascolarctos cinereus*) was undertaken in 2021. Call playback included projecting recorded calls of each species over a handheld speaker for five minutes, then listening for five minutes, and repeating for a total of a minimum of 20 minutes at each survey location.

4.3.10. Spot Assessment Technique (SAT) Surveys

Surveys were undertaken for the Koala, utilising the Spot Assessment Technique (SAT) methodology as outlined in Phillips and Callaghan (2011). A total of thirty-five (35) SAT survey sites established across the study area. Five (5) of these surveys were undertaken on 15 October 2020 and thirty (30) were undertaken between 24, 28 and 30 September 2021. Field assessments carried out at the SAT survey site included:

- Selection and sampling of a central mature Koala feed tree (or another species if no feed trees are present);
- Subsequent sampling of up to 29 of the trees closest to this central tree, i.e. a total of 30 trees sampled at each SAT site;
- At each SAT survey site, a maximum of two-person minutes was spent searching for faecal pellets (scats) within a one metre radius of the base of each selected tree. Searching ceased if a Koala faecal pellet was located before the two minutes expired;
- Searching for faecal pellets involved an initial inspection of the ground surface followed by a robust disturbance, i.e. raking of the leaf litter if necessary to search for faecal pellets; and
- The species of each tree searched was recorded along with presence/absence of Koala faecal pellets. Notes were made on whether the scats were fresh or old and a photograph and/or sample was taken.

Area searches for the Koala were also undertaken at each of the SAT survey site, irrespective of result of the faecal pellet searches. At each of the SAT survey sites, a five-minute visual inspection of trees was conducted within a 25 m radius of the central tree. Any individual Koalas present during this inspection were recorded.

4.3.11. Infra-red Cameras

Six (6) Infra-red (IR) Reconyx cameras were set out within the study area on 22 September 2021 and were collected on 9 November 2021. The IR cameras were attached to trees in patches of woodland vegetation at a height of approximately 2 m and were focused on the trunks and branches of nearby trees; targeting koalas, woodland birds and arboreal mammals. The IR cameras recorded three consecutive photographs following each triggering movement.

4.3.12. Koala Detection Dogs

Koala detection dogs were used to survey all significant woodland and treed patches of vegetation within the study area on 12, 13 and 14 October 2021 to target presence of the koala. Steve Austin, a renowned dog trainer and handler, was engaged to conduct the surveys alongside a Cumberland Ecology ecologist. Four (4) Working Line English Springer Spaniels dogs that have been trained to detect koala scat and koala scent were used throughout the survey. With one dog working at a time, Steve Austin and the ecologist walked through areas of treed vegetation while the dog scouted within an approximate buffer area of 30 m either side. Each dog scouted for up to one hour before it was rotated for another; with the surveys conducted for approximately eight (8) hours each day over the three days of survey. A hand-held GPS was used by to track the area walked by the ecologist throughout the surveys.

4.3.13. Incidental Fauna Observations

Any incidental fauna species that were observed, heard calling, or otherwise detected based on tracks or signs, were recorded and listed in the total species list for the development footprint.

4.3.14. Proposed Conservation Areas Habitat Assessment and Fauna Survey

Conservation areas are proposed under the Menangle Park Structure Plan and details of the proposed conservation areas have been included within this SIS to demonstrate that larger areas of suitable habitat are proposed to be retained in the long-term within nearby areas under the Menangle Park Structure Plan.

A habitat survey of the conservation areas proposed under the Menangle Park Structure Plan was undertaken on 19 March 2020 to address comments made by Council previously relating to the suitability of the proposed conservation areas identified in the Menangle Park Structure Plan for threatened fauna that may be impacted by the proposed development works. The purpose of the survey was to provide further details that the proposed conservation areas provide better habitat for fauna to what is proposed to be removed as well as determine that the proposed conservation areas are suitable to have nest boxes/salvaged hollows installed to offset any impacts associated with the removal of tree hollows associated with the proposed development works.

The proposed conservation areas include areas of the Howes Creek Riparian Corridor located in the north of the study area, as well as areas to the west of the rail corridor to the northwest and west of the study area. These areas are proposed to be utilised to offset impacts associated with the Site-wide Bulk Earthworks DA (3574/2019/DA-CW).

Surveys undertaken in March 2020 consisted of a random meander through all conservation areas where the following tasks were undertaken:

- Details of all hollow-bearing trees were recorded, including: location, height, diameter at breast height, number of hollows and size of hollows; and
- Details of all trees with a diameter at breast height >30 cm and no hollows that were determined to be suitable recipient trees of tress hollows/nest boxes including: location, species and vegetation community.

Additionally, the following fauna surveys, that are detailed in ***Section 4.3.5*** – ***Section 4.3.13*** above and shown in **Figure 14**, were conducted throughout the conservation areas:

- Cumberland Plain Land Snail targeted searches;
- Green and Golden Bell Frog targeted searches;
- Diurnal bird census;
- Microchiropteran bat surveys;
- Spotlighting and call playback;
- SAT surveys;
- IR cameras;
- Koala detection dogs; and
- Incidental fauna observations.

Detailed descriptions of the survey effort specific to the Howes Creek and Northern conservation areas and the Parks K and L conservation areas are provided within each conservation areas VMP (REF. 17072 RP36 and 17072RP29, respectively).

4.4. Survey Effort

CER 4.3 Documentation

CER 4.3.2 Documenting survey effort and results

4.4.1. Flora Survey Effort

Flora surveys methods and effort conducted within the study area to date by Cumberland Ecology including surveys for the SIS and the additional surveys carried out in March and June 2021 are summarised in **Table 7** below. This does not include the BBAM plots and transects undertaken for the original version of this SIS as the data has since been replaced by the latest survey data collected in September to November 2021.

Table 7 Flora survey effort within the study area

Survey Type *	Date	Number of Plots	Person Hours
BioBanking Plots/Transects	22-24/09/2021, 29/09/2021, 30/09/2021, 05/10/2021, 08/10/2021, 05/11/2021, 15/11/2021	65	-
Random Meander	7/09/2016, 8/09/2016, 9/09/2016, 12/09/2016, 28/09/2016, 13/10/2016, 3/10/2017, 5/07/2018	-	-

Survey Type *	Date	Number of Plots	Person Hours
	2/03/2020, 29/04/2020, 22/06/2021, 22-24/09/2021, 29/09/2021, 30/09/2021, 05/10/2021, 08/10/2021, 05/11/2021, 15/11/2021		
Targeted Threatened Flora Surveys	7/09/2016, 8/09/2016, 09/09/2016, 12/09/2016, 28/09/2016, 3/10/2017, 05/07/2018, 2/03/2020, 29/04/2020, 15/09/2020, 17/03/2021, 18/03/2021	-	130
Vegetation Mapping	7/09/2016, 8/09/2016, 3/10/2017, 2/03/2020, 29/04/2020, 22-24/09/2021, 29/09/2021, 30/09/2021, 05/10/2021, 08/10/2021, 05/11/2021, 15/11/2021	-	70
Stadia Metric Survey (trees)	13-16/07/2021, 20-21/07/2021, 22/09/2021	-	-

**Threatened flora species surveys and vegetation mapping were undertaken concurrently with BBAM plot and transects, and random meander.*

4.4.2. Fauna Survey Effort

Fauna survey methods and survey effort conducted within the study area by Cumberland Ecology are summarised in **Table 8** below.

Table 8 Fauna survey effort within the study area

Survey Technique	Dates	Total Survey Effort
General Habitat Assessment	7/09/2016, 8/9/2016, 3/10/2017, 2/03/2020, 18/05/2020, 9 – 12/03/2021, 16 – 17/03/2021, 30 – 31/03/2021, 24/09/2021, 28/09/2021, 30/09/2021	50 person hours
Cumberland Plain Land Snail Surveys	3/10/2017, 2/03/2020, 18/05/2020, 24/09/2021, 28/09/2021, 30/09/2021	28 person hours
Green and Golden Bell Frog Surveys	30/09/2021, 5 – 7/10/2021	16 person hours
Diurnal Bird Surveys	11/12/2017, 12/12/2017, 13/12/2017, 19/03/2018, 23/03/2018, 9-12/03/2021	18 person hours
Spotlighting/ Call Playback	18/12/2017, 19/12/2017, 21/12/2017, 26 - 28/03/2018, 9-12/03/2021*, 30/09/2021, 5 – 7/10/2021	72 person hours

Survey Technique	Dates	Total Survey Effort
Bat Call detectors	11-18/12/2017, 19-23/03/2018, 9-12/03/2021**	27 nights (3 units for 7 nights, 2 units for 3 nights)
Roost Watches	8 - 11/03/2021, 15 – 16/03/2021, 29 – 30/03/2021	16 person hours
Spot Assessment Technique (SAT) Surveys	15/10/2020, 24/09/2021, 28/09/2021, 30/09/2021	24 person hours
IR Cameras	22/09/2021 – 09/11/2021	288 trap nights
Koala Detection Dog Survey	12 – 14/10/2021	24 hours
Conservation Areas Survey	19/3/2020	20 person hours
Incidental Fauna Observations	Throughout survey periods	n/a

** 9-12/03/2021 survey dates only included spotlighting.*

*** 9-12/03/2021 surveys were limited roost watch surveys (i.e., not left overnight).*

4.4.3. Weather Conditions

Weather conditions during flora and fauna surveys were generally appropriate for detection of a variety of flora and fauna. Surveys were undertaken in spring (September 2016, October 2017, and September and October 2020, September to November 2021), summer (December 2017), autumn (March, April, and May 2020. and March 2021), and winter (June 2021). A summary of weather conditions in the local area during the flora and fauna survey periods is provided in **Table 9** below. Weather station data was obtained from station 68216 Menangle Bridge (Nepean River) for rainfall data and 68257 Campbelltown (Mount Annan) for temperature. Dates without data are due to data for these dates not being recorded within the BOM historical climate data records.

Table 9 Weather conditions during surveys

Date	Temperature Cº (Min)	Temperature Cº (Max)	Rainfall (mm)
7/09/2016	7.4	23.3	0
8/09/2016	13.6	23.7	0
10/09/2016	21.9	12.9	2
12/09/2016	21.2	6.2	0
28/09/2016	20.9	3.7	0
13/10/2016	19.5	9.1	0
3/10/2017	10.2	25.2	0
11/12/2017	13.5	31.5	0
12/12/2017	16.9	30.9	0
13/12/2017	15.3	35.7	0
18/12/2017	20.3	34.6	0

Date	Temperature C° (Min)	Temperature C° (Max)	Rainfall (mm)
19/12/2017	19.7	40.0	0
21/12/2017	18.9	25.8	0
14/03/2018	16.5	28.8	2
15/03/2018	15.8	35.7	0
16/03/2018	19.5	27.0	0
17/03/2018	16.1	36.8	0
18/03/2018	14.6	39.7	0
19/03/2018	15.4	35.4	0
20/03/2018	14.7	30.5	0
21/03/2018	16.4	19.5	12
22/03/2018	15.3	21.9	11
23/03/2018	NA	22.4	1
24/03/2018	13.6	27.8	0
25/03/2018	17.2	32.8	0
26/03/2018	16.1	25.3	1
27/03/2018	8.0	25.8	0
28/03/2018	12.0	30.0	0
5/07/2018	4.1	23.9	0
3/04/2019	11.0	26.5	0
29/10/2019	9.8	23.4	0
2/03/2020	14.9	36.9	0*
19/03/2020	12.5	32.1	0
29/04/2020	13.1	26.0	0
18/05/2020	7.8	21.3	0
15/09/2020	12.8	23.8	0**
15/10/2020	10.0	29.8	0
8/03/2021	15.4	29.2	0
9/03/2021	14.2	31.7	0
10/03/2021	17.5	26.6	0
11/03/2021	18.5	26.5	0
12/03/2021	19.0	24.5	1
13/03/2021	16.7	33.0	0
16/03/2021	10.4	20.0	0
17/03/2021	14.1	24.2	1
18/03/2021	15.8	20.2	3

Date	Temperature C° (Min)	Temperature C° (Max)	Rainfall (mm)
23/03/2021	16.5	19.7	41
24/03/2021	14.8	-	32
25/03/2021	-	-	0
30/03/2021	11.2	-	0
7/04/2021	16.2	30.9	0
23/04/2021	3.0	22.6	0
22/06/2021	6.0	18.4	36***
21/07/2021	5.8	15.9	0
22/09/2021	2.8	21.8	0
23/09/2021	3.8	27.7	0
24/09/2021	6.2	27.2	0
28/09/2021	6.4	24.8	0
29/09/2021	10.4	18.6	0
30/09/2021	10.7	23.0	5
5/10/2021	9.7	20.8	0
6/10/2021	5.6	25.9	0
7/10/2021	6.9	30.6	0
5/11/2021	15.6	22.4	47

**Rainfall the month prior was a total of 274 mm*

***Rainfall the month prior was a total of 79 mm*

****Rainfall the month prior was a total of 304.6 mm*

4.4.4. Survey Personnel

The details of survey personnel are provided in **Table 10**.

Table 10 Survey personnel

Survey Personnel	Role	Company	Contact Details
Dr David Robertson	Director	Cumberland Ecology	(02) 9868 1933
Mikael Peck	Principal Ecologist	Cumberland Ecology	(02) 9868 1933
Bryan Furchert	Senior Botanist	Cumberland Ecology	(02) 9868 1933
Dr Rohan Mellick	Botanist	Cumberland Ecology	(02) 9868 1933
Matt Freeman	Senior Ecologist	Cumberland Ecology	(02) 9868 1933
Heather Gosper	Senior Ecologist	Cumberland Ecology	(02) 9868 1933
Rebeca Violante	Ecologist	Cumberland Ecology	(02) 9868 1933
John Foster	Ecologist	Cumberland Ecology	(02) 9868 1933

Survey Personnel	Role	Company	Contact Details
Sally Dupont	Ecologist	Cumberland Ecology	(02) 9868 1933
Eleanor Saxon	Ecologist	Cumberland Ecology	(02) 9868 1933
Julian Reyes	Research Assistant	Cumberland Ecology	(02) 9868 1933
Jesse Luscombe	GIS Specialist	Cumberland Ecology	(02) 9868 1933
Steve Austin	Koala Dog Trainer/Handler	Steve Austin Canine Training and Behaviour	0419 983 164

4.4.5. Survey Limitations

Adequate ecological data exists for the assessment of the ecological impacts for the proposed development works. The flora and fauna of the subject site and study area have been subject to a series of surveys over several years. Consequently, the biodiversity values of the study area are well known.

i. Flora

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. Shrubs, grasses, herbs and creepers were readily identifiable in most instances. It is expected that not all flora species present would have been recorded during surveys. Despite this, it is considered that sufficient information has been collected to assess issues including conservation significance of the flora, condition and viability of vegetation and likely impact on native vegetation.

Council has previously requested further information pertaining to the survey effort associated with the threatened plant *Pimelea spicata* (Spiked-rice Flower). Targeted threatened flora surveys for *Pimelea spicata* (Spiked-rice Flower) were undertaken in 2016, 2017 and 2020. The 2016 surveys occurred within three weeks of receiving greater than 30 mm of rain as recommended under the BioNet survey guidelines for the species. Surveys in March 2020 for this species occurred within approximately one month of receiving 274 mm of rain, while the surveys in September 2020 occurred within approximately one month of receiving 79 mm of rain. Furthermore, the surveys undertaken in September 2020 included a survey of a reference site (undertaken on the same day of targeted surveys within the study area) of a nearby population (located along the M7 near Quakers Hill, NSW) that was flowering, to ensure the targeted surveys of the study area were within the species' flowering period, and thus increasing the likelihood of any individuals within the study area being detected. It is also noted that the species can be identified when not in flower and can be surveyed for year-round. Therefore, the survey effort and timing for this species is appropriate.

ii. Fauna

The vertebrate fauna of the local area is well known based upon a sizeable database of past records and various published reports. The surveys by Cumberland Ecology added to the existing database and helped to provide a clear indication of the likelihood that various species occur or are likely to occur.

Targeted fauna surveys for the preparation of this SIS were undertaken in spring (September to November 2021) and summer (December 2017). The results of previous surveys undertaken in the wider study area and study area by Cumberland Ecology (2016), Eco Logical Australia (2009) and Travers Bushfire and Ecology (2013) were also considered, as well as subsequent surveys in 2020 thereby increasing the amount of survey effort considered for this SIS.

In general, the opportunistic observations and targeted fauna surveys undertaken for fauna provides a good indication of the fauna likely to utilise the habitat within the study area. However, it is acknowledged that not all fauna utilising the study area are likely to have been recorded, therefore, the data produced by the surveys is not an absolute census of all vertebrate fauna species occurring within the study area. An assessment of the likelihood of occurrence of threatened and migratory fauna species listed for the local area in the database searches was undertaken to supplement the fauna surveys. The combination of these techniques is considered appropriate for assessing the habitat values of the site for threatened fauna within the study area.

4.5. Vegetation Survey Results

CER 4.3 Documentation

CER 4.3.3 Description and mapping of results of vegetation, flora and fauna surveys

4.5.1. Introduction

The vegetation within the study area is made up of remnant and non-remnant vegetation communities. Vegetation mapping of the study area is provided in **Figure 15** and includes mapping by Cumberland Ecology within the study area and subject site in land owned by the proponent, and OEH (2013) mapping in areas outside of this. Where possible, vegetation community names follow names within DECCW (2007).

Table 11 lists the vegetation communities occurring within the study area, the equivalent DECCW (2007) map unit, the PCT and associated Biometric Vegetation Type (BVT), conformance with TECs listed under the TSC Act, and the area of occupancy. It is recognised that some of the larger areas of woodland and extant vegetation have the potential to conform to TECs listed under the EPBC Act; however, a detailed assessment of these will be undertaken during the process of a Referral to the Commonwealth following this DA.

Much of the woody vegetation is made up of Cumberland Plain Woodland (both Shale Hills Woodland and Shale Plains Woodland), with patches of shrubby regrowth, EBSF, River-flat Eucalypt Forest and Swamp Oak Floodplain Forest. The remaining areas are generally comprised of exotic vegetation along with areas of Freshwater Wetland and artificial farm dams with fringing vegetation.

The vegetation within the study area, subject site, proposed development works area and proposed conservation works area have been ground-truthed and are described in more detail in the following sections.

Table 11 Vegetation communities occurring within the study area and subject site

Vegetation Community	DECCW (2007) Map Unit	PCT/BVT	TSC Act Status	Proposed Development Works Area (ha)	Proposed Conservation Works Area (ha)	Study Area (ha)*	Subject Site (ha)*
Shale Plains Woodland	10 – Shale Plains Woodland	849/ HN528	CEEC	5.94	11.59	30.41	17.53
Shale Plains Woodland (derived native grassland)	10 – Shale Plains Woodland	849/ HN528	CEEC	8.67	0.43	23.01	9.09
Shale Hills Woodland	9 – Shale Hills Woodland	850/ HN529	CEEC	4.80	0.00	20.75	4.80
Shale Hills Woodland (derived native grassland)	9 – Shale Hills Woodland	806/ HN627	CEEC	3.28	0.00	3.48	3.28
Shale Hills Woodland (shrubby regrowth)	9 – Shale Hills Woodland	806/ HN627	-	0.49	0.00	1.49	0.49
Moist Shale Woodland	14 - Moist Shale Woodland	830/ HN524	EEC	0.00	0.00	12.16	0.00
Elderslie Banksia Scrub Forest	37 – Elderslie Banksia Scrub Forest	774/ HN635	CEEC	0.77	1.75	2.50	2.49
Elderslie Banksia Scrub Forest (non-TEC)	37 – Elderslie Banksia Scrub Forest	774/ HN635	-	0.10	0.00	0.12	0.10
River-flat Eucalypt Forest	12 – Riparian Forest	835/ HN526	EEC	1.51	8.44	58.52	9.96
	11 – Alluvial Woodland						

Vegetation Community	DECCW (2007) Map Unit	PCT/BVT	TSC Act Status	Proposed Development Works Area (ha)	Proposed Conservation Works Area (ha)	Study Area (ha)*	Subject Site (ha)*
River-flat Eucalypt Forest (derived native grassland)	12 – Riparian Forest 11 – Alluvial Woodland	835/ HN526	-	0.00	0.00	0.19	0.00
Swamp Oak Floodplain Forest	11 – Alluvial Woodland	1800/ HN674	EEC	3.39	7.16	11.12	10.55
River Oak Riparian Woodland	12 – Riparian Forest	1105/ HN574	-	0.00	0.01	4.62	0.01
Freshwater Wetlands	36 – Freshwater Wetlands	1071/ HN630	EEC	0.37	6.15	6.86	6.52
Exotic Grassland/ Cleared Land	-	-	-	119.80	19.68**	398.91	138.68
African Olive Dominated Exotic Woody Vegetation	-	-	-	1.32	0.01	1.46	1.33
Privet Dominated Exotic Woody Vegetation	-	-	-	0.00	3.46	6.62	3.46
Other Exotic Dominated Woody Vegetation	-	-	-	0.05	0.06	3.08	0.11
Dam	-	-	-	1.01	0.84	3.29	1.86
Unmapped Areas	-	-	-	0.00	0.00	398.79	0.00
Total				**151.58***	**59.59**	**987.32**	**210.33**

**Areas may not exactly add up due to rounding.*

***Includes 0.77 ha of that will be removed of Swamp Oak Floodplain Forest*

4.5.2. Shale Plains Woodland

TEC: Cumberland Plain Woodland in the Sydney Basin Bioregion

TSC Act Status: CEEC

PCT/ BVT: 849/ HN528

This community occurs as scattered patches of varying sizes within the study area, with the largest patches located around the Howes Creek riparian corridor and in the northwest corner of the study area. Within the subject site, Shale Plains Woodland primarily occurs as small, isolated patches surrounded by exotic vegetation or derived native grasslands (see **Figure 15**).

The canopy of the community is comprised of mature *Eucalyptus tereticornis* (Forest Red Gum) and/or *Eucalyptus moluccana* (Grey Box) trees. The community lacks a substantial shrub layer in most areas but does contain scattered regrowth *Eucalyptus tereticornis* (Forest Red Gum) and/or *Eucalyptus moluccana* (Grey Box) trees, *Acacia decurrens* (Black Wattle) and the exotic *Olea europaea* subsp. *cuspidata* (African Olive) and *Lycium ferocissimum* (African Boxthorn). The groundcover of the community is comprised of exotic herbs and grasses interspersed within native grasses. The most prevalent native species present are *Microlaena stipoides* (Weeping Grass), *Sporobolus creber* (Slender Rat's Tail Grass), *Themeda triandra*, *Oxalis perennans, Einadia trigonos* (Fishweed) and *Cotula australis* (Common Cotula). Exotic species include *Cyclospermum leptophyllum* (Slender Celery), *Facelis retusa* (Annual Trampweed), (Fireweed), *Bromus catharticus* (Praire Grass) and *Ehrharta erecta (*Panic Veldtgrass). An example of this vegetation community is shown in **Photograph 1**.

Despite the generally degraded nature of the vegetation within this community, it is considered to form the Critically Endangered Ecological Community (CEEC) Cumberland Plain Woodland listed under the TSC Act. This is due to the alignment with locational and floristic descriptions contained within the Final Determination (NSW Scientific Committee 2009).

Photograph 1 Shale Plains Woodland in the north of the subject site. Trees are relatively young regrowth and the shrubs are African Boxthorn (*Lycium ferocissimum*) and African Olive (*Olea europaea*).



4.5.3. Shale Plains Woodland derived native grassland

TSC Act Status: CEEC

PCT/ BVT: 849/ HN528

Shale Plains Woodland derived native grassland is present within the study area in the northern portion of the study area, particularly within the paddocks surrounding Glenlee Road and at higher elevations where exotic species invasion is less prevalent. Within the subject site, it occurs in two large patches associated with scattered woodland patches of Shale Plains Woodland (see **Figure 15**). This community has a relatively high cover of native species and a high native species richness which includes native grasses such as *Microlaena stipoides*, *Aristida ramosa* (Purple Wiregrass), *Bothriochloa decipiens* (Red Grass) and *Sporobolus creber*. Exotic species present include *Briza subaristata*, *Verbena bonariensis* (Purpletop), *Plantago lanceolata* (Lamb's Tongue), *Axonopus fissifolius* (Narrow-leafed Carpet Grass), *Bromus hordeaceus* (Soft Brome), *Eragrostis curvula* (African Lovegrass), *Paspalum dilatatum* (Paspalum) and *Hypericum perforatum* (St. John's Wort). The non-endemic native *Cynodon dactylon* (Couch) is present in relatively low abundance; however, there are areas of grassland where this species was the dominant grass and these have not been included within the community. An example of this vegetation community is shown in **Photograph 2**.

Although the community has been heavily modified through use for agriculture, due to the relatively high native cover and species richness present, it is still considered to form the TSC Act listed Cumberland Plain Woodland CEEC. This is due to the alignment with locational and floristic descriptions contained within the Final Determination (NSW Scientific Committee 2009), which includes derived native grasslands.

Photograph 2 Shale Plains Woodland derived native grassland in the north of the subject site



4.5.4. Shale Hills Woodland

TSC Act Status: CEEC

PCT/ BVT: 850/ HN529

This community occurs as scattered patches of varying sizes within the study area, with the largest patches located along Cummins Road and adjacent to Menangle Road in the south west of the study area. Within the subject site, Shale Hills Woodland primarily occurs as two large patches that are linked by derived native grasslands of the same community. The northern woodland patch of the community located along Cummins Road provides connectivity to adjacent areas of the same community located within residential areas outside of the subject site (see **Figure 15**).

The canopy of this community consists of mature *Eucalyptus crebra* (Narrow-leaved Ironbark) with a mid-storey comprised of regrowth *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus tereticornis* (Forest Red Gum)

and *Acacia decurrens* (Black Wattle). The shrub layer contains regrowth of the canopy and mid-storey, along with the native *Bursaria spinosa* (Blackthorn) of exotics *Olea europaea* subsp. *94uspidate* (African Olive) and *Lycium ferocissimum* (African Boxthorn). The groundcover of this community is dominated by exotic species with scattered native species present scattered throughout. Native herbs and grasses present include *Cotula australis*, *Cyperus gracilis* (Slender Flat-sedge), *Dichondra repens* (Kidney Weed), *Lomandra filiformis subsp. Filiformis*, *Oxalis perennans,* and *Microlaena* stipoides. Dominant exotic groundcovers include *Sida rhombifolia* (Paddy's Lucerne), *Ehrharta erecta* (Panic Veldtgrass), *Lysimachia arvensis* (Scarlet Pimpernel) and *Asparagus asparagoides* (Bridal Creeper). An example of this vegetation community is shown in **Photograph 3**.

Despite the degraded nature of the vegetation within this community, it is considered to form the TSC Act listed Cumberland Plain Woodland CEEC. This is due to the alignment with locational and floristic descriptions contained within the Final Determination (NSW Scientific Committee 2009).

Photograph 3 Shale Hills Woodland within the west of the subject site



4.5.5. Shale Hills Woodland derived native grassland

TSC Act Status: CEEC

PCT/ BVT: 806/ HN627

Shale Hills Woodland derived native grassland is present within the study area as a large patch between the two patches of Shale Hills Woodland adjacent to Cummins Road in the south-west of the subject site (see **Figure 15**). This community has a relatively high cover of native species and a high native species richness which includes native grasses such as *Microlaena stipoides, Themeda triandra*, *Carex inversa*, *Anthosachne scabra* (Wheatgrass), *Geranium solanderi var. solanderi, Oxalis perennans, Rytidosperma caespitosum* (Ringed Wallaby Grass) and *Asperula conferta* (Common Woodruff). Exotic species present include *Briza subaristata*, *Paspalum dilatatum*, *Eragrostis curvula*, *Bromus hordeaceus*, *Verbena bonariensis* (Purpletop), *Lolium perenne* (Perennial Ryegrass), Lysimachia arvensis, *Sonchus asper* (Prickly Sowthistle), and *Hypericum perforatum* (St. John's Wort). The non-endemic native *Cynodon dactylon* occurs in low abundance throughout. An example of this vegetation community is shown in **Photograph 4**.

Although the community has been heavily modified, due to the relatively high native cover and species richness present, it is still considered to form the TSC Act listed Cumberland Plain Woodland CEEC. This is due to the alignment with locational and floristic descriptions contained within the Final Determination (NSW Scientific Committee 2009), which includes derived native grasslands.

Photograph 4 Shale Hills Woodland derived native grassland in the southeast of the subject site (see Q26 in Figure 12)



4.5.6. Shale Hills Woodland shrubby regrowth

TSC Act Status: Does not conform to listing

PCT/ BVT: 849/ HN528

Shale Hills Woodland shrubby regrowth is present as small patches in the centre of the study area generally. Within the subject site, this community is present as a small patch in the west that forms part of a larger patch of the community comprising both woodland and derived native grassland (see **Figure 15).**

Within the subject site this community is comprised of a mid-storey dominated by *Acacia decurrens* (Black Wattle) and *Acacia implexa* (Hickory Wattle). Shrub species present include the native *Duboisia myoporoides* (Corkwood) and regrowth *Acacia decurrens* (Black Wattle). The exotics *Lycium ferocissimum* and *Olea europaea subsp. cuspidata* are abundant in some areas of the community occurrence. The groundcover includes exotic herbs and grasses such as *Eragrostis curvula, Polygala virgata*, *Verbena bonariensis*, *Senecio madagascariensis* and *Sida rhombifolia*. The most dominant native groundcover within this community is *Microlaena stipoides* with others present including *Themeda triandra, Asperula conferta, Cymbopogon refractus* (Barbed Wire Grass), *Dichondra repens, Einadia nutans subsp. nutans, Geranium solanderi, Rumex brownii* (Swamp Dock), and *Sporobolus creber*.

Historically, the vegetation of this community was likely Cumberland Plain Woodland based on the canopy species in nearby areas. As a result of previous land uses, the community within the study area is highly degraded, lacks a canopy and contains a low native species richness comprised largely of pioneer species common to a number of vegetation communities known to occur in the locality.

Due to its degraded nature, the community is considered to have a low recovery potential to recover to its original community without active management in the form of rehabilitation works. Therefore, the Shale Hills Woodland Shrubby Regrowth does not conform to a listed ecological community under the TSC Act or EPBC Act. These conclusions align with the results of a detailed assessment and Peer Review by senior ecologist Alex Cockerill, who's peer review was provided for the approved Stage 2B SIS (ref. 17072 RP31), in which a shrubby regrowth community occurring in the Menangle Park URA was referred to as Acacia Regrowth; the defined mapping unit at the time. The community was noted as being dominated by *Acacia decurrens* (Black Wattle) and *Acacia decurrens* (Hickory Wattle) and comprised of a very small number of native plant species above a ground stratum dominated by weeds. Both Stage 2B and the previous Stage 1 DA were approved, within which the shrubby regrowth vegetation akin to that within the proposed development works area was not aligned with the TEC Cumberland Plain Woodland or any other TECs.

Therefore, the Shale Hills Woodland shrubby regrowth within the subject site and study area does not conform to a listed ecological community under either the TSC Act. An example of this community in the study area is shown in **Photograph 5**.

Photograph 5 Shale Hills Woodland shrubby regrowth dominated by *Acacia decurrens* within the centre of the study area



4.5.7. Moist Shale Woodland

TSC Act Status: EEC

PCT/ BVT: 830/ HN524

Moist Shale Woodland has been mapped by the Remnant Vegetation of the Western Cumberland Subregion mapping project (OEH 2013b) in the north of the study area in areas adjacent to the Mt. Annan Botanical Garden (see **Figure 15**). Areas mapped as this community were not accessed during surveys as the land is not owned by the proponent.

The community occurs on the upper slopes of the southern half of the Cumberland Plain. It typically contains a canopy comprised of *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus moluccana* (Grey Box), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Corymbia maculata* (Spotted Gum). Mid-storey species include *Acacia implexa* (Hickory Wattle) or *Acacia parramattensis* subsp. *parramattensis* (Parramatta Wattle). The shrub layer is usually sparse and comprised of the species such as *Bursaria spinosa* (Blackthorn) and *Breynia oblongifolia* (Coffee Bush). Native groundcover species include *Microlaena stipoides* (Weeping Grass), *Cyperus gracilis* (Slender Flat-sedge) and *Glycine clandestina* (NSW Scientific Committee 2002) .

This community is listed as an EEC under the TSC Act and a CEEC; however, areas of the community present within the study area were not able to be surveyed. Therefore, we cannot confirm if the community mapped in the study area conforms to the listing for this community under the TSC Act.

4.5.8. Elderslie Banksia Scrub Forest

TSC Act Status: CEEC

PCT: 774/ HN635

Within the subject site and study area, EBSF is present as small isolated patches that are surrounded mostly by previously cleared lands. The largest patch of the community is located in the centre of the study area, within the Parks K and L Conservation Area (see **Figure 15**).

Within the subject site, this community either consists of a canopy and mid-storey comprised of mature and regrowth *Angophora subvelutina* (Broad-leaved Apple) or *Banksia integrifolia* (Coast Banksia), but not both. *Angophora floribunda* (Rough-barked Apple) occurs as an additional canopy species. The shrub layer is comprised of the native *Duboisia myoporoides* (Corkwood) and regrowth *Angophora subvelutina*. Dominant exotic shrubs include *Olea europaea* subsp. *cuspidata* (African Olive) and *Lycium ferocissimum* (African Boxthorn). The groundcover in areas is dominated by native species and in other areas is dominated by exotic species. Common native groundcover species include *Pteridium esculentum* (Common Bracken), *Hydrocotyle laxiflora (*Stinking Pennywort), *Einadia trigonos* (Fishweed), *Dichondra repens*, and *Microlaena stipoides*. Common exotic groundcovers include *Asparagus asparagoides*, *Sida rhombifolia, Ehrharta erecta*, *Lantana camara* (Lantana), *Gomphocarpus fruticosus* (Narrow-leaved Cotton Bush), *Senecio madagascariensis* (Fireweed) and *Eragrostis curvula*. An example of this vegetation community is shown in **Photograph 6**.

This community within the subject site is considered to form the TSC Act listed EBSF CEEC. This is due to the alignment with locational and floristic descriptions contained within the Final Determination (NSW Scientific Committee 2015).

Photograph 6 Elderslie Banksia Scrub Forest in the Parks K and L Conservation Area



Photograph 7 Elderslie Banksia Scrub Forest in the Stage 6B EBSF Conservation Area



4.5.9. Elderslie Banksia Scrub Forest (non-TEC)

TSC Act Status: Does not conform to listing

PCT: 774/ HN635

Elderslie Banksia Scub Forest (non-TEC) comprises several small, isolated scattered patches along the peripherals of Park L within the proposed development works area. The vegetation of the patches had a consistent, low diversity of native shrubs, including scattered regrowth *Duboisia myoporoides* (Corkwood) shrubs and the occasional pioneering species *Acacia decurrens* (Black Wattle). Neither *Banksia integrifolia* nor *Angophora subvelutina*, the two dominant canopy species typical of EBSF, were present.

The ground layer in most areas was almost entirely the high threat weed *Eragrostis curvula* (African Lovegrass), with limited occurrences of native ground cover species such as the hardy *Microleana stipoides* (Weeping Grass) and/or *Pteridium esculentum* (Bracken), which is common to previously cleared and poorly drained areas.

None of the areas of interest contained regenerating native canopy species and no traces of old dead canopy remain. The lack of trees and tree stumps indicates that the land has been sewn to crops in the past. Further evidence to support this comes from the array and predominance of exotic plant species. These occur with higher covers and are more diverse than native plant species.

Of the native species present, the majority are hardy native species that can survive in highly modified land. For example, *Microlaena stipoides* (Weeping Grass) and *Pteridium esculentum* (Bracken).

A detailed peer reviewed assessment of this vegetation community and the non-conformance with the TEC EBSF is provided in '17072 – Let50_31.08.2023' that is submitted alongside this SIS.

An example of this vegetation community is shown in **Photograph 8.**

Photograph 8 Elderslie Banksia Scrub Forest (non-TEC) within the subject site



4.5.10. River-flat Eucalypt Forest

TSC Act Status: EEC

PCT/ BVT: 835/ HN526

River-flat Eucalypt Forest is present primarily within or adjacent to the riparian corridors of the study area. Areas of the community within riparian corridors also contain the largest patches of the community (see **Figure 15**).

Within the proposed development works area, this community exists primarily as a moderate-sized isolated patch surrounded by previously cleared areas and as small patches that adjoin other native vegetation communities. The canopy of this community within the subject site is comprised of mature *Eucalyptus tereticornis* trees. The mid-storey contains mature *Casuarina glauca* (Swamp Oak) and *Grevillea robusta* (Silky Oak). Exotic shrubs include *Olea europaea* subsp. *Cuspidate*. Common native groundcover species include *Microlaena stipoides*, *Pteridium esculentum*, *Solanum prinophyllum* (Forest Nightshade), *Cyperus polystachyos*, and the non-endemic *Cynodon dactylon*. Common exotic groundcover species includes and *Eragrostis curvula*, *Ehrharta erecta*, *Cirsium vulgare* (Spear Thistle), *Paspalum dilatatum*, *Conyza sumatrensis* (Tall Fleabane), and *Asparagus asparagoides*. An example of this vegetation community is shown in **Photograph 9**.

This community within the subject site is considered to form the TSC Act listed River-flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC.

This is due to the alignment with locational and floristic descriptions contained within the Final Determination (NSW Scientific Commitee 2011a).

Photograph 9 River-flat Eucalypt Forest dominated by young Forest Red Gum (*Eucalyptus tereticornis*) in the centre of the subject site



4.5.11. River-flat Eucalypt Forest derived native grassland

TSC Act Status: Does not conform to listing

PCT/ BVT: 835/ HN526

River-flat Eucalypt Forest derived native grassland is present primarily within a single patch in the southern portion of the study area adjacent to a small patch of River-flat Eucalypt Forest Woodland. This community is not present within the subject site (see **Figure 15**).

Within the subject site, this community exists primarily as a small isolated adjacent to an existing patch of River-flat Eucalypt Forest. Common native groundcover species include *Microlaena stipoides*, *Carex inversa*, *Geranium solanderi*, *Einadia trigonos*, and *Sporobolus creber*. Common exotic groundcover species includes and *Eragrostis curvula*, *Bromus hordeaceus* and *Paspalum dilatatum*.

This community within the subject site is not considered to conform to the TSC Act listed River-flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC. This is due to the listing not including derived native grasslands as part of the listing criteria.

4.5.12. Swamp Oak Floodplain Forest

TSC Act Status: EEC

PCT/ BVT: 1800/ HN674

Swamp Oak Floodplain Forest is present in areas adjacent to riparian corridors within the study area with the largest patches of the community present along the Howes Creek riparian corridor in the centre of the study area (see **Figure 15**).

Within the subject site, this community primarily consists of small isolated patches or the peripherals of larger patches that are located mostly outside of the subject site. Within the subject site, the canopy and mid-storey are comprised entirely of the native *Casuarina glauca* (Swamp Oak). The exotic shrub *Olea europaea* subsp. *cuspidata* and *Lycium ferocissimum* are present. Common native groundcover species include *Microlaena stipoides*, *Isolepis inundata* and *Solanum prinophyllum*. Exotic groundcovers include *Ehrharta erecta*, *Asparagus asparagoides*, *Modiola caroliniana* (Red-flowered Mallow), *Bromus catharticus* (Praire Grass), *Cenchrus clandestinus* (Kikuyu), *Plantago lanceolata* (Lamb's Tongue), *Sida rhombifolia*, and *Cirsium vulgare* (Spear Thistle). An example of this vegetation community is shown in **Photograph 10**.

This community within the subject site is considered to form the TSC Act listed Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC. This is due to the alignment with locational and floristic descriptions contained within the Final Determination (NSW Scientific Commitee 2011b).

Photograph 10 Swamp Oak Floodplain Forest dominated entirely by *Casuarina glauca* within the centre of the study area



4.5.13. Freshwater Wetlands

TSC Act Status: EEC

PCT/ BVT: 1071/ 630

Freshwater Wetlands are only present within the low lying riparian corridors of the study area. Areas of the community present within the subject site consist primarily of areas that form the peripheral areas of larger patches of the community located outside of the subject site (see **Figure 15**).

The canopy and mid-storey layers of this community within the subject site are mostly absent, with the exception of a few regrowth native *Casuarina glauca* (Swamp Oak). The shrub layer is comprised of regrowth native *Casuarina glauca* (Swamp Oak) along with exotic shrubs *Ligustrum lucidum* (Large-leaved Privet), *Olea europaea* subsp. *cuspidata* (African Olive) and *Ligustrum sinense* (Small-leaved Privet) in places. The majority of the groundcover is comprised of native species including *Phragmites australis* (Common Reed), *Carex appressa* (Tall Sedge), *Juncus usitatus* (Common Rush) and the non-endemic *Cynodon dactylon* (Couch Grass). Common exotic species within the ground stratum include *Cyperus eragrostis* (Umbrella Sedge), *Paspalum dilatatum* (Paspalum), and *Rubus fruticosus* spp. agg. (Blackberry). An example of this vegetation community is shown in **Photograph 11**.

This community within the subject site is considered to form the TSC Act listed Freshwater Wetlands of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC. This is due to the alignment with locational and floristic descriptions contained within the Final Determination (NSW Scientific Committee 2011b).

Photograph 11 Freshwater Wetlands in study area



4.5.14. River Oak Riparian Woodlands

TSC Act Status: Not listed

PCT/ BVT: 1105/ HN574

River Oak Riparian Woodland is present along the southern boundary of the study area in areas adjacent to the Nepean River and to the far west of the study area along the Nepean River. This vegetation community is not present within the subject site (see **Figure 15**).

Within the study area this community has a canopy layer comprised entirely of *Casuarina cunninghamiana* (River Oak) and a mid-storey containing regrowth *Casuarina cunninghamiana* and the exotic species *Ligustrum lucidum* (Large-leaved Privet) and *Ligustrum sinense* (Small-leaved Privet). The shrub layer is dominated by the exotics *Ligustrum lucidum* and *Ligustrum sinense,* but also contains scattered native shrubs consisting of *Kunzea ambigua* (Tick Bush), *Casuarina cunninghamiana*, *Callistemon salignus* (Willow Bottlebrush), and *Melicytus*

dentatus (Tree Violet). Most of the groundcover is comprised of exotic herbs and grasses including *Eragrostis curvula* (African Lovegrass), *Ehrharta erecta,* and *Cirsium vulgare*. The most common native groundcover species include *Dichondra repens* (Kidney Weed), *Oxalis perennans*, *Microlaena stipoides* and *Oplismenus aemulus*.

This community is not listed under the TSC Act. An example of this community is shown in **Photograph 12**.

Photograph 12 River Oak Riparian Woodlands in the south of the study area



4.5.15. Exotic Grassland/Cleared Land

TSC Act Status: Not listed

PCT: None

"Exotic Vegetation/Cleared Land" is present throughout the study area and subject site as exotic dominated grasslands or as areas cleared for roads, buildings and other development. Within the subject site, the community is dominated by exotic pasture grasses. Common exotic grasses occurring throughout this community include *Eragrostis curvula*, *Nasella neesiana* (Chilean Needle Grass), *Bromus hordeaceus* (Soft Broome), *Briza minor, Cenchrus clandestinus, Conyza bonariensis,*. Other exotic species include *Plantago lanceolata, Verbena rigida, Taraxacum officinale* (Dandelion), and *Trifolium campestre* (Hop Clover). Native grasses are present but comprise less than 40% the native groundcover. Native grasses present include

Microlaena stipoides (Weeping Grass), *Sporobolus creber* and *Themeda triandra*; along with the non-endemic native *Cynodon dactylon* which is not considered native for the purposes of assessing derived native grasslands as this has been planted within or invaded the pasture lands as a grazing species.

This community within the subject site is not listed under the TSC Act.

An example of this vegetation community is shown in **Photograph 13**.

Photograph 13 Exotic Grassland/Cleared Land within the study area



4.5.16. African Olive Dominated Exotic Woody Vegetation

TSC Act Status: Not listed

PCT: None

African Olive Dominated Exotic Woody Vegetation is present throughout the study area and subject site as dense patches of *Olea europaea* subsp. *cuspidata* with few other species present. This community occurs in the northern portion of the subject site near Glenlee Road interspersed within areas of Shale Plains Woodland and Shale Plains Woodland derived native grassland.

This community within the subject site is not listed under the TSC Act.

An example of this vegetation community is shown in **Photograph 14**.

Photograph 14 African Olive Dominated Exotic Woody Vegetation in the study area



4.5.17. Privet Dominated Exotic Woody Vegetation

TSC Act Status: Not listed

PCT: None

Privet Dominated Exotic Woody Vegetation is present throughout the study area as dense patches of *Ligustrum lucidum* associated with riparian areas. The community is present in two patches within the study area, one to the far west near the Neapean River and one to the far south along the Nepean River. This community does not occur within the subject site. Additional exotic species recorded include *Ligustrum sinense, Ulmus glabra* and *Gleditsia triacanthos* (Honey Locust). No native species were recorded within this community.

This community within the subject site is not listed under the TSC Act

An example of this vegetation community is shown in **Photograph 15**.

Photograph 15 Privet Dominated Exotic Woody Vegetation within the study area



4.5.18. Other Exotic Dominated Woody Vegetation

TSC Act Status: Not listed

PCT: None

Other Exotic Dominated Woody Vegetation is present throughout the study area as scattered occurrences of exotic woody vegetation including species such as *Maclura pomifera* (Osage Orange), *Gleditsia triacanthos* and *Pinus pinaster* (Cluster Pine). One small patch of this community occurs adjacent to a dam in the northern portion of the subject site.

This community within the subject site is not listed under the TSC Act.

4.5.19. Dams

TEC: None

TSC Act Status: not listed

PCT/ BVT: None

Within the study area, numerous dams are present; with approximately five occurring within the subject site. The dams within the study area have varying degrees of fringing vegetation are present, with those in the Howes Creek Conservation Area generally having a higher occurrence of fringing vegetation while the dams present in the north of the subject site have minimal fringing vegetation as a result of livestock accessing the dams for water (see **Photograph 16**). The dams appear to be artificial in nature, likely made to support historical farm production. The dams within the subject site do not conform to the listed ecological community 'Freshwater Wetlands' listed under the TSC act according to the community's Final Determination as it states the following:

"Artificial wetlands created on previously dry land specifically for purposes such as sewerage treatment, stormwater management and farm production, are not regarded as part of this community, although they may provide habitat for threatened species" (NSW Scientific Committee 2004a)

Photograph 16 Farm dam within the study area



4.6. Flora Species Survey Results

CER 4.3 Documentation

CER 4.3.3 Description and mapping of results of vegetation, flora and fauna surveys

4.6.1. General Species

Over 300 flora species were recorded throughout the study area, which included 148 locally native, naturally occurring species; and 157 exotic or non-endemic species. Floristic data collected within the study area is provided in **Appendix D**.

4.6.2. Threatened Species

No threatened flora species known to occur within the local area were recorded during surveys in the study area. The vegetation present is too disturbed and is predominantly comprised of disturbed grassland, therefore no suitable habitat is present and threatened flora are considered unlikely to occur, including *Pimelea spicata*.

No *Pimelea spicata* individuals have been recorded in the study area, and the additional targeted surveys did not result in any records. No *Pimelea spicata* individuals have been previously recorded within the study area and surrounds by previous targeted surveys for the species undertaken by Cumberland Ecology, GHD (2009), Travers Bushfire and Ecology (2013) and Eco Logical (2009). A total of four reference site were surveyed (see **Figure 13)** that all contained flowering *Pimelea spicata* individuals, thereby indicating that the timing of surveys was optimal to record flowering individuals. One of the reference sites surveyed (Quakers Hill Site – see Site 1 in **Figure 13**) was previously surveyed as part of the SIS assessment. Due to extensive previous surveys for the species (including most recent surveys by Cumberland Ecology using reference sites and conducting a grid-based survey) as well as the poor quality of the habitat in the subject site, it is considered highly unlikely that this species is present, and a local population will not be impacted. Therefore, no further consideration of impacts on this species is required as an appropriate level of survey has now been carried out and the species has been confirmed as not being present. Therefore, no offsetting for this species is proposed or required.

4.6.3. Weeds

A total of 31 weeds recorded within the study area are listed as priority weeds or weeds of regional concern under the *Biosecurity Act 2015* (see **Table 12**). This includes seven state priority weeds, two regional priority weeds and 22 weeds of regional concern. All seven state priority weeds are also Weeds of National Significance (WONS) (Department of the Environment 2014).

Table 12 State and regional priority weeds, weeds of regional concern and weeds of national significance

Scientific Name	Common Name	Weed Status	Recorded within the subject site
Andropogon virginicus	Crofton weed	RC	Yes
Apium graveolens	Mistflower	RC	Yes
Araujia sericifera	Whisky grass	RC	Yes
Asparagus asparagoides	Moth vine, Moth plant	RC	Yes
Cardiospermum grandiflorum	Balloon vine	RC	Yes
Cenchrus clandestinus	Kikuyu	RC	Yes
Chloris gayana	Rhodes grass	RC	Yes
Cestrum parqui	Green Cestrum	RP	No

Scientific Name	Common Name	Weed Status	Recorded within the subject site
Echium plantagineum	Paterson's curse	RC	Yes
Eragrostis curvula	African lovegrass	RC	Yes
Heliotropium amplexicaule	Blue heliotrope	RC	Yes
Hypericum perforatum	St John's wort	RC	Yes
Lantana camara	Lantana	SP, WONS	Yes
Ligustrum lucidum	Large-leaved Privet	RC	Yes
Ligustrum sinense	Small-leaved Privet	RC	Yes
Lonicera japonica	Japanese honeysuckle	RC	Yes
Lycium ferocissimum	African boxthorn	SP, WONS	Yes
Nassella neesiana	Chilean needle grass	SP, WONS	Yes
Nassella trichotoma	Serrated tussock	SP, WONS	Yes
Ochna serrulata	Mickey Mouse Plant	RC	No
Olea europaea subsp. cuspidata	African olive	RP	Yes
Onopordum acanthium	Scotch thistle	RC	Yes
Opuntia stricta	Common Prickly Pear	SP, WONS	Yes
Passiflora suberosa	Corky passionflower	RC	Yes
Romulea rosea	Onion Grass	RC	Yes
Rubus fruticosus	Blackberry	SP, WONS	Yes
Senecio madagascariensis	Fireweed	SP, WONS	Yes
Solanum linnaeanum	Apple of Sodom	RC	Yes
Solanum mauritianum	Wild tobacco bush	RC	Yes
Tradescantia fluminensis	Trad	RC	Yes
Nassella hyalina	Cane needle grass	RC	Yes

**SP=state priority, RC=regional concern, RP=regional priority, WONS=weed of national significance*

4.7. Fauna Species Survey Results

CER 4.3 Documentation

CER 4.3.3 Description and mapping of results of vegetation, flora and fauna surveys

4.7.1. Fauna Habitat

Most of the study area and subject site comprises exotic vegetation, therefore, the habitat value is quite limited for fauna. Nevertheless, the study area and subject site do contain woodland/forest areas that provide potential habitat for native fauna. Within the study area, the most suitable fauna habitat is in and adjacent to riparian areas that contain the most extensive areas of woodland/forest that are generally also in the best condition.

Within the subject site, the most suitable fauna habitat is within woodland/forest areas, most of which are comprised of mostly small, isolated patches with little connectivity to offsite habitat, with the exception of the northern patch of Shale Hills Woodland to the west of the subject site and the vegetation within the Howes Creek and Northern Conservation Area. Although these areas within the subject site provide suitable habitat for native fauna, they are surrounded by extensively cleared areas or developed areas that are exposed to a high degree of edge effects, limiting its suitability for threatened species.

4.7.1.1. Woodland/Forest

Woodland/forest areas within the study area and subject site provide the most optimum habitat for fauna including birds, reptiles and mammals. The areas of woodland/forest within the proposed development area are either comprised of a canopy with an open understorey or a canopy and understorey that is comprised of regrowth canopy species. All patches of woodland/forest surveyed in the study area contained at least one remnant tree that contains hollows. Due to the presence of hollow bearing trees in all patches of woodland/forest, all areas constitute potential foraging, roosting and/or nesting habitat for several threatened species (primarily birds and bats) previously recorded in the study area. Although suitable habitat for threatened species is present, most of the habitat is highly disturbed and most likely utilised by commonly occurring species that adapt well to edge affected areas, and by threatened species (primarily birds and bats) on occasion as part of a broader foraging range. The most suitable roosting/nesting habitat for native fauna, including threatened species, is within the riparian corridors located outside of the subject site that contain the largest patches of woodland/forest and highest number of tree hollows that are less exposed to edge effects.

The Shale Hills Woodland (shrubby regrowth) patches also provide suitable habitat for fauna but lack tree hollows. As a result, areas of this habitat provide suitable habitat primarily for small woodland birds that may utilise the area for nesting and/or foraging. Microchiropteran bats may also utilise this habitat, but not for roosting purposes due to the lack of tree hollows.

Woody debris is present within the woodland/forest habitat of the study area and subject site, which provides suitable habitat for native fauna, including the Cumberland Plain Land Snail (only within areas of Shale Plains Woodland and Shale Hills Woodland). Although suitable habitat is present for the Cumberland Plain Land Snail, such areas are bound by exotic grasslands and are sub-optimal for the species.

4.7.1.2. Exotic Vegetation

Areas of exotic vegetation within the study area and subject site consist primarily of exotic grasslands and some exotic woody areas. Such habitat is likely to provide potential foraging habitat for macropods and birds of prey. Grassland areas can provide suitable foraging habitat for microchiropteran bats when treed areas are nearby. Due to historic and current land uses of the region, large areas of exotic vegetation comprised primarily of exotic grasslands (i.e. former improved pastures) are present in the locality. Such areas have the potential to be utilised by some animals, including threatened species; however, due to the abundance of this type of habitat in the locality, the exotic vegetation within the subject site would likely only be utilised periodically by native species as part of a much broader foraging range. This includes species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*) and microchiropteran bats, primarily within areas containing scattered trees or adjacent to treed areas. Potential roosting habitat for some microchiropteran bats is present within man-made

structures; however, such structures are limited, isolated from areas of suitable foraging habitat, and are therefore considered sub-optimal.

4.7.1.3. Waterbodies

Waterbodies within the study area include 12 dams and areas of Freshwater Wetland. Within the subject site, waterbodies are limited to five dams and the edges of Freshwater Wetland that are mostly surrounded by exotic vegetation. These areas provide potential habitat for aquatic and semi-aquatic fauna, including reptiles and amphibians, especially after periods of rain; however, they are likely to be sub-optimal for native fauna due to their small area, limited connectivity to off-site habitat and having been heavily modified as a result of previous land disturbances.

4.7.1.4. Habitat Features

Habitat features recorded within the proposed development works area includes 49 hollow-bearing trees and one stick nest (see **Figure 17**). The tree hollows present include large, medium and small hollows. Five (5) large tree hollows were recorded that have the potential to be suitable for threatened owls known to occur in the local area. The medium and small hollows have the potential to provide suitable roosting/nesting habitat for threatened birds and bats assessed as having the potential to utilise the study area. The details of the number of hollows recorded (182) within the 49 hollow-bearing trees are provided below:

- 4 large hollows (>20 cm diameter);
- 71 medium hollows (10.1-20 cm diameter); and
- 100 small hollows (2-10 cm diameter).

Surveys of the proposed conservation works areas under the Menangle Park Structure plan determined that the proposed conservation works areas contain 61 hollow-bearing trees as well as three trees with decorticating bark suitable for microchiropteran bats. Summaries of the hollow-bearing trees in these areas are provided below in **Table 13**.

Table 13 Summary of hollow-bearing tree details within proposed conservation areas

Vegetation Community	No. of Hollow-bearing Trees	No. of Large Hollows	No. of Medium Hollows	No. of Small Hollows	# of Trees with Decorticating Bark Suitable for Microchiropteran bats
Cumberland Plain Woodland	61	12	66	150	1
River-flat Eucalypt Forest	3	2	5	5	0
Swamp Oak Floodplain Forest	1	0	0	3	2
Totals	**65**	**14**	**71**	**158**	**3**

Hollow Size Classes: Large = >20cm entrance, Medium = 10.1-19.9cm entrance, Small = 3-10 cm entrance

4.7.2. Fauna Species

4.7.2.1. General Species

A total of 72 birds, 28 mammals, seven frogs, three reptiles, one gastropod and two fish species were recorded during surveys within the study area. It is likely that additional species utilise the study area as part of a larger foraging habitat and or breeding habitat. A fauna species list is provided in **Appendix E**.

i. Birds

A total of 72 bird species were recorded within the study area, with four of these being exotic. It is likely that additional common species utilise the study area as part of a larger foraging habitat, therefore this list is not exhaustive.

Four species recorded are listed as threatened or migratory under the TSC Act or EPBC Act. Threatened bird species listed under the TSC Act recorded include the Brown Treecreeper (*Climacteris picumnus victoriae*), Dusky Woodswallow (*Artamus cyanopterus*), Little Eagle (*Hieraaetus morphnoides*) and Varied Sittella (*Daphoenositta chrysoptera*). All four species are listed as vulnerable under the TSC Act and are not listed under the EPBC Act. The Rufous Fantail (*Rhipidura rufifrons*) was also recorded which is listed as migratory under the EPBC Act. All four species listed under the TSC Act were recorded during bird surveys within woodland patches of the study area. The Rufous Fantail was recorded outside of the subject site within the Howes Creek riparian corridor.

ii. Mammals

A total of 28 mammal species were recorded within and near the subject site. This includes eight threatened species. The Grey-headed Flying-fox was recorded flying over the subject site in multiple locations during prior and recent spotlighting surveys. The Greater Broad-nosed Bat, Eastern False Pipistrelle, Little Bent-winged Bat, Eastern Coastal Free-tailed Bat, Southern Myotis and Eastern Cave Bat were recorded as occurrences within the subject site during targeted bat surveys. The Large Bent-winged Bat was recorded close to the subject site and is a likely occurrence. Little Bent-winged Bat

No bat roosts were identified during the March 2021 surveys or September to November surveys of the study area. It is likely that areas of Shale Plains Woodland containing hollows within the south-west of the subject site are utilised for roosting by the common *Vespadelus vulturnus* (Little Forest Bat) as individuals were caught by harp traps on multiple occasions and recorded on call detection devices near dusk, meaning individuals are likely roosting near the survey location (i.e., within hollows of the subject site). *Miniopterus australis* (Little Bent-winged Bat) was detected an hour after sunset and therefore it could have been detected foraging a reasonable distance from its roost site. The species are assessed appropriately as affected species within this SIS.

Bat call analysis reports are provided in **Appendix H** and the locations of all threatened fauna recorded in the study area are provide in **Figure 17**.

iii. Amphibians

Seven (7) amphibian species were recorded within the study area during surveys, particularly around dams and waterbodies. No threatened amphibian species listed under either the TSC Act or EPBC Act were seen or heard during targeted surveys of the study area.

iv. Reptiles

Three (3) reptile species were recorded during any of the surveys by Cumberland Ecology. None of the three were threatened species listed under the TSC Act or EPBC Act.

v. Threatened Species

The Brown Treecreeper, Dusky Woodswallow and Varied Sittella were recorded within the subject site, while the Little Eagle was recorded in the study area. The Grey-headed Flying-fox was recorded as passing over the subject site. The Greater Broad-nosed Bat, Eastern False Pipistrelle, Little Bent-winged Bat, Eastern Coastal Free-tailed Bat, Southern Myotis and Eastern Cave Bat were recorded as occurring within the subject site and the Greater Broad-nosed Bat, Eastern False Pipistrelle and Eastern Cave Bat were recorded within the proposed development works area. The Large Bent-winged Bat was recorded as potentially occurring within the subject site. No other threatened fauna species were recorded within the subject site or adjacent areas during surveys by Cumberland Ecology.

Based on the results of surveys (including previous surveys) and consideration of habitat and species distributions, the following threatened fauna species are considered to have potential to occur within the subject site:

- Black-necked Stork (*Ephippiorhynchus asiaticus*) – Endangered TSC Act;
- Brown Treecreeper (*Climacteris picumnus*) – Vulnerable TSC Act;
- Dusky Woodswallow (*Artamus cyanopterus*) – Vulnerable TSC Act;
- Eastern Cave Bat (*Vespadelus troughtoni*) – Vulnerable TSC Act;
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) – Vulnerable TSC Act;
- Eastern Coastal Free-tailed Bat (*Mormopterus norfolkensis*) – Vulnerable TSC Act;
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – Vulnerable TSC Act;
- Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable TSC Act and EPBC Act;
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) – Vulnerable TSC Act and EPBC Act;
- Little Bent-winged Bat (*Miniopterus australis*) – Vulnerable TSC Act;
- Little Eagle (*Hieraaetus morphnoides*) – Vulnerable TSC Act;
- Little Lorikeet (*Glossopsitta pusilla*) – Vulnerable TSC Act;
- Powerful Owl (*Ninox strenua*) – Vulnerable TSC Act;
- Southern Myotis (*Myotis macropus*) – Vulnerable TSC Act;
- Varied Sittella (*Daphoenositta chrysoptera*) – Vulnerable TSC Act; and
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*) – Vulnerable TSC Act.

Except for threatened microchiropteran bats (excluding the Large Bent-winged Bat and Eastern Cave Bat), the occurrence of these threatened fauna species is considered to be limited to occasional passage through the study area as part of a wider foraging range. The threatened microchiropteran bats (excluding the Large Bent-winged Bat and Eastern Cave Bat) may utilise the subject site for roosting purposes due to the presence of hollow bearing trees. The Large Bent-winged Bat and Eastern Cave Bat are unlikely to utilise the subject site or study area for roosting as its preferred roosting habitat (i.e. caves) are not present. Additionally, no breeding habitat is available for these species as their required breeding habitat (i.e. caves) are not present.

The locations of all threatened fauna previously recorded in the study area by Cumberland Ecology are provided in **Figure 17**.

5. Likely Impacts on Threatened Species and Populations

This chapter covers the following CER:

CER 5 LIKELY IMPACTS ON THREATENED SPECIES AND POPULATIONS

CER 5.2 DISCUSSION OF LOCAL AND REGIONAL ABUNDANCE AND DISTRIBUTION

An estimate for the local and regional abundance of those species or population (Section 110(2)(d)).

CER 5.2.1 Discussion of regional occurrences and the local population

CER 5.3 ASSESSMENT OF HABITAT

A full description of the type, location, size and condition of the habitat (including critical habitat) of those species and population and details of the distribution and condition of similar habitats in the region (Section 110(2)(f)).

CER 5.3.1 Description of habitat values

CER 5.3.2 Discussion of habitat utilisation

CER 5.4 DISCUSSION OF CONSERVATION STATUS

For each species or population likely to be affected, details of its local, regional and State-wide conservation status, the key threatening process generally affecting it, its habitat requirements and any recovery plan of threat abatement plan applying to it (Section 110(2));

An assessment of whether those species or population are adequately represented in conservation reserves (or other similar protected area) in the region (Section 110(2)(e);

An assessment of whether any of those species or populations is at the limit of its known distribution (Section 110(2) (e1)).

CER 5.5 Discussion of the likely effect of the proposal at local and regional scales

A full assessment of the likely effect of the action on those species and populations, including, if possible, the quantitative effect of local populations in the cumulative effect in the region (Section 110(2)(g)).

CER 5.5.1 Significance within a local context

CER 5.5.2 Extent of habitat removal or modification

CER 5.5.3 Discussion of connectivity

CER 5.5.4 Consideration of threatening processes

This Chapter also responds to all items about impact assessment raised by Council. Responses draw upon the results of the latest field surveys and in some cases additional data analysis. Note that the regional abundance of each species cannot be determined based on the information available. Records from the local area (within 5 km of the study area) and greater locality (within 10 km of the study area) have been used as this is considered the most appropriate way to estimate regional abundance for species.

5.1.1. Direct Impacts of the Proposed development works

5.1.1.1. Vegetation Communities

The primary and direct impact resulting from the proposed development works is the loss of vegetation that also provides habitat for flora and fauna species within the subject site. The proposed development works require the clearing of approximately 151.58 ha of vegetation, most of which (approximately 121 ha or ~80%) is comprised of exotic vegetation that offers little ecological value other than marginal foraging habitat for fauna species. The proposed conservation works area to be retained and rehabilitated comprises approximately 59.59 ha of vegetation, of which approximately 60% comprises native vegetation (accounting for removal of the two areas due to land contamination) and that will comprise 100% native vegetation following the implementation of the VMPs proposed for these areas (REF. 17072 RP36 and 17072 RP29), and the Stage 6B EBSF Conservation Area VMP that will be prepared as a Condition of Consent. **Table 14** provides a summary of the areas of each vegetation community to be cleared within the proposed development works area, along with the percentage of each community cleared in the subject site and study area. The distribution of these communities is shown in **Figure 15**. Of the six TECs occurring within the study area, a total of five TECs listed under the TSC Act will be directly impacted by the proposed development works. Impacts to these TECs are discussed further in **Chapter 6**.

Table 14 Approximate areas of vegetation to be cleared within the subject site

Vegetation Community	PCT/BVT	TSC Act	Proposed Development Works Area (ha)	Subject Site (ha)	% Retained in Subject Site
Shale Plains Woodland	849/ HN528	CEEC	5.94	17.53	66.08
Shale Plains Woodland (derived native grassland)	849/ HN528	CEEC	8.67	9.09	4.62
Shale Hills Woodland	850/ HN529	CEEC	4.80	4.80	0.00
Shale Hills Woodland (derived native grassland)	806/ HN627	CEEC	3.28	3.28	0.00
Shale Hills Woodland (shrubby regrowth)	806/ HN627	-	0.49	0.49	0.00
Moist Shale Woodland	830/ HN524	EEC	0.00	0.00	-
Elderslie Banksia Scrub Forest	774/ HN635	CEEC	0.77	2.49	69.08
Elderslie Banksia Scrub Forest (non-TEC)	774/HN635	-	0.10	0.10	0.00
River-flat Eucalypt Forest	835/ HN526	EEC	1.51	9.96	84.84

Vegetation Community	PCT/BVT	TSC Act	Proposed Development Works Area (ha)	Subject Site (ha)	% Retained in Subject Site
River-flat Eucalypt Forest (derived native grassland)	835/ HN526	-	0.00	0.00	-
Swamp Oak Floodplain Forest	1800/ HN674	EEC	3.39	10.55	67.87
River Oak Riparian Woodland	1105/ HN574	-	0.00	0.01	-
Freshwater Wetlands	1071/ HN630	EEC	0.37	6.52	94.33
Exotic Grassland/Cleared Land	-	-	119.80	138.68	13.61
African Olive Dominated Exotic Woody Vegetation	-	-	1.32	1.33	0.90
Privet Dominated Exotic Woody Vegetation	-	-	0.00	3.46	100.00
Other Exotic Dominated Woody Vegetation	-	-	0.05	0.11	54.55
Dam	-	-	1.01	1.86	45.70
Unmapped Developed, Exotic and Cleared Land	-	-	0.00	0.00	-
Total			**151.51**	**210.33**	-

**Areas have been rounded to the nearest 2 decimal places*

5.1.1.2. Habitat Removal

The vegetation occurring within the proposed development works area provides potential habitat for a range of flora and fauna, including threatened fauna species listed the TSC Act and/or EPBC Act. The vegetation communities also support specific habitat features that provide foraging, shelter and breeding opportunities for fauna. The proposal will remove these habitats and features from the subject site.

Fauna habitat features that will be removed because of the proposed development works include:

- Terrestrial habitat features such as ground and shrub layer vegetation, leaf litter, coarse woody debris;
- Hollow-bearing trees;
- Man-made structures;

- Blossom-producing trees and shrubs;
- Stick nests;
- Farm dams; and
- Freshwater wetlands.

The removal of these habitat features also has the potential to directly impact the fauna species utilising the habitats during the clearing process. Although some species, including diurnal species and highly mobile species may relocate during this period, there is potential for fauna to remain within the habitat features, such as hollows and/or nests.

Although the habitat features listed above within the proposed development works area will be removed, the area of retained habitat has increased in this updated version of the BEW DA with the retention of the Stage 6B EBSF Conservation Area, and mitigation measures are proposed during the clearing process to ameliorate any impacts on resident fauna, including, birds, roosting microchiropteran bats, frogs and small reptiles.

The mitigation measures provided in **Chapter 7** are considered to adequately minimise any direct and/or indirect impacts on native fauna, including threatened species.

5.1.2. Indirect Impacts of the Proposed Development Works

The proposed development works may have indirect impacts on the ecological values of remaining vegetation and habitat within the study area, including edge effects, shading because of future development, alteration to hydrological regimes and changes to weed abundance.

Additionally, the future development the proposed development works will facilitate may contribute to several construction and operational impacts, such as those relating to dust, noise and light, that will also impact the remaining vegetation and habitat. Indirect impacts relevant to the project are considered in more detail below and as a precaution consider indirect impacts associated with future development that may occur because of the proposed development works. Any future development within the subject site for residential uses will require a separate DA and will require a separate assessment of impacts.

Indirect impacts may also be felt outside the study area. For mobile species with large territories, such as the Grey-headed Flying-fox, the clearance of habitat within the proposed development works area may potentially impact the territories further afield. These indirect impacts have been considered within the Assessments of Significance within **Chapter 8**.

5.1.2.1. Habitat Fragmentation

Fragmentation is the process where habitats that were once continuous become divided into separate fragments isolated from each other by non-forest land (Primack 1993) (Fahrig 2003) (Lindenmayer and Fischer 2006). This process, together with habitat loss, is a major cause of biodiversity loss and a threat to native species (Rand et al. 2006) (Laurance et al. 2007). Habitat fragmentation affects biodiversity by reducing the amount of available habitat for some species to occupy due to increased distances between habitat patches. Plants and other sessile organisms are usually directly removed, while mobile animals (especially birds and mammals)

retreat into other remnant patches of habitat (Lindenmayer and Fischer 2006). The displacement of mobile fauna can reduce the survivorship of species in the case where there are limited areas of sufficiently large habitat within dispersal distance to retreat to.

The proposed development works involve clearing of approximately 152 ha of vegetation and potential habitat within the subject site, most of which (~80%) is comprised of various condition states of exotic vegetation. The remaining areas of habitat to be removed occurs as relatively isolated patches that are already fragmented and generally degraded. Nevertheless, the proposed clearing of vegetation will encroach further into remaining habitat and further isolate retained patches of habitat from other areas of habitat in the study area. As such, the proposed removal of the vegetation and associated habitat within the proposed development works area would add to fragmentation further than current conditions, even though this further fragmentation pertains to already fragmented areas. The proposed development works have avoided most areas of habitat that provide connectivity within the study area (e.g. riparian corridors).

Within the Howes Creek riparian corridor, the fragmentation of habitats will be reduced in the long-term by the implementation of the associated VMP and incorporated revegetation strategy. Currently, there is a substantial break in connectivity between the train line in the west and the vegetation further to the south east. While the proposed development footprint includes a road break further east in the Howes Creek riparian corridor, the width of this break is less than what currently exists and therefore the proposed conservation works will likely assist in increasing the habitat connectivity for threatened species and TECs long-term.

5.1.2.2. Edge Effects

Edge effects are impacts that occur at the interface between natural habitats, especially forests and disturbed or developed land (Yahner 1988). When an edge is created between woodland and a cleared area, changes to ecological processes within the vegetation can extend between 10 m and 100 m from the edge (Yahner 1988). These include microclimatic changes in light, temperature, humidity and wind, which can favour a suite of different species and therefore cause significant changes to the ecology of the patch (Lindenmayer and Fischer 2006). These changes include; invasion by weeds, increase in feral animals, reduction in tree health, and barriers to dispersal or distribution (Yahner 1988). Edge effects are typically more pronounced in small habitat fragments and they may extend throughout small patches, rendering them unsuitable for some species. In particular, small patches of woodland habitat may be unfavourable for species which require interior habitat. As habitat loss progresses, the understanding of edge effects on ecological processes becomes increasingly important (Rand et al. 2006).

The vegetation within the proposed development works area consists of patches of vegetation that are currently considered to be subject to a high degree of edge effects because of being bounded by previously cleared areas. The proposed development works will increase the edge effects within the study area; however, these effects are likely to have minor impacts on the flora and fauna present as they currently utilise habitat experiencing these effects due to the large areas of previously cleared land present in the study area.

5.1.2.3. Alteration to Hydrological Regimes and Groundwater

Groundwater flows beneath parts of the subject site and supports a suite of presumed groundwater dependent ecosystems (GDEs). These plant communities rely at least in part for their survival on groundwater.

GDEs are most likely to occur on site where groundwater is found within deeper, more permeable soil substrates including deep sandy soils and gravels. According to a review of groundwater at Menangle Park by JBSG (2021) the following relevant geological settings occur:

- Quaternary aged quartz and lithic fluvial sand, silt and clay;
- Tertiary aged alluvial;
- Alluvium gravel, swamp deposits and sand dunes; and
- Triassic aged Wianamatta Group Shale and Sandstone.

A groundwater investigation of the study area by JBSG (2021) found that the Bringelly Shallow (Wianamatta Group) is present along the elevated southern portion of the site and to the northeast of Howes Creek. The central portion of the site is dominated by Tertiary Alluvium while the north-west portions of Howes Creek are present in an area of Quaternary Alluvium.

Based upon groundwater sampling and these geological formations, a conceptual hydrogeological model for the Menangle Park site may be summarised as follows:

- Groundwater is present in two distinct aquifers. The first is located within the unconsolidated (alluvium/fluvium) sands and the second is within the consolidated (shale) formation. Measured hydraulic conductivity in the sand aquifer is relatively high and ranges from approximately 1 to 10 m/day. As hydraulic conductivity is likely to be several orders of magnitude lower in the shale than in the sand most of the groundwater flow at the site will occur in the sand aquifer.
- Recharge occurs by direct infiltration of rainfall across the site with relatively high recharge (>20%) likely to occur over the sandy areas and low recharge (<5%) occurring in areas of residual clay/shale. Runoff from the southern clay/shale area may also recharge the upper portions of the sand aquifer.
- Groundwater flows from the southern portion of the site towards Howes Creek. While most of the groundwater is likely to discharge directly to Howes Creek measured water levels also indicate that some discharge of groundwater may occur (during high groundwater conditions) in some low-lying areas of the site.

This model indicates that the plant communities on the deeper sandier soils in the central and low-lying parts of the site are likely to be groundwater dependent. Those occurring where clay soils occur, on the steeper parts of the subject site are not likely to be groundwater dependent (JBS&G, 2021). The likely GDEs based upon the BOM definitions include:

- River-flat Eucalypt Forest – Terrestrial Ecosystem;
- Elderslie Banksia Scrub Forest – Terrestrial Ecosystem;
- Swamp Oak Floodplain Forest – Terrestrial Ecosystem; and
- Freshwater Wetlands – Aquatic Ecosystem.

Some limited areas of groundwater dependent ecosystems will be cleared within the subject site. However, most groundwater dependent ecosystems will be conserved within Parks K and L, and the Howes Creek and Northern Park Conservation Areas.

As development takes place in the subject site there is potential to change groundwater resources available to groundwater dependent ecosystems within the conservation areas.

According to JBS&G (2021) based on a review of the conceptual hydrogeological site model and considering the proposed development the following could impact groundwater flow or levels (and therefore groundwater dependent ecosystems):

- Infrastructure installed below the pre-development groundwater level that acts a preferential flow pathway. Stormwater drainage and gravity sewer systems are likely to pose the most significant risk to groundwater flow; and
- Changes to groundwater recharge due to decreases in open areas subject to infiltration as well as decreased surface flows from areas of low (clay/shale) recharge to high (sand) recharge. Roofed and paved areas connected directly to stormwater pipes in the sand areas is likely to decrease recharge to the sand aquifer resulting in decreased water levels in the aquifer. It is noted that lower overall evapotranspiration rates and watering of lawn areas using mains (or tank) water will decrease the development impact on groundwater levels.

To minimise potential impacts to groundwater levels a range of mitigation strategies could be implemented at the subject site. The specific strategies selected will be based on the detailed development plans for each stage but should also consider the cumulative impacts of the overall development. Potential mitigation strategies include:

- In areas where groundwater levels are high installation of fully sealed pipe work along with restrictions to minimise preferential flow in backfill along pipe routes;
- In areas where groundwater levels are low utilisation of the stormwater network to actively recharge the groundwater system;
- Utilisation of road reserves, stormwater pits, road curbs and detention basins to recharge stormwater to the groundwater system. This is particularly relevant to areas overlying the sand aquifer; and
- Identifying areas where irrigation/injection can occur to artificially recharge the aquifer.

While there is potential for indirect impacts to groundwater and groundwater dependent ecosystems, these will continue to be monitored as development proceeds. Corrective action, as described above, will be implemented as necessary to ensure that groundwater dependent ecosystems in the conservation areas are protected during the development of the subject site.

In addition to the measures included within **Chapter 7** of this report, most of the vegetation within the Howes Creek riparian corridor considered the most susceptible to alterations to hydrological regimes is proposed to be retained under a long-term VMP (REF. 17072RP36). If controls prescribed within **Chapter 7** of this report

and within the proposed VMP are implemented, it is expected that these indirect impacts will be appropriately mitigated.

5.1.2.4. Increased Sedimentation, Erosion and Runoff

During the proposed development works, any retained adjacent vegetation in the study area could potentially be impacted by sedimentation, erosion and runoff. Eroded sediment can smother retained vegetation if appropriate control measures are not implemented. Smothering can cause dieback of herbs and shrubs and reduce regeneration of groundcover species. Sediment and eroded material can also contain weed matter and nutrients, and movement of this material into the retained vegetation or any of the drainage lines in the study area can facilitate the spread of weeds. Increased weed invasion can result in changes to community composition and spread of weed to surrounding areas within the study area.

The areas considered to be most prone to these processes are the areas of vegetation to be retained within the Howes Creek Conservation Area and the patches of EBSF to be retained within the Parks K and L and Stage 6B Conservation Areas. Sediment and erosion control and reduction measures will be implemented prior to the clearing phase of the proposed development works to reduce sediment runoff into retained habitat, with particular focus on the retained areas of vegetation identified above. Additionally, management plans have been developed that outline measures to mitigate potential impacts on retained vegetation (including impacts associated with sedimentation, erosion and runoff) within the study area from the commencement of the proposed development works to the completion of future development within the subject site; these plans are for Parks K and L Conservation Area (REF. 17072 RP29) and for the Howes Creek and Northern Conservation Area (REF. 17072 RP36), with another plan following the same management measures to be prepared for the Stage 6B EBSF Conservation Area as a Condition of Consent. If controls prescribed within **Chapter 7** of this report and within the management plans are implemented, it is expected that these indirect impacts will be appropriately mitigated.

5.1.2.5. Weeds

Alterations to habitat conditions often favour introduced and/or hardy native plant species that can proliferate in disturbed conditions. Such species have potential to impact upon the original local native plant species. Weeds such as exotic grasses and other introduced plants have potential to outcompete regenerating native plant species.

There are 31 species of weeds listed as priority weeds or weeds of concern in the Greater Sydney area under the *Biosecurity Act 2015* currently present within parts of the study area.

There is a risk that seeds or other propagules from these weeds could be dispersed while the proposed development works are being undertaken, either on vehicles or clothing of the workers involved, and from the time the proposed development works are completed until future development is completed, which may be several years. This could potentially be a serious threat to remaining vegetation within the study area and immediate surrounds. To mitigate the risk of weed dispersal, a monitoring plan will be developed that will include the monitoring of any weed dispersal into areas of retained vegetation and provide appropriate mitigation measures and/or management actions to minimise any significant weed dispersal found to occur. It is expected that the monitoring plans developed for Parks K and L, Stage 6B EBSF, and for the Howes Creek

and Northern Conservation Areas will be implemented as part of the conditions of consent for the proposed development works.

5.1.2.6. Construction and Operational Impacts

Several indirect impacts relevant to the construction and operational phases of the proposed development works have the potential to impact the ecological values of the study area, such as those relating to dust, noise, light and shading.

i. Dust

Construction activities can generate dust, which may impact on the ecology within the study area in several ways. Dust that settles can accumulate on leaf surfaces and reduce essential physiological processes including photosynthesis, respiration, and transpiration. It can also permit the penetration of phytotoxic gaseous pollutants into plants (Farmer 1993).

Dust can also produce physical effects on plants such as blockage and damage to stomata, shading, and abrasion of leaf surface or cuticle. This can result in cumulative effects such as drought stress on already stressed species, which can lead to decreased plant health, and even death in extreme circumstances. Decreased growth and vigour of plants may mean that they are more susceptible to pathogens and other disturbance, and these plants are more likely to be subject to increased mortality. Such impacts to individual plants generally result in decreased productivity and can result in changes in vegetation and community structure (Farmer 1993).

The effect of dust deposition also affects animals that use plants, either as a source of food or habitat. Dust on the foliage and fruit may reduce palatability to animals and decreased health of trees and changed community structure results in a reduction in the amount of available habitat. Dust pollution can lead to a decrease in habitat quality which has the potential to extend the area of impact beyond the area directly disturbed by the proposed development works.

Dust generated by the proposed development works could impact vegetation retained within parts of the study area, reducing health of some species within this area. This is not considered likely to be significant as any high dust levels during construction are short-term and levels will be reduced in the long-term during the operational phase of the development. Additionally, dust levels during the construction phase are expected to be mitigated appropriately with standard dust control measures.

ii. Noise

Noise can affect animal physiology and behaviour, and if it becomes an ongoing stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. There are other potential impacts that include habitat loss through avoidance, reduced reproductive success and a retreat away from favourable habitats (AMEC 2005).

Noise also affects the way that animal-created sounds are heard and interpreted by other animals. This can include mating calls, territorial calls and alarm calls. Interference with these calls by noise generated by the project has the potential to disrupt the species relying on these calls with deleterious results including reduced reproductive success and mortality (AMEC 2005).

The proposed development works and future development they will facilitate can generate significant noise during construction of infrastructure and buildings. Noise can be generated by large volumes of traffic, particularly large trucks and excavation machinery. Some fauna species are sensitive to elevated levels of noise in their environment and this has the potential to impact negatively on these species (AMEC 2005).

The noise created by the proposed development works and future development it facilitates is unlikely to significantly affect native species, and the value of the habitats that remain in the study area, further than current conditions. The location of the proposed development works is in an area that is currently exposed to a low to moderate degree of noise being in close proximity to the Hume Motorway. Nevertheless, noise associated with the proposed development works and future development is likely to be significantly higher than what currently occurs. It is expected that some species are likely to relocate in response to noise, and this has the potential effect of increasing the amount of habitat for native species that will be displaced because of the proposal. However, it is likely that most animal species will habituate to the periodic noise disturbance (AMEC 2005), and future construction facilitated by the proposed development works is likely to cause only temporary disturbance to fauna.

iii. Light

The proposed development works and future development it will facilitate has the potential to increase the level of artificial light in the natural environment during the construction phase and after the completion of construction. Increased light levels may adversely impact wildlife by direct glare, chronic or periodic increased illumination and temporary unexpected fluctuations in light levels (Saleh 2007).

Research into impacts from altered lighting indicates that it can trigger behavioural and physiological responses that include but are not limited to:

- Changes in foraging behaviour;
- A disruption of seasonal day length cues which trigger critical behaviours;
- Disorientation and/or temporary blindness; and
- Interference with predator-prey relationships (Longcore and Rich 2007, Saleh 2007, Longcore and Rich 2010).

The study area is currently exposed to a minimal amount of artificial lighting. The proposed development works and the future development it will facilitate is likely to result in an increase of artificial light coming from the residential development, particularly in the evening.

Potential impacts from light pollution during the proposed development works is unlikely as the clearing works will be carried out during the day. Light pollution associated with future development as a result of the proposed development works (subject to a future DA) is considered to elevate further than current level; however, this increase is unlikely to significantly impact any fauna species as the majority of the fauna species recorded or are considered to have the potential to utilise the habitat within the study area are either nocturnal or small birds. Nocturnal species are unlikely to be impacted by light pollution during the construction phase as works will be limited to daylight hours.

Small birds are generally active within woodland areas in the study area including larger patches to be retained. These areas are densely vegetated and are well shaded during the day. As such, any artificial light during the day is unlikely to increase current light levels within retained vegetation.

Furthermore, it is likely that most fauna species would habituate to the periodic disturbance and light pollution from the proposal is unlikely to have a significant or long-term impact on any fauna species.

iv. Shading

The proposed development works will not increase shading on retained vegetation as it is limited to clearing works. Future development because of the proposed development works (subject to a future DA) is also unlikely to increase the level of shading on retained vegetation within the study area as most of the structures being build will be for residential purposes.

v. Urbanisation and Human Behaviour

The proposed works will lead to increase of urbanisation which will likely result in an increase of human activities within the study area that may have deleterious impact on the areas of biodiversity proposed to be retained. Common human activity that result in impacts on biodiversity include dumping of rubbish and green waste, mountain bike/BMX bike riding, introduction/increase in domestic pets and increased traffic volumes. Such impacts are associated with the proposed works as well as wider development part of other developments of the area following the Menangle Park Structure Plan. The aforementioned activities are most relevant to areas of vegetation that are proposed to be retained and become an offset for impacts associated with development. Such activities may lead to degradation of retained areas overtime in the absence of management and protective measures. All areas proposed to be conserved as part of the Menangle Park Structure Plan are proposed to be managed in perpetuity which is considered to appropriately mitigate any impacts associated with human disturbance/urbanisation. Furthermore, all conserved areas will have fencing as well as education signage to further reduce impacts on the areas.

5.2. Assessment of Species Likely to be Affected

CER 5.1 ASSESSMENT OF SPECIES LIKELY TO BE AFFECTED

An assessment of which threatened species or populations known or likely to be present in the area are likely to be affected by the action (Section 110(2)(b)).

Affected species are defined within the SIS as subject species and populations likely to be affected by the proposed development works. The impacts include the direct impact of loss of habitat through clearing and/or indirect impacts. The species and populations and communities selected as "affected" include threatened fauna species that are known to occur in the local area and that have the potential to utilise habitat within the study area.

The following threatened species and populations include those that are considered most likely be affected by the proposed development works and have been determined to be "affected species". These are assessed in subsequent sections of this chapter:

- Black-necked Stork (*Ephippiorhynchus asiaticus*) – Endangered TSC Act;

- Brown Treecreeper (*Climacteris picumnus*) – Vulnerable TSC Act;
- Dusky Woodswallow (*Artamus cyanopterus*) – Vulnerable TSC Act;
- Eastern Cave Bat (*Vespadelus troughtoni*) – Vulnerable TSC Act;
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) – Vulnerable TSC Act;
- Eastern Coastal Free-tailed Bat (*Mormopterus norfolkensis*) – Vulnerable TSC Act;
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – Vulnerable TSC Act;
- Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable TSC Act and EPBC Act;
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) – Vulnerable TSC Act and EPBC Act;
- Little Bent-winged Bat (*Miniopterus australis*) – Vulnerable TSC Act;
- Little Eagle (*Hieraaetus morphnoides*) – Vulnerable TSC Act;
- Little Lorikeet (*Glossopsitta pusilla*) - Vulnerable TSC Act;
- Powerful Owl (*Ninox strenua*) – Vulnerable TSC Act;
- Southern Myotis (*Myotis macropus*) – Vulnerable TSC Act;
- Varied Sittella (*Daphoenositta chrysoptera*) – Vulnerable TSC Act; and
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*) – Vulnerable TSC Act.

A total of 16 threatened species listed under the TSC Act are affected species. Fourteen (14) of the affected species have been recorded in the study area previously and have the potential to utilise habitat within the subject site for foraging purposes. The Powerful Owl and Little Lorikeet have not been recorded in the study area previously but are considered to have the potential to utilise habitat within the study area for foraging. Additionally, suitable roosting/nesting habitat is present within the subject site for all of these species except for the Large Bent-winged Bat, Eastern Cave Bat and Grey-headed Flying-fox. The Large Bent-winged Bat and Eastern Cave Bat's primary roosting habitat (i.e. caves) are not present within the study area and no Grey-headed Flying-fox camps are present within the study area.

No threatened flora species are considered likely to occur within the subject site, based on the results from 2016, 2017, 2018 and 2019, 2020 and 2021 field surveys, hence no threatened flora species are included in the assessment in this chapter.

The list of "affected species" has been refined from the list of subject species (see **Chapter 3**) based on the listing in the CERs, their potential occurrence in and around the subject site, their likelihood of occurrence, specific habitat requirements, results from surveys, and the extent of impacts. The remaining subject species listed in **Chapter 3** are not analysed further for the following reasons:

- They are not considered likely to occur in the subject site (based on general species distribution information); and/or
- Are not known to utilise the habitat types of the subject site: and/or
- Only a minimal amount of sub-optimal habitat is present that would be utilised for foraging purposes only periodically as part of a much broader foraging range and would not be important to the species' long- or short-term survival in the locality.

5.3. Analysis of Affected Species

5.3.1. Black-necked Stork

5.3.1.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW *Threatened Species Assessment Guidelines* (DECC 2007), the local population of the Black-necked Stork is considered to be any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. There are two records of the Black-necked Stork within a 10 km radius of the study area, two records of the Black-necked Stork from within a five km radius of the study area, and one record located within the study area, but outside of the subject site. The record of the species in the study area was by Travers Bushfire & Ecology in 2013. The species is known to occupy floodplain wetlands such as swamps, billabongs, watercourses and dams within NSW as well as coastal sand plain wetlands and estuaries. The species utilises large trees in close proximity to water as nesting and breeding habitat, and the species has been recorded breeding as far south as Bulahdelah (over 200 km north of the subject site).

ii. Discussion of other known regional populations

The species is widely distributed across the coastal and sub-coastal northern and eastern regions of Australia extending as far south as central NSW (OEH 2018a). In NSW, the species becomes increasingly uncommon south of the Clarence Valley, and rarely occurs south of Sydney. The NSW breeding population has been estimated at about 75 pairs (OEH 2017a).

The Black-necked Stork has territories that are large and variable in size. They have been estimated to average about 9,000 ha, ranging from 3,000-6,000 ha in high quality habitat and 10,000-15,000 ha in areas where habitat is poor or dispersed. Accordingly, the significance of the subject site for this species in the locality and region is considered to be extremely low, as it would form a very small part of a much larger territory.

5.3.1.2. Assessment of Habitat

i. Description of habitat values

The species is widely distributed across the coastal and sub-coastal northern and eastern regions of Australia extending as far south as central NSW. The species is known to occupy floodplain wetlands such as swamps, billabongs, watercourses and dams within NSW as well as coastal sand plain wetlands and estuaries. The species utilises large trees near water as nesting and breeding habitat.

ii. Discussion of habitat utilisation

The study area provides potential foraging habitat in the form of dams and wetlands that the species may utilise on occasion as part of a broader foraging range. Potential roosting habitat is also present as large trees close to dams and wetlands.

The significance of the habitat in the study area for the Black-necked Stork is considered likely to be relatively low, as this species occupies extremely large territories, and the small area of relatively degraded habitat is unlikely to be significant to viability of this species in the locality. Other areas of similar habitats (i.e., degraded fragments of woodland with farm dams) occur throughout the locality and the region. The habitats in the study area are not protected and are likely to continue to degrade in the long term in the absence of management measures. Other habitats in the region are protected, such as those in the Dharawal National Park, and these will provide suitable habitats for this species in the long term.

5.3.1.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Black-necked Stork has been listed as Endangered under the TSC Act (OEH 2018a). In NSW, the species becomes increasingly uncommon south of the Clarence Valley, and rarely occurs south of Sydney. The NSW breeding population has been estimated at about 75 pairs (OEH 2017a).

5.3.1.4. Threatening processes

The following key threatening processes are known to affect the Black-necked Stork:

- 'Clearing of native vegetation';
- 'Electrocution on power lines';
- 'Loss of wetland habitat through clearing and draining for development';
- 'Invasion and establishment of exotic vines and scramblers';
- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'; and
- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)'.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- 'Degradation of wetland habitats through pollution';
- 'Loss of paddock trees used for nesting'; and
- 'Degradation of wetlands as a result of salinity' (OEH 2018a).

5.3.1.5. Habitat requirements

The species is widely distributed across the coastal and sub-coastal northern and eastern regions of Australia extending as far south as central NSW. The species occurs in floodplain wetlands such as swamps, billabongs,

water courses and dams within NSW as well as coastal sand plain wetlands and estuaries. The species utilises large trees near water as nesting and breeding habitat. The trees utilised for nesting usually provide a clear line of site. Preferred foraging habitat includes waters that are 5-30 cm in depth that contain vertebrate and invertebrate prey, including eels, fish, frogs, beetle, grasshoppers, crickets and crayfish.

5.3.1.6. Other documentation

This species has been assigned to the Partnership (range-restricted) management stream under the 'Saving our Species' program. The major objective aims to secure critical populations within NSW. No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species.

5.3.1.7. Assessment of adequacy of reservation

Only two records of the species are present from the study area which is within a dam located to the south of Howes Creek. The location of the occurrence is not within the proposed development works area. As both records of the species occur outside of a reserve, the species is considered to have inadequate reservation.

5.3.1.8. Limit of known distribution

The species is limited to the coastal and sub-coastal northern and eastern regions of Australia extending as far south as central NSW.

5.3.1.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Black-necked Stork has been recorded within the study area by Travers Bushfire & Ecology (2013). The study area provides suitable foraging and roosting habitat; however, it is unlikely to nest in the study area as no large nests typical of this species are present and the furthest south the species has been recorded breeding is Bulahdelah, located over 200 km north of the subject site. The habitats in the study area are like the types of habitats that are present elsewhere in the locality and are unlikely to be important to the species. In common with the study area, areas of habitat elsewhere in the locality are not secure or within conservation reserves and are subject to the same threatening processes. The proposed development works will remove a small area of potential habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the species in the local context as extensive areas of similar potential habitat occur in the study area that are proposed to be retained, and suitable habitat is present outside the study area along the Nepean River.

ii. Extent of habitat removal or modification

The proposal will remove a very small area of habitat for this species, consisting of a few farm dams (total 1.01 ha) a small area of freshwater wetlands (0.37 ha) and some associated trees that may be used for roosting.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity either VMPs. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of ~67 ha of native vegetation.

iii. Discussion of connectivity

Suitable habitat for the Black-necked Stork to be removed within the proposed development works area has limited connectivity to larger patches of habitat. The habitat to be removed as part of the proposed development works will not fragment suitable foraging habitat but requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although potential foraging habitat will be removed, larger areas of more optimal foraging habitat will be retained in the study area and locality, around Howes Creek and the Nepean River. This species is also highly mobile and able to access other areas of more suitable habitat in the wider locality. Due to this, the proposed development works will not likely affect habitat connectivity for this species as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

- Clearing of native vegetation'

Several farm dams totalling approximately 1.01 ha that provides potential habitat for these species will be cleared as part of the proposed development works as well as woodland areas adjacent to the dams that may provide potential roosting habitat. Larger Additional 'Electrocution on power lines'

The proposed development works has the potential to contribute to electrocution on power lines, as these will need to be installed to support residences that will be built. However, as the subject site likely only constitutes a small area of foraging habitat, any increase in electrocution is likely to be minimal.

- 'Loss of wetland habitat through clearing and draining for development'

The proposed development works will remove one dam that provides suitable foraging habitat for the species and a small area of potential roosting habitat. Such removal is not likely to have an adverse impact on the survival of the species. Additionally, the retention of most of the Howes Creek riparian corridor will ensure the majority of wetland habitat is retained.

- Invasion and establishment of exotic vines and scramblers'

The proposed development works has the potential to result in the spread of exotic weeds. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'

The subject site currently contains Lantana in areas, all of which will be cleared. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)';

The subject site currently contains African Olive in areas, all of which will be cleared. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Degradation of wetland habitats through pollution

The wetland habitats to be retained may be impacted by pollution associated with the proposed development works, however appropriate pollution controls will be implemented during the proposed development works making it unlikely that the proposed development works will significantly contribute to increased pollution within retained area. Furthermore, all areas of wetland within the Howes Creek Conservation Area are proposed to be conserved under the proposed Master Plan (Cumberland Ecology 2018a) and managed under a VMP.

- Degradation of wetlands as a result of salinity

The proposed development works is unlikely to increase salinity to levels that will have deleterious effects on areas of wetland proposed to be retained.

- Loss of paddock trees used for nesting

The proposed development works will clear areas of paddock trees; however, large trees in close proximity to water will also be retained. Furthermore, this species is highly mobile and capable of accessing other areas of suitable habitat. No large nests were recorded within paddock trees in close proximity to water.

5.3.2. Brown Treecreeper

5.3.2.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Brown Treecreeper is considered to be any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are nine records of the Brown Treecreeper within 10 km of the study area, seven records of the Brown Treecreeper from within 5 km of the study area, and the species has been recorded within the study area by Cumberland Ecology in 2018. Potential foraging and nesting habitat exists for the species mainly within and around the woodland/forest areas of the study area. The species is known to occur in eucalypt woodlands and coastal regions, including the Cumberland Plain Woodland and particularly inhabits woodlands dominated by stringy bark with open grassy understorey.

ii. Discussion of other known regional populations

This species is distributed along the east coast of Australia from Queensland to South Australia. It is unknown how abundant this species is in the region however Brown Treecreepers have declined to near extinction on the Cumberland Plain and they are of the highest conservation priority for this area (DECC, 2007).

That notwithstanding, the significance of the subject site for this species in the locality and region is relatively low. The species appears unable to maintain viable populations in remnants less than 200 ha and its abundance decreases as remnant size decreases (Barret & Ford, 1994). The degraded patches in the proposed development works area are considerably less than 200 ha and are unlikely to be able to support a viable population of this species. Similar fragmented habitats occur outside the proposed development works area will remain, along with the substantial area of less fragmented woodland within the Howes Creek Conservation Area that will be retained in perpetuity.

5.3.2.2. Assessment of Habitat

i. Description of habitat values

The species is known to occur throughout eucalypt woodlands and coastal regions, including the Cumberland Plain Woodland and particularly inhabits woodlands dominated by stringy bark with open grassy understorey. It breeds in hollows in standing dead or live trees and tree stumps, and these resources are essential for nesting (EES, 2021)

ii. Discussion of habitat utilisation

The subject site provides both potential foraging and nesting habitat within woodland/forest vegetation present. The species is likely to utilise the suitable habitat within the subject site primarily for foraging purposes and is considered more likely to utilise habitat within the study area proposed to be retained for nesting purposes as these areas include larger tracts of vegetation that are less exposed to edge effects.

The habitat for this species that is present in the study area is not considered to be significant to the viability of the Brown Treecreeper in the locality. Similar fragmented patches of woodland occur outside the study area that will not be impacted, and the degraded areas of vegetation within the proposed development works area are not considered to be important to this species. The habitats in the proposed development works area are not protected for conservation, in common with other habitats that remain in the locality and region.

5.3.2.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Brown Treecreeper is listed as Vulnerable under the TSC Act (OEH 2018b). The broad range of the Brown Treecreeper has not changed but it is now extinct in parts of its range. Declines in populations have been recorded from the Cumberland Plain (EES, 2003).

5.3.2.4. Threatening processes

The following Key Threatening Processes listed under the TSC Act are likely to affect the Brown Treecreeper:

- 'Clearing of native vegetation';
- 'Removal of hollow bearing trees';
- 'Removal of dead wood and dead trees';
- 'Invasion and establishment of exotic vines and scramblers';

- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)';
- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)';
- 'Invasion of native plant communities by exotic grasses';
- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'; and
- Predation from foxes and feral cats.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- 'Fragmentation of woodland and forest remnants which isolates populations and causes local extinctions';
- 'Ongoing degradation of habitat, particularly the loss of tree hollows and fallen timber from firewood collection and overgrazing';
- 'Lack of regeneration of eucalypt overstorey in woodland due to overgrazing and too-frequent fires';
- 'Loss of ground litter from compaction and overgrazing';
- 'Inappropriate forestry management practices;
- 'Loss of understorey habitat'; and
- 'Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners' (OEH 2018b).

5.3.2.5. Habitat requirements

The Brown Treecreeper is distributed along the east coast of Australia from Queensland to South Australia. The species is known to occur throughout eucalypt woodlands and coastal regions, including the Cumberland Plain Woodland and particularly inhabits woodlands dominated by stringy bark with open grassy understorey. The species utilises hollows within live trees and tree stumps for breeding and is generally sedentary in nature with an average range of 4.4 ha. Preferred foraging habitat includes areas without a dense shrub layer that contain fallen timber (OEH 2018b).

5.3.2.6. Other documentation

The Brown Treecreeper has been assigned to the 'Landscape species' management stream under the 'Saving our Species' program. The major objective of the program is to ensure that the species is secure in the wild in NSW and that its' NSW geographic range is extended or maintained (OEH 2018b). No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species.

5.3.2.7. Assessment of adequacy of reservation

Records of the Brown Treecreeper are scattered throughout the area outside of reserves. Presently there is inadequate reservation of this species in the region as all individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.2.8. Limit of known distribution

The known distribution of the species extends along the east coast of Australia from Queensland to South Australia.

5.3.2.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Brown Treecreeper has been recorded within the study area by Cumberland Ecology in 2018. The subject site provides suitable foraging and nesting habitat. The proposed development works will remove some suitable habitat for this species; however, this removal of habitat is considered unlikely to be significant to the long-term survival of the species in the local context as similar areas of habitat occurs in the study area and beyond. Furthermore, large areas of habitat will be conserved within the study area which are considered to be suitable habitat for the species.

ii. Extent of habitat removal or modification

The proposal will remove some habitat for this species, consisting of approximately 17 ha of vegetation, which is a reduction from the previous version of the BEW DA. As a conservative estimate, this includes all the vegetation in the subject site except for exotic vegetation, grasslands, freshwater wetlands and dams. Most of the native vegetation in the study area will remain and continue to provide habitat for this species.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of ~67 ha of native vegetation.

The proportion of each vegetation community that is being removed by the current proposal is presented in **Table 14**. The relatively minor removal of habitat in the subject site is not expected to affect its viability as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Suitable habitat for the Brown Treecreeper to be removed within the proposed development works area has limited to no connectivity to larger patches of habitat and the habitats present in the study area are already highly fragmented. Although the proposed development works will exacerbate existing fragmentation of habitat to some extent by increasing the distance between fragments and reducing the ability for movement and gene flow, fragmentation of intact foraging habitat will not occur. Rather, the proposal requires clearing of an already fragmented patch and will therefore encroach further into remaining habitat rather than create additional fragmented habitat patches.

Although the Brown Treecreeper is considered to be a sedentary species, with distinct home territories, some birds disperse locally after breeding (OEH 2017b). The species disperses locally, with an average recorded dispersal distance of approximately one kilometre, but ranging up to over 2 km (Doerr, 2011). Accordingly, they are able to access other resources if required and are not dependent on the resources in a single patch.

Although suitable habitat will be removed, larger areas of habitat will be retained in the study area and beyond, around Howes Creek and the Nepean River. The Brown Treecreeper is more likely be dependent on larger tracts of less disturbed vegetation, such as the areas to be conserved. Due to this, the proposed development works will not likely affect habitat connectivity for this species as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Brown Treecreeper may be generally threatened by the following processes:

- Clearing of native vegetation

Approximately 17 ha of native vegetation that provides suitable habitat for this species (i.e., woodland, forest and shrubby regrowth) will be cleared as part of the proposed development works, which is a reduction from the previous version of the BEW DA. Although a moderate area of habitat will be removed, larger areas of Suitable habitat will be retained within surrounding areas, including the Howes Creek conservation area.

- Removal of hollow bearing trees

The proposed development works will remove approximately 17 ha of woodland and forest vegetation that contains hollow bearing trees; however, larger areas of woodland/forest containing hollow bearing trees will be retained and conserved in the subject site and study area. Furthermore, the species is highly mobile and able of accessing other areas of suitable habitat.

- Removal of dead wood and dead trees

The proposed development works will result in the removal of dead wood and dead trees. Although all of these items will be removed from the proposed development works area, additional areas containing dead wood and dead trees will be retained in the subject site and study area. Mitigation measures such as the salvage of dead wood and dead trees and placement into retained areas will also occur to enhance the habitat values of retained vegetation within the subject site.

- Invasion and establishment of exotic vines and scramblers

The proposed development works has the potential to result in the spread of exotic weeds. In order to mitigate this key threatening process, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion and spread of Lantana (*Lantana camara* L. Sens lat)

The subject site currently contains Lantana in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The subject site currently contains African Olive in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by exotic grasses

Clearing from the proposed development works are unlikely to significantly contribute to the spread of exotic grasses further than current conditions as all areas are currently subject to this process. In order to mitigate the spread of exotic grasses into retained vegetation within the proposed conservation works areas, VMPs will be implemented that will monitor areas of retained vegetation and provide recommendations and/or management actions to minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

The proposed development works are unlikely to increase this key threatening process, but the future development it facilitates does. Nevertheless, all retained vegetation within the subject site that would be susceptible to this process will be managed in perpetuity, likely mitigating this key threatening process from occurring.

- Fragmentation of woodland and forest remnants which isolates populations and causes local extinctions

The proposed development works is unlikely to exacerbate this process as the habitat to be removed is comprised of fragmented remnants. Furthermore, the species is highly mobile and capable of accessing additional areas of suitable habitat in the area.

- Ongoing degradation of habitat, particularly the loss of tree hollows and fallen timber from firewood collection and overgrazing

The proposed works will contribute to this process as habitat will be removed; however, large areas of habitat will be retained within the study area which will provide suitable nesting and foraging habitat for this species.

- Lack of regeneration of eucalypt overstorey in woodland due to overgrazing and too-frequent fires

The proposed development works is unlikely to contribute to overgrazing and too frequent fires as grazing will not occur and bushfire APZ will be implemented.

- Loss of ground litter from compaction and overgrazing

The proposed development works will result in the loss of ground litter; however, large areas containing ground litter will be retained within the subject site and study area.

- Loss of understorey habitat

The proposed development works will result in the loss of understorey habitat; however, large areas native vegetation containing understorey habitat will be retained within the subject site and study area.

- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners

The proposed development works has the potential to increase this process within the study area.

- Predation by cats and foxes

The proposed development works are likely to increase the number of cats within the study area as a result of future development, but unlikely to increase the number of foxes. Although an increase in cats will occur, this key threatening process is unlikely to occur as this species is highly mobile.

5.3.3. Dusky Woodswallow

5.3.3.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Dusky Woodswallow is considered to be any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are 134 records of the Dusky Woodswallow within 10 km of the study area, 97 records of the Dusky Woodswallow within 5 km of the study area, and the species has been recorded within the study area by Cumberland Ecology in 2018. Potential foraging and nesting habitat exists for the species mainly within and around the woodland/forest areas of the study area. The species is found in a variety of habitats, particularly in woodlands and dry open sclerophyll forests that are dominated by eucalypts with a shrubland/heathland understorey.

ii. Discussion of other known regional populations

The species is widely distributed throughout eastern, southern and south-western Australia. Depending on location and local climatic conditions (primarily temperature and rainfall), the Dusky Woodswallow can be resident year-round or migratory. In NSW, after breeding, birds migrate to the north of the state and to south-eastern Queensland (NSW Scientific Committee, 2016).

The total population size of the Dusky Woodswallow in NSW is unknown. Using published density estimates an estimated population size of approximately 200,000 adults has been estimated in NSW (NSW Scientific

Committee, 2016). Whilst this population estimate is coarse, the total population in NSW is unlikely to be low or moderately low.

The relative significance of the subject site as habitat for the Dusky Woodswallow in the region and locality is considered to be low, due to the relatively small area of native vegetation in the subject site and due to a high degree of degradation. This species prefers larger remnants over smaller remnants (NSW Scientific Committee, 2016) and the small areas of habitat in the subject site is not likely to be important to this species in the locality or region.

5.3.3.2. Assessment of Habitat

i. Description of habitat values

The Dusky Woodswallow occurs throughout eastern, southern and south-western Australia. The species is found in a variety of habitats, particularly in woodlands and dry open sclerophyll forests that are dominated by eucalypts with a shrubland/heathland understorey. The species also utilised the edges of forest and woodland near farmlands. The Dusky Woodswallow forages below the canopy and utilises a variety of habitats for nesting including exposed or well concealed areas (OEH 2018c). There is some evidence for site fidelity for breeding.

The species was recorded within the study area by Cumberland Ecology in 2018. The study area and subject site provides suitable nesting and foraging habitat for the species within and alongside the patches of woodland/forest present.

ii. Discussion of habitat utilisation

The subject site provides both potential foraging and nesting habitat within woodland/forest vegetation present. The species has the potential to utilise the suitable habitat within the subject site for nesting and foraging purposes.

The habitat of the study area is not considered to be significant to the viability of the species in the locality or region. As mentioned previously, this species prefers large remnants, and the subject site represents only a few fragmented area of degraded habitat that is not likely to be important to the long-term survival of the species.

Similar types of habitat in similar condition occur in the locality and region that offer similar habitat to that in the study area. These small patches of vegetation on private land are not protected or secured for long term conservation, although larger areas of suitable habitat occur in the Dharawal National Park.

5.3.3.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Dusky Woodswallow is listed as Vulnerable under the TSC Act (OEH 2018c).

5.3.3.4. Threatening processes

The following Key Threatening Processes listed under the TSC Act are likely to affect the Dusky Woodswallow:

- 'Clearing of native vegetation';

- 'Removal of dead wood and dead trees';
- 'Invasion and establishment of exotic vines and scramblers';
- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)';
- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)';
- 'Invasion of native plant communities by exotic grasses';
- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'; and
- Predation from foxes and feral cats.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- 'Reduction in area, and increased isolation of patches of remnant woodland and open forest';
- 'Ongoing degradation of habitat through the loss of dead timber, removal of coarse woody debris and other disturbances of the ground layer';
- 'Aggressive exclusion by over abundant Noisy Miners'; and
- 'Lack of regeneration of eucalypt overstorey in woodland due to overgrazing and too-frequent fires' (OEH 2018c).

In addition, the Final Determination for this species states that given the foraging habit of the Dusky Woodswallow and its association with dead timber, other disturbances to the ground layer that impact invertebrate availability such as inappropriate fire regimes, excessive grazing and removal of coarse woody debris are potential threats to this species that decrease habitat quality (NSW Scientific Committee, 2016)

5.3.3.5. Habitat Requirements

The Dusky Woodswallow is distributed throughout NSW and are widespread in eastern, southern, and south western Australia. The species is known to occur throughout dry, open eucalypt forests and woodlands, mallee, shrublands, heathlands and occasionally in moist forests. The species nests in shrubs or low trees (living or dead) (OEH 2018c).

5.3.3.6. Other documentation

The Dusky Woodswallow has been assigned to the 'Landscape species' management stream under the 'Saving our Species' program. The major objective of the program is to ensure that the species is secure in the wild in NSW and that its' NSW geographic range is extended or maintained (OEH 2018c). No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species.

5.3.3.7. Assessment of adequacy of reservation

Records of the Dusky Woodswallow are scattered throughout the region within and outside of reserves. Presently there is inadequate reservation of this species in the region as a high number of individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.3.8. Limit of known distribution

The known distribution of the species extends throughout eastern, southern and south-western Australia.

5.3.3.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Dusky Woodswallow has been recorded within the study area by Cumberland Ecology in 2018. The subject site provides suitable foraging and nesting habitat. The proposed development works will remove some suitable habitat for this species; however, this removal of habitat is considered unlikely to be significant to the long-term survival of the species in the local context as extensive areas of suitable habitat occur, including within nearby reserves. Furthermore, large areas of suitable habitat will be conserved within the study area, including within the proposed conservation works areas. Additionally, the species is highly mobile and capable of accessing other areas of suitable habitat within study area and beyond.

ii. Extent of habitat removal or modification

The proposal will remove some habitat for this species, consisting of approximately 17 ha. As a conservative estimate, this includes all the vegetation in the subject site except for exotic vegetation, grassland, freshwater wetlands and dams. Most of the native vegetation in the study area will remain and continue to provide habitat for this species.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 67 ha of native vegetation.

The proportion of each vegetation community that is being removed for the current proposal is presented in **Table 14** of the SIS. The relatively minor removal of habitat in the subject site is not expected to affect its viability as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Suitable habitat for the Dusky Woodswallow to be removed within the proposed development works area has limited connectivity to larger patches of habitat. Although the proposed development works will exacerbate existing fragmentation of habitat to some extent by increasing the distance between fragments and reducing opportunities for movement and gene flow, fragmentation of intact foraging habitat will not occur. Rather, the proposal requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than create additional fragmented habitat patches. Although some suitable habitat will be removed, larger areas of suitable habitat will be retained in the study area and beyond, including around

Howes Creek and the Nepean River. The Dusky Woodswallow is also a highly mobile species which would more likely be dependent on larger tracts of vegetation located outside of the subject site. Due to this, the proposed development works will not likely affect habitat connectivity for this species as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Dusky Woodswallow may be generally threatened by the following processes:

- Clearing of native vegetation

Approximately 17 ha of native vegetation that provides suitable habitat for this species (i.e., woodland, forest and shrubby regrowth) will be cleared as part of the proposed development works which is a reduction from the previous version of the BEW DA. The foraging habitat to be removed is unlikely to be important to this species as it would likely only be used on occasion as part of much broader foraging range. Larger areas of Therefore, although some habitat will be removed, larger patchesRemoval of dead wood and dead trees

The proposed development works will result in the removal of dead wood and dead trees. Although all of these items will be removed from the proposed development works area, additional areas containing dead wood and dead trees will be retained in the study area and locality. Mitigation measures such as the salvage of dead wood and dead trees and placement into retained areas will also occur to enhance the habitat values of retained vegetation within the subject land.

- Invasion and establishment of exotic vines and scramblers

The proposed development works have the potential to result in the spread of exotic weeds both during the clearing process and into areas of retained vegetation. To mitigate this key threatening process, a monitoring plan will be implemented that will monitor areas of retained vegetation and provide recommendations and/or management actions to minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works.

Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion and spread of Lantana *(Lantana camara* L. Sens lat)

The proposed development works area currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during the clearing process and into areas of retained vegetation. In order to mitigate this key threatening process, the VMPs for the proposed conservation works areas will be implemented that will monitor areas of retained vegetation and provide recommendations and/or management actions to minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The proposed development works area currently contains African Olive in areas, all of which will be cleared.

The proposed development works have the potential to result in the spread of this weed both during the clearing process and into areas of retained vegetation. In order to mitigate this key threatening process, a monitoring plan will be implemented that will monitor areas of retained vegetation and provide recommendations and/or management actions to minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by exotic grasses

Clearing from the proposed development works is unlikely to cause the spread of exotic grasses further than current conditions as all areas of exotic grasses will be cleared. To mitigate the spread of exotic grasses into retained vegetation, the monitoring plans for the proposed conservation areas will be implemented that will monitor areas of retained vegetation and provide recommendations and/or management actions to minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

The proposed development works are unlikely to increase this key threatening process, but the future development it facilitates does. Nevertheless, all retained vegetation within the subject land that would be susceptible to this process will be managed in perpetuity, likely mitigating this key threatening process from occurring.

- Reduction in area, and increased isolation of patches of remnant woodland and open forest

Although areas of habitat will be reduced, the proposed development works are unlikely to exacerbate this process as the habitat to be removed is comprised of fragmented remnants. Furthermore, the species is highly mobile and capable of accessing additional areas of suitable habitat in the area.

- Ongoing degradation of habitat through the loss of dead timber, removal of coarse woody debris and other disturbances of the ground layer

The proposed development works will contribute to this process; however, large areas of habitat will be retained providing suitable foraging habitat for the species.

- Lack of regeneration of eucalypt overstorey in woodland due to overgrazing and too-frequent fires

The proposed development works is unlikely to contribute to overgrazing and too frequent fires as grazing will not occur and bushfire APZ will be implemented.

- Loss of ground litter from compaction and overgrazing

The proposed development works will result in the loss of ground litter; however, large areas containing ground litter will be retained within the study area and beyond.

- Loss of understorey habitat

The proposed development works will result in the loss of understorey habitat; however, large areas native vegetation containing understorey habitat will be retained within the study area and beyond.

- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners

The proposed development works has the potential to increase this process within the study area.

- Predation by cats and foxes

The proposed development works are likely to increase the number of cats within the study area as a result of future development, but unlikely to increase the number of foxes. Although an increase in cats will occur, this key threatening process is unlikely as the species is highly mobile.

5.3.4. Eastern Cave Bat

5.3.4.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Eastern Cave Bat is considered to be any individuals known or likely to occur in the study area, as well as any individuals in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available.

There are no records of the Eastern Cave Bat from the locality; however, the species was recorded by Cumberland Ecology within the study area in 2018. Potential foraging habitat exists for the species mainly within and around the woodland/forest areas of the study area. No preferred roosting habitat (i.e. caves) is present.

ii. Discussion of other known regional populations

The Eastern Cave Bat is distributed along both sides of the Great Dividing Range from Cape York to Kempsey. The species has also been recorded as far south as southern NSW, east of the ACT. The western limit for the species within NSW is considered to be the Warrumbungle Range (OEH 2017e) The study area is within the species' known distribution.

5.3.4.2. Assessment of Habitat

i. Description of habitat values

The Eastern Cave Bat is a cave-roosting species that prefers dry open forest and woodland, near rocky overhangs and cliffs. The species is also known to utilise derelict mines for roosting. Little is known about the biology of this species, including its breeding and/or foraging requirements (OEH 2017e).

The species was recorded within the study area by Cumberland Ecology in 2018. The study area provides a small area of potential foraging habitat for the species within and alongside the patches of woodland/forest present.

ii. Discussion of habitat utilisation

The study area provides potential foraging habitat, but no roosting habitat. The Eastern Cave Bat has the potential to forage above the woodland/forest canopy on occasion as part of a broader foraging range.

5.3.4.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Eastern Cave Bat is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act.

5.3.4.4. Threatening processes

The following key threatening processes are known to affect the Eastern Cave bat:

- 'Clearing of native vegetation';
- 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition'; and
- 'Infection of native plants by *Phytophthora cinnamomi*'.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- 'Clearing and isolation of dry eucalypt forest and woodland, particularly about cliffs and other areas containing suitable roosting and maternity sites, mainly as a result of agricultural and residential development';
- 'Loss of suitable feeding habitat near roosting and maternity sites as a result of modifications from timber harvesting and inappropriate fire regimes usually associated with grazing';
- 'Pesticides and herbicides may reduce the availability of invertebrates, or result in the accumulation of toxic residues in individuals' fat stores';
- 'Damage to roosting and maternity sites from mining operations, and recreational activities such as caving'; and
- 'Predation by cats and foxes' (OEH 2017e).

5.3.4.5. Habitat requirements

Very little is known about the habitat requirements of the Eastern Cave Bat, but the species is a cave-roosting species that prefers dry open forest and woodland, near rocky overhangs and cliffs. The species is also known to utilise derelict mines for roosting (OEH 2017e).

5.3.4.6. Other documentation

The Eastern Cave Bat has been assigned to the 'Landscape species' management stream under the 'Saving our Species' program. The major objective of the program is to ensure that the species is secure in the wild in NSW and that its' NSW geographic range is extended or maintained (OEH 2017e). No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species.

5.3.4.7. Assessment of adequacy of reservation

No records of the Eastern Cave Bat are present within the locality; however, the species was recorded by Cumberland Ecology within the northwest corner of the study area in 2018. Due to the lack of records in the locality, there is likely to be inadequate reservation of this species in the region and the species is considered susceptible to further habitat removal.

5.3.4.8. Limit of known distribution

The known distribution of the species spans nearly the entire east coast of NSW and as far inland as Warrumbungle Range (OEH 2018d). The study area falls within the known distribution of this species.

5.3.4.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Eastern Cave Bat has been recorded within the study area by Cumberland Ecology in 2018. The study area provides suitable foraging habitat only. The proposed development works will remove potential foraging habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the species in the local context as extensive areas of more suitable habitat occur in nearby reserves, including William Howe Reserve. Furthermore, suitable foraging habitat will also be retained within the study area including areas surrounding Howes Creek and the Nepean River.

ii. Discussion of connectivity

Suitable habitat for the Eastern Cave Bat to be removed within the proposed development works area has limited connectivity to larger patches of habitat. The habitat to be removed as part of the proposed development works will not fragment suitable foraging habitat but requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although, potential foraging habitat will be removed, the majority of suitable foraging habitat present within the study area will be retained. The Eastern Cave Bat is also a highly mobile species which would more likely occur in large tracts of less disturbed vegetation. Due to this, the proposed development works will not likely affect habitat connectivity for the Eastern Cave Bat as no existing connectivity to off-site reserves will be affected.

iii. Consideration of threatening processes

The Eastern Cave Bat may be generally threatened by the following processes:

- Clearing of native vegetation

The proposed development works will result in the clearing of approximately 17 ha of native forest, woodland and shrubby regrowth vegetation, which is a reduction from the previous version of the BEW DA. The clearing of this vegetation will result in the removal of potential foraging habitat for this species. The foraging habitat to be removed is unlikely to be important to this species as it would likely only be used on occasion as part of much broader foraging range.

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

The proposed development works are unlikely to contribute to high frequency fire.

- Infection of native plants by Phytophthora cinnamomi

The proposed development works are unlikely to increase the risk of infection of native plants by *Phytophthora cinnamomi*. Wash-down stations will be established and all construction vehicles entering and leaving the site will be required to be washed down to prevent pathogens entering or leaving the site.

- Clearing and isolation of dry eucalypt forest and woodland, particularly about cliffs and other areas containing suitable roosting and maternity sites, mainly as a result of agricultural and residential development

The proposed development works are unlikely to contribute to this threatening process as the vegetation to be cleared is not in close proximity to suitable roosting and/or maternity sites for this species.

- Loss of suitable feeding habitat near roosting and maternity sites as a result of modifications from timber harvesting and inappropriate fire regimes usually associated with grazing

The proposed development works will result in the clearing of approximately 17 ha of potential feeding habitat; however, the foraging habitat to be removed is unlikely to be important to this species as it would likely only be used on occasion as part of much broader foraging range.

- Pesticides and herbicides may reduce the availability of invertebrates, or result in the accumulation of toxic residues in individuals' fat stores

This threatening process has the potential to occur as a result of pesticide and herbicide usage within the development of residential areas that the proposed development works will facilitate. It is unlikely that levels of pesticide and herbicide usage will increase significantly further than current levels.

- Damage to roosting and maternity sites from mining operations, and recreational activities such as caving

No caves are present within the study area and as such this threatening process does not apply.

- Predation by cats and foxes

The proposed development works are likely to increase the number of cats within the study area as a result of future development, but unlikely to increase the number of foxes. Although an increase in cats will occur, this key threatening process is unlikely to occur as no roosting habitat is present, which is when this species would be most susceptible to this process.

5.3.5. Eastern False Pipistrelle

5.3.5.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Eastern False Pipistrelle is considered to be any individuals known or likely to occur in the study area, as well as any individuals in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are 23 records of the Eastern False Pipistrelle within 10 km of the study area and 10 records of the Eastern False Pipistrelle from within 5 km of the study area. Potential foraging habitat exists for the species within the subject site. Potential roosting habitat is present in the form of tree hollows.

ii. Discussion of other known regional populations

The Eastern False Pipistrelle occurs in moist habitats containing trees taller than 20 m. It is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania (OEH 2017f). The total population size of the Eastern False Pipistrelle in NSW is unknown.

The relative significance of the proposed development works area as habitat for the Eastern False Pipistrelle in the locality and region is considered to be low, due to the relatively small area of native vegetation in the proposed development works area and due to a high degree of degradation. The habitat in the proposed development works area is not likely to be important to this species in the locality and region. The long-term security of habitats in the proposed development works area is generally similar to other habitats outside the proposed development works area in the locality and region as the majority are not secured for conservation and subject to ongoing degradation due to land use. Large areas of suitable habitat for this species are considered likely to occur in National Parks in the region, including the Dharawal National Park and further afield in the Blue Mountains National Park.

5.3.5.2. Assessment of Habitat

i. Description of habitat values

The Eastern False Pipistrelle is found in various moist habitats where trees are typically taller than 20 m. It has been found occasionally in Sydney including Cumberland State Forest, Berowra and suburbs on the Cumberland Plain such as Camden and Box Hill, but not in highly urbanised areas (OEH, 2019). Known roosting habitat is within tree hollows, as well as in buildings and under loose bark. The study area contains areas of woodland and grasslands adjacent to woodlands which provide suitable potential foraging habitat for the species. The species was recorded as occurring within the subject site during recent targeted surveys by

Cumberland Ecology. A total of 100 tree hollows are present within the proposed development works area which provide potential roosting habitat. **Figure 17** identifies the locations of tree hollows recorded.

ii. Discussion of habitat utilisation

The Eastern False Pipistrelle occurs in a variety of moist habitats, where trees are generally over 20 m. The study area provides potential foraging habitat, and potential roosting habitat in the form of tree hollows.

The significance of the habitat of the proposed development works area to the viability of the Eastern False Pipistrelle in the locality is relatively low. Large areas of similar habitat occur outside of the proposed development works area in the locality that will remain, including within the proposed conservation worsk areas, and this species is unlikely to rely on the habitats present in the proposed development works area.

5.3.5.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Eastern False Pipistrelle is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act.

5.3.5.4. Threatening processes

The following threatening processes are known to affect the Eastern False Pipistrelle:

- Disturbance to winter roosting and breeding sites;
- Loss of roosting habitat, primarily hollow-bearing eucalypts; and
- Loss and fragmentation of foraging habitat, particularly extensive areas of continuous forest and areas of high productivity.

5.3.5.5. Habitat requirements

The Eastern False Pipistrelle forages above or just beneath the tree canopy, more often within moist habitat. It roosts in tree hollows, under loose bark and buildings.

5.3.5.6. Other documentation

No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species. The Eastern False Pipistrelle has been included as a 'Landscape species' in the 'Saving our Species' program. The management aim of the program is to ensure that this species is secure in the wild in NSW and that its NSW geographic range is extended or maintained.

5.3.5.7. Assessment of adequacy of reservation

Records of the Eastern False Pipistrelle are scattered throughout the wider locality, with most records located within and near Dharawal National Park, as well as at the Nepean River and Georges River. The species is therefore considered to be generally well protected.

5.3.5.8. Limit of known distribution

The Eastern False Pipistrelle occurs from southern Queensland to Victoria and Tasmania along the south-east coast and ranges of Australia. The study area is within the known distribution for this species.

5.3.5.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Eastern False Pipistrelle has been recorded as occurring within the subject site by Cumberland Ecology. The study area provides suitable foraging and roosting habitat. The proposal will remove a small area of potential foraging and roosting habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the Eastern False Pipistrelle in the local context as suitable foraging habitat will be retained within the study area. Extensive areas of similar habitat occur in the locality, comprising remnant patches of native vegetation.

ii. Extent of habitat removal or modification

The proposal will remove some habitat for this species, consisting of approximately 17 ha (woodland/forest/shrubby regrowth). Most of the native vegetation in the study area will remain and continue to provide habitat for this species.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 67 ha of native vegetation.

The proportion of each vegetation community that is proposed to be removed by the current proposal is presented in **Table 14**. The relatively minor removal of habitat in the proposed development works area is not expected to affect its viability as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Suitable habitat for the Eastern False Pipistrelle to be removed within the proposed development works area does not have connectivity to larger patches of habitat and the habitats present in the study area are already highly fragmented. Although the proposed development works will exacerbate existing fragmentation of habitat to some extent by increasing the distance between fragments and reducing the ability for movement and gene flow, fragmentation of intact foraging habitat will not occur. Rather, the proposal requires clearing of an already fragmented patches and will therefore encroach further into remaining habitat rather than create additional fragmented habitat patches. Larger areas of similar foraging habitat will be retained in the wider study area and locality. The Eastern False Pipistrelle is also a highly mobile species which would more likely occur in large tracts of less disturbed vegetation. Due to this, the proposed development works will not likely affect habitat connectivity for the Eastern False Pipistrelle as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Eastern False Pipistrelle may be generally threatened by the following processes:

- Disturbance to winter roosting and breeding sites.

Tree hollows are present, and there is potential for impacts to occur to roosting and breeding sites. Although 49 hollow-bearing trees will be removed, larger areas containing hollows will be retained in the study area and wider locality, including the 61 hollow-bearing trees to be retained within the Howes Creek conservation area. Mitigation measures will be implemented to reduce potential impacts to the species if it roosts within the proposed development works area and it will be ensured that roosting bats are not present before removing or disturbing hollow-bearing trees in winter.

- Loss of roosting habitat, primarily hollow-bearing eucalypts

  Hollow-bearing trees will be removed for the proposal. These may potentially provide habitat for the species; however, large areas of similar patches of native vegetation to be retained in the study area and wider locality.

- Loss and fragmentation of foraging habitat, particularly extensive areas of continuous forest and areas of high productivity

  The subject site and study area have already undergone extensive clearing. Foraging habitat within the subject site and surrounding study area has already been significantly impacted from previous land use and is already disturbed and fragmented. Although the proposed development works within the subject site will remove these fragments, these only provide marginal habitat and would unlikely be considered as high productivity habitat.

5.3.6. Eastern Coastal Free-tailed Bat

5.3.6.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW *Threatened Species Assessment Guidelines* (DECC 2007), the local population of the Eastern Coastal Free-tailed Bat is considered to be any individuals known or likely to occur in the study area, as well as any individuals in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are 66 records of the Eastern Coastal Free-tailed Bat within 10 km of the study area and 27 records of the Eastern Coastal Free-tailed Bat from the within 5 km of the study area. Potential foraging habitat exists for the species within woodland areas. Potential roosting habitat is present in the form of tree hollows.

ii. Discussion of other known regional populations

The Eastern Coastal Free-tailed Bat is found in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. It occurs along the east coast from south Queensland to southern NSW. The total population size of the Eastern Coastal Free-tailed Bat in NSW is unknown.

The relative significance of the proposed development works area as habitat for the Eastern Coastal Free-tailed Bat in the region and locality is low, due to the small, fragmented areas of native vegetation in the proposed development works area and due to a high degree of degradation. The habitat in the subject site is not likely to be important to this species in the locality or region. The long-term security of habitats in the subject site

is generally like other habitats outside the subject site in the locality, they are typically not secured for conservation and subject to ongoing degradation due to land use. Further afield however, large areas of suitable habitat occur in the Dharawal National Park and the Blue Mountains National Park.

5.3.6.2. Assessment of Habitat

i. Description of habitat values

The Eastern Coastal Free-tailed Bat is found in dry sclerophyll forest, woodland, swamp forests and mangrove forests. Roost habitat for the species includes tree hollows, under bark or in manmade structures (OEH 2017g) and the species has been recorded roosting in paddock trees. Core habitat for this species is the Grassy Box Woodlands of the coastal plains, such as the Cumberland Plain, and the study area contains patches of Cumberland Plain Woodland which provides suitable known foraging and roosting habitat for the species. The species has not been positively recorded by Cumberland Ecology within the study area, but it was recorded in the study area by Travers Bushfire & Ecology (2013). A total of 49 hollow-bearing trees are present within the proposed development works area which provide potential roosting habitat.

ii. Discussion of habitat utilisation

The study area provides known foraging and potential roosting habitat. The Eastern Coastal Free-tailed Bat likely forages on occasion within areas of Cumberland Plain Woodland in the study area.

The significance of the habitat of the study area to the viability of the Eastern Coastal Free-tailed Bat in the locality is considered to be relatively low. Large areas of similar habitat occur outside of the proposed development works area in the locality that will remain, including within the proposed conservation works area, and this species is unlikely to rely on the habitats present in the proposed development works area.

5.3.6.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Eastern Coastal Free-tailed Bat is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act.

5.3.6.4. Threatening processes

The following threatening processes are known to affect the Eastern Coastal Free-tailed Bat:

- Loss of hollow-bearing trees;
- Loss of foraging habitat;
- Application of pesticides in or adjacent to foraging areas;
- Artificial light sources spilling onto foraging and/or roosting habitat; and
- Large scale wildfire or hazard reduction burns on foraging and/or roosting habitat.

5.3.6.5. Habitat requirements

The Eastern Coastal Free-tailed Bat occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests. It roosts in tree hollows but will also roost under bark or in man-made structures.

5.3.6.6. Other documentation

No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species. The Eastern Coastal Free-tailed Bat has been included as a 'Landscape species' in the 'Saving our Species' program. The management aim of the program is to ensure that this species is secure in the wild in NSW and that its NSW geographic range is extended or maintained.

5.3.6.7. Assessment of adequacy of reservation

Records of the Eastern Coastal Free-tailed Bat are scattered throughout the wider locality, including outside of reserves as well as within protected areas such as Dharawal National Park. Presently there is inadequate reservation of this species in the region as most individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.6.8. Limit of known distribution

The Eastern Coastal Free-tailed Bat occurs along the east coast from south Queensland to southern NSW. The study area is within the known distribution for this species.

5.3.6.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Eastern Coastal Free-tailed Bat has been recorded within the study area by Travers Bushfire & Ecology (2013), and as potentially occurring within the subject site by Cumberland Ecology. The study area provides suitable known foraging and roosting habitat. The proposal will remove some potential foraging and roosting habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the Eastern Coastal Free-tailed Bat in the local context as extensive areas of similar habitat occur in in the locality, and further afield in the region within the Dharawal National Park and the Blue Mountains National Park. Furthermore, suitable foraging habitat will also be retained within the study area.

ii. Extent of habitat removal or modification

The proposal will remove some habitat for this species, consisting of approximately 17 ha. Most of the native vegetation in the study area will remain and continue to provide habitat for this species.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of ~67 ha of native vegetation.

The proportion of each vegetation community that is proposed to be removed by the current proposal is presented in **Table 14**. The removal of habitat in the proposed development works area is not expected to affect its viability as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Suitable habitat for the Eastern Coastal Free-tailed Bat to be removed within the proposed development works area has limited connectivity to larger patches of habitat. The habitat to be removed as part of the proposed development works will not fragment suitable foraging habitat, but requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although potential habitat will be removed, larger areas of more optimal habitat will be retained in the study area and wider locality. The Eastern Coastal Free-tailed Bat is also a highly mobile species which would more likely occur in large tracts of less disturbed vegetation. Due to this, the proposed development works will not likely affect habitat connectivity for the Eastern Coastal Free-tailed Bat as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Eastern Coastal Free-tailed Bat may be generally threatened by the following processes:

- Loss of hollow-bearing trees.

  Hollow-bearing trees will be removed for the proposal. These may potentially provide roosting habitat for the species as it is known to utilise isolated remnants, however the species would more likely roost in less fragmented and disturbed habitat.

- Loss of foraging habitat.

  The proposal will result in the loss of some degraded potential foraging habitat; however, this foraging habitat is not critical to the survival of the species. Additionally, larger areas of similar foraging habitat will be retained in the study area and beyond.

- Application of pesticides in or adjacent to foraging areas.

  The proposal will not use pesticides resulting in individuals being poisoned.

- Artificial light sources spilling onto foraging and/or roosting habitat.

  Although light sources will increase because of the proposal other than current conditions, it will not likely result in spilling onto any important foraging or roosting habitat. Adjacent areas to the subject site are predominantly open areas of exotic vegetation comprised of grasslands.

- Large scale wildfire or hazard reduction burns on foraging and/or roosting habitat.

  The proposal is unlikely to lead to hazard reduction and/or wildfires impacting on foraging resources.

5.3.7. Greater Broad-nosed Bat

5.3.7.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Greater Broad-nosed Bat is considered to be any individuals known or likely to occur in the study area, as well

as any individuals in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are 41 records of the Greater Broad-nosed Bat within 10 km of the study area and 13 records of the Greater Broad-nosed Bat from within 5 km of the study area. The species was also recorded within the subject site by Cumberland Ecology and within the study area by Travers Bushfire & Ecology (2013). Known foraging habitat exists for the species within the subject site and potential roosting habitat is present in the form of tree hollows. Existing buildings to be demolished are also present within the study area which may form potential roosting habitat.

ii. Discussion of other known regional populations

The Greater Broad-nosed Bat occurs mainly in the gullies and river systems that drain the Great Dividing Range. It is found from north-eastern Victoria to the Atherton Tableland and extends to the coast throughout much of its range (OEH 2017h). The total population size of the Greater Broad-nosed Bat in NSW is unknown. In NSW it is widespread on the New England Tablelands, however, does not occur at altitudes above 500 m.

The relative significance of the proposed development works area as habitat for the Greater Broad-nosed Bat in the region and locality is low, due to the relatively small area of native vegetation in the proposed development works area and due to a high degree of degradation. The habitat in the proposed development works area is not likely to be important to this species in the locality or region. The long-term security of habitats in the subject site is generally like other habitats outside the subject site in the locality, they are typically not secured for conservation and subject to ongoing degradation due to land use. Further afield however, approximately 41% of the species' distribution occurs on reserve (within NSW National Parks and Wildlife Service estate).

5.3.7.2. Assessment of Habitat

i. Description of habitat values

The Greater Broad-nosed Bat is found in various habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow flying insects. It usually roosts in tree hollows, in cracks and fissures in trunks or under exfoliating bark, though it may also utilise old buildings. The study area contains patches of Cumberland Plain Woodland which provides suitable known foraging habitat for the species. A total of 49 hollow-bearing trees are present within the proposed development works area which provide potential roosting and breeding habitat.

ii. Discussion of habitat utilisation

The study area provides known foraging habitat in the form of eucalypt forest, and potential roosting and breeding habitat in the form of tree hollows. The species was recorded as occurring within the subject site during targeted surveys by Cumberland Ecology. It has also been recorded in the wider study area by Travers Bushfire & Ecology (2013).

The significance of the habitat of the study area to the viability of the Greater Broad-nosed Bat in the locality is relatively low. Large areas of similar habitat occur outside of the proposed development works area in the

locality and beyond, including within the proposed conservation works area, that will remain and this species is unlikely to rely on the habitats present in the proposed development works area.

5.3.7.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Greater Broad-nosed Bat is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act. Within the Sydney Basin Bioregion, very few records exist within sandstone environments, with records concentrated in the coastal environments of the Illawarra, Central Coast and the Cumberland Plain and in the larger valleys of the Dividing Range, such as Kangaroo Valley and the Hunter Valley (DECC, 2007)

5.3.7.4. Threatening processes

The following threatening processes are known to affect the Greater Broad-nosed Bat:

- Disturbance to roosting and summer breeding sites;
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions;
- Loss of hollow-bearing trees;
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores; and
- Changes to water regimes are likely to impact food resources, as is the use of pesticides and herbicides near waterways.

5.3.7.5. Habitat requirements

The Greater Broad-nosed Bat forages along creeks and rivers in open woodland habitat and dry open forest. Typically it occurs more often within tall wet forest (OEH 2017h). It roosts in tree hollows as well as buildings.

5.3.7.6. Other documentation

No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species. The Greater Broad-nosed Bat has been included as a 'Landscape species' in the 'Saving our Species' program. The management aim of the program is to ensure that this species is secure in the wild in NSW and that its NSW geographic range is extended or maintained.

5.3.7.7. Assessment of adequacy of reservation

Records of the species beyond the study area are scattered within urban areas of Sydney as well as some reserved areas such as Dharawal National Park, Nepean River and Georges River riparian corridor. Records in close vicinity of the study area consist of scattered occurrences alongside riparian corridors of major rivers, and within and adjoining vegetation to national parks. Therefore, much of the species' habitat is within reserved areas.

5.3.7.8. Limit of known distribution

The Greater Broad-nosed Bat occurs from north-eastern Victoria to the Atherton Tableland. In NSW, the species is widespread on the New England Tablelands, in altitudes less than 500 m. The study area is within the known distribution for this species.

5.3.7.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Greater Broad-nosed Bat has been recorded within the study area by Travers Bushfire & Ecology (2013) and as occurring within the subject site by Cumberland Ecology. The study area provides suitable foraging and roosting habitat. The proposal will remove known foraging and potential roosting habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the Greater Broad-nosed Bat in the local context as extensive areas of suitable habitat occur in nearby reserves. Furthermore, suitable foraging habitat will also be retained within the wider study area.

ii. Extent of habitat removal or modification

The proposal will remove habitat for this species, consisting of approximately 17 ha (woodland/forest/shrubby regrowth areas). Most of the native vegetation in the study area will remain and continue to provide habitat for this species.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 67 ha of native vegetation.

The proportion of each vegetation community that is being removed by the current proposal is presented in **Table 14**. The removal of habitat in the proposed development works area is not expected to affect its viability as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Suitable habitat for the Greater Broad-nosed Bat to be removed within the proposed development works area has limited connectivity to larger patches of habitat. The habitat to be removed as part of the proposed development works will not fragment suitable foraging habitat but requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although potential habitat will be removed, larger areas containing more optimal habitat will be retained in the study area and locality. The Greater Broad-nosed Bat is also a highly mobile species which would more likely occur in large tracts of less disturbed vegetation. Due to this, the proposed development works will not likely affect habitat connectivity for the Greater Broad-nosed Bat as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Greater Broad-nosed Bat may be generally threatened by the following processes:

- Disturbance to roosting and summer breeding sites.

  A total of 49 hollow-bearing trees are present, and there is potential for impacts to occur to roosting and breeding sites. Although the hollow-bearing trees will be removed, large areas containing hollows will be retained in the study area and wider locality, including within the conservation areas. Mitigation measures will be implemented to reduce potential impacts to the species if it roosts within the proposed development works area and it will be ensured that roosting bats are not present before removing or disturbing hollow-bearing trees in winter.

- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions.

  The subject site and study area have already undergone extensive historical clearing. Habitat in the subject site is already surrounded by cleared land in the form of exotic grassland.

- Loss of hollow-bearing trees.

  A total of 49 hollow-bearing trees will be removed for the proposal.

- Pesticides and herbicides may reduce the availability of insects or result in the accumulation of toxic residues in individuals' fat stores.

  The proposal will not use pesticides resulting in individuals being poisoned.

- Changes to water regimes are likely to impact food resources, as is the use of pesticides and herbicides near waterways.

  No major waterways are present on the proposed development works area. Several dams are present; however, their removal is not expected to have a significant impact on the water regimes within the study area.

5.3.8. Grey-headed Flying-fox

5.3.8.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Grey-headed Flying-fox is any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are 355 records of the Grey-headed Flying-fox within 10 km of the study area and 207 records of the Grey-headed Flying-fox from within 5 km of the study area. The species roosts in colonies known as camps. The nearest Flying-fox camp to the subject site is located at Campbelltown, which is approximately 5 km north-east of the subject site.

Individuals of the species have been detected flying over the subject site during spotlighting surveys by Cumberland Ecology. The species was also recorded in the study area by Travers Bushfire & Ecology (2013a).

The habitat within the proposed development works area is likely to be limited to opportunistic foraging habitat as part of a larger foraging range and is unlikely to exclusively support a local population.

ii. Discussion of other known regional populations

The Grey-headed Flying-fox occurs primarily along the eastern coastal plain from Bundaberg in Queensland, through NSW and south to eastern Victoria. A colony has also established in Melbourne. Small numbers may occur as far west as Warrnambool in Victoria. Regular movements are made over the Great Dividing Range to the western slopes of NSW and Queensland.

The total population size of the Grey-headed Flying-fox in NSW is unknown. There are approximately 18 Grey-headed Flying-fox camps in the greater Sydney metropolitan area (Ku-ring-gai Bat Conservation Society 2017). These camps are located as far west as Penrith Lakes Regional Park, as far south as Camden, as far north as Richmond and several located near the east coast.

The relative significance of the proposed development works area as habitat for the Grey-headed Flying-fox in the region and locality is considered to be low, due to the small area of native vegetation in the proposed development works area and due to a high degree of degradation. The habitat in the proposed development works area is not likely to be important to this species in the locality or region. The long-term security of habitats in the subject site is generally similar to other habitats outside the subject site, they are typically not secured for conservation and subject to ongoing degradation due to land use.

5.3.8.2. Assessment of Habitat

i. Description of habitat values

The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps, and in urban gardens and fruit crops. Roosting camps are typically located in vegetation with a dense canopy that is close to water and often in a gully. Camps are also usually located within 20 km of a regular food source preferring native trees in the genera *Eucalyptus, Melaleuca* and *Banksia*, but will also forage on rainforest trees, cultivated gardens and fruit crops (OEH 2017i).

The study area does not contain a roosting camp for this species, but some potential suitable foraging habitat is present within woodland areas of the study area and subject site in the form of Eucalypts and other canopy species including exotics.

ii. Discussion of habitat utilisation

The study area is unlikely to be utilised for roosting purposes as no camp is present. Although no known roost camps are present on or near to the subject site, the presence of the Campbelltown camp, within approximately 5 km of the subject site along with the presence of potential suitable foraging vegetation suggests that the study area may be utilised as foraging habitat on occasion by this species.

As the species is known to travel up to 50 km from its roosting site to forage (OEH 2017i), this species is unlikely to be entirely dependent on the study area for foraging and it likely only forms a very small portion of a much larger foraging range.

5.3.8.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Grey-headed Flying-fox is listed as Vulnerable under the TSC Act. It is also listed as Vulnerable under the EPBC Act.

5.3.8.4. Threatening processes

The following key threatened processes listed under the TSC Act are likely to affect the Grey-headed Flying-fox:

- Clearing of native vegetation;
- Anthropogenic climate change;
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants;
- Invasion and establishment of exotic vines and scramblers;
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae;
- Forest Eucalypt dieback associated with over-abundant psyllids and bell miners;
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition; and
- Infection of native plants by *Phytophthora cinnamomi*.

In addition to the above listed key threatening processes, the following threats have also been identified for the species (OEH 2017i):

- Loss of roosting and foraging sites;
- Electrocution on powerlines, entanglement in netting and on barbed wire;
- Heat stress;
- Conflict with humans; and
- Incomplete knowledge of abundance and distribution across the species' range (OEH 2017i).

5.3.8.5. Habitat requirements

The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps, and in urban gardens and fruit crops. Roosting camps are typically located in vegetation with a dense canopy that is close to water and often in a gully. Camps are also usually located within 20 km of a regular food source preferring trees in the genera *Eucalyptus, Melaleuca* and *Banksia*, but will also forage on rainforest trees, cultivated gardens and fruit crops (OEH 2017i).

5.3.8.6. Other documentation

The Grey-headed Flying-fox has been included as a 'Landscape species' in the 'Saving our Species' program. The management aim of the program is to ensure that this species is secure in the wild in NSW and that its NSW geographic range is extended or maintained (OEH 2017i).

A Draft National Recovery Plan has also been developed for the Grey-headed Flying Fox. The relevant objectives of the plan are (DECCW 2009a).

- **Objective 1**: To identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range.

The study area does not provide foraging habitat critical to the survival of Grey-headed Flying-foxes as identified in the Draft National Recovery Plan for this species. For habitat to be identified as critical to this species survival, one or more of the following criteria must be met:

  - productive during winter and spring, when food bottlenecks have been identified (Parry Jones and Augee 1991, Eby *et al.* 1999);
  - known to support populations of > 30 000 individuals within an area of 50 km radius (the maximum foraging distance of an adult);
  - productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (September to May);
  - productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes (months vary between regions); and/or
  - known to support a continuously occupied camp.

- **Objective 2**: To protect and increase the extent of key winter and spring foraging habitat of Grey-headed Flying-foxes.

Key winter and spring foraging habitat for the Grey-headed Flying-fox includes the following species: *Eucalyptus tereticornis*, *E. albens*, *E. crebra*, *E. fibrosa*, *E. melliodora*, *E. paniculata*, *E. pilularis*, *E. robusta*, *E. siderophloia*, *Banksia integrifolia*, *Castanospermum australe*, *Corymbia citriodora*, *C. eximia*, *C. maculata* (south from Nowra), *Grevillea robusta* and *Melaleuca quinquenervia*.

The study area contains four of these key species: *Eucalyptus tereticornis*, *Eucalyptus crebra*, *Grevillea robusta* and *Banksia integrifolia*.

- **Objective 3**: To identify roosting habitat critical to the survival of Grey-headed Flying-foxes.

According to the Draft National Recovery Plan for the Grey-headed Flying-fox, at least one of the following criteria must be met for roosting habitat to be considered as critical to the survival of the species must:

  - is used as a camp either continuously or seasonally in > 50% of years;

- has been used as a camp at least once in 10 years (beginning in 1995) and is known to have contained > 10 000 individuals, unless such habitat has been used only as a temporary refuge, and the use has been of limited duration (i.e., in the order of days rather than weeks or months); and/or
- has been used as a camp at least once in 10 years (beginning in 1995) and is known to have contained > 2 500 individuals, including reproductive females during the final stages of pregnancy, during lactation, or during the period of conception (i.e., September to May).

The study area does not contain critical roosting habitat as the habitat present does not meet any of the above criteria.

- **Objective 4**: To protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes.

The study area does not contain roosting habitat critical to the survival of Grey-headed Flying-foxes.

5.3.8.7. Assessment of adequacy of reservation

Grey-headed Flying-fox camps in the greater Sydney metropolitan area exist both within and outside of reserves. Camps located within the current reserve system are more likely to provide roosting habitat in the long-term as they are less susceptible to future development. Although camps may be adequately protected under existing reserves, there has been a steady decline in population numbers in recent years. The cause of this decline has been attributed to several factors, one of which includes foraging habitat loss meaning that camps may be adequately reserved, but foraging habitat is not.

5.3.8.8. Limit of known distribution

The distribution of the Grey-headed Flying-fox within NSW extends to anywhere within 200 km of the east coast (OEH 2017i). The study area is within the known distribution for this species.

5.3.8.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The proposal will not remove any roosting habitat and only some (17 ha) of potential foraging habitat (woodland/forest and shrubby regrowth) for this species in relation to the habitat within the study area. The habitat to be removed is not considered to be critical to the survival of the species as identified in the Draft National Recovery Plan (2009). Additionally, as this species has a large foraging range, it likely only utilises the study area on occasion, if at all, as part of a much larger foraging range. Furthermore, suitable foraging and roosting habitat will be retained within nearby reserves, including the Mt. Annan Botanical Garden. With consideration of the above, the habitat removed within the proposed development works area because of the proposal is unlikely to be significant to the survival of the local population of this species in the long-term.

ii. Extent of habitat removal or modification

The proposal will remove some habitat for this species, consisting of approximately 17 ha. Most of the native vegetation in the study area will remain and continue to provide habitat for this species. As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern

Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of ~67 ha of native vegetation.

The proportion of each vegetation community that is being removed by the current proposal is presented in **Table 14**. The relatively minor removal of habitat in the proposed development works area is not expected to affect its viability as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Suitable habitat for the Grey-headed Flying-fox to be removed within the proposed development works area has limited connectivity to larger patches of habitat. The habitat to be removed as part of the proposed development works will not fragment suitable foraging habitat but requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although suitable foraging habitat will be removed, more optimal foraging habitat containing a greater number of native species for this species will be retained in the study area and locality. The Grey-headed Flying-fox is a highly mobile species capable of foraging up to 50 km from its camp. Due to this, the proposed development works will not likely affect habitat connectivity for the Grey-headed Flying-fox as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Grey-headed Flying-fox may be generally threatened by the following processes:

- Loss of roosting and foraging sites.

The proposal will result in the loss of some degraded potential foraging habitat; however, this foraging habitat is not critical to the survival of the species. Additionally, larger areas of suitable foraging habitat will be retained in the study area and beyond. The proposal will not result in the loss of roosting habitat as this species is not known to roost within the subject site.

- Electrocution on powerlines, entanglement in netting and on barbed wire.

The proposal has the potential to contribute to electrocution on powerlines, as these will need to be installed to support residences. However, as the proposed development works area likely only constitutes a small area of foraging habitat, any increase in electrocution is minimal.

- Heat stress.

The proposal will not contribute to heat stress for the Grey-headed Flying-fox.

- Conflict with humans.

The proposal will not result in a conflict with humans as a roosting camp is not present within the study area and only limited foraging habitat is present.

- Incomplete knowledge of abundance and distribution across the species' range.

The proposal does not contribute to incomplete knowledge of the species. The proposal has increased knowledge of the species' distribution as it was recorded within the subject site and this data will be submitted to OEH for their records.

5.3.9. Large Bent-winged Bat

5.3.9.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Large Bent-winged Bat is any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available.

There are 54 records of the Large Bent-winged Bat from within 10km of the study area, 24 records from within 5 km of the study area, and the species has been recorded within the study area by Cumberland Ecology in 2018. Potential foraging habitat exists for the species mainly within and around the woodland/forested areas of the study area. No preferred roosting habitat (i.e. caves) is present within the study area, however this species have also been known to use man-made structures and may therefore utilise the existing buildings found within the proposed development works area for roosting

ii. Discussion of other known regional populations

The Large Bent-winged Bat is distributed along the entire east coast of NSW and as far inland as Dubbo. This species is known to occur throughout the entire greater Sydney metropolitan area (OEH 2019a)

5.3.9.2. Assessment of Habitat

i. Description of habitat values

The Large Bent-winged Bat occurs along the entire east coast of NSW where it primarily utilises caves for roosting. The species is also known to utilise derelict mines, stormwater tunnels, buildings and other man-made structures for roosting. Foraging primarily occurs in forested areas where it preys on flying insects above the canopy (OEH 2019a).

The species was recorded within the study area by Cumberland Ecology in 2018 and by Travers Bushfire & Ecology (2013). The study area provides potential foraging habitat for the species within and alongside the patches of woodland/forest present.

ii. Discussion of habitat utilisation

The study area provides potential foraging and roosting habitat. The Large Bent-winged Bat has the potential to forage above the woodland/forest canopy on occasion as part of a broader foraging range and roost in the existing buildings

5.3.9.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Large Bent-winged Bat is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act.

5.3.9.4. Threatening processes

The following key threatening processes are known to affect the Large Bent-winged Bat:

- 'Clearing of native vegetation';
- 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition'; and
- 'Infection of native plants by *Phytophthora cinnamomi*'.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- 'Disturbance by recreational cavers and general public accessing caves and adjacent areas particularly during winter or breeding';
- 'Loss of high productivity foraging habitat';
- 'Introduction of exotic pathogens, particularly white-nose fungus';
- 'Cave entrances being blocked for human health and safety reasons, or vegetation (particularly blackberries) encroaching on and blocking cave entrances'; and
- 'Hazard reduction burns and wildfires during the breeding season' (OEH 2019a)

5.3.9.5. Habitat requirements

The Large Bent-winged Bat occurs along the entire east coast of NSW in a variety of habitats, but prefers well-timbered valleys. Other suitable vegetation types include wet and dry sclerophyll forest, open woodland, paperbark forest, rainforests and grasslands. It primarily utilises caves for roosting, but is known to utilise culverts, derelict mines and other manmade structures. Foraging requirements for the species include forested areas that contain flying insects (OEH 2019a)

5.3.9.6. Other documentation

The Large Bent-winged Bat has been assigned to the 'Landscape species' management stream under the 'Saving our Species' program. The major objective of the program is to ensure that the species is secure in the wild in NSW and that its' NSW geographic range is extended or maintained (OEH 2019a). No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species.

5.3.9.7. Assessment of adequacy of reservation

Records of the Large Bent-winged Bat are scattered throughout the locality, including outside of reserves as well as within protected areas such as William Howe Reserve. Presently there is inadequate reservation of this

species in the region as most individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.9.8. Limit of known distribution

The known distribution of the species spans the entire east coast of NSW and as far inland as Wagga Wagga. The study area falls within the known distribution of this species.

5.3.9.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Large Bent-winged Bat has been recorded within the study area by Travers Bushfire & Ecology (2013) and Cumberland Ecology in 2018. The study area provides suitable foraging habitat. The proposed development works will remove potential foraging habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the species in the local context as extensive areas of more suitable habitat occur in nearby reserves, including William Howe Reserve. Furthermore, the majority of suitable foraging habitat will also be retained within the study area.

ii. Discussion of connectivity

Suitable habitat for the Large Bent-winged Bat to be removed within the proposed development works area has limited connectivity to larger patches of habitat. The habitat to be removed as part of the proposed development works will not fragment suitable foraging habitat but requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although potential foraging habitat will be removed, larger areas of more optimal foraging habitat will be retained in the study area and locality, around Howes Creek and the Nepean River. The Large Bent-winged Bat is also a highly mobile species which would more likely occur in large tracts of less disturbed vegetation. Due to this, the proposed development works will not likely affect habitat connectivity for the Large Bent-winged Bat as no existing connectivity to off-site reserves will be affected.

iii. Consideration of threatening processes

The Large Bent-winged Bat may be generally threatened by the following processes:

- Clearing of native vegetation

Approximately 17 ha of native vegetation that provides suitable foraging habitat for this species will be cleared as part of the proposed development works, which is a reduction from the previous version of the BEW DA. The foraging habitat to be removed is unlikely to be important to this species as it would likely only be used on occasion as part of much broader foraging range. Furthermore, although a moderate area of habitat will be removed, larger areas of native vegetation will remain in the study area.

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

The proposed development works are unlikely to result in high frequency fire further than current conditions.

- Infection of native plants by *Phytophthora cinnamomi*

The proposed development works are unlikely to contribute to this key threatening process as mitigation measures will be implemented to minimise the process, including the implementation of wash-down stations for all machinery entering/exiting the site.

- Disturbance by recreational cavers and general public accessing caves and adjacent areas particularly during winter or breeding.

No caves are present in the study area so this threatening process does not apply.

- Loss of high productivity foraging habitat

The proposed development works will result in the loss of some degraded foraging habitat; however more suitable foraging habitat will be retained in the study area and wider locality.

- Introduction of exotic pathogens, particularly white-nose fungus

The proposed development works are unlikely to introduce exotic pathogens, especially white-nose fungus.

- Cave entrances being blocked for human health and safety reasons, or vegetation (particularly blackberries) encroaching on and blocking cave entrances

No caves are present in the study area so this threatening process does not apply.

- Hazard reduction burns and wildfires during the breeding season

The proposed development works and future development it facilitates are not likely to contribute to wildfires further than current levels as hazard reduction burns are unlikely to be required to protect future housing.

- Predation by cats and foxes

The proposed development works are likely to increase the number of cats within the study area as a result of future development, but unlikely to increase the number of foxes. Although an increase in cats will occur, this key threatening process is unlikely as the species is highly mobile.

5.3.10. Little Bent-winged Bat

5.3.10.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW *Threatened Species Assessment Guidelines* (DECC 2007), the local population of the Little Bent-winged Bat is any individuals known or likely to occur in the study area, as well as any individuals in adjoining areas that are known or likely to utilise habitats in the study area. This species has been recorded from the subject site and it is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are 14 records of the Little Bent-winged Bat within 10 km of the study area and 11 records of the Little Bent-winged Bat from within 5 km of the study area, including the subject site. Potential foraging habitat exists for the species within woodland areas of the subject site and potential roosting habitat is present in the form of tree hollows.

ii. Discussion of other known regional populations

The Little Bent-winged Bat mainly occurs in moist areas including rainforest, melaleuca swamps, coastal forests and moist eucalypt forest. Its primary distribution is in coastal areas along most of the east coast of NSW. The total population size of the Little Bent-winged Bat in NSW is unknown. Within the greater Sydney metro region, a number of populations exist with recorded occurrences of the species as far: north as Brisbane Water National Park; west to Ropes Crossing, south as far as Heathcote National Park; and east to Avalon (OEH 2018g).

The relative significance of the proposed development works area as habitat for the Little Bent-winged Bat in the region and locality is low, due to the relatively small area of native vegetation in the proposed development works area and due to a high degree of degradation. The habitat in the proposed development works area is not likely to be important to this species in the locality or region. The long-term security of habitats in the subject site is generally like other habitats outside the subject site in the locality, they are typically not secured for conservation and subject to ongoing degradation due to land use. Further afield however, large areas of suitable habitat occur in the Dharawal National Park and the Blue Mountains National Park.

5.3.10.2. Assessment of Habitat

i. Description of habitat values

The Little Bent-winged Bat primarily occurs in moist areas with dense vegetation which is utilises for foraging. Known roosting habitat includes mine shafts, caves, tunnels, tree hollows, storm water channels, buildings, under bridges and in dense foliage (OEH 2018g).

The study area contains patches of woodland which provides suitable known foraging habitat for the species. The species was recorded as potentially occurring within the subject site during targeted surveys by Cumberland Ecology. A total of 49 hollow-bearing trees are present within the proposed development works area which provide potential roosting habitat. Other habitat features listed above such as tunnels, caves, buildings, mine shafts and bridges do not occur in the proposed development works area.

ii. Discussion of habitat utilisation

Within the greater Sydney metropolitan area, the Little Bent-winged Bat has primarily been recorded in either densely vegetated areas near or along waterways (OEH 2018g). The study area provides potential foraging habitat, and marginal potential roosting habitat in the form of tree hollows. The Little Bent-winged Bat likely forages on occasion within areas of Cumberland Plain Woodland on the subject site and the study area.

The significance of the habitat of the study area to the viability of the Little Bent-winged Bat in the locality is relatively low. Large areas of similar habitat occur outside of the proposed development works area in the locality that will remain, and this species is unlikely to rely on the habitats present in the proposed development works area.

5.3.10.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Little Bent-winged Bat is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act.

5.3.10.4. Threatening processes

The following threatening processes are known to affect the Little Bent-winged Bat:

- Clearing of native vegetation;
- Loss of hollow-bearing trees;
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;
- Infection of native plants by *Phytophthora cinnamomi*; and
- Anthropogenic climate change.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- Disturbance of colonies, especially in nursery or hibernating caves, may be catastrophic;
- Destruction of caves that provide seasonal or potential roosting sites;
- Changes to habitat, especially surrounding maternity /nursery caves and winter roosts;
- Pesticides on insects and in water consumed by bats bio accumulates, resulting in poisoning of individuals;
- Predation from foxes, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges;
- Predation from feral cats, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges;
- Introduction of exotic pathogens such as the White-nosed fungus;
- Hazard reduction and wildfire fires during the breeding season;
- Large scale wildfire or hazard reduction can impact on foraging resources; and
- Poor knowledge of reproductive success and population dynamics (OEH 2018g).

5.3.10.5. Habitat requirements

The Little Bent-winged Bat requires areas with dense vegetation, often near water, where it forages for insects beneath the canopy. Roosting habitat occurs in caves, tunnels, tree hollows, mines, stormwater drains, culverts, bridges and buildings. The species has also been frequently recorded roosting with the Common Bentwing-bat (OEH 2018g).

5.3.10.6. Other documentation

No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species. The Little Bent-winged Bat has been included as

a 'Landscape species' in the 'Saving our Species' program. The management aim of the program is to ensure that this species is secure in the wild in NSW and that its NSW geographic range is extended or maintained.

5.3.10.7. Assessment of adequacy of reservation

Within the greater Sydney Metropolitan area, the species is known to occur primarily in areas with dense vegetation, often near waterways within and outside of existing reserves, with most records occurring outside. Reserves where the species has been recorded include Heathcote National Park, Ku-ring-gai Chase National Park and Berowra Valley National Park. Presently there is inadequate reservation of this species in the region as most individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal. Locally, most of the records are outside of reserves.

5.3.10.8. Limit of known distribution

The Little Bent-winged Bat occurs along most of the east coast of NSW, extending from the Queensland border to as far south and inland as Goulburn (OEH 2018g). The study area is within the known distribution for this species.

5.3.10.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Little Bent-winged Bat has been recorded as potentially occurring within the subject site by Cumberland Ecology. The study area provides suitable foraging and roosting habitat. The proposal will remove potential foraging and roosting habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the Little Bent-winged Bat in the local context as suitable foraging habitat will be retained within the study area and extensive areas of similar habitat occur in the locality.

ii. Extent of habitat removal or modification

The proposal will remove foraging and roosting habitat for this species, consisting of approximately 17 ha (woodland/forest and shrubby regrowth). Most of the native vegetation in the study area will remain and continue to provide habitat for this species.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of ~67 ha of native vegetation.

The proportion of each vegetation community that is proposed to be removed by the current proposal is presented in **Table 14**. The removal of habitat in the proposed development works area is not expected to affect the viability of this species as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Suitable habitat for the Little Bent-winged Bat to be removed within the proposed development works area has limited connectivity to larger patches of habitat. The habitat to be removed as part of the proposed development works will not fragment suitable foraging habitat but requires clearing of already fragmented

patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although potential habitat will be removed, larger areas of suitable habitat will be retained in the study area and wider locality. The Little Bent-winged Bat is also a highly mobile species which would more likely occur in large tracts of less disturbed vegetation. Due to this, the proposed development works will not likely affect habitat connectivity for the Little Bent-winged Bat as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Little Bent-winged Bat may be generally threatened by the following processes:

- Disturbance of colonies, especially in nursery or hibernating caves, may be catastrophic.

  The proposal is unlikely to disturb a nursery or hibernation caves as none are known to occur within the study area.

- Destruction of caves that provide seasonal or potential roosting sites.

  The proposal will not result in destruction of roosting caves as none are present.

- Changes to habitat, especially surrounding maternity/nursery caves and winter roosts.

  The proposal will change some habitat for the species as some foraging habitat will be removed; however, this habitat is not near any known maternity/nursery caves.

- Pesticides on insects and in water consumed by bats bio accumulates, resulting in poisoning of individuals.

  The proposal will not use pesticides resulting in individuals being poisoned.

- Predation from foxes, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges.

  The proposal is unlikely to increase the predation from foxes on the species, other than current conditions.

- Predation from feral cats, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges.

  The proposal is unlikely to increase the predation from feral cats on the species.

- Introduction of exotic pathogens such as the White-nosed fungus.

  The proposal is unlikely to introduce any exotic pathogens.

- Hazard reduction and wildfire fires during the breeding season.

  The proposal is unlikely to lead to hazard reduction and/or wildfires during the breeding season.

- Large scale wildfire or hazard reduction can impact on foraging resources.

  The proposal is unlikely to lead to hazard reduction and/or wildfires impacting on foraging resources.

- Poor knowledge of reproductive success and population dynamics.

  The species has not been recorded in the study area during surveys, so the proposal does not provide any additional data.

5.3.11. Little Eagle

5.3.11.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Little Eagle is any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available.

There are 32 records of the Little Eagle from within 10 km of the study area, 14 records from within 5 km of the study area, and the species was recorded within the study area by Cumberland Ecology in 2018. Potential foraging habitat exists for the species primarily within and around the woodland/forest areas of the subject site and nesting habitat is present in the form of tall trees occurring within the remnant patches of woodland/forest.

ii. Discussion of other known regional populations

The Little Eagle is distributed throughout the entirety of mainland Australia except for some densely forested areas of the Great Dividing Range. The NSW population is recognised as a single population of the species (OEH 2017j).

5.3.11.2. Assessment of Habitat

i. Description of habitat values

The Little Eagle is distributed throughout NSW where it utilises tall living trees within remnant patches of vegetation as nesting sites. The species forages in a variety of woodland habitats such as open eucalypt forest, woodland, open woodland, she-oak and acacia woodland, and riparian woodland. Little Eagles prey on birds, reptiles, mammals, and occasionally large insects and carrion.

The species was recorded within the study area by Cumberland Ecology in 2018. The study area provides potential foraging and nesting habitat for the species within and alongside the patches of remnant woodland/forest present. One large nest that could be utilised by the Little Eagle was observed in the study area; however, no individuals were observed.

ii. Discussion of habitat utilisation

The study area provides potential foraging and nesting habitat for the species. The Little Eagle has the potential to forage on prey items throughout the woodland/forest and surrounding grassland areas as part of a much broader foraging range.

5.3.11.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Little Eagle is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act.

5.3.11.4. Threatening processes

The following key threatening processes are known to affect the Little Eagle:

- Clearing of native vegetation; and
- Removal of dead wood and dead trees.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- Secondary poisoning from rabbit baiting; and
- Clearing and degradation of foraging and breeding habitat.

5.3.11.5. Habitat requirements

The Little Eagle is distributed throughout mainland Australia, preferring areas of woodland and open woodland type vegetation. The species utilises mature, living trees in patches of remnant woodland for construction of the large stick nests the pair inhabit throughout the breeding period. Foraging occurs in a variety of habitats where their preferred prey is abundant including woodland, treed farmland and riparian areas (OEH 2017j).

5.3.11.6. Other documentation

The Little Eagle has been assigned to the 'Landscape species' management stream under the 'Saving our Species' program. The major objective of the program is to ensure that the species is secure in the wild in NSW and that it's NSW geographic range is extended or maintained (OEH 2017j). No threat abatement plan is relevant to the species, no recovery plan exists and no critical habitat has been identified by the Chief Executive of the OEH for this species.

5.3.11.7. Assessment of adequacy of reservation

Records of the Little Eagle occur throughout the wider locality, appearing more frequently in areas around the Nepean River. Records of the species occur both within reserve areas such as the Dharawal National Park, however most exist from outside the reservation along riparian corridors or within agricultural lands. Currently, there is inadequate reservation of this species in the region as most individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.11.8. Limit of known distribution

The known distribution of this species spans the entirety of the Australian mainland with the exception of some densely forested areas of the Great Dividing Range.

5.3.11.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Little Eagle was recorded in the study area by Cumberland Ecology in 2018. The study area provides some potential nesting and foraging habitat for the species, however this habitat is considered unlikely to be significant to the long-term survival of the species in the local context as this highly mobile species frequents multiple nesting sites over the years and would not be reliant upon the remnant habitat present within the study area. More suitable habitat is present for the species in the locality along the Nepean River and Mt Annan Botanic Gardens, and within Dharawal National Park within the wider locality. Furthermore, larger areas of suitable habitat for the species will be retained within the study area.

ii. Discussion of connectivity

Habitat for the Little Eagle to be removed within the proposed development works area is fragmented and has little connectivity to larger tracts of habitat. Therefore, the removal of this habitat will not further fragment suitable foraging or roosting habitat, instead requiring clearing of an already fragmented patches. While this will marginally encroach into the remaining habitat for the species, it will not create additional fragmentation of habitat areas.

Although potential foraging and nesting habitat will be removed, larger areas of suitable foraging and nesting habitat will be retained within the study area and in the locality. The Little Eagle is a highly mobile species that utilises numerous nesting locations throughout a landscape and would more likely inhabit larger patches of more intact vegetation that maintain connectivity throughout a foraging range. For this reason, the proposed development works are unlikely to affect the habitat connectivity for the Little Eagle as no existing connectivity to other areas of habitat occurs.

iii. Consideration of threatening processes

- Clearing of native vegetation

The proposed development works will result in the clearing of 17 ha of native vegetation that provides habitat for this species; however, this foraging and nesting habitat does not represent a reliable resource for the survival of the species and this is a reduction from the previous version of the BEW DA. Additionally, the proposed conservation areas and surrounding locality will provide continuous suitable habitat for the species. Furthermore, the species is highly mobile and capable of accessing suitable habitat in the wider locality.

- Removal of dead wood and dead trees

Some dead wood and dead trees will be removed under the proposed development works; however, this is not considered to significantly impact on the foraging opportunities for the Little Eagle and is not expected to impact on nesting habitat for the species. More suitable foraging habitat will be retained elsewhere in the study area and locality.

- Secondary poisoning from rabbit baiting

No poisoning of rabbits is expected to occur as a result of the proposed development works.

- Clearing and degradation of foraging and breeding habitat

Potential foraging and breeding habitat will be removed as a result of the proposed development works; however larger areas of habitat will be retained in the study area and locality for this highly mobile species that can access resources across a vast territory.

5.3.12. Little Lorikeet

5.3.12.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Little Lorikeet is any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. There are 82 records of the Little Lorikeet within 10 km of the study area, 36 records of the Little Lorikeet from within 5 km of the study area, and there is potential habitat in the study area due to the presence of forest and woodland vegetation which they are known to use along with riparian areas and isolated paddock trees, roadside remnants and urban trees. Furthermore, there are many small hollows in the study area which could be suitable for breeding. A local population may extend outside of the study area, but this is unable to be determined based on the information currently available.

ii. Discussion of other known regional populations

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia, and westwards in NSW until Dubbo and Albury. The total population size of this species in NSW is unknown. There is no evidence of regular migration, but Little Lorikeets are generally considered to be nomadic, with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability. However, long term investigation of the breeding population on the north-western slopes indicates that breeding birds are resident from April to December, and even during their non-resident period, they may return to the nest area for short periods if there is some tree-flowering in the vicinity (NSW Scientific Committee, 2009).

The significance of the proposed development works area for this species in the locality and region is relatively low. The degraded patches of native vegetation in the proposed development works area may provide periodic habitat for this species, but they are unlikely to rely on the area of degraded habitat that is present in the proposed development works area. Similar fragmented habitats occur outside the proposed development works area that will remain.

5.3.12.2. Assessment of Habitat

i. Description of habitat values

The species is known to occur throughout eucalypt woodlands including Cumberland Plain Woodland. It nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like *Allocasuarina* (OEH, 2019).

ii. Discussion of habitat utilisation

The subject site provides both potential foraging and nesting habitat within woodland/forest vegetation present. The species is likely to utilise the suitable habitat within the proposed development works area primarily for foraging purposes and is considered more likely to utilise habitat within the study area proposed to be retained for nesting purposes as these areas include larger tracts of vegetation that are less exposed to edge effects.

The habitat for this species that is present in the study area is not considered to be significant to the viability of the Little Lorikeet in the locality. Similar fragmented patches of woodland occur outside the study area that will not be impacted, and the small, degraded area of vegetation in the proposed development works area is not considered to be important to this species. The habitats in the subject site are not protected for conservation, in common with other habitats that remain in the locality and region.

5.3.12.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Little Lorikeet is listed as Vulnerable under the TSC Act. The broad range of the Little Lorikeet has not changed but recent evidence of declines has led to recommendations for an urgent Australia-wide review (NSW Scientific Committee, 2009).

5.3.12.4. Threatening processes

The following Key Threatening Processes listed under the TSC Act are likely to affect the Little Lorikeet:

- 'Clearing of native vegetation';
- 'Removal of hollow bearing trees';
- 'Removal of dead wood and dead trees';
- 'Invasion and establishment of exotic vines and scramblers';
- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)';
- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)';
- 'Invasion of native plant communities by exotic grasses'; and
- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'.
- In addition to the above listed key threatening processes, the following threats have also been identified for the species:
- 'Fragmentation of woodland and forest remnants which isolates populations and causes local extinctions';
- 'Ongoing degradation of habitat, particularly the loss of tree hollows and fallen timber from firewood collection and overgrazing';

- 'Lack of regeneration of eucalypt overstorey in woodland due to overgrazing and too-frequent fires';
- 'Loss of ground litter from compaction and overgrazing';
- 'Inappropriate forestry management practices';
- 'Loss of understorey habitat';
- 'Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners' (OEH 2018b); and
- Predation by foxes and feral cats.

5.3.12.5. Habitat requirements

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. The species is known to occur throughout eucalypt woodlands, including Cumberland Plain Woodland and in remnant woodland patches and roadside vegetation. The species utilises hollows within live trees for breeding, usually smooth barked eucalypts. There is no evidence of regular migration, but Little Lorikeets are generally considered to be nomadic, with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability.

5.3.12.6. Other documentation

The Little Lorikeet has been assigned to the 'Landscape species' management stream under the 'Saving our Species' program. The major objective of the program is to ensure that the species is secure in the wild in NSW and that its' NSW geographic range is extended or maintained (OEH 2018b). No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species.

5.3.12.7. Assessment of adequacy of reservation

Records of the Little Lorikeet are scattered throughout the region both within and outside of reserves. Presently there is likely to be inadequate reservation of this species in the region as many individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.12.8. Limit of known distribution

The known distribution of the species extends along the east coast of Australia from Queensland to South Australia.

5.3.12.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Little Lorikeet has not been recorded within the study area, though the subject site provides suitable foraging and nesting habitat. The proposed development will remove suitable habitat for this species; however, this removal of habitat is considered unlikely to be significant to the long-term survival of the species in the local context as extensive areas of more suitable habitat occur in nearby reserves. Furthermore, large areas of

suitable habitat will be conserved within the study area which is more suitable habitat for the species than what is proposed to be removed.

ii. Extent of habitat removal or modification

The proposal will remove habitat for this species, consisting of approximately 17 ha of native forest, woodland and shrubby regrowth vegetation. As a conservative estimate, this includes all the vegetation in the proposed development works area except for exotic vegetation, grassland, freshwater wetlands and dams.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of ~67 ha of native vegetation.

The majority of the native vegetation in the study area will remain and continue to provide habitat for this species. The proportion of each vegetation community that is being removed is presented in **Table 14**. The relatively minor removal of habitat in the proposed development works area is not expected to affect its viability as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Suitable habitat for the Little Lorikeet to be removed within the proposed development works area has limited to larger patches of habitat and the habitats present in the study area are already highly fragmented. Although the proposed development will exacerbate existing fragmentation of habitat to some extent by increasing the distance between fragments and reducing the ability for movement and gene flow, fragmentation of intact foraging habitat will not occur. Rather, the proposal requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than create additional fragmented habitat patches.

Although the Little Lorikeet is not migratory, it is nomadic and travels long distances in response to resource availability (OEH 2019b). Accordingly, they are known to access resources from across a broad range and are not likely to rely on the small areas of fragmented habitat within the proposed development works area.

Although suitable habitat will be removed, larger areas of habitat will be retained in the study area and beyond, around Howes Creek and the Nepean River. The Little Lorikeet is more likely be dependent on larger tracts of less disturbed vegetation, such as the areas to be conserved. Due to this, the proposed development will not likely affect habitat connectivity for this species as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Little Lorikeet may be generally threatened by the following processes:

- Clearing of native vegetation

Approximately 17 ha of native vegetation that provides suitable habitat for this species (i.e., woodland/forest and shrubby regrowth) will be cleared as part of the proposed development, which is a reduction from the previous version of the BEW DA. Although a moderate area of habitat will be removed, larger areas ofRemoval of hollow bearing trees

The proposed development will remove woodland vegetation that contains hollow bearing trees; however, larger areas of woodland/forest containing hollow bearing trees will be retained and conserved in the study area and beyond. Furthermore, the species is highly mobile and able of accessing other areas of suitable habitat.

- Invasion and establishment of exotic vines and scramblers

The proposed development has the potential to result in the spread of exotic weeds. To mitigate this key threatening process, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion and spread of Lantana (*Lantana camara* L. Sens lat)

The proposed development works area currently contains Lantana in areas, all of which will be cleared. The proposed development has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development. mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The proposed development works area currently contains African Olive in areas, all of which will be cleared. The proposed development has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by exotic grasses

Clearing from the proposed development is unlikely to significantly contribute to the spread of exotic grasses further than current conditions as all areas are currently subject to this process. Nevertheless, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development. mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

The proposed development has the potential to contribute to this key threatening process; however, it is unlikely to contribute significantly as the habitat to be retained is already degraded to some degree as a result of surrounding land uses.

- Fragmentation of woodland and forest remnants which isolates populations and causes local extinctions

The proposed development is unlikely to exacerbate this process as the habitat to be removed is comprised of fragmented remnants. Furthermore, the species is highly mobile and capable of accessing additional areas of suitable habitat in the area.

- Ongoing degradation of habitat, particularly the loss of tree hollows and fallen timber from firewood collection and overgrazing

The proposed development will contribute to this process as habitat will be removed; however, large areas of habitat will be retained within the study area, and beyond which will provide suitable nesting and foraging habitat for this species.

- Lack of regeneration of eucalypt overstorey in woodland due to overgrazing and too-frequent fires

The proposed development is unlikely to contribute to overgrazing and too frequent fires as grazing will not occur and bushfire APZ will be implemented.

- Loss of ground litter from compaction and overgrazing

The proposed development will result in the loss of ground litter; however, large areas containing ground litter will be retained within the study area and beyond.

- Loss of understorey habitat

The proposed development will result in the loss of understorey habitat; however, large areas native vegetation containing understorey habitat will be retained within the study area and beyond.

- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners

The proposed development has the potential to increase this process within the study area.

- Predation by foxes and feral cats

The proposed development works are likely to increase the number of cats within the study area as a result of future development, but unlikely to increase the number of foxes. Although an increase in cats will occur, this key threatening process is unlikely to occur as this species is highly mobile.

5.3.13. Powerful Owl

5.3.13.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Little Eagle is any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available.

There are 62 records of the Powerful Owl from within 10 km of the study area and 23 records from within 5 km of the study area. However, the Powerful Owl has not been recorded in the study area by Cumberland Ecology or by any previous surveys conducted. Potential foraging habitat exists for the species within and around the woodland/forest areas of the study area and potential roosting habitat is present in the form of large hollow-bearing trees.

ii. Discussion of other known regional populations

The Powerful Owl is distributed throughout eastern and south-eastern Australia on the eastern side of the Great Dividing Range, ranging from Mackay in the north to south-western Victoria. A few records occur west of the Great Dividing Range, however these are rare (OEH 2017k).

5.3.13.2. Assessment of Habitat

i. Description of habitat values

Within NSW the Powerful Owl is distributed primarily to the east of the Great Dividing Range where it inhabits a range of vegetation types including woodland and open sclerophyll forest to tall open wet forest and rainforest. The species prefers large tracts of undisturbed remnant vegetation; however, will occasionally inhabit fragmented landscapes. The Powerful Owl roosts in dense vegetation comprised of a variety of mature trees and a tall shrub layer throughout the day, and nest in hollows within large mature trees that are least 150 years old. These hollows that are at least 0.5 m deep and have a diameter of 80-240cm. Discussion of habitat utilisation

The study area provides potential foraging and roosting habitat for the Powerful Owl. The Powerful Owl has the potential to forage throughout the woodland/forest and surrounding grasslands of the study area as part of a much broader foraging range.

The Powerful Owl has not been recorded in the study area by Cumberland Ecology or by any previous surveys conducted.

5.3.13.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Powerful Owl is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act.

5.3.13.4. Threatening processes

The following key threatening processes are known to affect the Powerful Owl:

- Clearing of native vegetation; and
- Removal of dead wood and dead trees.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- Habitat loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development. The loss also affects the populations of arboreal prey species;

- Disturbance during the breeding period or around the nest site;
- High frequency hazard reduction burning;
- Road kills;
- Secondary poisoning; and
- Predation of fledglings by foxes, dogs and cats.

5.3.13.5. Habitat requirements

The Powerful Owl occupies forests and woodlands throughout the coastal and tableland areas of NSW. Suitable habitat occurs as large tracts of eucalypt forests and woodlands on sites that have tall shrub layers and abundant hollows to support the high densities of arboreal marsupials that are the preferred prey item of the species.

5.3.13.6. Other documentation

The Powerful Owl has been assigned to the 'Landscape species' management stream under the 'Saving our Species' program. The major objective of the program is to ensure that the species is secure in the wild in NSW and that it's NSW geographic range is extended or maintained (OEH 2017k). No threat abatement plan is relevant to the species, and no critical habitat has been identified by the Chief Executive of the OEH for this species.

The Recovery Plan for the Large Forest Owls provides a recovery outline for the species. The relevant objectives of the plan are:

Objective 1: Assess the distribution and amount of high-quality habitat for each owl species across public and private lands to get an estimate of the number and proportion of occupied territories of each species that are, and are not, protected.

No individuals were recorded during targeted surveys of the study area and the subject site is not considered to contain high quality habitat for species as it is not known to occupy it or utilise it as part of a territory.

Objective 2: To monitor trends in population parameters (numbers, distribution, territory fidelity and breeding success) across the range of the three species and across different land tenures and disturbance histories.

No populations or nesting is known to occur within the study area.

Objective 3: To assess the implementation and effectiveness of forest management prescriptions designed to mitigate the impact of timber-harvesting operations on the three owl species and, (if necessary), to use this information to refine the prescriptions so that forestry activities on state forests are not resulting in adverse changes in species abundance and breeding success.

No forestry activities will be undertaken as part of the proposed development works.

Objective 4: Ensure the impacts on large forest owls and their habitats are adequately assessed during planning and environmental assessment processes.

It is considered this SIS provides adequately assesses any impacts to the Powerful Owl and its habitat.

Objective 5: Minimise further loss and fragmentation of habitat by protection and more informed management of significant owl habitat (including protection of individual nest sites).

Some habitat will be removed as part of the proposed development works, however no further fragmentation will occur as the woodland exists as in relatively isolated patches of vegetation with little connectivity to other areas of suitable habitat.

Objectives 6-8 are not relevant to the proposed development works.

5.3.13.7. Assessment of adequacy of reservation

Records of the Powerful Owl are scattered throughout the locality within riparian, developed and agricultural areas. No records from the locality are within reserves, however the species is likely to utilise reserves in the locality in addition to areas outside of serves. Currently, there is inadequate reservation of this species in the region as most individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.13.8. Limit of known distribution

The known distribution of this species extends along the coastal side of the Great Dividing Range from Mackay to south-western Victoria.

5.3.13.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Powerful Owl has not been recorded in the study area but is considered to have the potential to utilise habitat within study area for foraging and/or roosting. The habitat present within the study area is considered unlikely to be significant to the long-term survival of the species in the local context as this highly mobile species has a large territory of anywhere between 400 and 4,000 ha and would unlikely be reliant upon the degraded remnant habitat present within the proposed development works area. More suitable habitat is present for the species in the locality along the Nepean River and Mt Annan Botanic Gardens, and within Dharawal National Park within the greater locality. Furthermore, larger areas of suitable habitat for the species will be retained within the subject site as part of the proposed conservation works, including areas surrounding Howes Creek.

ii. Discussion of connectivity

Habitat for the Powerful Owl to be removed within the proposed development works area is fragmented and has limited connectivity to larger tracts of habitat. Therefore, the removal of this habitat will not further fragment suitable foraging or roosting habitat, instead requiring clearing of already fragmented patches. While this will marginally encroach into the remaining habitat for the species, it will not create additional fragmentation of habitat areas.

Although potential foraging and roosting habitat will be removed, larger areas of suitable foraging and roosting habitat will be retained within the study area and the locality. The Powerful Owl is a highly mobile species with a large and would more likely inhabit larger patches of more intact vegetation that maintain

connectivity throughout a foraging range. For this reason, the proposed development works are unlikely to affect the habitat connectivity for the Powerful Owl as no existing connectivity to other areas of habitat occurs.

iii. Consideration of threatening processes

- Clearing of native vegetation

The proposed development works will result in the clearing of 17 ha of native vegetation that is potential habitat; however, this foraging and nesting habitat does not represent a reliable resource for the survival of the species and this is a reduction from the previous version of the BEW DA. Additionally, the proposed conservation areas and surrounding locality will provide continuous suitable habitat for foraging of each species.

- Removal of dead wood and dead trees

Some dead wood and dead trees will be removed under the proposed development works; however, this is not considered to significantly impact on the foraging opportunities for the Powerful Owl and would have no impact on the roosting habitat for the species. Larger areas of suitable foraging/roosting habitat will be retained elsewhere in the study area and locality.

- Habitat loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development. The loss also affects the populations of arboreal prey species

The proposed development works will result in the reduction of suitable habitat for this species, but the habitat to be removed is unlikely to be important for the long-term survival of this species as it likely only constitutes a very small portion of its total range.

- Disturbance during the breeding period or around the nest site

No nest sites are known to occur within the subject site.

- High frequency hazard reduction burning

The proposed development works is unlikely to contribute to high frequency hazard reduction burning.

- Road kills

The proposed development works has the potential to contribute to an increase in road kills as the future development it will facilitate will lead to an increase of traffic. However, as habitat present within the study area is unlikely to be significant to the long-term survival of the species as the species, road kills are likely to be rare events and any increase in road kills is not considered likely to significantly impact this species.

- Secondary poisoning

The proposed development works is not considered likely to increase the likelihood of secondary poisoning to this species.

- Predation of fledglings by foxes, dogs and cats

The proposed development works is not considered likely to increase predation of fledglings by foxes, dogs and/or cats.

5.3.14. Southern Myotis

5.3.14.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Southern Myotis is any individuals known or likely to occur in the study area, as well as any individuals in adjoining areas that are known or likely to utilise habitats in the study area. The species occurs in the subject site and study area, and it is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are 215 records of the Southern Myotis within 10 km of the study area and 164 records of the Southern Myotis from within 5 km of the study area. Potential foraging habitat exists within the proposed development works area in the form of several farm dams. Roosting habitat is present in the form of tree hollows.

ii. Discussion of other known regional populations

The Southern Myotis occurs at streams and pools along a coastal band extending from north-west of Australia and south to Western Victoria. The total population size of the Southern Myotis in NSW is unknown. It is rarely found more than 100 km inland, except along major rivers.

The relative significance of the proposed development works area as habitat for the Southern Myotis in the region and locality is considered to be low, due to the area of foraging habitat restricted to the several farm dams. The habitat in the proposed development works area is not likely to be important to this species in the locality or region, as a plethora of similar farm dams occur within the wider locality. The long-term security of habitats in the subject site is generally similar to other habitats outside the subject site in the locality, they are typically not secured for conservation and subject to ongoing degradation due to land use. Further afield however, larger areas of suitable foraging habitat occur along the Nepean River.

5.3.14.2. Assessment of Habitat

i. Description of habitat values

The Southern Myotis forages at streams and pools within various habitats, but typically within 100 km inland. Within the Greater Southern Sydney Region, the Southern Myotis is strongly associated with the Cumberland Plain where it utilises waterways in relatively disturbed environments. For example, it has been regularly recorded from the Georges River catchment around Liverpool and Campbelltown and from the Nepean River.

It roosts in groups of 10-15 close to water in caves, but can also roost in mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage (OEH 2017l). The study area contains suitable known foraging habitat for the species in the form of dams and a riparian corridor. The species was recorded within the subject site during targeted surveys by Cumberland Ecology and has been recorded in the study area by Travers Bushfire & Ecology (2013). A total of 49 hollow-bearing trees are present within the proposed development works area which provide potential roosting and breeding habitat, although only those

within 200 m of a waterbody would be considered suitable for the species. The locations of tree hollows are provided in **Figure 17**.

ii. Discussion of habitat utilisation

The study area provides known foraging habitat, and potential roosting and breeding habitat in the form of hollow trees. The other habitat features listed above such as mine shafts and buildings are not present on the subject site. The Southern Myotis likely forages on occasion within the dams on the subject site as well as other dams in the wider study area and the waterbodies in the Howes Creek corridor and along the Nepean River.

The significance of the habitat of the study area to the viability of the Southern Myotis in the locality is relatively low. Large areas of similar habitat that occur outside of the proposed development works area in the locality will remain, including within the proposed conservation works areas, and this species is unlikely to rely on the habitats present in the proposed development works area.

5.3.14.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Southern Myotis is listed as Vulnerable under the TSC Act. It is not listed under the EPBC Act.

Throughout its range, it is primarily a coastal species and there are few records outside of the maritime Bioregions. In the Sydney Basin Bioregion, it is strongly associated with the coastal plains and hinterland environments of the Central Coast, Cumberland Plain and Illawarra. Representation in NPWS reserves is relatively poor, however records are known from Nattai, Royal and Popran National Parks (DECC, 2007).

5.3.14.4. Threatening processes

The following threatening processes are known to affect the Southern Myotis:

- Loss or disturbance of roosting sites;
- Clearing adjacent to foraging areas;
- Application of pesticides in or adjacent to foraging areas; and
- Reduction in stream water quality affecting food resources.

5.3.14.5. Habitat requirements

The Southern Myotis occurs within various habitats, and forages over streams and pools. It roosts in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.

5.3.14.6. Other documentation

No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species. The Southern Myotis has been included as a 'Landscape species' in the 'Saving our Species' program. The management aim of the program is to ensure that this species is secure in the wild in NSW and that its NSW geographic range is extended or maintained.

5.3.14.7. Assessment of adequacy of reservation

Southern Myotis records are scattered throughout the region, however many of these records are located along riparian corridors at Nepean River and Georges River. Records are also located in the wider locality within Dharawal National Park. Therefore, the species is generally considered to be well protected within the region.

5.3.14.8. Limit of known distribution

The Southern Myotis occurs along a coastal band extending from north-west of Australia and south to Western Victoria. The study area is within the known distribution for this species.

5.3.14.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Southern Myotis has been recorded within the study area by Travers Bushfire & Ecology (2013) and by Cumberland Ecology in 2018. The study area provides suitable roosting and foraging habitat. The proposed development works will remove potential habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the Southern Myotis in the local context as extensive areas of suitable habitat occur in the locality, particularly the Nepean River riparian corridor.

ii. Discussion of connectivity

Suitable habitat for the Southern Myotis to be removed within the proposed development works area has limited connectivity to larger patches of habitat. The habitat to be removed as part of the proposed development works will not fragment suitable habitat but requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although potential roosting habitat will be removed, larger patches of suitable roosting habitat will be retained in the study area and locality. The Southern Myotis is also a highly mobile species which would more likely present in large tracts of less disturbed vegetation. Due to this, the proposed development works are considered unlikely to affect habitat connectivity for the Southern Myotis as no existing connectivity to off-site reserves will be affected.

iii. Consideration of threatening processes

The Southern Myotis may be generally threatened by the following processes:

- Clearing of native vegetation

The proposed works will result in the clearing of approximately 6.2 ha of native vegetation and 1.01 ha of dams suitable for this species, which is a reduction from the previous version of the BEW DA. The clearing of this vegetation will result in the removal of potential roosting and/or foraging habitat for this species. The foraging habitat to be removed is unlikely to be important to this species as it would likely only be used on occasion as part of much broader foraging range.

- Loss of hollow-bearing trees

The proposed works will result in the removal of hollow-bearing trees which provide suitable roosting habitat for this species. Although hollowing bearing trees will be removed, additional areas containing hollow bearing

trees will be retained in the study area and locality. Mitigation measures such as nest boxes will be implemented to reduce potential impacts to the species if it roosts within the proposed development works area.

- Removal of dead wood and dead trees

The proposed works will result in the removal of dead wood and dead trees. Although all these items will be removed from the proposed development works area, additional areas containing dead wood and dead trees will be retained in the study area and locality. Mitigation measures such as the salvage of dead wood and dead trees and placement into retained areas will also occur to enhance the habitat values of retained vegetation within the subject land.

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

The proposed works are unlikely to contribute to high frequency fire.

- Infection of native plants by *Phytophthora cinnamomi*

The proposed works are unlikely to increase the risk of infection of native plants by *Phytophthora cinnamomi*. Wash-down stations will be established and all construction vehicles entering and leaving the site will be required to be washed down to prevent pathogens entering or leaving the site.

- Anthropogenic climate change

The proposed works are unlikely to significantly increase anthropogenic climate change.

- Loss or disturbance of roosting sites

Hollow-bearing trees will be removed for the proposed works. Mitigation measures such as nest boxes will be implemented to reduce potential impacts to the species if it roosts within the proposed development works area.

- Clearing adjacent to foraging areas

The subject site and study area have already undergone extensive clearing and all potential foraging habitat within the subject site is already surrounded by cleared areas.

- Application of pesticides in or adjacent to foraging areas

This threatening process has the potential to occur because of pesticide and herbicide usage within residential areas. It is unlikely that levels of pesticide and herbicide usage will increase significantly further than current levels.

- Reduction in stream water quality affecting food resources

The proposed works have the potential to reduce stream water quality; however, a number of measures will be implemented to mitigate this risk. Furthermore, all major waterways within the study area will be avoided by the proposed works and retained.

5.3.15. Varied Sittella

5.3.15.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the Varied Sittella is any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available. There are 84 records of the Varied Sittella within 10 km of the study area, 52 records of the Varied Sittella within 5 km of the study area, and the species has been recorded within the study area by Cumberland Ecology in 2018. Potential foraging and nesting habitat exists for the species mainly within and around the woodland/forest areas of the study area. This species is known to inhabit eucalypt forest and woodlands, particularly those containing mature rough-barked and smooth-barked gums.

ii. Discussion of other known regional populations

The species is sedentary and occupies most of the Australian continent except for deserts and open grasslands. Its distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades (OEH, 2018). The Varied Sittella is likely to have declined significantly on the Cumberland Plain and it is a high local priority in this area (OEH, 2018)

The relative significance of the proposed development works area as habitat for the Varied Sitella in the region and locality is considered to be low, due to the relatively small area of native vegetation in the proposed development works area and due to a high degree of degradation. The habitat in the subject site is not likely to be important to this species in the locality or region. The long-term security of habitats in the subject site is generally like other habitats outside the subject site, they are typically not secured for conservation and subject to ongoing degradation due to land use.

5.3.15.2. Assessment of Habitat

i. Description of habitat values

The species is sedentary and occupies most of the Australian continent except for deserts and open grasslands. This species is known to inhabit eucalypt forest and woodlands, particularly those containing mature rough-barked and smooth-barked gums. The species forages for arthropods in rough or decorticating bark, dead branches/trees and branches within the canopy. Nesting occurs within high forks of living trees.

The species was recorded within the study area by Cumberland Ecology in 2018. The study area and subject site provides suitable nesting and foraging habitat for the species within and alongside the patches of woodland/forest present.

ii. Discussion of habitat utilisation

The subject site provides both potential foraging and nesting habitat within woodland/forest vegetation, including canopy trees with rough bark that would likely shelter insects for foraging. The species has the potential to utilise the suitable habitat within the subject site for nesting and foraging purposes, although

nesting has not been recorded. Although groundcover and understorey vegetation are limited in the proposed development works area, these habitat components are not utilised by this species for foraging or nesting. That notwithstanding, the significance of the habitat of the study area to the viability of the Varied Sitella in the locality is relatively low. Large areas of similar habitat occur outside of the proposed development works area in the locality that will remain, and this species is unlikely to rely on the habitats present in the proposed development works area.

5.3.15.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The Varied Sittella is listed as Vulnerable under the TSC Act (OEH 2018j).

5.3.15.4. Threatening processes

The following Key Threatening Processes listed under the TSC Act are likely to affect the Varied Sittella.

- 'Clearing of native vegetation';
- 'Removal of dead wood and dead trees';
- 'Invasion and establishment of exotic vines and scramblers';
- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)';
- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)';
- 'Invasion of native plant communities by exotic grasses';
- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'; and
- Predation from foxes and feral cats.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- 'Threats include habitat degradation through small-scale clearing for fence lines and road verges, rural tree decline, loss of paddock trees and connectivity, 'tidying up' on farms, and firewood collection';
- 'Inappropriate fire regimes'; and
- 'Aggressive exclusion by over abundant Noisy Miners'.

Furthermore, the Final Determination for the Varied Sitella identifies that survival and population viability are sensitive to habitat isolation, reduced patch size and habitat simplification, including reductions in tree species diversity, tree canopy cover, shrub cover, ground cover, logs and fallen timber (NSW Scientific Committee, 2010).

Lack of knowledge in the community regarding the species and its habitat requirements have also been identified as a threat to this species (OEH 2018j).

5.3.15.5. Habitat Requirements

This species occurs in eucalypt forests and woodland, preferring areas with rough-barked species, smooth-barked gums with dead branches and Acacia and mallee woodlands. It nests in tree forks high in the tree canopy (OEH 2018j).

5.3.15.6. Other documentation

The Varied Sittella has been assigned to the 'Landscape species' management stream under the 'Saving our Species' program. The major objective of the program is to ensure that the species is secure in the wild in NSW and that its' NSW geographic range is extended or maintained (OEH 2018j). No threat abatement plan is relevant to this species, no recovery plan exists, and no critical habitat has been identified by the Chief Executive of the OEH for this species.

5.3.15.7. Assessment of adequacy of reservation

Records of the Varied Sittella are scattered throughout the region within and outside of reserves. Presently there is inadequate reservation of this species in the region as a high number of individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.15.8. Limit of known distribution

The known distribution of the species extends throughout most of the Australian continent except for deserts and open grasslands throughout eastern, southern and south-western Australia.

5.3.15.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The Varied Sittella has been recorded within the study area by Cumberland Ecology in 2018. The subject site provides suitable foraging and nesting habitat. The proposed development works will remove suitable habitat for this species; however, this removal of habitat is considered unlikely to be significant to the long-term survival of the species in the local context as extensive areas of suitable habitat occur in nearby reserves. Furthermore, large areas of suitable habitat will be conserved within the study area. Although cleared lands pose a potential barrier to movement for the species due to its sedentary nature, the species currently exists within a matrix of woodland and cleared lands, likely meaning the current condition of the subject site is not a barrier to movement. Therefore, the species is capable of accessing other areas of suitable habitat within study area and beyond by moving between vegetation to be retained, including within the proposed conservation works area.

ii. Extent of habitat removal or modification

The proposal will remove habitat for this species, consisting of approximately 17 ha. As a conservative estimate, this includes all the vegetation in the proposed development works area except for exotic vegetation, grassland, freshwater wetlands and dams. Most of the native vegetation in the study area will remain and continue to provide habitat for this species.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~44 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 67 ha of native vegetation.

The proportion of each vegetation community that is proposed to be removed by the current proposal is presented in **Table 14**. The removal of habitat in the proposed development works area is not expected to affect its viability as it already exists in a fragmented and degraded condition.

iii. Discussion of connectivity

Reductions in connectivity has potential to impact on this species as cleared land is a potential barrier to movement, with small-scale clearing of various types of habitats being a key threat. However, suitable habitat for the Varied Sittella to be removed within the proposed development works area has limited connectivity to larger patches of habitat and the habitats present in the study area are already highly fragmented. Although the proposed development works will exacerbate existing fragmentation of habitat to some extent by increasing the distance between fragments, and reducing the ability for movement and gene flow, fragmentation of intact foraging habitat will not occur. Rather, the proposal requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than create additional fragmented habitat patches. Although suitable habitat will be removed, larger areas of suitable habitat will be retained in the study area and beyond, including around Howes Creek and the Nepean River. The Varied Sittella although sedentary in nature, is able access areas of habitat to be retained in the study area and beyond. Due to this, the proposed development works will not likely affect habitat connectivity for this species as no existing connectivity to off-site reserves will be affected.

iv. Consideration of threatening processes

The Varied Sittella may be generally threatened by the following processes:

- 'Clearing of native vegetation'

Approximately 17 ha of native vegetation that provides suitable habitat for this species (i.e., woodland and shrubby regrowth) will be cleared as part of the proposed development works, which is a reduction from the previous version of the BEW DA. Although a small area of habitat will be removed, larger areas of suitable habitat will be retained, including within Howes Creek riparian corridor.

- Removal of dead wood and dead trees

The proposed development works will result in the removal of dead wood and dead trees. Although all of these items will be removed from the proposed development works area, additional areas containing dead wood and dead trees will be retained in the study area and beyond.

- Invasion and establishment of exotic vines and scramblers

The proposed development works has the potential to result in the spread of exotic weeds. To mitigate this key threatening process, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion and spread of Lantana (*Lantana camara* L. Sens lat)

The proposed development works area currently contains Lantana in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The proposed development works area currently contains African Olive in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by exotic grasses

Clearing from the proposed development works is unlikely to significantly contribute to the spread of exotic grasses further than current conditions as all areas are currently subject to this process. Nevertheless, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

The proposed development works have the potential to contribute to this key threatening process; however, it is unlikely to contribute significantly as the habitat to be retained is already degraded to some degree as a result of surrounding land uses.

- Threats include habitat degradation through small-scale clearing for fence lines and road verges, rural tree decline, loss of paddock trees and connectivity, 'tidying up' on farms, and firewood collection.

The proposed development works will remove areas of suitable habitat; however, larger areas of suitable habitat will be retained within the study area and beyond that will provide ongoing suitable habitat for the species.

- Inappropriate fire regimes

The proposed development works are unlikely to contribute to this process. Furthermore, bushfire APZ will be implemented.

- Aggressive exclusion by over abundant Noisy Miners

The proposed development works has the potential to increase this process within the study area.

- Predation from foxes and feral cats

The proposed development works are likely to increase the number of cats within the study area as a result of future development, but unlikely to increase the number of foxes. Although an increase in cats will occur, this key threatening process is unlikely to occur as this species is highly mobile.

5.3.16. White-bellied Sea-Eagle

5.3.16.1. Discussion of Local and Regional Abundance and Distribution

i. Discussion of other known local populations

As defined by the NSW Threatened Species Assessment Guidelines (DECC 2007), the local population of the White-bellied Sea-Eagle is any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. It is likely that a local population may extend outside of the study area, but this is unable to be determined based on the information currently available.

There are 24 records of the White-bellied Sea-Eagle from within 10 km of the study area, 12 records from within 5 km of the study area, and one record occurring within the study area. Potential nesting habitat exists for the species mainly within and around the woodland/forest areas of the study area. Potential foraging habitat is quite limited for the species as the study area lacks substantial waterbodies preferred by the species. The species is known to inhabit areas in the presence of large rivers, swamps, lakes and the ocean. Habitats can range from reefs, lagoons, estuaries and mangroves to coastal dunes, tidal flats, grassland, woodland and forest

ii. Discussion of other known regional populations

In NSW, the species is widespread along the east coast and along all major rivers and waterways.

5.3.16.2. Assessment of Habitat

i. Description of habitat values

Within NSW, the White-bellied Sea-Eagle is distributed along the east coast and along all major rivers and waterways. The species is known to inhabit areas in the presence of large rivers, swamps, lakes and the ocean. Habitats can range from reefs, lagoons, estuaries and mangroves to coastal dunes, tidal flats, grassland, woodland and forest. The species constructs large stick nests in open forest and tall woodland that is close to foraging habitat (OEH 2019e)

The species has been previously recorded in the west of the study area, near the Nepean River (OEH 2019e). The study area provides foraging habitat alongside riparian areas and over dams and nesting habitat within woodland areas.

ii. Discussion of habitat utilisation

The study area provides limited foraging habitat alongside riparian areas and over dams, but the species is most likely to utilise the Nepean River for foraging and large dams located outside of the study area. Potential nesting habitat is present within woodland areas of the study area. Areas most likely to be utilised for nesting would be in close proximity to the Nepean River.

5.3.16.3. Discussion of Conservation Status

i. Local, regional and state-wide status

The White-bellied Sea Eagle is listed as Vulnerable under the TSC Act (OEH 2019e).

5.3.16.4. Threatening processes

The following Key Threatening Processes listed under the TSC Act are likely to affect the White-bellied Sea Eagle:

- 'Clearing of native vegetation';
- 'Removal of dead wood and dead trees';
- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'; and
- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)'.

In addition to the above listed key threatening processes, the following threats have also been identified for the species:

- 'Land clearing reduces the amount of suitable habitat available and this can force birds to nest in sub-optimal habitats where their breeding success is greatly reduced';
- 'Disturbance to nesting sites';
- 'Increased mortality or reduced breeding success due to non-target poisoning during vertebrate pest control, exposure to industrial chemicals and pesticides used for agriculture (directly or indirectly through prey), and deliberate poisoning'; and
- 'Climate change and associated sea-level rise'.

5.3.16.5. Habitat requirements

In NSW, this species is distributed along the entire east coast and along all major rivers and waterways. The species requires the presence of large rivers, swamps, lakes and/or the ocean. Habitats can range from reefs, lagoons, estuaries and mangroves to coastal dunes, tidal flats, grassland, woodland and forest. The species constructs large stick nests in open forest and tall woodland that is close to foraging habitat.

5.3.16.6. Other documentation

No approved recovery or threat abatement plans have been prepared for White-bellied Sea Eagle, however, a Conservation Project under the Saving our Species program is currently being developed (OEH 2019e).

5.3.16.7. Assessment of adequacy of reservation

Records of the White-bellied Sea Eagle are scattered throughout the locality with the majority being in close proximity to the Nepean River. Presently there is inadequate reservation of this species in the region as a high number of individuals have been recorded outside of reserves and the species is considered susceptible to further habitat removal.

5.3.16.8. Limit of known distribution

The species is distributed along the Australian coastline including Tasmania and extending inland, along rivers and wetlands of the Murray Darling Basin. In NSW, the species is widespread along the east coast and along all major rivers and waterways.

5.3.16.9. Discussion of the Likely Effect of the Proposal at Local and Regional Scales

i. Significance within a local context

The White-bellied Sea Eagle has been recorded within the west of study area previously. The study area provides limited foraging habitat and suitable nesting habitat within woodland areas. The proposed development works will remove a small area of potential habitat for this species; however, this removal of potential habitat is considered unlikely to be significant to the long-term survival of the species in the local context as extensive areas of more suitable habitat occur along the Nepean River, which will be retained.

ii. Discussion of connectivity

Potential habitat for the White-bellied Sea Eagle to be removed within the proposed development works area has limited connectivity to larger patches of habitat and is sub-optimal for the species. The habitat to be removed as part of the proposed development works will not fragment suitable foraging habitat but requires clearing of already fragmented patches and will therefore encroach further into remaining habitat rather than creating additional fragmented habitat patches. Although potential foraging habitat will be removed, larger areas of more optimal foraging habitat will be retained in the study area and locality, including areas surrounding the Nepean River. The White-bellied Sea Eagle is also a highly mobile species which would more likely occur in large tracts of less disturbed vegetation. Due to this, the proposed development works will not likely affect habitat connectivity for this species as no existing connectivity to off-site reserves will be affected.

iii. Consideration of threatening processes

The following Key Threatening Processes listed under the TSC Act are likely to affect the White-bellied Sea Eagle.

- Clearing of native vegetation.

Approximately 17 ha of native forest and woodland and ~ 0.37 ha of Freshwater Wetlands vegetation that provides suitable habitat and ~1.01 ha of dams for this species will be cleared as part of the proposed development works, which is a reduction from the previous version of the BEW DA. Although a moderate area

of habitat will be removed by the proposed development works, additional areas of native vegetation are present within the local area. The foraging habitat to be removed is unlikely to be important to this highly mobile species as it would likely only be used on occasion as part of much broader foraging range

- Removal of dead wood and dead trees.

The proposed development works will result in the removal of dead wood and dead trees, altering the suitability of the site for foraging. However, this foraging habitat is not critical to the survival of the species. Additionally, the conservation area and surrounding locality will provide continuous suitable habitat for foraging of the species.

- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'

The proposed development works area currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. To mitigate this key threatening process, a monitoring plan will be implemented that will monitor areas of retained vegetation and provide recommendations and/or management actions to minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- 'Invasion of native plant communities by African Olive (*Olea europaea L. subsp. cuspidata*)';

The proposed development works area currently contains a high abundance of African Olive in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. To mitigate this key threatening process, a monitoring plan will be implemented that will monitor areas of retained vegetation and provide recommendations and/or management actions to minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Land clearing reduces the amount of suitable habitat available and this can force birds to nest in sub-optimal habitats where their breeding success is greatly reduced.

The proposed development works will remove areas of potential habitat for this species, but the habitat to be removed is sub-optimal. The majority of areas considered most likely to be utilised by the species will be retained.

- Disturbance to nesting sites.

The proposed development works are unlikely to disturb any nesting sites as the species is likely to nest within areas closer to the Nepean River, which are outside of the proposed development works area.

- Increased mortality or reduced breeding success due to non-target poisoning during vertebrate pest control, exposure to industrial chemicals and pesticides used for agriculture (directly or indirectly through prey), and deliberate poisoning

The proposed development works have the potential to lead to increased poisoning; however, there is likely to be a reduction in chemical and pesticides for agriculture as the area to be developed will primarily be for residential purposes. Pest control may occur within conservation areas; however, such control would be targeted and monitored.

- Climate change and associated sea-level rise

The proposed development works are unlikely to significantly contribute to sea-level rise due to the scale of the project.

6. Assessment of Likely Impacts on Endangered Ecological Communities and Groundwater Dependent Ecosystems

This chapter covers the following CERs:

CER 6. ASSESSMENT OF LIKELY IMPACTS ON ENDANGERED ECOLOGICAL COMMUNITIES

6.1. Determining Affected Endangered Ecological Communities

CER 6.1 Assessment of endangered ecological communities likely to be affected

A general description of the ecological community present in the area that is the subject of the action and in any area that is likely to be affected by the action (Section 110(3)(a)).

Occurrences of five TECs listed under the TSC Act will be cleared by the proposed development works and so are "affected TECs" for the purposes of this SIS:

- Cumberland Plain Woodland;
- EBSF;
- River-Flat Eucalypt Forest;
- Swamp Oak Floodplain Forest; and
- Freshwater Wetlands

The area of each community within the subject site, study area, and local area (within 5 km radius of the study area) is shown in **Table 15** and illustrated in **Figure 15**. The native vegetation within the subject site will be removed but forest, woodland and wetland vegetation will be conserved within Park K, Park L, Stage 6 EBSF Conservation Area, Howes Creek Conservation Area and the Northern Conservation Area. Native vegetation occurrences in the two larger reserves will form extensive, connected areas of native vegetation habitats of about 57 ha that will be managed in perpetuity for conservation.

There is potential for indirect impacts to the vegetation in the conservation areas from works proposed for the BEW DA and from subsequent residential development. Such indirect impacts include surface water runoff, changes to groundwater, and ongoing weed invasion. These impacts will be addressed by measures within the VMPs proposed for the conservation areas. Amelioration measures proposed are described in **Chapter 7**.

Table 15 Approximate areas of endangered ecological communities within the subject site and surrounds

Vegetation Community	Area in the Proposed Development Works Area (ha)	Area in the subject site (ha)	Area in the study area (ha)	Area in the local area (ha)
Cumberland Plain Woodland	22.68	34.68	76.30	1,151.69
Elderslie Banksia Scrub Forest	0.77	2.49	2.50	13.44
River-Flat Eucalypt Forest	1.51	9.96	58.70	809.44*
Swamp Oak Floodplain Forest	3.39	10.55	11.12	761.86*
Freshwater Wetlands	0.37	6.52	6.86	0.00

**These are both based on the area of Alluvial Woodland mapped in the local area plus the area of each community recorded within the study area*

6.1.1. Cumberland Plain Woodland

Cumberland Plain Woodland TEC can be a grassy woodland, with trees, shrubs, forbs and grasses, or a grassland state lacking trees and shrubs (derived native grassland).

Approximately 76 ha of the TEC is present within the study area and 23 ha within the proposed development works area. Occurrences within the proposed development works area generally comprise patches of woodland amid various types of grasslands. In total these amount to the following areas:

- ~11.94 ha of derived native grassland (~3.28 Shale Hills Woodland (derived native grassland) and ~8.67 ha Shale Plains Woodland (derived native grassland); and
- ~ 10.74 ha of woodland (~4.80 ha Shale Hills Woodland and ~5.94 ha Shale Plains Woodland).

As shown in **Figure 15** the largest, most continuous patches of woodland are in the Howes Creek and Northern Conservation Areas. Small to moderate sized patches of Shale Plains Woodland occur in the north of the subject site, isolated and surrounded by previously cleared lands.

Two larger Shale Hills Woodland patches occur along the southwest of the subject site that retain some connectivity with off-site vegetation within residential development to the west of the subject site along Cummins Road. These two patches are largely comprised of young trees lacking hollows and the ground stratum has been heavily modified. The northernmost patch occurs beside an old house site and has extensive garden escapes and high threat exotic weeds that dominate the ground stratum.

The main areas of derived native grasslands occur in the north of the subject site, on upper slopes, and these occurrences have lower densities of exotic plant species. There is also some derived native grassland in the southwest of the subject site, between two patches of Cumberland Plain Woodland.

6.1.2. Elderslie Banksia Scrub Forest

Approximately 2.50 ha of EBSF is present within the study area in the form of two larger patches, two small patches adjacent to other native vegetation communities and several small, isolated patches. One of the two larger patches will be conserved within Parks K, with the exception of the ~0.02 to be removed due for

remediation of contamination and then rehabilitated, and the two smaller patches adjacent to other native vegetation communities will be retained in Park L as shown in **Figure 15** and as detailed in VMP 2**.** One of the larger patches and one of the small, isolated patches to be removed occur within land that was previously used as an old fireworks factory and subsequently has contaminated soils. The soils require excavation for remediation and so these patches cannot be avoided or retained. This remediation will also involve the removal of a small portion of the northern corner of Park K, which will then be subsequently rehabilitated under the VMP (REF. 17072 RP29).

A moderately sized ~0.21 ha patch in the Stage 6B EBSF Conservation Area will now be conserved and retained, resulting in a total of 1.72 ha of EBSF being retained in the subject site, with an additional 0.56 ha to be revegetated in Park K. Therefore, a total of 2.28 ha of EBSF will be conserved in perpetuity.

Some very small patches of EBSF, which lack *Banskia integrifolia* and many other plant species typical of the community are isolated amid exotic grassland to the south of the remediation area. Because of their size, isolation and low diversity these occurrences are not proposed to be retained and, like the vegetation in the remediation area, will be subject to offsetting as explained in **Chapter 7**.

In total ~ 0.77 ha are proposed to be removed for the proposed development works.

6.1.3. River-flat Eucalypt Forest

This is a forest community where the final determination does not include derived native grasslands as part of the TEC. The community is widespread in the study area, with extensive mapped occurrences along the Nepean River, and along Howes Creek. In total about 58.7 ha of the community has been mapped (**Figure 15**).

Most of the TEC within the subject site is to be retained within the Howes Creek Conservation Area where it will be actively managed for conservation as set out in **Chapter 7** and VMP 1.

A small proportion of this community (~1.51 ha) occurs within the proposed development works area, mostly around the proposed Park L and as patch to the north of Park L (**Figure 15**).

Within the proposed development works area the community occurs as isolated patches or on the peripherals of larger patches that are generally bound by previously cleared lands. The community within the proposed development works area is substantially degraded from previous and current agricultural land uses.

6.1.4. Swamp Oak Floodplain Forest

This is a forest community where the final determination does not include derived native grasslands as part of the TEC.

Within the proposed development works area the community occurs as small, isolated patches in poorly drained depressions and as moderate sized patches that extend alongside riparian areas. Patches are generally degraded from previous and current agricultural land uses.

The community contains a canopy and mid-storey comprised entirely of the native *Casuarina glauca* (She Oak). Exotic shrubs are present in areas consisting of *Olea europaea* subsp. *cuspidata* (African Olive). Common native groundcover species include *Cynodon dactylon* (Couch), *Paspalum distichum* (Water Couch) and *Isolepis*

inundata. Exotic groundcovers include *Asparagus asparagoides* (Bridal Creeper), *Ehrharta erecta* (Panic Veldtgrass), *Plantago lanceolata* (Lamb's Tongue) and *Cirsium vulgare* (Spear Thistle). The community is widespread in the study area, with extensive mapped occurrences along the Nepean River, and along Howes Creek. In total about 11.12 ha of the community has been mapped in the study area (**Figure 15**).

Most of the TEC within the subject site (~7.16 ha or 68%) is to be retained within the Howes Creek Conservation Area where it will be actively managed for conservation as set out in **Chapter 7** and VMP 1. About 3.39 ha is located within the proposed development works area and will be cleared; however, approximately 0.77 ha of this is within the decontaminated land area in Howes Creek Riparian Corridor to be initially removed and then rehabilitated under the VMP (REF. 17072 RP36).

6.1.5. Freshwater Wetlands

Within the proposed development works area, the community largely occurs as the peripheral areas of a larger patch of Swamp Oak Floodplain Forest in the far north. The community is generally degraded from previous and current agricultural land uses. It may be a disclimax community created by the historic clearing of Swamp Oak Floodplain Forest and in some places scattered Swamp Oaks are regenerating along its margins.

A total of approximately 6.86 ha of Freshwater Wetlands is present within the study area and 6.52 ha within the subject site. The mapping of such reed lands in the wider study area is probably an underestimate and areas of the community may be mapped within other riparian communities along the Nepean River.

Extensive areas totalling ~ 5.37 ha (~93%) occur in the Howes Creek and Northern Conservation Area and the majority is proposed for conservation (**Figure 15**). About 0.37 ha (~7%) occurs within the proposed development area and will be removed.

6.2. Description of Endangered Ecological Communities Likely to be Affected

CER 6.2 Description of habitat

> *A full description of the type, location, size and condition of the habitat of the ecological community and details of the distribution and condition of similar habitats in the region (Section 110(3)(c)).*

CER 6.2.1 Description of ecological community and habitat

CER 6.2.2 Discussion of regional occurrences and the local occurrence

CER 6.3 Discussion of conservation status

The following are further requirements related to your obligation under Section 110(3)(b) to address the following:

> *for each ecological community present, details of its local, regional and State-wide conservation status, the key threatening processes generally effecting it, its habitat requirements and any recovery plan or any threat abatement plan applying to it.*

The following are further requirements related to your obligation under Section 110(3)(b1) to address the following:

an assessment of whether those ecological communities are adequately represented in conservation reserves (or other similar protected areas) in the region.

The following are further requirements related to your obligation under Section 110(3)(b2) to address the following:

an assessment of whether any of those ecological communities is at the limit of its known distribution.

The relative significance of the subject site for each EEC/CEEC in the locality must be discussed. Such an assessment must consider and compare the differences in the type, extent, quality and long-term security with other known occurrences and habitats in the locality with those in the study area.

The assessment should document and consider other now-extinct or diminished populations of each EEC/ CEEC in the locality and region and the fragmentation, decrease in extent or degradation of their habitats.

CER 6.4 Discussion of the likely effect of the proposal at local and regional scales

A full assessment of the likely effect of the action on those species and populations, including, if possible, the quantitative effect of local populations in the cumulative effect in the region (Section 110(2)(g)).

CER 6.4.1 Significance within a local context

CER 6.4.2 Extent of habitat removal or modification

CER 6.4.3 Discussion of connectivity

CER 6.4.4 Consideration of threatening processes

6.2.1. Cumberland Plain Woodland (CPW)

Cumberland Plain Woodland typically comprises an open tree canopy layer, sometimes with a shrub layer and groundcover dominated by grasses and herbs. Dominant canopy species are *Eucalyptus moluccana* (Grey Box) and *E. tereticornis* (Forest Red Gum), often with *E. crebra* (Grey Ironbark), *E. eugenioides* (Narrow-leaved Stringybark), *Corymbia maculata* (Spotted Gum) or other less frequently occurring eucalypts, including *Angophora floribunda*, *A. subvelutina* (Broad-leaved Apple), *E. amplifolia* (Cabbage Gum) and *E. fibrosa* (Broad-leaved Ironbark) (OEH 2017c). Soils within this community are derived from Wianamatta Group geology, typically on heavy clay soils. Less often the community can occur on alluvial substrates. Cumberland Plain Woodland can also include 'derived' native grasslands where canopy and shrubs have been largely or completely removed.

Within the subject site, Shale Hills Woodland, Shale Hills Woodland derived native grassland, Shale Plains Woodland and Shale Plains Woodland derived native grassland are present. All four vegetation communities conform to Cumberland Plain Woodland listed as a CEEC under the TSC Act.

A floristic summary of the both Shale Hills Woodland and Shale Plains Woodland is provided in **Table 16** and **Table 17** below, respectively (DECCW 2007).

Both Shale Hills Woodland and Shale Plains Woodland are referred to collectively as Cumberland Plain Woodland within the subsequent sections of this chapter.

Table 16 Floristic summary of Shale Hills Woodland

Stratum	Frequency (%)	Mean Height (m) (±sd)	Mean Foliage Cover (%) (±sd)	Typical Species
Tree	100	22.8 (6.1)	18.5 (9.4)	*Eucalyptus moluccana, Eucalyptus tereticornis, Eucalyptus crebra*
Small Tree	59	10.5 (4.2)	11.1 (11.4)	*Acacia implexa*
Shrub	95	3.8 (1.6)	19.6 (13.6)	*Bursaria spinosa*
Forb	100	0.5 (0.5)	43.9 (24.3)	*Brunoniella australis, Dichondra repens, Microlaena stipoides var. stipoides, Aristida ramosa, Cheilanthes sieberi subsp. sieberi, Desmodium varians, Themeda australis*

Source: (DECCW 2007)

Table 17 Floristic summary of Shale Plains Woodland

Stratum	Frequency (%)	Mean Height (m) (±sd)	Mean Foliage Cover (%) (±sd)	Typical Species
Tree	100	20.8 (5.1)	17.2 (9.3)	*Eucalyptus moluccana, Eucalyptus tereticornis, Eucalyptus crebra, Eucalyptus eugenioides, Eucalyptus fibrosa*
Small Tree	57	9.8 (3.5)	9.5 (7.3)	*Exocarpos cupressiformis, Acacia parramattensis subsp. parramattensis, Acacia decurrens*
Shrub	100	3.1 (1.3)	14.0 (9.6)	*Bursaria spinosa*
Forb	99	0.5 (0.5)	45.1 (19.2)	*Dichondra repens, Aristida vagans, Microlaena stipoides var. stipoides, Themeda australis, Brunoniella australis, Desmodium varians, Opercularia diphylla, Wahlenbergia gracilis and Dichelachne micrantha.*

Source: (DECCW 2007)

The geographic distribution of Cumberland Plain Woodland is limited to the Sydney Basin Bioregion. It has been estimated that approximately 9% of the original extent of the community currently exists as a result of a number of threats such as previous development, fragmentation and weed invasion (OEH 2017c).

6.2.1.1. Description of Habitat within the Study Area and Surrounds

i. The Study Area and Surrounds

Within the study area, the community occurs over an area of approximately 77 ha. For the purposes of this assessment, the study area is taken to span a wide area around the subject site. The reason for this is to take a broad assessment of the cumulative impacts of the project.

These occur as patches of varying size, with the largest patches located near Cummins Road along the western border of the study area, and around Howes Creek, along the northern border of the study area. The woodland patches in the north of the subject site are generally isolated and have little connectivity between patches or beyond the subject site. The Cumberland Plain Woodland around Howes Creek provides connectivity to woodland areas extending outside of the study area but is still part of a larger fragmented patch of woodland that is bound by cleared lands to the north and south, and the Hume Motorway and a rail corridor to the east and west, respectively. The two larger patches adjacent to Cummins Road in the west of the subject site have some connectivity continuing to the west through residential areas; however, this patch is also fragmented and does not have further connectivity to larger patches or corridors adjoining the Nepean River.

ii. Disturbance, Seed Bank and Recovery Potential

Disturbance on the study area is likely to have included clearing, soil disturbances, historical planting of non-endemic species and general weed invasion. Overall, the Cumberland Plain Woodland within the subject site and wider study area is dominated by exotics and in some areas lacks any native shrub layer.

Despite the level of disturbance within the study area, a seed bank is evident within all areas of Cumberland Plain Woodland. This is evidenced by native species regrowth appearing in the ground and/ or shrub layers, despite its current level of disturbance and weed invasion. Although areas of the community are degraded and currently dominated/co-dominated by exotic species, appropriate management would likely result in the community recovering to high condition over time. Areas of Shale Hills Woodland derived native grassland and Shale Plains derived native grassland are considered to require significant management over the long-term to recover to high condition.

Common weeds occurring within Cumberland Plain Woodland within the study area include *Lycium ferocissimum* (African Boxthorn), *Olea europaea* subsp. *cuspidata* (African Olive), *Gomphocarpus fruticosus* (Narrow-leaved Cotton Bush), *Eragrostis curvula* (African Lovegrass), *Sida rhombifolia* (Paddy's Lucerne) and *Asparagus asparagoides* (Bridal Creeper) and *Lolium perenne (*Perennial Ryegrass).

For the community to recover to high condition, the following management action would be required:

- Initial weed management to eradicate problematic weeds present;
- Ongoing weed management and monitoring;
- Planting of shrub/canopy species (Shale Hills Woodland derived native grassland only); and
- Restriction of human disturbances and access.

iii. Comparison with the Final Determination

The final determination for Cumberland Plain Woodland describes the community as typically containing an open tree canopy, groundcover dominated by grasses and herbs and sometimes layers of small trees and shrubs. The community also occurs as 'derived' native grasslands where canopy and shrubs have been largely or completely removed. The community persists on Wianamatta Group clay soils within the Sydney Basin Bioregion. The composition of the community can vary depending on factors including recent rainfall, disturbance, drought conditions and size of the site.

The community is currently known to occur within the LGAs of Auburn, Bankstown, Baulkham Hills, Blacktown, Camden, Campbelltown, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta, Penrith and Wollondilly.

The study area is located within the Campbelltown LGA and has been previously mapped as Shale Hills Woodland and Shale Plains Woodland, which are recognised as the CEEC. The soil landscape of the study area is mapped as the Blacktown landscape group (Hazelton and Tille 1990) which is consistent with the soils of the study area.

The number of characteristic species as per the community's final determination (NSW Scientific Committee 2011a) recorded within the 29 BBAM plots undertaken within the community within the study area (including 15 within the proposed development works area) in 2021 is 43 species. **Table 18** identifies the characteristic species recorded.

Table 18 Cumberland Plain Woodland characteristic species

Species	Species
Acacia decurrens	*Eragrostis leptostachya*
Acacia implexa	*Eriochloa pseudoacrotricha*
Aristida ramosa	*Eucalyptus crebra*
Asperula conferta	*Eucalyptus moluccana*
Bothriochloa decipiens	*Eucalyptus tereticornis*
Bothriochloa macra	*Euchiton sphaericus*
Brunoniella australis	*Glycine clandestina*
Bursaria spinosa	*Glycine microphylla*
Carex inversa	*Glycine tabacina*
Cheilanthes sieberi	*Hypericum gramineum*
Chloris ventricosa	*Juncus usitatus*
Commelina cyanea	*Lomandra filiformis subsp. filiformis*
Crassula sieberiana	*Microlaena stipoides*
Cymbopogon refractus	*Oxalis perennans*
Cyperus gracilis	*Panicum effusum*
Desmodium varians	*Paspalidium distans*

Species	Species
Dichondra repens	*Sida corrugata*
Einadia hastata	*Solanum prinophyllum*
Einadia nutans subsp. linifolia	*Sporobolus creber*
Einadia nutans subsp. nutans	*Themeda triandra*
Einadia polygonoides	*Veronica plebeia*
Einadia trigonos	

iv. Recovery Plan

A recovery plan has been developed for Cumberland Plain Woodland. The overall objective of the Recovery Plan (DECCW 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. The study area has not been mapped as priority conservation lands within the Campbelltown LGA.

v. Maps

Figure 15 shows the location of Cumberland Plain Woodland within the study area (i.e., locality) and subject site. Mapping of the community's occurrence within the local area is provided in **Figure 9**.

vi. CPW within the locality

Approximately 1,151.69 ha of Cumberland Plain Woodland is present in the local area (5 km radius of the study area) and ~76.30 ha is present in the locality (considered to comprise the study area). Many of the woodland occurrences of the community in the locality consist of small, fragmented patches, except for areas within the Howes Creek and Northern Conservation Areas and a further two areas along Cummins Road located to the south west of the subject site.

The fragmented nature of the vegetation in a 5 km radius of the study area is shown in **Figure 9**. Cumberland Plain Woodland is also highly fragmented on a regional level, and the community exists in a series of small remnant patches.

6.2.1.2. Discussion of conservation status

i. Conservation status

Cumberland Plain Woodland is listed as a CEEC under the TSC Act and EPBC Act. Within the subject site this community is determined to correspond to only the TSC Act listing for the community as described in the final determination (NSW Scientific Committee 2011a). Cumberland Plain Woodland within the subject site also meets the listing for the community under the EPBC Act following an assessment against the 'Flowchart of key diagnostic features and condition thresholds to identify the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community' on Page 11, Chapter 3 of the EPBC Guidelines on Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest. Both the Shale Hills Woodland and Shale Plains Woodland and their associated derived native grassland condition states meet the listing criteria, as described in ***Section 4.5***.

The significance of the Cumberland Plain Woodland in the subject site to the occurrence of this community in the region is relatively low due to its high degree of degradation and fragmentation. As discussed previously, except for the patch of the community around Howes Creek and the two larger patches adjacent to Cummins Road in the west, remaining areas of the community within the subject site exist as isolated woodland patches with little connectivity to adjoining habitat. Disturbance on the study area is likely to have included clearing, soil disturbances, historical planting of non-endemic species and general weed invasion. Overall, the Cumberland Plain Woodland within the subject site and study area is dominated by exotics and in some areas lacks any native shrub layer, and in others lacks a canopy cover. Due the threats identified above, in the absence of ongoing management, the Cumberland Plain Woodland in the subject site is considered likely to continue to degrade over time and lose biodiversity value. Larger areas of Cumberland Plain Woodland that are protected within conservation reserves in the region (e.g., Scheyville National Park and Mulgoa Nature Reserve), and those that are proposed to be protected and managed in the on-site conservation areas, are considered to have a much higher conservation significance than the degraded patches in the subject site.

ii. Key Threatening Processes

The following key threatening processes are considered to potentially impact Cumberland Plain Woodland:

- Clearing of native vegetation;
- Invasion of native plant communities by exotic perennial grasses;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of Lantana (Lantana camara L. sens. Lat);
- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*);
- Loss of hollow-bearing trees;
- Removal of dead wood and dead trees; and
- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

Other threats to the community include:

- The main threat is further clearing for urban or rural development, and the subsequent impacts from fragmentation;
- Grazing and mowing, which stops regrowth of the community;
- Inappropriate water run-off entering the site, which leads to increased nutrients and sedimentation;
- Weed invasion;
- Anthropogenic climate change; and
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity (OEH 2017).

The primary key threatening process relevant to the proposed development works is the clearing of native vegetation, as all of the community will be removed within the subject site.

iii. Habitat requirements

Cumberland Plain Woodland occurs on clay soils derived from Wianamatta Group geology, and less often on alluvial substrates. The community occurs up to 350 m in elevation on flat to undulating or hilly terrain (NSW Scientific Committee 2011a). The community is also restricted to the Sydney Basin Bioregion.

iv. Recovery or Threat Abatement Plan

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;

2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;

3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program; and

4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The Recovery Plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the subject site itself has not been mapped within the boundary of these priority conservation lands.

v. Conservation reserves

Known areas of Cumberland Plain Woodland within conservation reserves in the region include Kemps Creek, Mulgoa and Windsor Downs Nature Reserves, Scheyville National Park, Leacock Regional Park, and Rouse Hill and Western Sydney Regional Parks.

vi. Limit of distribution

Cumberland Plain Woodland occurs on clay soils derived from Wianamatta Group geology and is restricted to the Sydney Basin Bioregion. The community has been recorded from the Local Government Areas of Auburn, Bankstown, Baulkham Hills, Blacktown, Camden, Campbelltown, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta, Penrith and Wollondilly (NSW Scientific Committee 2011a). It occurs up to 350 m in elevation.

The study area is within the known distribution of the community.

6.2.1.3. Discussion of the likely effect of the proposal at local and regional scales

i. Significance within a local context

The local occurrence of Cumberland Plain Woodland is limited to the study area as defined in the Threatened Species Assessment Guidelines (DECC (NSW) 2007) as genetic transfer is unlikely to occur between the community present within the study area and nearby small isolated patches of the community that extend beyond the boundary of the study area. As the precise line of where the local occurrence ends is difficult to determine, for the purposes of this report we have assumed that the local occurrence is limited to the study area ('locality'), and the area within a 5 km radius from the study area is defined as the local area. The areas to be removed and retained at the local occurrence and local area scale for the proposed development works are shown in **Table 20**.

Table 19 Cumberland Plain Woodland at a local and regional scale

Vegetation Community	Local Occurrence (ha)	Local Occurrence Removal (ha)	Local Occurrence Retention	Local Area Occurrence (ha)	Local Area Retention
Cumberland Plain Woodland	76.30	22.68	70.26%	1,151.69	98.03%

Due to the already reduced extent and degraded nature of this community, the conservation of remaining remnants is critical to the recovery of the community. Although all remaining remnants are considered important to the long term survival of the community's local population, the removal of 22.68 ha within the proposed development works area is unlikely to contribute to the extinction of the community's local occurrence as the majority of the community's local occurrence will be retained. This includes the retention of the largest patches of the community present with the Howes Creek riparian corridor and in the northeast of the study area. In addition to the areas retained within the study area, additional areas of the community in better condition will be retained within the local area locality, including areas within Mt Annan and Camden Park, which will be retained in perpetuity as they contain priority conservation lands.

Furthermore, appropriate offsetting can improve the recovery and long-term viability of better condition patches of the community in the locality, which will occur under the proposed development works. Offsetting details are discussed in **Chapter 7**.

In addition to the removal of 22.68 ha of Cumberland Plain Woodland, there is potential for indirect impacts to occur on areas of Cumberland Plain Woodland that are being retained outside the subject site. This includes potential for increased weed invasion, sedimentation from construction in the subject site, and increased impacts of noise, dust and light. Indirect impacts have potential to further degrade areas of retained native vegetation. That notwithstanding, a range of mitigation measures will be implemented to avoid indirect impacts on areas of Cumberland Plain Woodland, including erosion and sedimentation control measures, hollow offset replacement strategy and weed management. It is considered that with the implementation of these measures, indirect impacts can be managed and appropriately mitigated.

Due to the already reduced extent and degraded nature of this community, the conservation of remaining remnants is critical to the recovery of the community.

Significant areas of the community are proposed to be retained under the Master Plan submitted to Council including land within the Howes Creek riparian corridor that are owned by the proponent (see **Figure 2**). A total of approximately 12.00 ha of Cumberland Plain Woodland is proposed to be retained within the conservation areas, with a further 11.55 ha proposed to be revegetated. This will result in a combined conservation area of ~23.55 ha of Cumberland Plain Woodland within the proponent's landholding.

Furthermore, all impacts on this community will be offset through the retirement of ecosystem credits and a range of offsetting and associated management measures have been proposed that will improve the recovery and long-term viability of better condition patches of the community in the study area (e.g., Cumberland Plain Woodland within the Howes Creek riparian corridor). These include provision for weed management, a hollow replacement strategy, and pre-clearance/clearance surveys.

ii. Extent of habitat removal or modification

The proposal will result in the complete removal of 22.68 ha of Cumberland Plain Woodland within the subject site, comprising ~11.94 ha of derived native grassland and ~10.74 ha of woodland. Within the study area there is 76.30 ha of Cumberland Plain Woodland and 1,151.69 ha in a 5 km radius of the study area. This equates to the removal of approximately 29.74% from the study area and 1.97% of the community's extent within a 5 km radius of the study area. It is also likely that additional areas of Cumberland Plain Woodland occur within the local area in the form of derived native grasslands that have not been included within the broad-scale mapping, as observed within the existing mapping of the study area which did not include derived native grasslands.

A cumulative total of approximately ~12.00 ha of the community is proposed to be retained within the conservation areas, with a further 11.55 ha revegetated to Cumberland Plain Woodland. Due to the proposed conservation of these areas of Cumberland Plain Woodland, the cumulative impacts of vegetation removal because of the proposed development works and other proposals within the Menangle Park URA are not considered likely to affect the long-term security of the local occurrence of the community in the study area. In addition, there is potential for indirect impacts to occur on areas of this community that are being retained outside the subject site as identified above. A range of mitigation measures will be implemented to avoid indirect impacts, and it is considered that with the implementation of these measures, indirect impacts can be managed and appropriately mitigated.

6.2.1.4. Discussion of connectivity

The Cumberland Plain Woodland to be removed occurs predominately as small isolated patches within the subject site. The removal of the community within the subject site will further encroach on the community's current extent, however, it will not result in substantial further fragmentation as the vegetation to be removed provides no connectivity to any large tracts of vegetation, including any nearby reserves or National Parks.

i. Consideration of threatening processes

The primary key threatening process relevant to the proposed development works is the clearing of native vegetation, as 22.68 ha of Cumberland Plain Woodland will be removed within the subject site. Although a moderate area of the community will be removed, compensatory measures are proposed that will adequately

offset the impacts to the community and ensure that its local occurrence is not placed at risk of extinction. This includes the conservation, revegetation and management of ~23.55 ha of the community within the subject land in perpetuity as well as the purchase and retirement of additional credits.

In addition, the following key threatening process have the potential to impact on Cumberland Plain Woodland:

Invasion of native plant communities by exotic perennial grasses

The proposed development works have the potential to result in the spread of exotic weeds both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion and establishment of exotic vines and scramblers

The proposed development works have the potential to result in the spread of exotic weeds both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The subject site currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion of native plant communities by African Olive (*Olea europaea L. subsp. cuspidata)*

The subject site currently contains a high abundance of African Olive in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

The proposed development works are unlikely to contribute to high frequency fire further than current conditions.

Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Future development will facilitate have the potential to contribute to this key threatening process. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process.

Anthropogenic climate change

It is not considered likely that the proposed development works will exacerbate anthropogenic climate change.

6.2.2. Elderslie Banksia Scrub Forest

Elderslie Banksia Scrub Forest is present as small, isolated patches located on deep sandy soils. It is in places dominated by taller trees, and in others it is a scrub dominated community that has a diverse shrubby understorey. The dominant canopy species is typically *Banksia integrifolia* subsp. *integrifolia* (Coastal Banksia), but *Angophora subvelutina* (Broad-leaved Apple) is also often present. The understorey of the community is usually diverse and comprised of species typical of sandstone areas including *Ricinocarpos pinifolius* (Wedding Bush), *Pimelea linifolia* subsp. *linifolia* (Rice-flower) and *Brachyloma daphnoides* (Daphne Heath). The soils of this community consist of sand deposits on old terraces that have been deposited by ancient river systems that are now known as the Nepean River. The community requires deep sandy soil to fully regenerate. Elderslie Banksia Scrub Forest often intergrades with River-flat Eucalypt Forest and/or Cumberland Plain Woodland (OEH 2018e).

Within the overall subject site, there is about 2.49 ha of the forest, of which the majority, including the largest patch, is to be conserved. In the footprint of the proposed development works, several patches occur, including one larger patch and a number of smaller patches totalling ~0.77 ha. The community has been degraded by livestock grazing, with patches isolated amid grasslands. Rabbits are abundant in the sandy soils that support this community and have impacted the ground stratum.

Following a comparison with the final determination for EBSF (NSW Scientific Committee 2015), all areas of the community mapped by Cumberland Ecology within the subject site conform to EBSF listed as a CEEC under the TSC Act. The area mapped as EBSF (non-TEC) do not conform to the CEEC and are not included within this section. Within the study area, EBSF is present as small to medium sized patches located on sandy soils.

The geographic distribution of EBSF is limited to Camden, Elderslie and Sydney's south-west. It has been estimated that the total area of remaining remnants of this community is as high as 17.3 ha and as low as less than 15 ha. The community has been extensively cleared previously for sand mining, agricultural purposes and more recently for residential development. As a result, only small isolated patches of the community remain that are threatened by further development and associated nutrient enrichment (NSW Scientific Committee 2015).

6.2.2.1. Description of Habitat within Study Area and Surrounds

i. The Study Area and Surrounds

Within the study area, the community occurs as scattered patches that are almost surrounded by previously cleared lands. The most extensive area of the community within the study area is in the centre of the study area, to the south of Howes Creek. Areas of the community are all on sandy soils, and typically contain a dense shrub layer and remnant canopy trees. The total area of the community in the study area is 2.50 ha. The habitat present, although isolated and exposed to a high degree of edge effects, may be utilised by a suite of native fauna species, including threatened bats and birds.

ii. Disturbance, Seed Bank and Recovery Potential

Disturbance within the study area is likely to have included clearing, soil disturbances, grazing, and general weed invasion. Overall, the Elderslie Banksia Scrub within the study area is in moderate condition. Strata are generally dominated by native species, and although exotic weed species are common the sandy low-nutrient soils have resulted in less intense weed invasion than surrounding communities on more fertile soils. The ground layer of patches generally contains large occurrences of exotic species such as *Ehrharta erecta*, and *Eragrostis curvula*. The patches are not particularly diverse in species composition when compared to the description in the final determination (NSW Scientific Committee 2015), though additional species are present that are likely naturally occurring that are not listed in the final determination.

A seed bank is evident within all areas of the community. This is evidenced by native species regrowth appearing in the ground layer, and shrub layer despite weed invasion. Evidence of regrowth of the shrub/tree layer is indicated by the presence of juvenile *Angophora floribunda* and *Banksia integrifolia*. Although the community is not in a high condition, appropriate management would likely result in the community recovering to a better condition over time. In order for the community to recover to high condition, the following management action would be required:

- Initial weed management to eradicate problematic weeds present, with a targeted focus on exotic grasses;
- Grazing exclusion;
- Ongoing weed management and monitoring;
- Planting of shrub and ground cover species; and
- Restriction of human disturbances and access.

iii. Comparison with the Final Determination

The final determination for EBSF describes the community as occurring generally as an open-scrub or woodland that may occur as remnant trees. The community typically is associated with is associated with alluvium of tertiary age, soils on which are sandy and may be well-drained or poorly drained. The composition of the community depends on local topography and drainage conditions.

The community at the time of the preparation of the final determination was known to occur within the Camden LGA only principally near Elderslie in the area known as Spring Farm.

The study area is located within the Campbelltown LGA, though is located within a kilometre of the boundary with Camden LGA, and approximately 3 km from Spring Farm. The site is bound by the Nepean River on the western and southern boundary, and patches of the community are located on a large mass of loose sand which runs through the study area in a north-westerly to south-easterly direction around the north of the township of Menangle Park.

The number of characteristic species as per the community's final determination (NSW Scientific Committee 2009) recorded within the three BBAM plots undertaken within the community within the study area (two within the subject site) in 2021 is seven species. **Table 20** identifies the characteristic species recorded.

Table 20 Elderslie Banksia Scrub Forest characteristic species recorded within the study area

Scientific Name	Scientific Name
Angophora subvelutina	*Imperata cylindrica*
Duboisia myoporoides	*Kunzea ambigua*
Glycine clandestina	*Pteridium esculentum*
Hibbertia diffusa	

iv. Recovery Plan

The Cumberland Plain Recovery Plan (2011) has been developed for the Cumberland Plain, but EBSF was specifically excluded from the recovery plan. It states, 'EBSF will also be excluded from consideration in this recovery plan as the future of the remaining area of this threatened ecological community at Spring Farm, Camden has already been determined through the land-use planning system' (see Section 2, page 3 of The Cumberland Plain Recovery Plan).

v. Maps

Figure 15 shows the location of Elderslie Banksia Scrub within the study area. Mapping of the community's occurrence within the local area is provided in **Figure 9**.

vi. Elderslie Banksia Scrub Forest within the locality

The extent of EBSF in the locality is 2.50 ha. It has been estimated that the total area of remaining remnants of this community is as high as 17.3 ha and as low as less than 15 ha (NSW Scientific Committee 2015). These estimates appear to be limited to the Spring Farm area near Elderslie, with the nearest patch approximately 2 km to the north-west of the study area boundary. The estimates provided in the community's final determination are likely underestimations of the community's remaining remnants as previously unmapped remnants were recorded for this SIS. The community has the potential to occur further west of the study area in areas that may have been incorrectly mapped in regional mapping schemes as Alluvial Woodland or Shale Plains Woodland outside of the proponent's landholdings.

6.2.2.2. Discussion of conservation status

i. Conservation status

Elderslie Banksia Scrub Forest is listed as a CEEC under the TSC Act as well as the EPBC Act.

The majority of the EBSF that occurs in the study area will be retained. The significance of the retained areas of EBSF in the study area to the conservation of this community in the region is relatively high due to very small area of this community that remains (approximately 15 ha in total).

The relative significance of the occurrence in the subject site is limited by its high degree of degradation and fragmentation. All areas of the community within the study area exist as isolated patches with little to no connectivity to adjoining habitat. Disturbance on the study area is likely to have included clearing, soil disturbances, historical planting of non-endemic species and general weed invasion. Overall, the EBSF within the study area is dominated by exotics and in some areas lacks any native shrub layer. Due the threats identified above, in the absence of ongoing management, the EBSF in the subject site is considered likely to continue to degrade over time and lose biodiversity value. Accordingly, it is proposed that 1.72 ha of the 2.50 ha within the study area will be retained under 20-year VMPs prepared based on the monitoring and management measures required of a BSA.

ii. Key Threatening Processes

The following key threatening processes are considered to potentially impact EBSF:

- Clearing of native vegetation;
- Invasion of native plant communities by exotic perennial grasses;
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat);
- Invasion of native plant communities by African Olive (*Olea europaea L.* subsp. *cuspidata)*;
- Loss of hollow-bearing trees;
- Removal of dead wood and dead trees;
- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition; and
- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'.

Other threats to the community include:

- The main threat is further clearing for urban or rural development, and the subsequent impacts from fragmentation;
- Grazing and mowing, which stops regrowth of the community.
- Inappropriate water run-off entering the site, which leads to increased nutrients and sedimentation;

- Weed invasion;
- Urbanisation;
- Anthropogenic climate change; and
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.

iii. Habitat requirements

Elderslie Banksia Scrub Forest occurs on soils formed on Tertiary alluvium which are sandy with good to poor drainage. The soils are sand deposits on old terraces deposited by ancient river systems of what is now the Nepean River. The alluvium occurs on sites which are elevated in relation to the current bed of the Nepean River. Elderslie Banksia Scrub Forest within the study area fits the habitat requirements for this community as it occurs on sandy substrates associated with and at higher elevations than the Nepean River (NSW Scientific Committee 2009).

iv. Recovery or Threat Abatement Plan

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;

2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;

3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program; and

4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The recovery plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the study area itself has not been mapped within the boundary of these priority conservation lands.

Elderslie Banksia Scrub Forest was specifically excluded from the recovery plan which states EBSF will also be excluded from consideration in this recovery plan as the future of the remaining area of this threatened ecological community at Spring Farm, Camden has already been determined through the land-use planning system.

It is assumed that when the recovery plan for the Cumberland Plain and the final determination for Elderslie Banksia Scrub were developed, that the community was only known to occur within the Camden Council LGA in the Spring Farm locality. As a result of the fieldwork undertaken for this SIS, the extent of EBSF has now been expanded from what was previously referenced. If the true extent of the community was known at the time of

developing the final determination and recovery plan, it is reasonable to assume that the areas of EBSF within the study area would have been included as priority lands.

Nevertheless, the proposed compensatory measures for this community would be generally consistent with the recovery plan as approximately 1.72 ha the community within the subject land will be conserved and managed in perpetuity under VMPs. The VMPs will conserve a total of 1.72 ha of extant vegetation of the community as well as revegetate an additional 0.56 ha of the community within areas with deep sandy soils surrounding the extant vegetation in Park K. As a result, with the implementation of the VMPs, approximately 2.28 ha of the community is expected to persist within the subject land in the long-term. Offsetting details are discussed in **Chapter 7**.

v. Conservation reserves

Elderslie Banksia Scrub is not known to occur within any conservation reserves. Elderslie Banksia Scrub Forest remaining in the Spring Farm area is afforded some level of protection in a bushland corridor associated with development in the area.

vi. Limit of distribution

Elderslie Banksia Scrub Forest has a very limited known distribution primarily occurring within the Spring Farm locality near Elderslie, in Camden LGA, and the Menangle Park locality, within Campbelltown LGA, solely within the study area.

6.2.2.3. Discussion of the likely effect of the proposal at local and regional scales

i. Significance within a local context

The local occurrence of Elderslie Banksia Scrub is limited to the study area as defined in the *Threatened Species Assessment Guidelines* (DECC (NSW) 2007) as genetic transfer is unlikely to occur between the community present within the study area and the nearest known occurrences which are further than 2 km away between the nearest patch within the study area and patch in the Spring Farm area.

As the precise line of where the local occurrence ends is difficult to determine, for the purposes of this report, we have assumed that the local occurrence is limited to the study area (approximately 2.50 ha).

Approximately 2.50 ha are present in the study area and up to 19.8 ha within the local area (study area plus 17.3 ha Spring Farm occurrence) (**Table 22**), noting that only 13.44 ha was recorded in the local area based on the existing broad-scale mapping. The proposed development works will result in the clearance of approximately 30.8% (0.77 ha) of the community's occurrence in the study area, which represents 3.89% of the community's extent within the local area utilising mapping provided by OEH (2013) and the Cumberland Ecology mapping within the study area.

Due to the already reduced extent and degraded nature of this community, the conservation of remaining remnants is critical to the recovery of the community. Although all remaining remnants are considered important to the long-term survival of the community's local population, the removal of 0.77 ha within the subject site is unlikely to contribute to the extinction of the community's local occurrence as all remaining areas of the community within the subject land will be conserved and managed in perpetuity under VMPs. The VMPs will conserve a total of 1.72 ha of extant vegetation of the community as well as revegetate an additional

0.56 ha of the community within areas with deep sandy soils surrounding the extant vegetation in Park K. As a result, with the implementation of the VMPs, approximately 2.28 ha of the community is expected to persist within the subject land in the long-term. Offsetting details are discussed in **Chapter 7**.

In addition to the areas proposed to be conserved within the subject land, additional areas of the community in better condition will be retained within the local area, in the Spring Farm area.

Table 21 Elderslie Banksia Scrub Forest at a local and regional scale

Vegetation Community	Local Occurrence (ha)	Local Occurrence Removal (ha)	Local Occurrence Retention	Local Area Occurrence (ha)	Local Area Retention
Elderslie Banksia Scrub Forest	2.50	0.77	60.8%	13.44	92.71%

The long-term security of the local occurrence of this community is currently very low, and in the absence of any management the threatening processes that are operating will continue unchecked, threatening the long-term viability of this community in the study area. The proposal will result in the conservation and management of ~2.28 ha of EBSF in the study area that will be managed for conservation in the long term, thereby increasing its security and long-term viability.

ii. Extent of habitat removal or modification

The proposed development works will result in the removal of 0.77 ha of EBSF within the subject site. Within the study area and local area, a total of 2.50 ha and 13.44 ha of the community is present, respectively. The proposed development works equates to the removal of 39.2% community's extent within the study area and 7.29% within the local area.

There is potential for indirect impacts to occur on areas of this community that are being retained outside the subject site. This includes potential for increased weed invasion, sedimentation from construction in the subject site, and increased impacts of noise, dust and light. Indirect impacts have potential to further degrade areas of retained native vegetation. That notwithstanding, a range of mitigation measures will be implemented to avoid indirect impacts, including erosion and sedimentation control measures, hollow offset replacement strategy and weed management. It is considered that with the implementation of these measures, indirect impacts can be managed and appropriately mitigated.

Taking into consideration previously approved DAs and currently submitted DAs a total of 0.77 ha of EBSF is proposed to be removed by the Master Plan. However, a cumulative total of approximately 1.72 ha of EBSF is proposed to be retained for conservation and management in two areas referred to as Parks K and L and the Stage 6B EBSF Conservation Area.

Parks K and L contain the largest patch of EBSF within the study area and Park L includes the only patch containing *Banksia integrifolia*. The avoidance and future conservation of these two parks has been negotiated with Council and the option to manage the area under a Biodiversity Stewardship Agreement (BSA) has been explored by Dahua. The Biodiversity Conservation Trust (BCT) does not support the parks being managed as a

BSA due to their degraded and fragmented nature. Therefore, management of such areas under a VMP provides the best remaining conservation outcome for the parks and will be implemented as part of this DA to ensure these local occurrences of the community persists in the long-term. The Stage 6B EBSF will also be managed under a VMP that will be prepared as a Condition of Consent and will include the same management strategies as those included in the Park K and L VMP (REF: 17072RP29).

Ongoing vegetation monitoring of the areas of EBSF to be retained within Parks K and L has commenced as part of the approved Stage 2A development (which comes within ~10m of extant vegetation within Park L) with no impacts detected to the community recorded to date.

Due to the proposed conservation of these areas of EBSF, the cumulative impacts of limited proposed vegetation removal in the Menangle Park URA are not considered likely to affect the long-term security of the local occurrence of EBSF in the study area.

iii. Discussion of connectivity

The EBSF to be removed occurs predominately as small isolated patches within the subject site. The removal of the community within the subject site will further encroach on the community's current extent, which is limited, however, it will not result in further fragmentation as the vegetation to be removed provides no connectivity to any large tracts of vegetation, including any nearby reserves or National Parks.

iv. Consideration of threatening processes

The following key threatening process have the potential to impact on EBSF:

Clearing of native vegetation

Approximately 0.77 ha of EBSF will be removed for the proposed development works. Although a moderate area of the community will be removed, all remaining areas of the community are considered to be important to the community's long-term survival in the locality. In order to compensate for the removal of the community, 1.72 ha of the community will be conserved and managed in perpetuity. An additional 0.56 ha will also be revegetated around the extant vegetation in Park K.

Invasion of native plant communities by exotic perennial grasses

The proposed development works have the potential to result in the spread of exotic grasses both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under VMPs that will minimise the key threatening processes. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion and establishment of exotic vines and scramblers

The proposed development works have the potential to result in the spread of exotic weeds both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed VMPs that will minimise the key threatening process. Furthermore, mitigation

measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The subject site currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under VMPs that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata)*

he subject site currently contains a high abundance of African Olive in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under VMPs that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

The proposed development works are unlikely to contribute to high frequency fire further than current conditions as bushfire APZs will be implemented.

Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Future development has the potential to contribute to this key threatening process, but this is unlikely to occur until development within the subject site is completed and housing is occupied.

Areas of the community to be retained are proposed to be managed under VMPs that will include a requirement of fencing (noting that fencing has already been installed as a condition of consent for a separate DA around Park K and L), educational signage and ongoing management including the removal of rubbish. The proposed ongoing management of retained areas is considered to appropriately mitigate any impacts on the community associated with urbanisation and human behaviour. It is not considered that urban development will increase impacts of threatening processes on the community because these areas to be retained have been previously cleared and until recently were cattle grazed. Therefore, they are already degraded and suffering from a variety of ongoing threats. The small size and poor condition of these patches has ruled them out for Stewardship Agreements by the BCT, however, they will be conserved and managed in

perpetuity under 20-year VMPs that include the monitoring and management measures that would apply to a BSA.

6.2.3. River-flat Eucalypt Forest

River-flat Eucalypt Forest is found on coastal floodplains and has a tall canopy of eucalypts. The most widespread canopy trees include *Eucalyptus tereticornis*, *E. amplifolia*, *Angophora floribunda* and *A. subvelutina*. It may have a layer of small trees and a scattering of shrubs. Small trees and shrubs characteristic of the community include *Melaleuca styphelioides* (Prickly-leaved Teatree), *Backhousia myrtifolia* (Grey Myrtle), *Melia azedarach* (White Cedar), *Casuarina cunninghamiana* (River Oak), *Casuarina glauca* (Swamp Oak), *Bursaria spinosa* (Blackthorn), *Solanum prinophyllum* (Forest Nightshade), *Rubus parvifolius* (Native Raspberry) and *Breynia oblongifolia* (Coffee Bush). The ground cover consists of abundant forbs, scramblers and grasses including *Microlaena stipoides* (Weeping Grass), *Dichondra repens* (Kidney Weed), *Glycine clandestina*, *Oplismenus aemulus* (Australian Basket Grass) and *Oxalis perennans*. This community occurs on alluvial soils on river-flats of the NSW North Coast, Sydney Basin and South East Corner bioregions (OEH 2019c).

Within the subject site, River-flat Eucalypt Forest is present as fragmented patches on alluvial soils within depressions. Following a comparison with the final determination for River-flat Eucalypt Forest (NSW Scientific Committee 2011c), all areas of the community within the study area conform to River-flat Eucalypt Forest listed as an EEC under the TSC Act.

This community contains a canopy comprised of mature *Eucalyptus amplifolia* (Cabbage Gum) trees and a mid-storey of mature *Casuarina glauca* (Swamp Oak) and regrowth *Eucalyptus amplifolia* (Cabbage Gum). Native shrub species present include regrowth *Casuarina glauca* (Swamp Oak) and *Eucalyptus amplifolia* (Cabbage Gum), and *Melaleuca linearifolia* (Flax-leaved Paperbark). Exotic shrubs include *Olea europaea* subsp. *cuspidata* (African Olive). Common native groundcover species include *Microlaena stipoides* (Weeping Grass), *Persicaria decipiens* (Slender Knotweed) and *Cynodon dactylon* (Couch). Common exotic groundcover species includes and *Ehrharta erecta* (Panic Veldtgrass) and *Asparagus asparagoides* (Bridal Creeper).

The geographic distribution of River-Flat Eucalypt Forest extends as far north as the NSW North Coast and south as the southern border of NSW. It is estimated that less than 30% of its original extent still remains. Threats to the community include further land clearing and degradation of existing patches by weed invasion, grazing and pollution (NSW Scientific Committee 2011c).

Detailed estimates of the entire remaining area of remnants of the community have not been undertaken as not all areas the community occurs in have been subject to detailed vegetation mapping schemes. Remaining areas of the community are likely to represent significantly less than 30% of the pre-European extent of the community and less than 13,000 ha is estimated to remain in the Hunter, Sydney to Moruya, and Eden regions (NSW Scientific Committee 2011c).

6.2.3.1. Description of Habitat within Study Area and Surrounds

i. The Study Area and Surrounds

Within the study area, the community occurs as scattered patches that are almost entirely surrounded by previously cleared lands. The most extensive areas of the community within the study area are located in the

west of the study area along the Nepean River and in the centre of the study area, along Howes Creek. The total area of the community in the study area is 58.70 ha. All areas of the community are comprised of a remnant canopy. The habitat present, although bound by cleared lands, may be utilised by a number of native fauna species, including threatened bats and birds.

ii. Disturbance, Seed Bank and Recovery Potential

Disturbance within the study area is likely to have included clearing, soil disturbances, grazing, and general weed invasion. Overall, the River-flat Eucalypt Forest within the study area is in moderate condition. Strata are generally dominated by native species, although exotic weed species are common to dominant in some areas in the shrub and ground layers. The ground layer of patches varies, and in some areas is dominated by exotic species such as *Ehrharta erecta*, and *Eragrostis curvula*. The patches are not particularly diverse in species composition when compared to the description in the final determination (NSW Scientific Committee 2011c), though additional species are present that are likely naturally occurring that are not listed in the final determination.

A seed bank is evident within all areas of the community. This is evidenced by native species regrowth appearing in the ground layer, and shrub layer despite weed invasion. Evidence of regrowth of the shrub/tree layer is indicated by the presence of juvenile *Eucalyptus amplifolia*. Although the community is not in a good condition, appropriate management would likely result in the community recovering to a better condition over time. In order for the community to recover to high condition, the following management action would be required:

- Initial weed management to eradicate problematic weeds present, with a targeted focus on exotic grasses;
- Grazing exclusion;
- Ongoing weed management and monitoring;
- Planting of shrub and ground cover species; and
- Restriction of human disturbances and access.

iii. Comparison with the Final Determination

The final determination for River-flat Eucalypt Forest describes the community varying in structure from tall open forests to woodlands that may have a canopy reduced to scattered trees due to clearing. The community typically is associated with is associated with silts, clay-loams, and sandy loams, on periodically inundated alluvial flats, drainage lines, and river terraces. The composition of the community depends on the frequency and duration of waterlogging and the texture, nutrient, and moisture content of the soil.

The community is known to occur within the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Eastern Capital City Regional, Eurobodalla and Bega Valley.

The study area is located within the Campbelltown LGA. The site is bound by the Nepean River on the western and southern boundary, and River-flat Eucalypt Forest within the study area is associated floodplains/banks of the Nepean River, and Howes Creek and smaller tributaries at higher elevations within the central area of the study area.

The number of characteristic species as per the community's final determination (NSW Scientific Committee 2009) recorded within the six BBAM plots undertaken within the community within the study area (one within the subject site) is 27 species. **Table 23** identifies the characteristic species recorded.

Table 22 River-flat Eucalypt Forest characteristic species recorded within the study area

Scientific Name	Common Name
Angophora subvelutina	*Eucalyptus tereticornis*
Backhousia myrtifolia	*Geranium solanderi*
Bursaria spinosa	*Glycine clandestina*
Casuarina cunninghamiana	*Glycine microphylla*
Casuarina glauca	*Melaleuca linariifolia*
Cheilanthes sieberi	*Microlaena stipoides*
Clematis glycinoides	*Oplismenus aemulus*
Dichondra repens	*Oxalis perennans*
Einadia hastata	*Persicaria decipiens*
Entolasia marginata	*Poranthera microphylla*
Eucalyptus amplifolia	*Pteridium esculentum*
Eucalyptus botryoides	*Solanum prinophyllum*
Eucalyptus elata	*Veronica plebeia*
Eucalyptus moluccana	

iv. Recovery Plan

A recovery plan has been developed for the Cumberland Plain, which includes River-flat Eucalypt Forest. The overall objective of the Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. The study area has not been mapped as priority conservation lands within the Campbelltown LGA.

v. Maps

Figure 15 shows the location of River-flat Eucalypt Forest within the study area and subject site. Mapping of the community's occurrence within the local area is provided in **Figure 9.**

vi. River-flat Eucalypt Forest within the locality

Approximately 809.44 ha of Alluvial Woodland is present in the local area (see **Figure 9**). Within the local area, this community is comprised of both River-flat Eucalypt Forest and Swamp Oak Floodplain Forest as described

by Tozer (2010). The majority of the occurrences of the community in the locality consist of small, fragmented patches, similar to its occurrences within the local area with the exception of an area to the west of the study area in Camden Park where more substantial areas occur along creeks and floodplains. The River-flat Eucalypt Forest within the study area does not have connectivity to these larger areas of Alluvial Woodland.

The fragmented nature of the vegetation in the locality and the local area is shown in **Figure 9**. The community is also highly fragmented on a regional level, and the community exists in a series of small to medium size remnant patches.

6.2.3.2. Discussion of conservation status

i. Conservation status

River-flat Eucalypt Forest is listed as an EEC under the TSC Act. All patches within the study area are considered to conform to the TSC Act listing as they have canopy, shrub, and ground layer species consistent with the description of the community in the final determination (NSW Scientific Committee 2011c).

The woodland condition state of River-flat Eucalypt Forest in the subjects site is also considered to form the EPBC Act listed Coastal Floodplain Eucalypt Forest of Eastern Australia CEEC following an assessment against the 'Table 1: Condition thresholds and categories for patches of Coastal floodplain eucalypt forest of eastern Australia' on Page 18 of the EPBC Draft Conservation Advice (incorporating listing advice) for Coastal floodplain eucalypt forest of eastern Australia (REF), as described in ***Section 4.5***. The derived native grassland condition state, which is not present within the subject site, does not meet the listing criteria for the EPBC Act.

~1.51 of River-flat Eucalypt Forest occurs within the subject site and will be removed, though ~8.44 ha of woodland and ~ 0.19 ha of derived native grassland will be retained within the on-site conservation areas, not including the additional River-flat Eucalypt Forest adjacent to the Nepean in the south of the study area; where further retention will occur as part of the riparian corridor. Furthermore, ~3.84 ha of exotic grassland within the Howes Creek conservation area and will be revegetated, resulting in over 12 ha of River-flat Eucalypt Forest conserved and managed in perpetuity under a VMP.

ii. Key Threatening Processes

The following key threatening processes are considered to potentially impact River-flat Eucalypt Forest:

- Clearing of native vegetation;
- Invasion of native plant communities by exotic perennial grasses;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of Lantana (Lantana camara L. sens. Lat);
- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*);
- Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners;
- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants; and
- 'Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.

Other threats to the community include:

- The main threat is further clearing for urban or rural development, and the subsequent impacts from fragmentation;
- Flood mitigation and drainage works;
- Grazing and mowing, which stops regrowth of the community;
- Landfilling and earthworks associated with urban and industrial development;
- Overgrazing, trampling, and other soil disturbance from domestic livestock including pigs;
- Activation of 'acid sulphate soils';
- Inappropriate water run-off entering the site, which leads to increased nutrients and sedimentation;
- Weed invasion;
- Anthropogenic climate change;
- Urbanisation; and
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.

iii. Habitat requirements

River-flat Eucalypt Forest is associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The soils the community occurs on within the study area are associated with the floodplains and channels of the Howes Creek and smaller tributaries, and are subject to varying levels of periodic inundation (NSW Scientific Committee 2011c).

iv. Recovery or Threat Abatement Plan

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;

2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;

3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program;

4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The Recovery Plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the subject site itself has not been mapped within the boundary of these priority conservation lands.

v. Conservation reserves

River-flat Eucalypt Forest is known to occur within Blue Mountains, Cattai, Dharug, Georges River, Marramarra, Morton, Deua and Wadbilliga National Parks, and Gulguer and Mulgoa Nature Reserves.

vi. Limit of distribution

River-flat Eucalypt Forest is distributed from the North Coast bioregion south to the South-east Corner bioregion.

6.2.3.3. Discussion of the likely effect of the proposal at local and regional scales

i. Significance within a local context

The local occurrence of River-flat Eucalypt Forest is limited to the study area as defined in the *Threatened Species Assessment Guidelines* (DECC (NSW) 2007) as genetic transfer is unlikely to occur between the community present within the study area and isolated patches outside of the study area. Within the study area, 58.70 ha of the community is present. The areas to be removed and retained at the local occurrence and local area scale for the proposed development works are shown in **Table 24**.

Table 23 River-Flat Eucalypt Forest at a local and regional scale

Vegetation Community	Local Occurrence (ha)	Local Occurrence Removal (ha)	Local Occurrence Retention	Local Area Occurrence (ha)	Local Area Retention
River-Flat Eucalypt Forest	58.70	1.51	97.4%	809.44	99.81%

It is acknowledged that previously approved DAs and currently submitted DAs propose some minor clearing of the community's local occurrence. A total of 1.51 ha of River-flat Eucalypt Forest is proposed to be removed. However, a cumulative total of approximately 11 ha of River-flat Eucalypt Forest is proposed to be retained within the Menangle Park URA under the proposed Master Plan. Additional areas of the community will also be retained within areas alongside the Nepean River that are considered unlikely to be developed in the future. Accordingly, the local occurrence of the community will remain viable in the long term.

Within the study area and local area, up to 58.70 ha of the community and up to 809.44 ha (Alluvial Woodland and Riparian Forest) are present, respectively. It should be noted however due to the amalgamation of the River-flat Eucalypt Forest and Swamp Oak Floodplain Forest communities in the regional mapping that some

of the Alluvial Woodland and Riparian Forest is likely to be comprised of Swamp Oak Floodplain Forest instead. Within the study area some of the community was not able to be accessed to the west of Menangle Park Race Course. This vegetation is considered unlikely to contain areas of Swamp Oak Floodplain due to the river being freshwater and the steep topography of the sandy bank. The proposed development works will result in the clearance of approximately 2.6% (1.51 ha) of the occurrence within the study area, which represents 0.19% of the potential extent within the local area.

Due to the already reduced extent and degraded nature of this community, the conservation of remaining remnants is critical to the recovery of the community. Although all remaining remnants are considered important to the long term survival of the community's local population, the removal of 1.51 ha within the subject site is unlikely to contribute to the extinction of the community's local occurrence as the majority of the community's local occurrence will be retained. This includes the retention of the largest patches of the community present along the Nepean River corridor, and patches within a retained riparian corridor along Howes Creek. In addition to the areas retained within the study area, additional areas of the community will be retained throughout the locality, primarily in the Camden Park area.

Furthermore, appropriate offsetting can improve the recovery and long-term viability of better condition patches of the community in the locality, which will occur under the proposed development works. Offsetting details are discussed in **Chapter 7**.

ii. Extent of habitat removal or modification

The proposed development works will result in the removal of 1.51 ha of River-flat Eucalypt Forest within the subject site. Within the study area and local area, a total of ~58.70 ha and up to 809.44 ha of the community is present, respectively. The proposed development works equates to the removal of 2.6% of the community's extent within the study area and potentially 0.19% within the local area.

There is potential for indirect impacts to occur on areas of this community that are being retained outside the subject site. This includes potential for increased weed invasion, sedimentation from construction in the subject site, and increased impacts of noise, dust and light. Indirect impacts have potential to further degrade areas of retained native vegetation. That notwithstanding, a range of mitigation measures will be implemented to avoid indirect impacts, including erosion and sedimentation control measures, hollow offset replacement strategy and weed management. It is considered that with the implementation of these measures, indirect impacts can be managed and appropriately mitigated.

Taking into consideration previously approved DAs and currently submitted DAs a total of 1.51 ha of River-flat Eucalypt Forest is proposed to be removed by the Master Plan. However, a cumulative total of approximately 11 ha of River-flat Eucalypt Forest is proposed to be retained. Due to the proposed conservation of these areas of River-flat Eucalypt Forest, the cumulative impacts of vegetation removal as a result of other proposals are not considered likely to affect the long-term security of the local occurrence of River-flat Eucalypt Forest in the study area.

iii. Discussion of connectivity

The River-flat Eucalypt Forest to be removed occurs predominately as small isolated patches within the subject site. The removal of the community within the subject site will further encroach on the community's current

extent, which is limited, however, it will not result in further fragmentation as the vegetation to be removed provides no connectivity to any large tracts of vegetation, including any nearby reserves or National Parks.

iv. Consideration of threatening processes

The following key threatening process have the potential to impact on River-flat Eucalypt Forest:

Clearing of native vegetation

Approximately 1.51 ha of River-flat Eucalypt Forest will be removed for the proposed development works. Although a moderate area of the community will be removed, compensatory measures are proposed that will adequately offset the impacts to the community and ensure that its local occurrence is not placed at risk of extinction. This includes the conservation, revegetation and management of ~12.28 ha of the community within the subject site in perpetuity.

Invasion of native plant communities by exotic perennial grasses

The proposed development works have the potential to result in the spread of exotic grasses both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a BSA or VMP (REF. 17072 RP36 and 17072 RP29) that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion and establishment of exotic vines and scramblers

The proposed development works have the potential to result in the spread of exotic weeds both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion, establishment and spread of Lantana (Lantana camara L. sens. Lat)

The subject site currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata)*

The subject site currently contains a high abundance of African Olive in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners

The proposed development works are unlikely to contribute to high frequency fire further than current conditions.

High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

The proposed development works are unlikely to contribute to high frequency fire further than current conditions.

Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Future development has the potential to contribute to this key threatening process, but this is unlikely to occur until development within the subject site is completed and housing is occupied. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process.

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

The project has the potential to alter the hydrology of the subject site and thereby impact on River-flat Eucalypt Forest through changes in groundwater and/or surface water hydrology. These are discussed further below.

Groundwater:

Groundwater has potential to be impacted by the project, by the proposed earthworks and future development of the land. However, the potential for such impacts is low due to the proposed implementation of water cycle management and associated engineering as detailed in the Masterplan Water Cycle Management Report (SMEC Australia 2018) and Menangle Park Site Clearance and Bulk Earthworks Future Residential Subdivision Engineering Report (SMEC 2021) (see further details ***Section 6.3***)**.**

Notwithstanding the low potential for substantial groundwater changes, monitoring of groundwater has commenced to monitor the impacts of development within the Menangle Park URA. Ten (10) groundwater monitoring wells have been installed within the proponent's lands and the initial sampling event of the monitoring wells has been completed (see **Appendix E** for the JBS&G report). Development of some parts of the Menangle Park URA has commenced and includes some vegetation clearance and earthworks.

Groundwater monitoring is ongoing in the study area and to date no observable change in groundwater has occurred.

Vegetation monitoring of Parks K and L is being done in conjunction with the groundwater monitoring. There have been no observable changes to vegetation condition recorded to date. Based on available data it is considered unlikely that changes to vegetation due to groundwater will occur because of the project.

Cumberland Ecology has had discussions with the project hydrogeologists from JBS&G about potential corrective measures to implement if development is thought to have changed groundwater levels. JBS&G has confirmed that corrective measures can be implemented to restore groundwater levels if required. Examples of corrective measures include the construction of additional retention basins and diverting stormwater into areas requiring recharge, or the installation of impervious barriers into soil profiles to impede groundwater flows in selected areas and so raise groundwater upstream of the barriers.

Surface Water:

Surface hydrology in development areas will be altered to by the project but measures have been or will be taken to prevent significant impacts to vegetation within conservation areas.

Hydrological changes in development areas will be caused by vegetation clearance, earthworks and the construction of various hard surfaces including roads and footpaths. However, mitigation measures have been specifically designed to ameliorate such changes. These include but are not limited to the installation of retention basins and stormwater discharge locations as described in the Masterplan Water Cycle Management Report and Menangle Park Site Clearance and Bulk Earthworks Future Residential Subdivision Engineering Report (SMEC 2021). Retention basins associated with the approved Stage 1 and Stage 2A DA's have already been constructed.

Further details of the surface hydrology measures are provided in the Masterplan Water Cycle Management Report and Menangle Park Site Clearance and Bulk Earthworks Future Residential Subdivision Engineering Report (SMEC 2021).

Development that forms part of the approved Stage 1 and 2A DAs has occurred and is close to River-flat Eucalypt Forest. There has been no observable impact to this vegetation.

In addition to the Key Threatening Processes considered above, the Threatened Species Profile Database (NSW Government 2021) for this community also mentions the following threats: "*Altered hydrology particularly from narrowing of corridors and the installation of infrastructure for flood mitigation and drainage causing: a lack of periodic flooding, water entering more quickly and in larger volumes, water not standing long enough or being inundated for too long leading to changes in floristics*" and "*Flood mitigation and drainage works*". As outlined above, these potential indirect impacts related to changes in surface hydrology will be managed according to the Masterplan Water Cycle Management Report and Menangle Park Site Clearance and Bulk Earthworks Future Residential Subdivision Engineering Report (SMEC 2021) which include the details of retention basins and water flow paths through the subject site.

6.2.4. Swamp Oak Floodplain Forest

Swamp Oak Floodplain Forest is found on coastal floodplains and has a sparse to dense tree layer typically dominated by *Casuarina glauca* (Swamp Oak). Additional trees sometimes present include *Acmena smithii* (Lilly Pilly), *Glochidion* spp. and *Melaleuca* spp. (paperbarks). The community has a sparse cover of shrubs, but typically has a continuous groundcover comprised of grasses, sedges and forbs. Groundcover species characteristic of the community within less saline areas include *Centella asiatica* (Indian Pennywort), *Commelina cyanea, Persicaria decipiens* (Slender Knotweed), *Carex appressa* (Tall Sedge) and *Lomandra longifolia* (Spiny-headed Mat-rush). Vines are also frequent within the community including *Parsonsia straminea* (Common Silkpod) and *Geitonoplesium cymosum* (Scrambling Lily).This community grows on clay and sandy loams within waterlogged or periodically inundated areas (OEH 2018h).

Within the subject site, Swamp Oak Floodplain Forest is present alongside Howes Creek and within low lying areas that are periodically inundated. Following a comparison with the final determination for Swamp Oak Floodplain Forest (NSW Scientific Commitee 2011b), all areas of the community within the subject site conform to Swamp Oak Floodplain Forest listed as an EEC under the TSC Act.

The geographic distribution of Swamp Oak Floodplain Forest extends as far north as the NSW North Coast and south as the southern border of NSW. It is estimated that less than 30% of its original extent still remains. Threats to the community include further land clearing and degradation of existing patches by weed invasion, grazing and pollution (NSW Scientific Commitee 2011b).

6.2.4.1. Description of Habitat within Study Area and Surrounds

i. The study area and surrounds

Within the study area, the community occurs as large to small patches alongside riparian areas, and as small, isolated patches located outside of riparian areas. All areas of the community are bound by previously cleared lands. The most extensive area of the community within the subject site is located within Howes Creek and as part of a patch adjoining EBSF and River-flat Eucalypt near Park L. The total area of the community in the study area mapped by Cumberland Ecology is 11.12 ha, of which 3.39 occurs within the proposed development works area; however, approximately 0.77 ha of this is within the contaminated land in the Howes Creek riparian corridor where the community will be initially cleared and then rehabilitated under the VMP (REF. 17072 RP36). All areas of the community are comprised of a dense canopy and sparse shrub layer. Hollows are present, but in low supply due to the tree species present (e.g. *Casuarina glauca*). The habitat present, although bound by cleared lands, may be utilised by a number of native fauna species, including threatened bats and birds. This is particularly true for areas located along Howes Creek and nearby the Nepean River as they form larger tracts of habitat.

ii. Disturbance, seed bank and recovery potential

Disturbance within the study area is likely to have included clearing, soil disturbances, grazing, and general weed invasion. Overall, the Swamp Oak Floodplain Forest within the Study Area is in moderate condition. Strata are generally dominated by native species, particularly the canopy, sub-canopy and shrub strata which have dense stands mature and regenerating *Casuarina glauca*. The ground layer of patches varies, and in some areas contains large occurrences of exotic species such as *Ehrharta erecta*, and *Cynodon dactylon*, although

some areas are dominated by the native *Microlaena stipoides*. The patches are not particularly diverse in species composition when compared to the description in the final determination (NSW Scientific Commitee 2011b), though in some areas native species are limited due to the ground layer being comprised predominately of *Casuarina glauca* cladode litter and mud due to frequent inundation.

A seed bank is evident within all areas of the community. This is evidenced by dense *Casuarina glauca* regrowth appearing in the shrub layer, though some regrowth is likely to be due to suckering or from seed rain from canopy-stored seed, and the presence of native annual and perennial herbaceous species in the ground layer, which can regenerate from rhizomes, stolons or soil-stored seed. Although the community is not in a high condition, appropriate management would likely result in the community recovering to a better condition over time. In order for the community to recover to high condition, the following management action would be required:

Initial weed management to eradicate problematic weeds present, with a targeted focus on exotic grasses;

- Grazing exclusion;
- Ongoing weed management and monitoring;
- Planting of shrub and ground cover species; and
- Restriction of human disturbances and access.

iii. Comparison with the Final Determination

The final determination for Swamp Oak Floodplain Forest describes the community varying in structure from open forests to low woodlands, scrubs, or reedlands with scattered trees. The community is typically associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. The composition of the community depends on the frequency and duration of waterlogging and the levels of salinity in the groundwater, and latitude.

The community is known from within the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby, Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may be distributed elsewhere in these bioregions.

The study area is located within the Campbelltown LGA. Within the study area the community predominately occurs along Howes Creek and its floodplain, and in a large patch in the central-west of the site associated with an area of impeded drainage. The community has small, scattered occurrences elsewhere in the north of the study area in areas associated with minor tributaries and low-lying areas within impeded drainage.

The number of diagnostic species as per the community's final determination (NSW Scientific Committee 2009) recorded within the six BBAM plots undertaken within the community within the study area (three within the subject site) is nine species. **Table 25** identifies the diagnostic species recorded.

Table 24 Swamp Oak Floodplain Forest diagnostic species recorded within the study area

Scientific Name	Common Name
Casuarina glauca	*Oplismenus imbecillis*
Commelina cyanea	*Parsonia straminea*
Cynodon dactylon	*Persicaria decipiens*
Isolepis inundata	*Stephania japonica var. discolor*
Juncus usitatus	

iv. Recovery Plan

A recovery plan has been developed for the Cumberland Plain (DECCW (NSW) 2011). This recovery plan states that five threatened ecological communities including Swamp Oak Floodplain Forest are not specifically addressed in the plan "*as only a small proportion of their distribution occurs within the study area, or a recovery plan already exists*".

The overall objective of the Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. The study area has not been mapped as priority conservation lands within the Campbelltown LGA.

A separate recovery plan for Swamp Oak Floodplain Forest has not been developed.

v. Maps

Figure 15 shows the location of Swamp Oak Floodplain Forest within the study area and subject site. Mapping of the community's occurrence within the locality (study area) and local area is provided in **Figure 9**.

6.2.4.2. Swamp Oak Floodplain Forest within the locality

Swamp Oak Floodplain Forest is not mapped as a separate vegetation community in regional vegetation mapping for the area. Approximately 761.86 ha of Alluvial Woodland is present in the local area (see **Figure 9**). Within the local area, this community is comprised of both River-flat Eucalypt Forest and Swamp Oak Floodplain Forest (NSW Scientific Commitee 2011b). The majority of the occurrences of the community in the local area consist of small fragmented patches, with the exception of area to the west of the study area in Camden Park where more substantial areas occur along creeks and floodplains. The Swamp Oak Floodplain Forest within the study area does not have connectivity to these larger areas of Alluvial Woodland.

The fragmented nature of the vegetation in the locality and the local area is shown in **Figure 9**. The community is also likely to be highly fragmented on a regional level, and the community likely exists as a series of small to medium area remnant patches.

6.2.4.3. Discussion of conservation status

i. Conservation status

Swamp Oak Floodplain Forest is listed as an Endangered Ecological Community under the TSC Act. All patches within the study area are likely to conform to the TSC Act listing as they have canopy, shrub, and ground layer species consistent with the description of the community in the final determination (NSW Scientific Commitee 2011b). The community is noted in the final determination as having very few examples unaffected by weeds, so degraded examples within the study area are likely to meet the listing of the community under the TSC Act.

~3.39 ha of Swamp Oak Floodplain Forest occurs within the subject site and will be removed by the proposed development works, though ~7.16 ha will be retained within the on-site conservation areas and conserved and managed in perpetuity under a VMP.

ii. Key Threatening Processes

The following key threatening processes are considered to potentially impact Swamp Oak Floodplain Forest:

- Clearing of native vegetation;
- Invasion of native plant communities by exotic perennial grasses;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat);
- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*;
- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;
- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'; and
- 'Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.

Other threats to the community include:

- The main threat is further clearing for urban or rural development, and the subsequent impacts from fragmentation.
- Flood mitigation and drainage works.
- Pollution from agricultural and urban runoff.
- Rubbish Dumping.
- Grazing and mowing, which stops regrowth of the community.
- Landfilling and earthworks associated with urban and industrial development.

- Overgrazing, trampling, and other soil disturbance from domestic livestock including pigs.
- Activation of 'acid sulphate soils'.
- Inappropriate water run-off entering the site, which leads to increased nutrients and sedimentation.
- Weed invasion.
- Anthropogenic climate change.
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.

iii. Habitat requirements

Swamp Oak Floodplain Forest is associated typically associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. The soils the community occurs on within the study area are associated with the floodplains and channels of Howes Creek and smaller tributaries, and low-lying areas of the site subject to varying levels of periodic inundation (NSW Scientific Commitee 2011b).

iv. Recovery or Threat Abatement Plan

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;
2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;
3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program;
4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The Recovery Plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the subject site itself has not been mapped within the boundary of these priority conservation lands.

v. Conservation reserves

Swamp Oak Floodplain Forest is known to occur within Stotts Island, Ukerebagh, Tuckean, Pambalong, Wamberal, Towra Point and Cullendulla Creek Nature Reserves and Bongil, Myall Lakes and Conjola National Parks

vi. Limit of distribution

Swamp Oak Floodplain Forest is distributed from the North Coast bioregion south to the South-east Corner bioregion.

6.2.4.4. Discussion of the likely effect of the proposal at local and regional scales

i. Significance within a local context

The local occurrence of Swamp Oak Floodplain Forest is limited to the study area as defined in the *Threatened Species Assessment Guidelines* (DECC (NSW) 2007) as genetic transfer is unlikely to occur between the community present within the study area and isolated patches outside of the study area. Within the local area, a portion of 761.86 ha of Alluvial Woodland is likely to be comprised of Swamp Oak Floodplain Forest. There is 11.12 ha of the community within the study area. The proposed development works will result in the clearance of approximately 30.5% (3.39 ha) of the occurrence within the study area. The areas to be removed and retained at the local occurrence and local area scale for the proposed development works are shown in **Table 26**.

Table 25 Swamp Oak Floodplain Forest at a local and regional scale

Vegetation Community	Local Occurrence (ha)	Local Occurrence Removal (ha)	Local Occurrence Retention	Local Area Occurrence (ha)	Local Area Retention
Swamp Oak Floodplain Forest	11.12	3.39	69.5%	761.86	99.56%

Due to the already reduced extent and degraded nature of this community, the conservation of remaining remnants is critical to the recovery of the community. Although all remaining remnants are considered important to the long term survival of the community's local population, the removal of 3.39 ha within the subject site is unlikely to contribute to the extinction of the community's local occurrence as the majority of the community's local occurrence will be retained. This includes the retention of the largest patches of the community present along the Howes Creek riparian corridor and in the central-west of the study area close to the Nepean River. In addition to the areas retained within the study area, additional areas of the community are likely to be present within the locality, particularly within mapped areas of Alluvial Woodland to the west in Camden Park.

Furthermore, appropriate offsetting can improve the recovery and long-term viability of better condition patches of the community in the locality, which will occur under the proposed development works. Offsetting details are discussed in **Chapter 7**.

ii. Extent of habitat removal or modification

The proposed development works will result in the removal of 3.39 ha of Swamp Oak Floodplain Forest within the subject site. Within the study area, a total of approximately 11.12 ha is present. The proposed development works equates to the removal of 30.5% of the community's extent within the study area.

There is potential for indirect impacts to occur on areas of this community that are being retained outside the subject site. This includes potential for increased weed invasion, sedimentation from construction in the subject site, and increased impacts of noise, dust and light. Indirect impacts have potential to further degrade areas of retained native vegetation. That notwithstanding, a range of mitigation measures will be implemented to avoid indirect impacts, including erosion and sedimentation control measures, hollow offset replacement strategy and weed management. It is considered that with the implementation of these measures, indirect impacts can be managed and appropriately mitigated.

Taking into consideration previously approved DAs and currently submitted DAs a total of 3.39 ha of Swamp Oak Floodplain Forest is proposed to be removed by the Master Plan. However, a cumulative total of approximately 7.16 ha of Swamp Oak Floodplain Forest is proposed to be retained. Due to the proposed conservation of these areas of Swamp Oak Floodplain Forest, the cumulative impacts of vegetation removal as a result of other proposals are not considered likely to affect the long-term security of the local occurrence of Swamp Oak Floodplain Forest in the study area.

iii. Discussion of connectivity

The Swamp Oak Floodplain Forest to be removed occurs predominately as small isolated patches within the subject site. The removal of the community within the subject site will further encroach on the community's current extent, which is limited; however, it will not result in further fragmentation as the vegetation to be removed provides no connectivity to any large tracts of vegetation, including any nearby reserves or National Parks.

iv. Consideration of threatening processes

The following key threatening processes are considered to have the potential to impact on Swamp Oak Floodplain Forest:

- Clearing of native vegetation

Approximately 3.39 ha of Swamp Oak Floodplain Forest will be removed for the proposed development works. Although a moderate area of the community will be removed, compensatory measures are proposed that will adequately offset the impacts to the community and ensure that its local occurrence is not placed at risk of extinction. This includes the conservation and management of ~7.16 ha of the community within the subject land in perpetuity.

- Invasion of native plant communities by exotic perennial grasses

The proposed development works have the potential to result in the spread of exotic grasses both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion and establishment of exotic vines and scramblers;

The proposed development works have the potential to result in the spread of exotic weeds both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The subject site currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*;

The subject site currently contains a high abundance of African Olive in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

The proposed development works are unlikely to contribute to high frequency fire further than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'.

Future development the proposed development works will facilitate have the potential to contribute to this key threatening process. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process.

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

The proposed development works have the potential to alter flow regimes of the study area; however, this key threatening process is expected to be adequately mitigated by the implementation of sediment/erosion and wastewater management plans that will be implemented. Additionally, the majority of Howes Creek will be retained and conserved by the proposed development. The discussion of hydrology management and

monitoring within the study area applicable to Swamp Oak Floodplain Forest is the same as that provided for River-flat Eucalypt Forest in ***Section 6.2.3.2.iv*.**

6.2.5. Freshwater Wetlands

Freshwater Wetlands occurs on low-lying parts of floodplains, alluvial flats, depressions, drainage lines, back swamps, lagoons and lakes. The community is dominated by herbaceous plants including sedges, emergent plants, floating and submerged plants (NSW Scientific Committee 2004a). Species characteristic of the community include *Paspalum distichum* (Water Couch), *Leersia hexandra* (Swamp Rice-grass), *Pseudoraphis spinescens* (Mud Grass), *Carex appressa* (Tall Sedge), *Hydrocharis dubia* (Frogbit), *Philydrum lanuginosum* (Frogsmouth), *Ludwigia peploides* subsp. *montevidensis* (Water Primrose), *Marsilea mutica* (Nardoo) and *Myriophyllum* spp. (OEH 2018f).

Within the subject site, the Freshwater Wetlands community is present alongside Howes Creek. Following a comparison with the final determination for Freshwater Wetland (NSW Scientific Committee 2004b), all areas of the community within the subject site have been determined to conform to Freshwater Wetland listed as an EEC under the TSC Act. On the subject site the community lacks a canopy and midstorey layer in nearly all areas with the exception of a few regrowth native *Casuarina glauca* (Swamp Oak). The shrub layer is comprised of regrowth native *Casuarina glauca* (Swamp Oak) along with exotics *Ligustrum lucidum* (Large-leaved Privet), *Olea europaea* subsp. *cuspidata* (African Olive) and *Ligustrum sinense* (Small-leaved Privet) in places. The majority of the groundcover is comprised of native species including *Phragmites australis* (Common Reed), *Carex appressa* (Tall Sedge), *Juncus usitatus* (Common Rush) and *Cynodon dactylon* (Couch). Common exotics within the ground stratum include *Cyperus eragrostis* (Umbrella Sedge), *Paspalum dilatatum* (Paspalum), and *Rubus fruticosus* (Blackberry).

The geographic distribution of Freshwater Wetland extends along the majority of the NSW coast. Within Sydney, on the Cumberland Plain, an estimated 660 ha remained in 1998. It is estimated that less than 60% of the community's original extent remains across NSW, and potentially significantly less. The community is threatened by land clearing, fragmentation, flood mitigation, land-filling, pollution from runoff, weed invasion, damage from livestock and feral animals, acid sulphate soils, rubbish dumping and climate change (NSW Scientific Committee 2004b).

6.2.5.1. Description of Habitat within Study Area and Surrounds

i. The study area and surrounds

Within the study area, the community is located alongside Howes Creek. The total area of the community in the study area is 6.86 ha, all of which is bound by previously cleared areas. The majority of this community is comprised of aquatic and semi-aquatic groundcovers, but occasional small trees and shrubs of *Casuarina glauca* are present where adjacent to Swamp Oak Floodplain Forest. The habitat present, although bound by cleared lands, may be utilised by a number of native aquatic and semi-aquatic fauna species, and the Southern Myotis for foraging.

ii. Disturbance, seed bank and recovery potential

Disturbance within the study area is likely to have included clearing, soil disturbances, grazing, and general weed invasion. Overall, the Freshwater Wetlands within the Study Area is in moderate to poor condition. The

community is dominated generally by natives directly in riparian areas with significant inundation where it is frequently dominated by *Phragmites australis*. In adjoining flats which are ephemerally inundated the community is often dominated by exotics such as pasture grasses and forbs and *Rubus fruticosus* spp. agg. (Blackberry).

A seed bank is evident within all areas of the community. This is evidenced by the presence of native species persisting in or dominating the ground layer. Although the community is not in a high condition, appropriate management would likely result in the community recovering to a better condition over time. In order for the community to recover to high condition, the following management action would be required:

- Initial weed management to eradicate problematic weeds present, with a targeted focus on exotic grasses and *Rubus fruticosus* spp. agg.;
- Grazing exclusion;
- Ongoing weed management and monitoring;
- Planting of shrub and ground cover species; and
- Restriction of human disturbances and access.

iii. Comparison with the Final Determination

The final determination for Freshwater Wetlands describes the community varying in structure from sedgelands and reedlands to herbfields, with woody plants generally scarce. It is associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. The community often includes areas of or is associated with ephemeral or semi-permanent standing water. Freshwater Wetlands typically form on silts, muds or humic loams in depressions, flats, drainage lines, back swamps, lagoons and lakes associated with coastal floodplains. The composition of the community is primarily determined by the frequency, duration and depth of waterlogging and may be influenced by the level of nutrients and salinity in the water and substrate.

The community is known to be distributed within the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Penrith, Fairfield, Liverpool, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may be distributed elsewhere in these bioregions.

The study area is located within the Campbelltown LGA. Within the study area the community predominately occurs along Howes Creek and its floodplain, and in areas associated with minor tributaries and drainage lines including dammed streams.

The number of diagnostic species as per the community's final determination (NSW Scientific Committee 2009) recorded within the six BBAM plots undertaken within the community within the study area (one within the subject site) is eight species. **Table 26** identifies the diagnostic species recorded.

Table 26 Freshwater Wetlands diagnostic species recorded within the study area

Scientific Name	Scientific Name
Alisma plantago-aquatica	*Persicaria decipiens*
Baumea rubiginosa	*Phragmites australis*
Carex appressa	*Potamogeton tricarinatus*
Juncus usitatus	*Typha orientalis*

iv. Recovery Plan

A recovery plan has been developed for the Cumberland Plain (DECCW (NSW) 2011). This recovery plan states that five threatened ecological communities including Freshwater Wetlands are not specifically addressed in the plan "*as only a small proportion of their distribution occurs within the study area, or a recovery plan already exists*".

The overall objective of the Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. The study area has not been mapped as priority conservation lands within the Campbelltown LGA.

A separate recovery plan for Freshwater Wetlands has not been developed.

v. Maps

Figure 15 shows the location of Freshwater Wetlands within the study area and subject site. Mapping of the community's occurrence within the local area is provided in **Figure 9**.

6.2.5.2. Freshwater Wetlands within the locality

No areas of Freshwater Wetlands are mapped in the local area, however the community is likely to persist in similar rural areas throughout the local area along similar creek lines and low-lying ephemerally inundated areas but have not been mapped due to the scale of the mapping. Approximately 6.86 ha of Freshwater Wetlands is present in the study area (see **Figure 15**). These areas do not have connectivity to larger patches of Freshwater Wetlands at a regional level and are isolated from each other by areas of exotic grassland.

The community is likely to be highly fragmented on a regional level, and the community likely exists as a series of small patches and larger areas where sizeable patches of shallow and ephemeral waters allow habitat for aquatic flora species.

6.2.5.3. Discussion of conservation status

i. Conservation status

Freshwater Wetlands is listed as an Endangered Ecological Community under the TSC Act. All patches within the Study Area are likely to conform to the TSC Act listing as they have aquatic and semi-aquatic species consistent with the description of the community in the final determination (NSW Scientific Committee 2009). The community is noted in the final determination as having very few examples unaffected by weeds, so highly degraded examples within the study area are likely to meet the listing of the community under the TSC Act where native aquatic and semi-aquatic species persist amongst weeds.

~0.37 of Freshwater Wetlands occurs within the subject site and will be removed, though ~6.15 ha will be retained within the on-site conservation areas and conserved and managed in perpetuity under a VMP.

ii. Key Threatening Processes

The following key threatening processes are considered to potentially impact Freshwater Wetlands:

- Clearing of native vegetation;
- Invasion of native plant communities by exotic perennial grasses;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat);
- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*;
- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;
- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants';
- 'Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands; and
- 'Activation of 'acid sulphate soils'.

Other threats to the community include:

- The main threat is further clearing for urban or rural development, and the subsequent impacts from fragmentation.
- Flood mitigation and drainage works.
- Pollution from agricultural and urban runoff.
- Rubbish dumping.
- Grazing and mowing, which stops regrowth of the community.
- Landfilling and earthworks associated with urban and industrial development.
- Overgrazing, trampling, and other soil disturbance from domestic livestock including pigs.
- Inappropriate water run-off entering the site, which leads to increased nutrients and sedimentation.
- Weed invasion.
- Anthropogenic climate change.
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.

iii. Habitat requirements

Freshwater Wetlands is a community associated typically associated with silts, muds or humic loams in depressions, flats, drainage lines, back swamps, lagoons and lakes associated with coastal floodplains. The soils the community occurs on within the study area are associated with the floodplains and channels of Howes Creek and smaller tributaries, and low-lying areas of the site subject to varying levels of periodic inundation (NSW Scientific Committee 2009).

iv. Recovery or Threat Abatement Plan

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;
2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;
3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program;
4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The Recovery Plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the subject site itself has not been mapped within the boundary of these priority conservation lands.

v. Conservation reserves

Freshwater Wetlands is known to occur within Ukerebagh, Tuckean, Tabbimoble Swamp, Hexham Swamp, Pambalong and Pitt Town Nature Reserves and Bungawalbin, Scheyville and Seven Mile Beach National Parks.

vi. Limit of distribution

The Freshwater Wetlands community is distributed from the North Coast bioregion south to the South-east Corner bioregion.

6.2.5.4. Discussion of the likely effect of the proposal at local and regional scales

i. Significance within a local context

The local occurrence of Freshwater Wetlands is limited to the study area as defined in the *Threatened Species Assessment Guidelines* (DECC (NSW) 2007) as genetic transfer is unlikely to occur between the community present within the study area and any isolated patches outside of the study area. Within the local area, the community is likely to have a scattered distribution within rural areas similar to those within the study area. There is ~6.86 ha of the community within the study area. The proposed development works will result in the clearance of approximately 5.4% (~0.37 ha) of the occurrence within the study area. The areas to be removed and retained at the local occurrence and local area scale for the proposed development works are shown in **Table 27**.

Table 27 Freshwater Wetlands at a local and regional scale

Vegetation Community	Local Occurrence (ha)	Local Occurrence Removal (ha)	Local Occurrence Retention	Local Area Occurrence (ha)	Local Area Retention*
Freshwater Wetlands	6.86	0.37	94.6%	0	NA

Due to the already reduced extent and degraded nature of this community, the conservation of remaining remnants is critical to the recovery of the community. Although all remaining remnants are considered important to the long term survival of the community's local population, the removal of 0.37 ha within the subject site is unlikely to contribute to the extinction of the community's local occurrence as the majority of the community's local occurrence will be retained. This includes the retention of the largest patches of the community present along the Howes Creek corridor. In addition to the areas retained within the study area, additional areas of the community are likely to be present within the local area, particularly in the proximity of Alluvial Woodland to the west in Camden Park.

Furthermore, appropriate offsetting can improve the recovery and long-term viability of better condition patches of the community in the locality, which will occur under the proposed development works. Offsetting details are discussed in **Chapter 7**.

ii. Extent of habitat removal or modification

The proposed development works will result in the removal of 0.37 ha of Freshwater Wetlands within the subject site. Within the study area, a total of approximately 6.86 ha is present. The proposed development works equates to the removal of 5.4% of the community's extent within the study area.

There is potential for indirect impacts to occur on areas of this community that are being retained outside the subject site. This includes potential for increased weed invasion, sedimentation from construction in the subject site, and increased impacts of noise, dust and light. Indirect impacts have potential to further degrade areas of retained native vegetation. That notwithstanding, a range of mitigation measures will be implemented to avoid indirect impacts, including erosion and sedimentation control measures, hollow offset replacement strategy and weed management. It is considered that with the implementation of these measures, indirect impacts can be managed and appropriately mitigated.

Taking into consideration previously approved DAs and currently submitted DAs a total of 2.69 ha of Freshwater Wetlands is proposed to be removed by the Master Plan. However, a cumulative total of approximately 8.42 ha of Freshwater Wetlands is proposed to be retained. Due to the proposed conservation of these areas of Freshwater Wetlands, the cumulative impacts of vegetation removal as a result of other proposals are not considered likely to affect the long-term security of the local occurrence of River-flat Eucalypt Forest in the study area.

iii. Discussion of connectivity

The Freshwater Wetlands occurs as both small, isolated patches and larger patches along Howes Creek. The removal of the community within the subject site will further encroach on the community's current extent,

which is limited; however, it will not result in further fragmentation as the vegetation to be removed provides no connectivity to any large tracts of vegetation, including any nearby reserves or National Parks.

iv. Consideration of threatening processes

The following key threatening processes are considered to have the potential to impact on Freshwater Wetlands:

- Clearing of native vegetation

Approximately 0.37 ha of Freshwater Wetlands will be removed for the proposed development works. Although areas of the community will be removed, compensatory measures are proposed that will adequately offset the impacts to the community and ensure that its local occurrence is not placed at risk of extinction. This includes the conservation and management of 6.15 ha of the community within the subject land in perpetuity.

- Invasion of native plant communities by exotic perennial grasses

The proposed development works have the potential to result in the spread of exotic grasses into retained Freshwater Wetlands. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion and establishment of exotic vines and scramblers;

The proposed development works have the potential to result in the spread of exotic weeds. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The subject site currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed, which can dominate the fringes of Freshwater Wetlands. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*;

The subject site currently contains a high abundance of African Olive in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and

into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

The proposed development works are unlikely to contribute to high frequency fire further than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'.

The future development the proposed development works will facilitate have the potential to contribute to this key threatening process. In order to mitigate this key threatening process, retained vegetation will be managed under a VMP that will minimise the key threatening process.

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

The proposed development works have the potential to alter flow regimes of the study area; however, this key threatening process is expected to be adequately mitigated by the implementation of sediment/erosion and wastewater management plans that will be implemented. Additionally, the majority of Howes Creek will be retained and conserved by the proposed development.

- 'Activation of 'acid sulphate soils'.

The proposed development works have the potential to activate acid sulphate soils within the study area as a result of clearing works and subsequent bulk earthworks that are likely to occur to facilitate future development. In order to minimise the risk of acid sulphate soils impacting areas of the study area or being carried off-site, it is expected that soil sampling will occur during the proposed development works. If found to occur, measures will be implemented to mitigate appropriately.

6.3. Groundwater Dependent Ecosystems

Groundwater flows beneath parts of the subject site and supports a suite of presumed groundwater dependent ecosystems (GDEs) (JBS&G, 2021). These plant communities rely at least in part for their survival on groundwater. Dependence ranges from complete reliance for some GDEs to others that rely partially on groundwater, particularly during times of drought. The degree and nature of dependency influences the extent to which ecosystems are affected by changes to groundwater aquifers, both in quality and quantity (DECCW 2009b). In general, the majority of Australian ecosystems have little dependence on groundwater, however, there are some localised or extensive ecosystems in Australia with at least a high dependence on groundwater (Hatton and Evans 1998).

GDEs are classified into separate types based on the types of groundwater they utilise. For the purposes of this report, we have utilised the classification system adopted by the Bureau of Meteorology's (BOM) GDE Atlas (BOM 2019), which identifies the three following classifications:

- **Aquatic Ecosystem:** rely on the surface expression of groundwater–this includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs. Marine and estuarine ecosystems can also be groundwater dependent, but these are not mapped in the Atlas.
- **Terrestrial Ecosystem:** rely on the subsurface presence of groundwater – this includes all vegetation ecosystems; and
- **Subterranean Ecosystem**: this includes cave and aquifer ecosystems.

6.3.1.1. Available Groundwater Data

Initial reports on groundwater at Menangle Park by Douglas Partners (2017a and b) recommended further studies be undertaken as development within Menangle Park URA progresses. Dahua is currently carrying out this recommendation and has commissioned an ongoing groundwater and soil moisture monitoring program by JBS&G (2021). That study has developed a conceptual model of groundwater occurrence and behaviour at Menangle Park and a copy is provided in **Appendix I**.

A total of ten groundwater monitoring wells have been installed within the proponent's lands and the initial sampling event of the monitoring wells has been completed (see **Appendix I**). This data provides the baseline data for ongoing monitoring which will be analysed to determine if development within Menangle Park could be impacting on groundwater levels and subsequently, any GDEs. Following the completion of the first groundwater monitoring event as well as ongoing vegetation condition monitoring of Elderslie Banksia Scrub vegetation within Parks K and L (monitoring occurs quarterly and commenced early 2021) as part of the Menangle Park Stage 2A approval, no observable changes to vegetation condition has been recorded to date. However, Boardman and Dasey (2021) have identified that corrective measures can be implemented to recharge groundwater if deemed to be necessary based on the results of the groundwater monitoring program (see **Appendix I**).

The BOM GDE Atlas identifies and maps a suite of vegetation on the Menangle Park site as 'Terrestrial' GDEs, including Shale Hills Woodland in the west of the study area, areas of EBSF, River-flat Eucalypt Forest and Swamp Oak Floodplain Forest within and surrounding Park L, and areas of Shale Plains Woodland, Freshwater Wetlands, Swamp Oak Floodplain Forest and River-flat Eucalypt Forest within Howes Creek in the north of the study area.

GDEs are most likely to occur on site where groundwater is found within deeper, more permeable soil substrates including deep sandy soils and gravels. According to a review of groundwater at Menangle Park by JBS&G (2021) the following relevant geological settings occur:

- Quaternary aged quartz and lithic fluvial sand, silt and clay;
- Tertiary aged alluvial;
- Alluvium gravel, swamp deposits and sand dunes; and

- Triassic aged Wianamatta Group Shale and Sandstone.

JBS&G (2021) found that the Bringelly Shallow (Wianamatta Group) is present along the elevated southern portion of the site and to the northeast of Howes Creek. The central portion of the site is dominated by Tertiary Alluvium while the north-west portions of Howes Creek are present in an area of Quaternary Alluvium.

Based upon groundwater sampling and these geological formations, the following conceptual hydrogeological model for the Menangle Park site has been prepared by JBS&G (2021):

- Groundwater is present in two distinct aquifers. The first is located within the unconsolidated (alluvium/fluvium) sands and the second is within the consolidated (shale) formation. Measured hydraulic conductivity in the sand aquifer is relatively high and ranges from approximately 1 to 10 m/day. As hydraulic conductivity is likely to be several orders of magnitude lower in the shale than in the sand most of the groundwater flow at the site will occur in the sand aquifer.
- Recharge occurs by direct infiltration of rainfall across the site with relatively high recharge (>20%) likely to occur over the sandy areas and low recharge (<5%) occurring in areas of residual clay/shale. Runoff from the southern clay/shale area may also recharge the upper portions of the sand aquifer.
- Groundwater flows from the southern portion of the site towards Howes Creek. While most of the groundwater is likely to discharge directly to Howes Creek measured water levels also indicate that some discharge of groundwater may occur (during high groundwater conditions) in some low-lying areas of the site.

In simple terms, this model indicates that the plant communities on the deeper sandier soils in the central and low-lying parts of the site are likely to be groundwater dependent. Those occurring where clay soils occur, on the steeper parts of the site are not likely to be groundwater dependent (JBS&G, 2021). The likely GDEs based upon the BOM definitions include:

- River-flat Eucalypt Forest – Terrestrial Ecosystem;
- Elderslie Banksia Scrub Forest – Terrestrial Ecosystem;
- Swamp Oak Floodplain Forest – Terrestrial Ecosystem; and
- Freshwater Wetlands – Aquatic Ecosystem.

The locations of these potential GDEs are identified in **Figure 15** and are discussed below.

a. Terrestrial Ecosystem GDEs

Areas of presumed GDEs including River-flat Eucalypt Forest, Swamp Oak Floodplain Forest and EBSF occur within and adjacent to the subject site. They are all 'Terrestrial Ecosystem' GDEs that either occur around low-lying riparian areas or, in the case of EBSF, on deep sands.

Terrestrial Ecosystem GDEs are reliant on the presence of sub-surface groundwater within the rooting depth of the ecosystem (Eamus and Froend 2006). Little information is available on the rooting depth of trees for these communities; however, literature identifies that the majority of deep rooted woody species have roots

to depths of approximately 10 m (Stygoecologia 2013). The dominant trees within the five communities referred to above reach 20 m in height, so the rooting depth is assumed to be at least up to 10 m in depth.

Groundwater monitoring has shown that where present, groundwater is relatively shallow ranging from 0.71 to 8.35 m (JBS&G (2021). Groundwater was found at all locations except the site "GWC". Therefore, based on the likely maximum root depths of trees in the potential GDE communities, roots of dominant trees would reach to and access the groundwater zones. It is likely that most presumed GDEs would be able to access this groundwater periodically,

b. Aquatic Ecosystem GDE

Freshwater Wetlands are largely excluded from the subject site and the majority are proposed to be retained within the Howes Creek riparian corridor of the study area.

These wetlands occur in low-lying areas that have substantial surface waters and a groundwater component. Freshwater wetlands lack large trees/shrubs and are generally limited to herbaceous plants such as *Typha orientalis* (Broad-leaf Cumbungi), though with some occurrences of *Casuarina glauca* (Swamp Oak). The root zone of the dominant plants would be shallow and only approximately 1 m in depth. Areas at greater depths tend to be stagnant and anoxic, which discourages deeper penetration of roots.

6.3.2. Impacts to Groundwater Dependent Ecosystems

Some groundwater dependent ecosystems will be cleared within the subject site, as explained in the ***Section 6.1.*** However, most groundwater dependent ecosystems will be conserved within Parks K and L, Howes Creek Conservation Area and the Northern Park.

As development takes place in the subject site there is potential to change groundwater resources available to groundwater dependent ecosystems within the conservation areas.

According to JBS&G (2021), based on a review of the conceptual hydrogeological site model and considering the proposed development the following could impact groundwater flow or levels (and therefore groundwater dependent ecosystems):

- Infrastructure installed below the pre-development groundwater level that acts a preferential flow pathway. Stormwater drainage and gravity sewer systems are likely to pose the most significant risk to groundwater flow; and
- Changes to groundwater recharge due to decreases in open areas subject to infiltration as well as decreased surface flows from areas of low (clay/shale) recharge to high (sand) recharge. Roofed and paved areas connected directly to stormwater pipes in the sand areas is likely to decrease recharge to the sand aquifer resulting in decreased water levels in the aquifer. It is noted that lower overall evapotranspiration rates and watering of lawn areas using mains (or tank) water will decrease the development impact on groundwater levels.

JBS&G (2021) have recommended that to minimise potential impacts to groundwater levels a range of mitigation strategies could be implemented at the site. The specific strategies selected will be based on the

detailed development plans for each stage but should also consider the cumulative impacts of the overall development. Potential mitigation strategies include:

- In areas where groundwater levels are high installation of fully sealed pipe work along with restrictions to minimise preferential flow in backfill along pipe routes;
- In areas where groundwater levels are low utilisation of the stormwater network to actively recharge the groundwater system;
- Utilisation of road reserves, stormwater pits, road curbs and detention basins to recharge stormwater to the groundwater system. This is particularly relevant to areas overlying the sand aquifer; and
- Identifying areas where irrigation/injection can occur to artificially recharge the aquifer.

While there is potential for indirect impacts to groundwater and groundwater dependent ecosystems, these will continue to be monitored as development proceeds. Corrective action, as described above will be implemented as necessary to ensure that groundwater dependent ecosystems in the conservation areas are protected during the development of the subject site.

6.4. Cumulative Impacts

This section examines the potential cumulative ecological impacts that would arise from the development of the Master Plan for Menangle Park URA. In so doing, it is important to recognise that development assessment and approvals are at an early stage. Most of the land within the Menangle Park URA awaits formal development applications and assessments. The total footprint of the development areas may change during the assessment and approval process. For that reason, the total cumulative ecological impact presented here is an estimate. All works for retention and removal are in accordance with the existing LEP and proposed Master Plan (Planning Proposal).

A summary of the cumulative impacts associated with previously approved DAs as well as all currently submitted DAs within the proponent's land holding at Menangle Park is provided in **Table 28** below. **Table 28** includes a detailed breakdown of the cumulative impacts of all works currently proposed by the proponent This includes:

- The stages of the Master Plan (see **Figure 2**);
- Applicable development application(s);
- Estimated construction start date;
- Vegetation communities proposed to be impacted/retained; and
- Total credit liability and description of the offsetting/conservation to be undertaken.

The Master Plan (Planning Proposal) presented in **Table 29** and **Figure 2** has been approved by the Gateway panel for exhibition and is currently on public exhibition. The Master Plan is supported by Local approvals. In effect, the Council must take into consideration both the existing LEP and the Master Plan (Planning Proposal).

As identified in **Table 28** and **Table 29**, development as per the Master Plan will result in the removal of approximately 51.59 ha of native vegetation while approximately 44.41 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of exotic grasslands with native vegetation, further increasing the total area of native vegetation to be managed in the long-term by approximately 22.78 ha, and the areas proposed to be managed under a VMP in the Parks K and L Conservation Area will include replanting of approximately 0.56 ha of exotic grasslands and cleared land with native vegetation, for a cumulative long-term retention of approximately 64 ha of native vegetation. All impacts to native vegetation will be appropriately offset either through the purchase and retirement of biodiversity credits and through payment into the Biodiversity Conservation Fund.

It is anticipated that any required species credits will also be offset through the appropriate mechanism. This is not detailed in **Table 28** or **Table 29**, however impacted areas for species credit species are likely to be minor compared to the areas to be retained and conserved in the long-term.

The removal and retention of vegetation is consistent with the current and proposed land zoning of Menangle Park. The Master Plan presented in **Figure 2** will retain similar habitats to what is proposed to be removed and will allow for threatened species habitat to be retained in the area in the long-term.

Although some habitat will be removed, it is degraded and subject to a range of threatening processes such as weed invasion and grazing. Currently there is no management required to be undertaken on these areas of native vegetation and if the *status quo* is maintained they would be expected to continue to degrade over time as the threatening processes present continue to operate, gradually reducing their biodiversity value and ability to provide habitat for native species.

Table 28 Summary of estimated cumulative impacts on native vegetation and areas proposed retained and managed in perpetuity under the Menangle Park Master Plan

Vegetation Community	Area of Impact (ha)*	BBAM Credit Liability	Area Retained (ha) and Managed in Perpetuity*	% Cleared
DNG - Shale Hills Woodland	3.28	58 HN529	0.00	100%
DNG – Shale Plains Woodland	22.56	146 HN528	0.43	98.1%
Elderslie Banksia Scrub Forest	0.77	22 HN635	1.72	30.8%
Freshwater Wetlands	0.70	10 HN630	6.17	10.19%
River-flat Eucalypt Forest	1.68	68 HN526	11.22	13.10%
River Oak Riparian Woodland	0.01	0	5.28	0.00%
Shale Hills Woodland	6.69	284 HN529	0.00	100%
Shale Plains Woodland	10.77	298 HN528	11.59	48.74%
Shrubby Regrowth – Shale Hills Woodland	1.47	10 HN529	0.00	100%

Vegetation Community	Area of Impact (ha)*	BBAM Credit Liability	Area Retained (ha) and Managed in Perpetuity*	% Cleared
Swamp Oak Floodplain Forest	3.39	161 HN674	8.00	29.76%
Total	**51.59**		**44.41**	

6.4.1. Offset Strategy

The proposed offset strategy for native vegetation impacts from the development of the Master Plan for Menangle Park URA includes a combination of the following methods:

- Offsetting will be through the purchase and retirement of credits following DA approval. A number of credits are currently owned by the client and all credits will be retired prior to issuing the Construction Certificate;
- Request reasonable equivalency based on BBAM offset liability and pay into the BCT. Payment into the BCT will occur prior to issuing Construction Certificate;
- Offset through conservation of on-site Conservation Areas under VMPs attached to a VPA. VPA and VMPs to be approved and implemented prior to issuing Construction Certificate.

The areas subject to each offsetting strategy are provided in **Table 29**.

6.4.2. Conservation Strategy

The proposed conservation strategy for areas of retained native vegetation in the Master Plan for Menangle Park URA includes a combination of the following methods:

- Assign VPA to land following DA approval that will include implementation of a permanent VMP (in perpetuity). Implementation of the VMP to commence prior to issuing Construction Certificate; and
- Assign VPA to lands within Park K and L managed under a VMP. Aim of the VMP will be to manage as per a BSA and include replanting's.

These are proposed under the Site Wide Bulk Earthworks DA. Note that EBSF is not eligible for a BSA as confirmed through site inspection and correspondence with the BCT. The areas subject to each conservation strategy are provided in **Table 29.**

Table 29 Summary of Menangle Park Master Plan stages, DAs, impacted vegetation and retained vegetation

Master Plan Stages	Applicable Development Application(s)	Est. Start Date	Impacted Vegetation				Retained Vegetation		
			Native Vegetation Community Impacted	Area of Impact (ha)	BBAM Credit Liability	Offsetting Proposed	Native Vegetation Community Retained	Area retained (ha)	Conservation Proposed***
Stage 3A-2 North	SW Bulk Earthworks DA / Stage 3A-2 North DA	2024	Elderslie Banksia Scrub Forest (non-TEC)	0.1	5	B	Elderslie Banksia Scrub Forest	0.23	B
			River-flat Eucalypt Forest	0.27	12	D	River-flat Eucalypt Forest	0.34	B
			Shale Hills Woodland	0.43	22	B	Swamp Oak Floodplain Forest	0.28	B
			DNG - Shale Hills Woodland	0.09	1	B	-	-	-
			Shrubby Regrowth – Shale Hills Woodland	0.19	3	B	-	-	-

Master Plan Stages	Applicable Development Application(s)	Est. Start Date	Impacted Vegetation				Retained Vegetation		
			Native Vegetation Community Impacted	Area of Impact (ha)	BBAM Credit Liability	Offsetting Proposed	Native Vegetation Community Retained	Area retained (ha)	Conservation Proposed***
			Shale Plains Woodland	0.02	1	B	-	-	-
			Swamp Oak Floodplain Forest	0.65	30	D	-	-	-
Stage 4A	SW Bulk Earthworks DA	2024	Shale Hills Woodland	4.36	218	A	-	-	-
			DNG - Shale Hills Woodland	3.19	52	A/B	-	-	-
			Shrubby Regrowth - Shale Hills Woodland	0.29	6	B	-	-	-
Riparian North 2	SW Bulk Earthworks DA	2025	Shale Plains Woodland	0.1	5	D	Shale Plains Woodland	5.48	A
			Swamp Oak Floodplain Forest	1.19	56	D	Swamp Oak Floodplain Forest	1.74	A

Master Plan Stages	Applicable Development Application(s)	Est. Start Date	Impacted Vegetation				Retained Vegetation		
			Native Vegetation Community Impacted	Area of Impact (ha)	BBAM Credit Liability	Offsetting Proposed	Native Vegetation Community Retained	Area retained (ha)	Conservation Proposed***
			Freshwater Wetlands	0.04	1	D	Freshwater Wetlands	0.91	A
Riparian North 3	SW Bulk Earthworks DA	2025	-	-	-	-	Freshwater Wetlands	0.05	A
							Shale Plains Woodland	0.58	A
Riparian North 1	SW Bulk Earthworks DA	2025	River Flat Eucalypt Forest	0.1	4	D	River Flat Eucalypt Forest	2.34	A
			Swamp Oak Floodplain Forest	0.27	13	D	Swamp Oak Floodplain Forest	4.12	A
			-	-	-	-	Freshwater Wetlands	1.11	A
RDL Riparian	SW Bulk Earthworks DA	2025	River Flat Eucalypt Forest	0.11	4	D	River Flat Eucalypt Forest	0.11	A

Master Plan Stages	Applicable Development Application(s)	Est. Start Date	Impacted Vegetation				Retained Vegetation		
			Native Vegetation Community Impacted	Area of Impact (ha)	BBAM Credit Liability	Offsetting Proposed	Native Vegetation Community Retained	Area retained (ha)	Conservation Proposed***
			Freshwater Wetlands	0.11	2	D	Freshwater Wetlands	0.78	A
			Shale Plains Woodland	0.8	37	D	Shale Plains Woodland	5.45	A
			Swamp Oak Floodplain Forest	0.07	3	D	DNG - Shale Plains Woodland	0.43	A
			-	-	-	-	Swamp Oak Floodplain Forest	0.24	A
Stage 5A	SW Bulk Earthworks DA	2025	Elderslie Banksia Scrub Forest	0.67	38	C/B	-	-	-
			Swamp Oak Floodplain Forest	0.12	6	D	-	-	-

Master Plan Stages	Applicable Development Application(s)	Est. Start Date	Impacted Vegetation				Retained Vegetation		
			Native Vegetation Community Impacted	Area of Impact (ha)	BBAM Credit Liability	Offsetting Proposed	Native Vegetation Community Retained	Area retained (ha)	Conservation Proposed***
			River Flat Eucalypt Forest	0.51	22	D	-	-	-
Stage 5B	SW Bulk Earthworks DA	2025	Shale Plains Woodland	0.25	11	B	-	-	-
			Elderslie Banksia Scrub Forest	0.07	3	B	-	-	-
			River-flat Eucalypt Forest	0.37	16	D	-	-	-
Stage 6A	SW Bulk Earthworks DA	2025	Swamp Oak Floodplain Forest	0.37	17	D	-	-	-
			Shale Plains Woodland	0.56	26	D	Shale Plains Woodland	0.08	B

Master Plan Stages	Applicable Development Application(s)	Est. Start Date	Impacted Vegetation				Retained Vegetation		
			Native Vegetation Community Impacted	Area of Impact (ha)	BBAM Credit Liability	Offsetting Proposed	Native Vegetation Community Retained	Area retained (ha)	Conservation Proposed***
			Freshwater Wetlands	0.1	2	D	Elderslie Banksia Scrub Forest	1.3029	B
Stage 6B	SW Bulk Earthworks DA	2024	-	-	-	-	Elderslie Banksia Scrub Forest	0.21	A
Stage 7	SW Bulk Earthworks DA	2024	Shale Plains Woodland	1.94	88	D	-	-	-
			Swamp Oak Floodplain Forest	0.19	9	D	-	-	-
Stage 7 Residue	SW Bulk Earthworks DA	2025	Shale Plains Woodland	0.08	5	D	-	-	-
Stage 8	SW Bulk Earthworks DA	2025	Shale Plains Woodland	1.08	49	A	-	-	-
			DNG - Shale Plains Woodland	0.43	7	A	-	-	-

Master Plan Stages	Applicable Development Application(s)	Est. Start Date	Impacted Vegetation				Retained Vegetation		
			Native Vegetation Community Impacted	Area of Impact (ha)	BBAM Credit Liability	Offsetting Proposed	Native Vegetation Community Retained	Area retained (ha)	Conservation Proposed***
Stage 8 Residue	SW Bulk Earthworks DA	2025	Shale Plains Woodland	0.16	8	B	-	- -	
Stage 9	Stage 9 DA	2025	Shale Plains Woodland	0.37	17	A	-	- -	
			DNG - Shale Plains Woodland	3.21	53	A	-	- -	
Employment and Rural Lands	Separate DA for Impact, BEW DA for Conservation Works	2026	Shale Plains Woodland	0.53	24	A/D	Shale Plains Woodland	5.45	A
			DNG - Shale Plains Woodland	5.02	84	D	DNG - Shale Plains Woodland	0.43	A
			River-flat Eucalypt Forest	0.11	4	D	River-flat Eucalypt Forest	5.76	A
			Freshwater Wetlands	0.12	5	D	Freshwater Wetlands	4.08	A

Master Plan Stages	Applicable Development Application(s)	Est. Start Date	Impacted Vegetation				Retained Vegetation		
			Native Vegetation Community Impacted	Area of Impact (ha)	BBAM Credit Liability	Offsetting Proposed	Native Vegetation Community Retained	Area retained (ha)	Conservation Proposed***
			Swamp Oak Floodplain Forest	0.21	13	D	Swamp Oak Floodplain Foreset	1.79	A
Park F	SW Bulk Earthworks DA	2025	Shale Plains Woodland	0.03	1	D	-	-	-
Park H	SW Bulk Earthworks DA	2025	Swamp Oak Floodplain Forest	0.08	4	D	-	-	-
Park I	SW Bulk Earthworks DA	2025	Swamp Oak Floodplain Forest	0.02	1	D	-	-	-
Spine Road	SW Bulk Earthworks DA	2025	Elderslie Banksia Scrub Forest	0.01	1	B	-	-	-
			River-flat Eucalypt Forest	0.15	6	D	-	-	-
			Swamp Oak Floodplain Forest	0.2	9	D	-	-	-

**Unless otherwise stated, all credit liabilities are a BBAM credit liability*

***Proposed Offsetting:*

A = Purchase and retirement of credits following DA approval. Sufficient number of credits currently owned by the client. All credits to be retired prior to issuing Construction Certificate.

B = Request reasonable equivalency based on BBAM offset liability and pay into the BCT. Payment into the BCT will occur prior to issuing Construction Certificate.

C = Offset through conservation of EBSF within Parks K and L by applying a Voluntary Planning Agreement (VPA) to lands managed under a VMP. VPA and VMP to be approved and implemented prior to issuing Construction Certificate.

D = Offset through conservation of the Howes Creek and Northern Conservation Area and the Stage 6B EBSF Conservation Area by applying a VPA to lands managed under a VMP. VPA and VMP to be approved prior to issuing Construction Certificate.

**** Proposed Conservation measures:*

A = Assign VPA to land following DA approval that will include implementation of a permanent VMP (in perpetuity). Implementation of the VMP to commence prior to issuing Construction Certificate.

B = Assign VPA to lands within Park K and L managed under a VMP. Aim of the VMP will be to manage as per a BSA and include replanting. Note that EBSF is not eligible for a BSA as confirmed through site inspection and correspondence with the BCT.

6.4.3. Affected Species Cumulative Impacts

A summary of the cumulative impacts on the likely affected threatened fauna species under the Master Plan is provided in **Table 30**.

Table 30 Cumulative impacts on likely threatened fauna species

Species	Cumulative Potential Habitat Area Removed (ha)	Cumulative Potential Habitat Area Retained (ha)	% Retained
Black-necked Stork*	1.38	8.57	84.33
Brown Treecreeper	51.79	44.41	46.50
Dusky Woodswallow	51.79	44.41	46.50
Varied Sittella	51.79	44.41	46.50
Little Lorikeet	51.79	44.41	46.50
Grey-headed Flying-fox	51.79	44.41	46.50
Eastern False Pipistrelle	51.79	44.41	46.50
Little Bent-winged Bat	51.79	44.41	46.50
Eastern Coastal Free-tailed Bat	51.79	44.41	46.50
Southern Myotis**	6.20	44.41	88.31
Large Bent-winged Bat	51.79	44.41	46.50
Little Eagle	51.79	44.41	46.50
Powerful Owl	51.79	44.41	46.50

**Includes dams and freshwater wetlands*

***Based on the species polygon*

6.5. Description of Feasible Alternatives

CER 6.5 Description of feasible alternatives

A description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development (Section 110(3)(e)).

There are three broad alternatives to the proposal:

- Do nothing;
- Alternative development layout; and
- Reduced scale.

These are discussed below.

6.5.1. Do Nothing

The subject site is within the 'Menangle Park URA', which is a priority release area in the Department of Planning and Environment's Greater Macarthur Priority Area. The objective of the 'Menangle Park URA' is to support the Campbelltown-Macarthur Regional City through land release, new infrastructure and urban renewal. Therefore, the proposed development works is in alignment with the aims of the NSW DCCEEW's Greater Macarthur Priority Area, and to do nothing would not support the Campbelltown-Macarthur Regional City. Further to this, the proposed development works is permissible under the current and proposed zoning of the area.

If nothing is done and no development occurs, the areas of vegetation within the subject site are likely to survive in the long term *in situ*, however the condition and structure of the vegetation is expected to continue to degrade and be further modified due to its current isolation and exposure to edge effects. If nothing is done, it is expected over time the exotic species will accumulate within the soil seed back and continue to provide competition for native species in the long term. Better conservation outcomes would eventuate from protecting and enhancing less fragmented areas of native vegetation that provide connectivity to areas of habitat located outside of the study area.

6.5.2. Alternative Development Layout

Menangle Park comprises old farmlands where scattered patches of forest, woodland and wetland occur amid grasslands that have developed on historically cleared lands. The mosaic of vegetation occurs on lands with differing histories of land use that influence the potential for long term conservation.

Any number of alternative development layouts could theoretically be developed within the study area. However, the proposed works form part of larger development within the Menangle Park URA as identified in the Menangle Park Structure Plan, which has been developed with consideration to Cumberland Ecology's 'Menangle Park Structure Plan Review' (2016a), along with a proposed Concept Plan for all lands within the 'Menangle Park Release Area' owned by the proponent. A significant amount of survey work and planning has been undertaken to identify areas most appropriate for development (exotic grassland and small isolated patches of woodland) as well as conservation (larger areas of woodland such as the Howes Creek Riparian Corridor) to minimise impacts on threatened entities.

Some of the land in the subject site, proposed for the development of the town centre, previously had an old fireworks factory, and must be decontaminated. The decontamination process is mandatory and must involve the clearance of vegetation to remediate the soil. Some patches of EBSF in this part of the subject site will unavoidably be removed.

Amongst the patches of other native woodland TEC vegetation, some have good potential for future regeneration and restoration of habitat connectivity. Some of the woodland that remains in the southwestern corner of the subject site are near old homesteads and have massive weed infestations that present an expensive challenge to restore. These patches are also isolated from other such patches and problematic if not impossible to reconnect with other continuous habitat. This is particularly so because of pre-existing neighbouring residential areas that occur adjacent to the southwestern boundary of the subject site.

Consideration of feasible alternatives for the BEW DA is also influenced by the approved DAs where construction of residential neighbourhoods is already underway. Such pre-existing approvals and the history of strategic planning for the site make it difficult to make significant changes to the proposed development layout.

The current proposed development works design has avoided multiple areas (including the largest patch) of EBSF (CEEC TSC Act), which is proposed to be retained in perpetuity. Areas of Cumberland Plain Woodland will be cleared because of the proposed development works but will be offset through the purchase and retirement of ecosystem credits. Areas of EBSF, River-flat Eucalypt Forest, Swamp Oak Floodplain Forest and Freshwater Wetlands will be partially or fully offset by the onsite conservation areas that form part of this DA (Howes Creek Corridor and the Northern Area) and part of a previous Stage 2B DA (Parks K and L). Where a shortfall of on-site offsets exist, purchase and retirement of biodiversity credits will occur. This provides for a sustainable ecological outcome as the fragmented and degraded areas of the communities to be removed will be balanced by conservation and restoration of areas of native vegetation that will be managed in perpetuity. The Howes Creek Conservation Area currently links to the Nepean River and the connectivity of habitat will be improved by revegetation works in the future. Similarly, the Northern Conservation Area is located adjacent to the Mount Annan Botanic Gardens and woodland vegetation that is being restored within it will complement and form a steppingstone habitat link to woodlands being restored at Mount Annan.

The current development layout maximises residential development within the subject site, while providing for sustainable conservation outcomes, which is in alignment with the aims of the NSW DCCEEW's Greater Macarthur Priority Area which is to provide land release, new infrastructure and urban renewal in order to support the Campbelltown-Macarthur Regional City.

6.5.3. Reduced Scale

A reduction to the proposed scope of works under this DA (as amended) could occur which could include nominating additional areas of woodland for retention. However, this has not been proposed because patches of woodland that will be cleared under the scope of this DA generally comprise of younger regrowth vegetation and disturbed ground stratum vegetation. Moreover, they are currently isolated from other patches of woodland, and if retained would become further isolated as development proceeds around them in accordance with the Concept Plan.

The retention of some additional patches of woodland would substantially reduce the financial incentives of development, as fewer or small lots would be required, while the overall ecological benefits would be limited by the isolation of these patches. The proposed development works are also consistent with the proposed Concept Plan that has been submitted to Council.

Any departure from the Concept Plan under this DA would also need to be justified in relation to separate DAs for future subdivision works / development that will be submitted in due course. In this instance, reducing the scale of the proposed development works would defer any scope exclusions to these future DAs. This would introduce the potential for avoidable complexity during the assessment of this DA and future subdivision DAs.

7. Ameliorative Measures

CER 7 AMELIORATIVE MEASURES

7.1. Introduction

CER 7.1 Description of ameliorative measures

A full description and justification of the measures proposed to mitigate any adverse effect of the action on the species and populations [s.110(2)(i)] [or] ecological community [s.110(3)(f)] including a compilation (in a single section of the statement) of those measures.

This chapter outlines proposed amelioration and offsetting measures including:

- amelioration measures within the proposed development works areas;
- amelioration measures within the proposed conservation areas; and
- biodiversity offsetting via the purchase and retirement of ecosystem and species credits.

The chapter also examines the adequacy of the compensatory measures by reference to the OEH's Principles for the Use of Biodiversity Offsets in NSW.

At the conclusion of the chapter the benefits of the amelioration measures are examined by assessing the significance of impacts to affected TECs and threatened species by reapplying the seven part test for each entity.

Amelioration measures for the proposed works include those that will be implemented within or along the boundary of the proposed works areas, and a suite of measures for the conservation and rehabilitation of flora and fauna habitat within the proposed conservation areas (Parks K and L, Howes Creek and the Northern Conservation Areas, and the Stage 6B EBSF Conservation Area).

Details of the proposed conservation works are summarised in this SIS and provided in detail in the vegetation management plan (VMP) for Parks K and L (Cumberland Ecology 2022c) and the VMP for the Howes Creek and the Northern Conservation Areas (Cumberland Ecology 2022d). The VMP for the Stage 6B EBSF will be prepared as a Condition of Consent. This chapter should be read in conjunction with the VMPs.

7.2. Amelioration Measures Within the Proposed Development Areas

Ameliorative measures for the proposed development works include the preparation of a CEMP for the proposed development works to provide management guidelines to minimise impacts on the environment, including biodiversity values. The CEMP will be developed by the contractor engaged to do the construction works and therefore the production of CEMP is anticipated to become a condition of consent for the DA that will require approval by Council prior to issuing a construction certificate for the DA. Ameliorative measures included in the CEMP will include pre- and during-construction mitigation measures. Pre-construction measures such as pre-clearance surveys to check for any nesting or roosting fauna and move them to adjacent habitat will be required due to the presence of habitat features suitable for native fauna with the subject site.

Potential impacts to flora and fauna occurring in the construction phase relating to the proposal and which can be managed include, but are not limited to runoff, sedimentation, erosion, spread of weeds and pollution. Precautions need to be taken to minimise the drainage impacts downslope. A geotechnical report (Douglas Partners 2017) has been prepared for an area that includes the subject site. All recommendations made within this report and any future geotechnical reports will be implemented. Sediment control and reduction measures should be implemented to reduce sediment runoff into adjacent habitat to be retained and within the waterways present in the study area. Adjacent habitat of particular importance includes Cumberland Plain Woodland, EBSF and River-flat Eucalypt Forest to be retained. Stormwater, and Sediment and Erosion Management Plans will be developed, which address the potential impacts to flora and fauna.

During development, precautions will be taken to ensure that no pollution escapes the construction site, Pollution traps and regular removal of pollution to an offsite location would assist to minimise pollution impacts. A Waste Management Plan will be developed to mitigate waste and pollution entering the surrounding development.

In addition to the measures included in the CEMP, some long-term management strategies, and compensatory strategies will also be implemented.

Compensatory strategies for the proposed development works will include the following:

- Purchase and retirement of biodiversity credits for all native vegetation within the subject site;
- Implementation of 20-year VMPs for the TECs occurring within Parks K and L, the Howes Creek and Northern Conservation Areas, and the Stage 6B EBSF Conservation Area - Cumberland Plain Woodland (Shale Plains Woodland), River-flat Eucalypt Forest, Freshwater Wetlands, Swamp Oak Floodplain Forest, and EBSF.

Further information about the compensatory measures is provided in ***Section 7.1.2***.

The Exotic Grassland/Cleared Land, African Olive Dominated Exotic Woody Vegetation, Other Woody Exotic Dominated Vegetation and Dams to be cleared do not conform to a listing under the TSC Act or EPBC Act and offer a minimal amount of sub-optimal habitat for threatened species. Therefore, offsetting is not proposed or required for these communities.

7.2.1. Mitigation Measures

A range of mitigation measures have been developed for the proposed development works to mitigate the impacts that are unable to be avoided using the measures outlined previously, including the preparation of a CEMP that is to be subsequently approved by Council prior to issuing a construction certificate (CC) for the DA. The CEMP is to include the following details at a minimum:

- Measures to delineate clearing areas and protect native vegetation that is to be retained, including EBSF directly north of the subject site;
- Pre-clearance and clearance survey requirements;
- Measures to prevent the spread of priority and environmental weeds and *Phytophthora cinnamonii*;

- Required Sediment and Erosion Control Measures/stockpile management as per Managing Urban Stormwater: Soils and Construction (Landcom, 2004) - The Blue Book;
- Noise control measures;
- Air quality control measures (dust);
- Hazardous material management protocols (i.e. fuel etc) addressing storage, use, refilling etc;
- Incident and emergency response protocols;
- Competence, training and awareness procedures (i.e. Environmental inductions, Toolbox talks, training and awareness);
- Roles and responsibilities for implementing, monitoring and reviewing CEMP requirements;
- An overview of relevant Environmental management documentation;
- Waste Management procedures as per the submitted Waste Management Plan; and
- Inspection, monitoring and auditing requirements for all environmental controls and adaptive management to ensure environmental mitigation measures remain effective.

These measures relevant to biodiversity are discussed in more detail below.

7.2.1.1. Vegetation Clearance and Fauna Management Protocols

i. Inductions/ Toolboxes

Prior to undertaking any works within the subject site inductions are to be given by the civil contractor to ensure all site workers and visitors are aware of any no-access areas. The inductions should also include details of the adjoining vegetation present (e.g. types and listing status) as well as any penalties (e.g. termination of employment) associated with damaging such areas. In addition to the site inductions, daily toolboxes should be provided by the civil contractor that reiterate the above to all site workers.

ii. Delineation of Clearing Areas

To avoid unnecessary removal or damage to native vegetation to be retained in areas adjacent to the subject site, the clearing area should be clearly demarcated and signed, where appropriate, to ensure no vegetation beyond these boundaries is removed. In areas adjacent to woodland/forest located outside of the subject site (i.e. extent of clearing), temporary fencing and signage should be installed to provide a physical barrier between machinery and nearby vegetation to be retained. Furthermore, any tree protection fencing recommended by the project arborist should also be installed, where required. Fencing is required to be installed prior to the commencement of any works.

No machinery will be parked on areas beyond the temporary fencing and no access will be allowed during construction. Ancillary facilities such as stockpile sites, site compounds and construction zones must be located within the limits of clearing or within lands approved to be cleared under a previously approved DA. Access to and from the subject site will only be from existing roads, or areas subject to an approved DA.

iii. Clearance Timing

Clearing of vegetation will be timed to avoid key lifecycle stages, such as breeding periods, of the likely affected species that have the potential to roost within the subject site, including woodland birds and microbat species. A pre-clearance survey by a qualified ecologist will be undertaken within seven days prior to the clearing of vegetation within the subject site, and should any threatened species be identified as breeding within the clearance areas then clearing will be timed to avoid the specified breeding periods for those species.

Clearing will preferably be undertaken during late autumn or early winter, as these times are the least likely to coincide with the breeding periods of the likely affected species with the potential to breed within the subject site. However, if microbats are found to be roosting on site during the pre-clearance survey, clearance would occur in warmer months (spring, summer and autumn) and no clearance will occur in winter (i.e. June, July, August) when bats are inactive and in torpor.

iv. Pre-clearance and Clearance Surveys

The following pre-clearance and clearance surveys will be conducted in the subject site. These include flora surveys for the presence of environmental weeds, and fauna pre-clearance surveys. Further details of these surveys are provided below.

a. Pre-clearance Surveys

Prior to the commencement of any works fauna pre-clearance surveys must be undertaken by a suitably qualified ecologist. Pre-clearance surveys must be undertaken that will:

- Detect roosting and/or nesting threatened and non-threatened fauna;
- Be carried out within two weeks prior to native vegetation being cleared;
- Include targeted surveys for microchiropteran bats using harp traps for a minimum of four nights without heavy rain, with the age, sex and reproductive status of captured bats being assessed and recorded;
- Include roost searches for microchiropteran bats by using a torch to shine in holes, cracks and crevices, and by using a handheld bat detector to locate and identify bats that may call;
- Include spotlighting, stag watching and hollow watching on the evening before the woodland vegetation will be cleared, for a minimum of one hour prior to dusk, and for at least one hour after dusk;
- Include roost watches using bat detectors undertaken prior to the demolition of existing buildings;
- Safely relocate non-threatened fauna to nearby woodlands before vegetation is cleared;
- Preparation of a detailed Threatened Species Relocation Plan (TSRP), if threatened species are roosting and/or nesting in any habitat to be removed; and
- Include the demarcation of all hollow-bearing trees and fallen logs (with the latter being >10cm diameter), along with any other key habitat features.

In addition, surveys for environmental weeds will be undertaken within the subject site in order to identify weed infestations to ensure they are dealt with appropriately (e.g. not reused as mulch). Any additional weed control requirements will be incorporated into a pre-clearance assessment letter (as required).

Upon the completion of preclearance surveys a report outlining all of the preclearance surveys carried out, including survey effort, results and outcomes must be submitted to Council's Executive Manager Urban Release and Engagement (or equivalent).

If threatened species are roosting and/or nesting in any habitat to be removed, a detailed threatened species relocation plan must be developed and submitted to Council's Executive Manager Urban Release and Engagement (or equivalent). This plan must be approved in writing by Council's Executive Manger Urban Release and Engagement (or equivalent) prior to the issuing of a construction certificate or the commencement of any on ground works.

As part of the preclearance survey work, and following clearing, an appropriately qualified ecologist must identify any trees and logs or parts thereof, that would be appropriate for use as fauna habitat within the proposed conservation areas in the Menangle Park URA. Where relevant, specifications for felling/removal (to enable retention of features for fauna habitat) must also be specified.

b. Clearance Surveys

To minimise impacts to native fauna species, clearing must be undertaken in the following two staged process under the supervision of a suitably qualified ecologist:

- The initial phase of clearing will involve clearing around the habitat features demarcated in a) i) above and leaving these habitat features overnight to encourage any resident fauna to self-relocate; and
- The second stage will involve clearing of the habitat features left overnight followed by an inspection. Prior to felling, habitat trees will be nudged using an excavator to promote any resident fauna to self-relocate. No habitat tree is to be felled without the attending ecologist providing approval to the excavator/machine operator.

During any vegetation clearing, no habitat tree is to be felled without the attending ecologist providing approval to the excavator/machine operator. Any confirmed microchiropteran bat roost trees identified during the targeted microchiropteran bat surveys undertaken as part of the pre-clearance surveys will be removed carefully in sections under ecologist supervision to minimise harm to roosting individuals. Where possible, any confirmed microchiropteran bat roost trees will be removed last so that they are isolated as long as possible to encourage bats to self-relocate.

All fallen trees should be investigated by the attending project ecologist for the presence of hollows not detected prior to clearing. Inspections should be undertaken of these hollows for native fauna, in particular bats. Any bats recovered from felled trees will be captured and identified by the attending ecologist and will be kept in a calico bag in a dark, quiet place until nightfall and then relocated according to the TSRP.

To minimise impacts to microchiropteran bat species, the demolition of existing buildings identified as potential habitat during pre-clearance surveys will be supervised by an ecologist.

Provisions to protect any native fauna encountered during clearing activities are to include:

- Briefing all people involved in the clearing works about the possibility of fauna being present;
- Any animals disturbed or dislodged during clearance but not injured should be assisted to move into the adjacent bushland or other specified locations; and
- If any animals are injured during vegetation clearance, appropriate steps must be taken to humanely treat the animal under the advice of the attending ecologist (either taken to the nearest veterinary clinic for treatment, or if the animal is unlikely to survive taken to the vet to be humanely euthanized).

Salvaged material suitable for use in proposed conservation areas as per above must be stockpiled in an appropriate place with appropriate signage, to ensure it can be reused at a later date. A report outlining how salvaged material has been/will be reused must be prepared and submitted to Council's Executive Manager Urban Release and Engagement (or equivalent) prior to the principal certifying authority issuing an occupation (Final compliance) certificate.

It is recommended that the removal of hollow-bearing trees not be undertaken during the colder winter months (June to August) when microchiropteran bats may be in torpor and are less likely to successfully relocate during clearing activities.

v. Hydrology Management

Ameliorative measures will be applied with respect to impacts to the hydrological cycle, both for surface water and groundwater. Mitigation measures for surface water include the construction of retention basins to receive the increased level of water runoff from the proposed development works to prevent excessive discharge into existing drainage ways. Further details of the surface drainage measures are provided in the Masterplan Water Cycle Management Report and Engineering Design Report for Menangle Park Stage 2B.

As identified in ***Section 6.3*** ongoing groundwater monitoring is being undertaken in the study area in order to determine if any changes to the groundwater hydrology of the study area occur as a result of the proposed development works, in particular any lowering of the water table that may affect the ability of tree roots to access it, or changes in flow rate. This monitoring will allow for recommendations and corrective actions to be implemented to ameliorate any impacts to GDEs. These measures will be developed and implemented when required and when it is determined to be appropriate and may include recharging groundwater if deemed to be necessary based on the results of the long-term groundwater monitoring program.

vi. Dam Dewatering Plan

For aquatic species, a dam dewatering plan will be developed to minimise impacts on native species. The plan will require the following elements at a minimum to minimise impacts of the dewatering on resident fauna and any fauna within nearby waterways:

- The obtainment of any relevant licences required to relocate native aquatic fauna;
- Detailed description of dewatering procedures including the requirement for dewatering to occur under the supervisor of an ecologist and the instalment of mesh netting over any pumps; and

- Identification of suitable fauna relocation areas where captured fauna will be relocated to.
- It is anticipated that the dam dewatering plan will form a condition of consent for the DA and require approval from Council prior to undertaking any dewatering works.

vii. Hollow Offset Replacement Strategy

A hollow-offset replacement strategy will be developed that outlines the number and type of nest boxes required to be installed within retained areas to appropriately offset the removal of hollow-bearing trees. The hollow-offset replacement strategy will also include details regarding on-going monitoring requirements.

A total of 49 hollow-bearing trees and 175 tree hollows are to be removed by the proposed development works. Section 11.2.2 of the *Campbelltown (Sustainable City) DCP 2015* identifies a 2:1 replacement ratio of nest boxes/salvaged hollows to the number of hollows removed. Accordingly, 372 nest boxes/salvaged hollows would be required to be installed to meet the DCP's offset ratio.

Areas of vegetation where nest boxes/salvaged hollows can be installed include areas proposed to be conserved under a VMP (i.e. Howes Creek Riparian Corridor and areas of EBSF). Areas proposed to be conserved under a VMP already contain a high number of hollow-bearing trees (see ***Section 4.8***) and the installation of an additional 350 nest boxes/salvaged hollows is considered to be excessive. It is also noted that the removal of hollows is considered within the BBAM credit calculations undertaken.

Initially, it was proposed to offset the loss of hollow-bearing trees at a 2:1 ratio with nest boxes/salvaged hollows, which has been agreed to previously with Council for a separate DA. Council has requested that additional hollow offsets are required. To address Council's request, it is proposed that each hollow removed be replaced at a 1:1 ratio, which would result in the installation of 175 nest boxes/salvaged hollows. The proposed 1:1 replacement ratio for nest boxes/salvaged hollows is appropriate considering that the area of habitat where nest boxes/salvaged hollows will be installed already contain a reasonably high number of tree hollows.

With consideration of the above, the proposed 1:1 replacement ratio for nest boxes/salvaged hollows to hollows removed is consistent with Section 11.2.2 of the *Campbelltown (Sustainable City) DCP 2015* as all hollows removed will be offset. A preference for the salvage of hollows over nest boxes is recommended and will be included in the hollow-offset replacement strategy.

The BEW DA nest box replacement works will be monitored for five years, consistent with the terms granted for other approved DAs in the Menangle Park URA. Such mitigation works will be part of an overall hollow offset replacement strategy.

The hollow-offset replacement strategy will consider the following recommendations provided by EHG for the previously submitted Stage 2B DA:

- Cover all conservation areas of the Menangle Park URA;
- Consider the faunal carrying capacity of the conservation areas receiving nest boxes;

- Provide a clear strategy for targeting priority native species by installing the most appropriate artificial hollow designs;
- Use the high quality, durable nest boxes; and
- Include a monitoring, management and replacement strategy of suitable duration.

viii. Weed Management

To minimise the spread of weeds throughout the subject site and into adjoining areas, appropriate weed control activities will be undertaken.

Prior to construction, environmental weeds present in the subject site will be identified during pre-clearing surveys. Due to the known presence of priority weeds occurring in high abundances within the subject site, no vegetation removed should be re-used as mulch within the site or offsite. Further to this, any areas of dense environmental weeds recorded during pre-clearing surveys will be removed and disposed of according to the following protocols:

- Areas of dense environmental weeds will not be mulched on-site, but will be removed;
- All weed material will be taken to an appropriate waste facility; and
- All weed material transferred off-site must be covered.
- A wash-down station will be established and all construction vehicles entering and leaving the site will be required to be washed down to prevent weed seeds entering or leaving the site. It is expected that the details of the wash-down station will be included in the CEMP. These procedures will also assist in preventing the introduction of *Phytophthora cinnamomi*, which is a pathogen of native vegetation that is carried in contaminated soil.

ix. Erosion, Sedimentation and Pollution Control

Potential impacts to flora and fauna occurring in the construction phase that can be managed include: run-off, sedimentation, erosion and pollution. To reduce sedimentation on the construction site, erosion control measures should be implemented. This includes minimising the amount of exposed soils on the subject site at any given time. All soil stockpiles should be adequately covered when not in use to prevent erosion from heavy rainfall.

Sediment fences should be established around the perimeter of the clearing areas to prevent the impacts of sedimentation on any adjoining vegetation. This is particularly important in areas adjacent to woodland/forest in the southeast and north of the subject site. During development, precautions should be taken to ensure that no pollution, such as petrochemical substances or water containing suspended solids, escapes the construction site. Pollution traps and efficient removal of pollution to an off-site location would help to minimise pollution impacts.

x. Other Relevant Measures

The following general construction mitigation measures are proposed to be undertaken during the construction phase and will also be included in the CEMP for the project:

- Dust management - to minimise the impacts to vegetation and habitat quality;
- Noise management - to minimise impacts to fauna species; and
- Light management – to minimise impacts to fauna species.

In addition to the above measures, it is recommended that no clearing of vegetation be undertaken during periods of heavy rain to minimise the risk of erosion/sediment controls failing.

Post-construction it is considered that light pollution may have the potential to impact on retained vegetation and fauna that utilise such areas. It is recommended that all lighting associated with development restrict light from entering areas of retained vegetation. It is anticipated that Council will provide final approval on future dwellings and that appropriate light restrictions be placed on building in close proximity to retained vegetation (e.g. no bright lights directed towards vegetation).

7.2.1.2. Protection of Conservation Area Boundaries during Construction

Edges between the proposed Parks K and L, Stage 6B EBSF Conservation Area, and the Howes Creek and Northern Conservation Areas will be protected from impacts in adjacent development works areas by a suite of measures, including:

- Installation of sediment fencing;
- Installation of protective fencing with signage; and
- Monitoring of vegetation condition.

Further details are provided below.

i. Sediment Fencing

Installation of sediment fencing along all borders of the EBSF will be undertaken under a Council approved sediment control plan. All sediment fencing is to be installed prior to issuing a Construction Certificate for the DA.

ii. Protective Fencing and Signage

Installation of protective fencing around all borders of the EBSF proposed to be retained will be undertaken under a Council approved fencing plan. Fencing will also be installed along the top-of-bank of the proposed temporary drainage line to provide an additional buffer to EBSF. Fencing will be either Australian Temporary Fencing or semi-permanent chain wire fencing. All fencing will also include signage identifying that the fenced vegetation is 'ecological sensitive' and no trespassing is permitted. All protective fencing and associated signage is to be installed prior to commencement of construction.

iii. Monitoring of vegetation condition

The integrity of conservation areas will be subject to regular monitoring during the development works to check that erosion and deposition are prevented in conservation areas, to monitor weed invasion and to ensure the integrity of the TECs within the conservation areas.

7.3. Amelioration Provided by the Conservation Areas

CER 7.1.1 Long-term management strategies

CER 7.1.3 Ongoing monitoring

The primary means of amelioration involves the establishment of conservation areas for the in-perpetuity protection of viable, representative occurrences of flora and fauna. Conservation areas include Parks K and L, the Stage 6B EBSF Conservation Area, and the Howes Creek and the Northern Conservation Area (**Figure 20**). These will conserve viable representative areas of all TECs that occur at Menangle Park as follows:

- Howes Creek and the Northern Conservation Areas will conserve areas of Cumberland Plain Woodland (Shale Plains Woodland), River-flat Eucalypt Forest, Freshwater Wetlands and Swamp Oak Floodplain Forest (REF. VMP 17072RP36);
- The Stage 6B EBSF Conservation Area will conserve areas of EBSF; and
- Parks K and L will retain and revegetate areas of EBSF (REF. VMP 17072RP29).

Further information is provided about the composition of the parks in **Table 32**.

The Howes Creek and Northern Conservation Areas have areas of grassland and cleared land that will be regenerated to woodland and open forest under the VMP (REF. 17072RP36). Revegetation of the Howes Creek Conservation Area will help to provide viable habitat corridors of native vegetation extending from Howes Creek to the Nepean River. The Northern Conservation Area will also be revegetated and will form proximal habitat to other Cumberland Plain Woodland that is being regenerated at Mount Annan Botanic Gardens to the north of the subject site.

The conservation areas will be secured under a legal mechanism to ensure that they are managed and funded in perpetuity, with details set out within of a Voluntary Planning Agreement (VPA).

Under the TSC Act, the legal mechanism for permanently funding conservation areas was via the creation of a BioBanking site utilising the BBAM. However, the TSC Act is now repealed and the creation of a BioBanking site is no longer an option. As a result, the five conservation areas are proposed to be conserved under 20-year VMPs included within a VPA.

i. Aims and objectives of the VMPs

The primary purpose of the VMPs will be to guide the reconstruction, regeneration and management of vegetation associated with each conservation area. Guidelines cover regeneration and management of all native vegetation including Cumberland Plain Woodland, Swamp Oak Floodplain Forest, EBSF and River-flat Eucalypt Forest.

The VMPs prescribe:

- Reconstruction of the VMP Areas currently mapped as Exotic Grassland/Cleared Land to original TEC communities, using bushland regeneration techniques; and

- Appropriate weed control techniques.

The aims of the VMPs are:

- To improve the biodiversity values of the VMP Area;
- To re-establish native vegetation that is broadly representative of the original plant communities of the conservation areas, comprising three strata including understorey small trees, shrubs and groundcovers;
- To establish and enhance habitat for local fauna species with the potential to occur or known to occur within the VMP Area; and
- To enhance the ecological character of the VMP Area by removal and routine control of weed and exotic species present.

It is expected that the VMPs will be included in the conditions of consent for the proposed development works and will include the following information:

- Costing of the VMP for 20 years;
- Detailed schedule of works that outlines when actions will occur, who is responsible for undertaking the action, reporting requirements; and
- Detailed description of key performance indicators that will be utilised to address the success of the VMP.

7.4. Compensatory Strategies

CER 7.1.2 Compensatory strategies

To address any potential residual ecological impacts and compensate for the proposed impacts on the TECs and threatened species associated with the proposed development works, the following measures will be implemented:

- Purchase and retirement of biodiversity credits to compensate for impacts to the TEC Cumberland Plain Woodland (Shale Hills Woodland and Shale Plains Woodland) and EBSF; and
- Purchase and retirement of species credits to compensate for impacts to the Southern Myotis.

A BioBanking Assessment was undertaken to determine the credit requirements for the Cumberland Plain Woodland, Shale Hills Woodland shrubby regrowth, River-flat Eucalypt Forest, Freshwater Wetlands, EBSF, Swamp Oak Floodplain Forest and Southern Myotis habitat proposed to be impacted, as well as the credits generated within the proposed conservation areas.

Impacts to EBSF will be partially offset through the retention and revegetation of areas to be managed under the VMP (REF. 17072RP29) for Parks K and L. The retention and management of Parks K and L is a result of ongoing negotiations with Council in order to conserve the largest known patch of EBSF within the subject land (Park K) as well as the only patch of the community (Park L) containing the characteristic species *Banksia integrifolia* (Coast Banksia) for which the community's name is derived. The retention of Parks K and L were

proposed in the previously submitted SIS (REF. 17072RP9) to offset all impacts to EBSF proposed to be impacted under that SIS as the end result would be no net loss of the community accounting for the retention and revegetation of the community within Parks K and L. Therefore, to maintain consistency with previous negotiations with Council surrounding Parks K and L, not all impacts on EBSF and associated offsets have been assessed utilising the BBAM. Instead, impacts to EBSF will be partially offset by the retention, revegetation and in-perpetuity management of Parks K and L, as well as the purchase and retirement of ecosystem credits (see ***Section 6.4.1.3***). In addition, the areas of EBSF (non-TEC) have been included within the BBAM calculations as part of the TEC community and will be offset through the purchase and retirement of biodiversity credits.

The BioBanking Assessment was undertaken according to the BioBanking Assessment Methodology 2014 (BBAM) (OEH 2014a) under the TSC Act. The BioBanking Assessment is provided in **Appendix H** and a summary of the BioBanking Assessment results are presented in **Table 31**.

This assessment indicated that the provision of the onsite conservation areas including retained vegetation (extant areas) and revegetation areas will adequately offset the impacts to the following TECs and associated Biometric Vegetation Type (BVT):

- River-flat Eucalypt Forest (BVT HN526);
- Swamp Oak Floodplain Forest (HN674); and
- Freshwater Wetlands (BVT HN630).

The provision of the onsite conservation areas does not offset the impacts to Shale Plains Woodland (HN528), Shale Plains Woodland derived native grassland (HN528), Shale Hills Woodland (HN529), Shale Hills Woodland derived native grassland (HN529), Shale Hills Woodland shrubby regrowth (HN529), and EBSF (HN635) as these communities will not be retained within offset areas or areas in the offset areas have only generated part of the credits required for the proposed impact to these communities. No species credits have been calculated for the offset areas and accordingly, no on-site offsets for the Southern Myotis occur. Remaining impacts to these communities will be offset by the purchase of ecosystem credits.

As identified in **Table 31**, the credit liability for native vegetation impacted by the proposed development works and the credits produced by on-site conservation areas results in a credit shortfall for Shale Plains Woodland (HN528) (-12 credits), Shale Plains Woodland derived native grassland (HN528) (-140 credits), Shale Hills Woodland (HN529) (-237 credits), Shale Hills Woodland derived native grassland (HN529) (-55 credits), Shale Hills Woodland shrubby regrowth (HN529) (-10 credits), and EBSF (HN635) (-15 credits). A credit surplus is generated for Freshwater Wetlands (94 credits), Swamp Oak Floodplain Forest (1 credit) and River-flat Eucalypt Forest (73 credits).

The details of the proposed compensatory measures are described in further detail in subsequent subsections below.

Table 31 BBAM credit summary

Vegetation Community	BVT	Impact		Offset Extant Area (CA)		Offset Revegetation Area (CA)		Offset Combined (CA)		Credit Surplus/ Deficit
	BVT	Area (ha)	Ecosystem Credits	Area (ha)	Ecosystem Credits	Area (ha)	Ecosystem Credits	Area (ha)	Ecosystem Credits	Ecosystem Credits
River-flat Eucalypt Forest	HN526	1.51	68	8.44	102	3.84	39	12.28	141	73
Shale Hills Woodland	HN529	4.80	237	0	0	0	0	0	0	-237
Shale Hills Woodland (shrubby regrowth)	HN529	0.49	10	0	0	0	0	0	0	-10
Shale Hills Woodland (derived native grassland)	HN529	3.28	55	0	0	0	0	0	0	-55
Shale Plains Woodland	HN528	5.94	271	11.57	132	11.55	127	23.12	259	-12
Shale Plains Woodland (derived native grassland)	HN528	8.67	146	0.43	6	0	0	0.43	6	-140

Vegetation Community	BVT	Impact		Offset Extant Area (CA)		Offset Revegetation Area (CA)		Offset Combined (CA)		Credit Surplus/ Deficit
Freshwater Wetlands	HN630	0.37	10	6.15	86	1.62	18	7.77	104	94
Swamp Oak Floodplain Forest	HN674	3.39	161	7.16	104	5.68	58	12.84	162	1
Elderslie Banksia Scrub Forest	HN635	0.87*	47	0.21	2	0.56**	30**	0.21	2	-15
Total		**29.32**	**1,005**	**34.83**	**432**	**23.25**	**242**	**58.73**	**674**	**-301**

**This includes 0.10 ha of EBSF (non-TEC).*

***0.56 ha of Elderslie Banksia Scrub removal has already been negotiated with Council based on the proposed retention in Parks K and L. Therefore, credit calculations only considered the additional 0.31 ha of removal proposed in this updated SIS.*

****These credits were not calculated based on BBAM, these are based on the change in credit liability calculated for the removal of 0.87 ha compared to 0.31 ha of Elderslie Banksia Scrub Forest. It is not included in the total ecosystem credit number for the Offset Revegetation Area (CA).*

7.4.1.1. Southern Myotis credit calculations

BBAM credit calculations have been undertaken for impacts to the Southern Myotis as this species is not a predicted ecosystem species, it has been recorded within the subject site and breeding habitat for the species occurs within the subject land in the form of woodland with hollow-bearing trees within 200 m of waterbodies with a width of 3m or greater (EES, 2022). The species polygon for the Southern Myotis shown in **Figure 18** and is ~6.20 ha comprising the following vegetation areas:

- 3.04 ha of Shale Plains Woodland (HN528);
- 2.63 ha of Swamp Oak Floodplain Forest (HN674);
- 0.29 ha of EBSF (HN635); and
- 0.23 ha of River-flat Eucalypt Forest (HN526).

Table 32 shows the total credit liability for impacts to the Southern Myotis.

Table 32 Southern Myotis BBAM credits

Scientific name	Common name	Red flag	TS offset multiplier	Species credits required
Myotis macropus	Southern Myotis	No	2.2	136

7.4.1.2. Purchase and retirement of biodiversity credits

The implementation of the conservation areas does not adequately offset the impacts to the following communities utilising BBAM:

- Shale Hills Woodland (HN529);
- Shale Hills Woodland shrubby regrowth (HN529);
- Shale Hills Woodland derived native grassland (HN529);
- Shale Plains Woodland (HN528);
- Shale Plains Woodland derived native grassland (HN528); and
- EBSF (HN635).

Measures proposed to adequately compensate for the proposed impacts to these three communities are discussed below.

The BBAM calculations identify a shortfall of 302 Shale Hills Woodland (HN529) credits, 151 Shale Plains Woodland (HN528) credits . The proponent has already acquired 227 Shale Hills Woodland (HN529) credits and 130 Shale Plains Woodland (HN528) credits. The remaining 75 Shale Hills Woodland (HN529) credits and 22 Shale Plains Woodland (HN528) credits will be purchased and retired either through the retirement of the

proponent's existing BBAM credits, purchase of BBAM credits, or by obtaining an assessment of reasonable equivalence to convert these to BAM credits and paying into the Biodiversity Conservation Fund.

7.4.1.3. Retention and revegetation of Elderslie Banksia Scrub Forest

The proposed development works require the removal of 0.77 ha of EBSF and 0.10 of EBSF (non-TEC) from the subject site. An area of 0.56 ha of the community within the subject land was previously proposed to be removed under a separate remediation DA (REF. 17072RP10), which has now been incorporated into the BEW DA impact area. The areas of the community proposed to be removed consist of small, isolated patches that are generally degraded. To compensate for the proposed removal of this community associated with this DA, extant areas of the community present within the subject land (1.72 ha) are proposed to be conserved and managed under VMPs. The VMP for Park K and L (REF. 17072RP29) will also include the revegetation of 0.56 ha of the community within areas with deep sandy soils surrounding the extant vegetation. The proposed area of the community to be managed under a VMP has been developed in consultation with Council. As a result, the implementation of the VMP will result in more than twice the area of the community being retained/revegetated and managed in perpetuity as what is proposed to be removed within the subject land under this DA. The additional 0.42 ha that has been mapped as part of Cumberland Ecology's updated 2021 mapping for this updated SIS (of which 0.21 ha is now within the Stage 6B EBSF Conservation Area), and the 0.10 ha of EBSF (non-TEC) included in response to EHG comments, was not included within these negotiations for the VMP area with Council and will be subject to credit liabilities calculated using BBAM (see **Table 31**)

Currently, none of the EBSF present within the subject land is managed and is susceptible to further degradation because of surrounding land uses. The implementation of the VMP will ensure that all retained areas of the community are managed and conserved in perpetuity. Furthermore, the area of the community proposed to be conserved includes the largest patch present within the subject land, which will be further increased through revegetation under the VMP resulting in a patch that will be less exposed to edge effects through having a decreased perimeter to total area ratio. With consideration of the above, the proposed retention and management of EBSF present is considered to adequately compensate for the proposed impacts to the community. **Table 35** includes the details of the proposed impacts on EBSF and what is proposed to be managed under the VMPs. The remaining 0.31 ha was included within the BBAM calculations for the subject site and generated a total of 15 credits that will be offset through the purchase and retirement of credits. An overview of the aims and objectives of the VMP are provided below.

It is expected that the implementation of the VMP will become a condition of consent for this DA, if approved.

Table 33 Details of Elderslie Banksia Scrub Forest to be impacted and managed under a VMP

Vegetation Community	Extant Area within the subject land	Proposed Impact (ha)	Extant Area Managed by VMP	Revegetation Area Managed by VMP	Total Area to be managed by VMP
Elderslie Banksia Scrub Forest	2.50	0.77	1.72	0.56	2.28

7.5. Adequacy of Compensatory Measures

The proposed compensatory measures aim to meet OEH's Principles for the Use of Biodiversity Offsets in NSW. **Table 36** below identifies how each of these principles has been addressed by this SIS. The results of the assessment of the proposed development works indicates that although not all of OEH's principles are met entirely, the SIS and its proposed mitigation and compensatory measures provides adequate offsets for the biodiversity predicted to be impacted.

Table 34 OEH's principles for the use of biodiversity offsets in NSW

OEH Principle	Description of proposed measure	Principle Met
1. Impacts must be avoided first by using prevention and mitigation measures.	The proposed development works will impact on a total of five TECs present within the study area. Avoidance of all areas of TECs is not deemed possible to meet the needs of the Campbelltown-Macarthur Regional City. Although areas of TECs will be removed, the areas proposed to be removed are generally small isolated patches that provide limited ecological value. Furthermore, the largest and best condition patches of vegetation are proposed to be conserved and managed in perpetuity. Additionally, except for a portion of the EBSF, all areas of TECs to be impacted will be offset utilising OEH's BioBanking Assessment Methodology (BBAM), including the purchase of biodiversity credits	Partially
2. All regulatory requirements must be met.	All regulatory requirements have been met.	Yes
3. Offsets must never reward ongoing poor performance.	There is no evidence to suggest that the proponent has done anything that would be considered as 'rewarding ongoing poor performance'.	Yes
4. Offsets will complement other government programs.	The proposed offsetting will complement other government programs including the Cumberland Plain Recovery Plan (DECCW (NSW) 2011). Specifically, the proposed offsetting will complement objectives one and two of the recovery plan which are: 1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands; and 2) To deliver best practice management for threatened species, populations and ecological communities across the Cumberland Plain, with a specific focus on the priority conservation lands and public.	Yes
5. Offsets must be underpinned by sound ecological principles.	Most of the proposed offsets were determined through BBAM, which is based on sound ecological principles. The proposed offsets for a portion of the EBSF includes the implementation of a VMP. Similar offsets for the	Yes

OEH Principle	Description of proposed measure	Principle Met
	community have been utilised in the area (e.g. Spring Farm) in the past and are considered to be effective.	
6. Offsets should aim to result in a net improvement in biodiversity over time.	The proposed offsets require the purchase and retirement of biodiversity credits and the implementation of long term VMPs under a VPA which will all allow for the funding of all offsets in perpetuity. The conservation and management of the proposed conservation areas is likely to result in the net improvement in biodiversity over time.	Yes
7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs.	As above	Yes
8. Offsets should be agreed prior to the impact occurring.	The proponent has already acquired the required a number of Shale Hills Woodland (HN529) and Shale Plains Woodland (HN528) Credits to offset the majority of the proposed development works as identified in the BBAM. It is also expected that the proposed VMP for EBSF will be included in the conditions of consent.	Yes
9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated.	Offsets have been calculated utilising the BBAM. For EBSF, the total impact and VMP Area have been determined resulting in more than twice the area of the community being retained and managed to what will be removed.	Yes
10. Offsets must be targeted.	The proposed offsetting is targeted as impacts to all TECs proposed will be offset either through the purchase and retirement of ecosystem credits or the implementation of a VMP.	Yes
11. Offsets must be located appropriately.	The offsets will be located appropriately as required under BBAM. The VMP Area includes extant patches of the community present within the subject land and includes surrounding areas that contain suitable sandy soils that once likely supported the remnant community to be reconstructed. The long term VMP area comprises existing remnants of the ecological communities that are proposed to be revegetated.	Yes
12. Offsets must be supplementary.	The proposed offset is supplementary as the land within the lot is privately owned and not subject to a current scheme.	Yes
13. Offsets and their action must be enforceable through development consent conditions, licence	It is expected that all compensatory measures proposed will form part of the conditions of consent for the proposed development works.	Yes

OEH Principle	Description of proposed measure	Principle Met
conditions, conservation agreements or contracts.		

8. Assessment of Significance of Likely Effects of Proposed Action

This chapter covers the following Chief Executive Requirements:

CER 8. ASSESSMENT OF SIGNIFICANCE OF LIKELY EFFECT OF PROPOSED ACTION

8.1. Introduction

This chapter contains formal Assessments of Significance for affected species required under Section 5A of the EP&A Act that have been prepared in accordance of the *Threatened Species Assessment Guidelines* (The Guidelines) (DECC (NSW) 2007). These Assessments of Significance have been updated from those presented in the previous SIS taking into consideration the comments provided by EHG, including consideration of cumulative impacts, and to include the results of additional surveys undertaken in the study area. The updated and revised Assessments of Significance are presented below in subsequent sub-sections.

Assessments of Significance provide a means by which to gauge the significance of predicted impacts to threatened species, populations and ecological communities listed under the TSC Act. They have been prepared to help examine the magnitude of impacts to local occurrences of threatened biota. Both direct and indirect impacts are considered within these assessments. Direct impacts have been quantified within the assessments and are represented by the subject site. Whilst it is acknowledged that indirect impacts can potentially be significant for a variety of species, such impacts cannot be mapped or accurately calculated in advance. As a precaution, the study area has been defined as the extent of potential indirect impacts and extends to either areas that act as a significant barrier (e.g. roads) or are well outside of the subject site (greater than 300m away). The study area is a conservative estimate as the impacts are expected to be contained entirely within the subject site if all mitigation measures recommended are implemented.

Assessments of Significance have been prepared for five TEC communities considered to be 'affected' by both direct and indirect impacts. Assessments of Significance have also been completed for all threatened flora and fauna species that have been recorded from within the study area, and as a precautionary measure for some threatened species that are considered to have potential to occur in the study area due to records of occurrence in the local area and the presence of suitable habitat. Note that the threatened fauna species not recorded from the study area are not considered to be affected species; the Assessments of Significance have been prepared only as a precautionary measure.

The Guidelines provide definitions for key terms including locality, local occurrence and local population. Further descriptions of these key terms are provided below.

Locality

The Guidelines define 'locality' as '*the same meaning as ascribed to local population of a species or local occurrence of an ecological community*'. The definition of locality utilised within this chapter (i.e. **Chapter 8**) means the same as defined under The Guidelines.

Local Occurrence

The Guidelines define 'local occurrence' as 'the ecological community that occurs within the study area'. However, the local occurrence may include adjacent areas if the ecological community on the study area forms part of a larger contiguous area of that ecological community and the movement of individuals and exchange of genetic material across the boundary of the study area can be clearly demonstrated'. The use of local occurrence within the body of this report as well as the Assessments of Significance is defined as the ecological community that occurs with the study area as defined by the Guidelines.

Local Population

The Guidelines define 'local population' as the population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions.

- The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.
- The local population of resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.
- The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the study area from time to time.

The definition of local population utilised within this report as well as the Assessments of Significance for threatened plant species and migratory/nomadic fauna is the same as defined as The Guidelines, noting that no threatened plant species were recorded within the subject site. For resident fauna, the local population is defined in the SIS as any individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. This definition is the standard definition applied for species impact statements and assessments of significance completed for Part 5A of the EP&A Act. Some local populations of resident fauna species would extend outside of the study area, but this is not feasible to be determined for an SIS, nor is it required. Therefore, we have focussed this assessment on the study area.

8.2. Endangered Ecological Communities

8.2.1. Cumberland Plain Woodland (CPW)

The proposed development works will result in the removal of 22.68 ha of Cumberland Plain Woodland from the subject site, or approximately 29.7% of the community's local occurrence. Under the Master Plan, approximately 44 ha of the community is proposed to be removed, of which approximately half is derived native grassland, and 12.00 ha is proposed to be protected and managed and 11.55 ha will be revegetated for conservation, for a total of 23.55 retained in perpetuity. The in-perpetuity protection of 23.55 ha of the

community proposed under the Master Plan will ensure that the community's local occurrence is not placed at risk of extinction in the long-term.

Assessment of Significance

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

The total area of CPW present within the proposed development works footprint is 22.68 ha, all of which is proposed to be removed. This represents approximately 29.7% of the community's local occurrence. Most of this area of the community to be removed is in moderate condition due to previous disturbance including presence of exotic species. In addition, a further 19.39 ha of CPW (including derived native grassland) is proposed to be removed outside of the proposed development works footprint for previously approved DAs and currently submitted DAs as part of the Master Plan (see ***Section 5.3.1***). This equates to the removal of approximately 61.7% of CPW across the Menangle Park URA. A total of 12.00 ha of CPW will be retained and conserved in Howes Creek and the Northern conservation areas according to the Master Plan. These areas will be managed and expanded by replanting to form ~24 ha that will be conservated in perpetuity. Accordingly, the project is not considered likely to place the local occurrence of CPW at risk of extinction, however it is a technically significant level of removal given the conservation status of the community.

There is potential for changes to species composition in the areas adjacent to the proposed development works footprint; however, these changes are expected to be localised and overall are not considered to cause a substantial change in species composition. That is because the adjacent areas of the conservation areas will be managed to monitor for and ameliorate such impacts. In the southwestern side of the site, the adjacent areas of CPW that will remain under private ownership are already highly modified and are not expected to suffer further weed invasion as a result. The proposed development will however reduce the overall patch size of the patches in this area.

As the CPW within the proposed development works footprint is highly fragmented and degraded, the vegetation in its current condition holds limited ecological value and may be unlikely to be viable in the long-

term without management. If the vegetation is left in perpetuity, it is likely that its condition will continue to deteriorate as a result of surrounding land uses.

For these reasons, although the proposed development works will adversely affect the extent of this community and modify the composition of the ecological community to some extent, it is unlikely to place the local occurrence at risk of extinction as the majority of the community's local occurrence will be retained.

d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 22.68 ha of CPW will be removed as a result of the proposed development works, which comprises approximately 1.97% and 29.7% of the community within 5 km of the subject site and its local occurrence, respectively. Additional areas of vegetation will be removed outside the subject site as part of the Master Plan (see ***Section 5.3.1***). Including the area on the subject site, this comprises a total of approximately 19.39 ha of CPW (including derived native grassland) that will be removed for previously approved DAs and currently submitted DAs.

The CPW occurring within the subject site and immediate surrounds is already fragmented due to previous clearing and currently occurs as isolated patches. Habitat within the subject site does not join onto any national parks or reserves or to any large remnant patch of native vegetation. Accordingly, the connectivity offered by these isolated patches is relatively low and limited to "stepping-stone" connectivity. The proposed development works will clear some patches of CPW, however other patches of CPW will remain in the study area and continue to provide stepping-stone connectivity between areas of retained vegetation.

The CPW within the subject site has already been impacted by previous and current land uses which has resulted in impacts such as spread of exotic species. Nevertheless, due to the small areas of this community occurring in the locality, the CPW in the subject site is considered to be important for the long-term survival of the community. Similarly, the total 19.39 ha of CPW that is proposed to be removed both outside of and including the subject site as part of the Master Plan is in similar condition, is not protected or managed for conservation, but due to the small areas that remain it is considered to be important to the long-term survival of the community.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There is no critical habitat for CPW currently listed by the Director-General of the OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;
2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;
3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program; and
4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The Recovery Plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the subject site itself has not been mapped within the boundary of these priority conservation lands. The threats to CPW listed in the Recovery Plan are further loss and fragmentation of habitat, weed invasion, changes in fire regimes and urban run-off.

Within the subject site, the community has been highly degraded from past clearing and fragmentation. Nevertheless, the project will result in further loss of this community, which has been listed in the Recovery Plan as a threat to the community.

All areas of Cumberland Plain Woodland proposed to be retained and conserved within the proponent's land will be managed in perpetuity. This ongoing management will ameliorate indirect impacts associated with urban development and result in an increase of vegetation condition over time. Increase in vegetation condition will be a requirement of the Vegetation Management Plan's key performance indicators. The conservation and management of areas of Cumberland Plain Woodland is consistent with the objectives of the Recovery Plan listed under part (f) above.

No threat abatement plan is relevant to this community.

g) 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.

The following key threatening processes are considered to potentially impact CPW:

- Clearing of native vegetation

Approximately 22.68 ha of CPW will be removed for the proposed development works. Although a moderate area of the community will be removed, this represents ~29.7% of the community's local occurrence.

- Invasion of native plant communities by exotic perennial grasses

The proposed development works has the potential to result in the spread of exotic grasses and other weeds into adjacent areas of woodland habitat that are not being cleared, particularly the conservation areas. To

mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. As set out in **Chapter 7** mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. VMPs will also be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of CPW.

- Invasion and establishment of exotic vines and scramblers;

The proposed development works has the potential to result in the spread of exotic weeds. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of CPW.

- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The subject site currently contains Lantana in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of CPW.

- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*;

The subject site currently contains African Olive in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of CPW.

- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

Bushfire APZs will be implemented making the proposed development works unlikely to contribute to high frequency fire further than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'.

The proposed development works has the potential to contribute to this key threatening process; however, it is considered unlikely to exacerbate this key threatening process significantly from current conditions as the area of the community immediately adjacent to the subject site is already degraded as a result of weed invasion and surrounding land uses. As part of the BEW DA, three VMPs will be prepared for the five Proposed Conservation Works areas in the Menangle Park URA. This will outline in perpetuity conservation works, including weed control, feral animal control and replanting. Therefore, this threatening process is unlikely to significantly impact on retained areas of CPW.

Conclusion

The proposed development works will result in the removal of approximately 22.68 ha of CPW from the subject site. This represents approximately 1.97% and 29.7% of the community within 5 km of the subject site and its local occurrence, respectively. Due to the proposed removal of CPW from the subject site, it is considered that the proposal is likely to result in a technically significant impact to CPW.

The subject site is part of the wider Menangle Park project area and cumulative impacts of the removal of CPW proposed for previously approved DAs and currently submitted DAs according to the Master Plan has also been considered. All areas of Cumberland Plain Woodland removed will be appropriately offset through the purchase and retirement of an appropriate number/type of ecosystem credits. Approximately 19.39 ha of CPW is proposed to be removed by the Master Plan, and a total of 12.00 ha of existing woodland is proposed to be protected, then doubled in size by replanting. The community will be further conserved in the wider locality including areas within the Howes Creek Riparian corridor under the Master Plan and within Mt Annan Botanic Garden.

Areas of the community located near the proposed development works are considered to have the potential to be indirectly impacted, however if the mitigation measures recommended within this report and the associated VMPs are implemented, indirect impacts associated with the proposed development works are considered likely to be appropriately controlled. These measures include protection fencing, silt fencing and ongoing groundwater monitoring. This assumption is supported by the outcomes of current development works on the Menangle Park URA for approved DAs. This development is in the same proximity to retained vegetation and is located upslope of it, thereby increasing the potential for indirect impacts such as sedimentation and erosion. The works associated with this DA have now been completed and ongoing monitoring has demonstrated that no observable impact to retained vegetation has been recorded. This indicates that the mitigation measures implemented were sufficient to ameliorate any potential indirect impacts and supports the conclusion that the implementation of appropriate mitigation measures will be able to avoid any impact to retained areas of CPW because of the current proposal.

8.2.2. Elderslie Banksia Scrub Forest (EBSF)

Approximately 2.50 ha of EBSF occurs in the study area. Of this the majority will be retained within three conservation areas, Parks K and L, conserving 1.51 ha and the Stage 6B EBSF Conservation Area, conserving

0.21 ha. Park K, the larger of the two retained patches has now been protected by a widened buffer, which is now 30 m wide. The widened buffer will help to reduce edge effects on this park.

Several patches occur in the proposed development area including a larger patch in an area requiring soil remediation that cannot be avoided and a few very small patches. The total areas to be cleared amount to about 0.77 ha.

Within Parks K and L, due to the community's proximity to the proposed development works, there is also potential or indirect impacts, which are considered in this assessment. For these reasons it has been assessed as an 'affected' ecological community due to potential indirect impacts that may occur.

Assessment of Significance

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

As part of the overall Master Plan, approximately 0.77 ha of EBSF is proposed to be removed by currently submitted DAs, and approximately 1.72 ha is proposed to be protected and managed for conservation in perpetuity. Although it is recognised that (as identified by EHG in comments on an earlier draft of this report) even when remnants are protected through Council reservation or formal offsetting mechanism, the outcomes have been mixed, the conservation of the patch of EBSF if still likely to result in higher conservation outcomes relative to no protection. The subject site is currently used for grazing and weeds are prevalent. In the absence of any action, this remnant would be likely to continue to degrade over time and lose ecological value.

The proposed development works is considered to have the potential to also impact on the community indirectly because of impacts associated with sedimentation and erosion. Specific mitigation measures have been proposed to ameliorate these indirect impacts and if implemented, the proposed development works is considered unlikely to have an adverse effect on the extent or the composition of the community's local occurrence. The protection of this remnant and the implementation of mitigation measures to avoid indirect

impacts is likely to result in an improved conservation outcome for the 1.51 ha conserved within Parks K and L and the 0.21 ha conserved within the Stage 6B EBSF Conservation Area.

Due to its potential to utilise groundwater on occasion, EBSF may comprise a GDE, and the project has the potential to indirectly impact this community outside of the subject site by altering the hydrology. However, the Masterplan Water Cycle Management Report and Engineering Design Report for Menangle Park Stage 2B demonstrate that significant changes to hydrology will not occur and that surface flows will be discharged in areas of potential GDEs (including EBSF). Additionally, groundwater monitoring is currently being undertaken in the study area and to date no observable change in groundwater has been documented as a result of previous development (see ***Section 6.3***). Further to the groundwater monitoring, no observable change to vegetation has been recorded by the ongoing vegetation monitoring being carried out within Parks K and L as part of the approved Stage 2A development. Therefore, based on available data it is considered unlikely that permanent detrimental changes to retained EBSF vegetation due to groundwater will occur as a result of the project.

Although some EBSF will be cleared, the largest patches will be retained and conserved and so the project is unlikely to make the local occurrence extinct.

d) In relation to the habitat of a threatened species, population or ecological community:

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

The community within the study area has already been impacted by previous and current land uses and is not currently managed for conservation. Nevertheless, all extant patches of the community are considered important to its long-term survival in the locality due the small extent of the community remaining.

About 0.77 ha of EBSF will be removed as a result of the proposed development and there is potential for some indirect impacts to this community such as sedimentation and erosion, but these are expected to be able to be appropriately managed through the implementation of mitigation measures contained in **Chapter 7**.

Approximately 1.72 ha will be retained and managed for conservation and an additional 0.56 ha of EBSF added through revegetation.

Clearance of several patches of EBSF in the remediation area will contribute to increasing isolation of the remaining areas in Parks K and L and the Stage 6B EBSF Conservation Area. As development takes place around these parks there will also be increasing fragmentation via roads and houses.

The proposed development works will technically clear a significant area and increase fragmentation and isolation of this community.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There is no critical habitat for this community currently listed by EHG.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Elderslie Banksia Scrub Forest was specifically excluded from the recovery plan which states EBSF will also be excluded from consideration in this recovery plan as the future of the remaining area of this threatened ecological community at Spring Farm, Camden has already been determined through the land-use planning system.

It is assumed at the time of the recovery plan as at the time of the preparation of the final determination that Elderslie Banksia Scrub was only known from the Camden Council LGA in the Spring Farm locality.

Assuming that areas of the community located outside of Spring Farm and Camden were included in the recovery plan, the community is considered to be significant as all remaining patches hold considerable ecological value due to its status; however, the proposed development works is not considered to threaten the objectives of the recovery plan as all areas of the community have been avoided.

No threat abatement plan is relevant to this community.

g) 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.

The following key threatening processes are relevant to EBSF occurring within the study area:

- Clearing of native vegetation

No areas of the community will be removed by the proposed development works.

- Invasion of native plant communities by exotic perennial grasses

The proposed development works has the potential to result in the spread of exotic grasses, including into areas of retained EBSF. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. As part of the Bulk Earthworks DA, three VMPs have/will be prepared for the five proposed conservation works areas in the Menangle Park URA. These will outline in perpetuity conservation works, including weed control, feral animal control and replanting. Therefore, this threatening process is unlikely to significantly impact on retained areas of EBSF.

- Invasion and establishment of exotic vines and scramblers

The proposed development works has the potential to result in the spread of exotic vines and scramblers including into areas of retained EBSF. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all

weeds off-site and weeds must be covered when transporting off-site. As part of the Bulk Earthworks DA, three VMPs have/will be prepared for the five proposed conservation works areas in the Menangle Park URA, which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of EBSF.

- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The study area currently contains Lantana in one area which is within the patch of EBSF immediately adjacent to the subject site. None of this community will be removed the VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of EBSF. Therefore, the proposed development works is considered unlikely to increase or contribute to this key threatening process.

- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata)*;

The subject site currently contains African Olive in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of EBSF.

- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

The proposed development works is unlikely to contribute to high frequency fire further than current conditions as bushfire APZs will be implemented as recommended in the bushfire protection assessment (Eco Logical Australia 2018) relevant to the subject site.

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Future development has the potential to contribute to this key threatening process, but this is unlikely to occur until development within the subject site is completed and housing is occupied. No mitigation measures are recommended within this SIS to ameliorate any impacts associated with this key threatening process. However, the patch of EBSF immediately adjacent to the subject site that is considered to be susceptible to indirect impacts from the proposed development works is proposed to be retained under the proposed Master Plan. This area of EBSF is also proposed to be managed and conserved in perpetuity under the Park K and L VMP (REF. 17072RP29).

Conclusion

The proposed development works will avoid the major patches of EBSF present in the study area, which are to be conserved within Parks K and L and the Stage 6B EBSF Conservation Area.

Several patches of the community amounting to 0.77 ha will be cleared and this will add to fragmentation and isolation of the CEEC community.

Mitigation measures include protection fencing, silt fencing and ongoing monitoring. This assumption is supported by the outcomes of a previous development associated with the Stage 2B DA. This development is in the same proximity to EBSF and is located upslope of it, thereby increasing the potential for indirect impacts such as sedimentation and erosion. The works associated with this DA have now been completed and ongoing monitoring has demonstrated that no observable impact to retained vegetation has been recorded. This indicates that the mitigation measures implemented were sufficient to ameliorate any potential indirect impacts and supports the conclusion that the implementation of appropriate mitigation measures will be able to avoid any impact to EBSF as a result of the current proposal.

Although EBSF may rely on groundwater occasionally, stormwater design as well as ongoing monitoring in the study area has indicated that to date, no impact to groundwater has been recorded as a result of previous development in the wider study area or is considered likely to occur. Accordingly, it is not expected that the current proposal will result in changes to the hydrology such that the area of EBSF outside of the subject site will be indirectly impacted.

The proposal will have a significant impact on the community. However, the retention and management of the community within Park K and L and the Stage 6B EBSF Conservation Area will retain and conserve patches of this community in the subject site in the long term.

8.2.3. River-flat Eucalypt Forest

A limited area of River Flat Eucalypt Forest estimated to be ~1.51 ha will be cleared from the subject site but ~8.5 ha is within the conservation reserves of Menangle Park.

The area of the community in the conservation areas has potential to be indirectly impacted by the proposed development works occurs in a low-lying area down slope of the subject site. Indirect impacts on this community and others in the conservation areas are anticipated and are proposed to be appropriately ameliorated by the mitigation measures proposed, as explained in **Chapter 7** and the VMPs. Therefore, no significant impact on the local occurrence of this community is considered likely to occur.

Assessment of Significance

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

River-flat Eucalypt Forest along Howes Creek and to a lesser extent within the proposed development works area within the subject site. Most of the community will be avoided and conserved in the long term. The VMP 1 also prescribes approximately 3.84 ha of replanting of this community within the Howes Creek Conservation Area.

As part of the overall Master Plan, approximately 1.51 ha of River-flat Eucalypt Forest is proposed to be removed by previously approved DAs or currently submitted DAs, and approximately 8.44 ha is proposed to be protected and managed for conservation in perpetuity.

The proposed development works may also indirectly impact on the community as a result of impacts associated with sedimentation and erosion. Mitigation measures have been proposed to ameliorate these indirect impacts and if implemented, the proposed development works is considered unlikely to have an adverse effect on the extent or the composition of the community's local occurrence.

River-flat Eucalypt Forest is likely to be a GDE to an extent as it typically occurs in areas with permeable soils and geology (e.g. alluvial deposits) where shallow groundwaters are present. However, to a large degree this community is likely to be sustained by overland flows and general soil moisture rather than groundwater. However, as recognised and explained elsewhere in this document the project has the potential to indirectly impact this community outside of the subject site by altering the hydrology. However, as explained elsewhere in this report, groundwater impacts are predicted to be limited.

Groundwater monitoring and modelling is currently being undertaken across Menangle Park and the latest groundwater report concludes that groundwater impacts will be manageable in the long term (see ***Section 5.4***). Further to the groundwater monitoring, no observable change to vegetation has been recorded by the ongoing vegetation monitoring being carried out within Parks K and L as part of the approved Stage 2A development.

Therefore, based on available data it is considered unlikely that changes to retained River-flat Eucalypt Forest vegetation due to groundwater will occur because of the project.

d) In relation to the habitat of a threatened species, population or ecological community:

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

Limited River-flat Eucalypt Forest will be removed by the proposed development works ..

As part of the overall Master Plan, approximately 1.51 ha of River-flat Eucalypt Forest is proposed to be removed by previously approved DAs or currently submitted DAs, and approximately 8.44 ha is proposed to be protected and managed for conservation in perpetuity. There will also be a further 3.84 ha replanted in the conservation land.

A limited portion of River-flat Eucalypt Forest will be cleared impacted by the proposed development works but most will be retained and connectivity along Howes Creek will be improved under the management proposed in VMP 1. Therefore, the proposed development works is unlikely to result in substantial further fragmentation or isolation of the community.

The community within the study area has already been impacted by previous and current land uses. Nevertheless, all extant patches of the community are considered important to its long-term survival in the locality due the small extent of the community remaining including, the limited area of River-flat Eucalypt Forest that is proposed to be removed as part of the Master Plan. However, the proposed development works is unlikely to significantly impact on any areas of the community if the mitigation measures recommended within this report and the SIS are implemented.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There is no critical habitat for this community currently listed by the Director-General of the OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;
2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;
3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program; and
4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The Recovery Plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the study area itself has not been mapped within the boundary of these priority conservation lands. Threats to the community include, but are not limited to, further loss and fragmentation of habitat, weed invasion, changes in fire regimes and urban run-off. The proposed development works only clear a limited area of this community and therefore it is considered to be consistent with the objectives of this plan.

No threat abatement plan is relevant to this community.

g) 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.

The following key threatening processes are relevant to River-flat Eucalypt Forest occurring within the study area:

- Clearing of native vegetation

No areas of the community will be removed by the proposed development works.

- Invasion of native plant communities by exotic perennial grasses

The proposed development works has the potential to result in the spread of exotic grasses. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of River-flat Eucalypt Forest.

- Invasion and establishment of exotic vines and scramblers

The proposed development works has the potential to result in the spread of exotic weeds. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of River-flat Eucalypt Forest.

- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The study area currently contains Lantana in one area which is within the patch of EBSF immediately adjacent to the subject site. None of this community will be removed and VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds. Therefore, the proposed development works is considered unlikely to increase or contribute to this key threatening process.

- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata)*

The subject site currently contains African Olive in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. VMPs associated

with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of River-flat Eucalypt Forest.

- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

The proposed development works is unlikely to contribute to high frequency fire further than current conditions as bushfire APZs will be implemented as recommended in the bushfire protection assessment (Eco Logical Australia 2018) relevant to the subject site.

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Future development has the potential to contribute to this key threatening process, but this is unlikely to occur until development within the subject site is completed and housing is occupied. No mitigation measures are recommended within this SIS to ameliorate any impacts associated with this key threatening process. It is also noted that this area of River-flat Eucalypt Forest will be offset for appropriately through the implementation of conservation areas within the Howes Creek Riparian Corridor. VMPs associated with the BEW DA will be prepared for all areas of retained vegetation in the subject site which will include measures to control weeds and therefore this threatening process is unlikely to impact on retained areas of River-flat Eucalypt Forest.

Conclusion

The proposed development works will almost all of the River-flat Eucalypt Forest present in the subject site and will conserve most of it in the long term.

An area of the community located adjacent to the subject site is considered to have the potential to be indirectly impacted by the proposed development works by sedimentation and erosion. However, if the mitigation measures recommended within this report and the VMPs are implemented, indirect impacts associated with the proposed development works are considered likely to be appropriately controlled. Although likely to comprise a GDE, stormwater design as well as ongoing monitoring in the study area has indicated that to date, no impact to groundwater has been recorded as a result of previous development in the wider study area or is considered likely to occur. Accordingly, it is not expected that the current proposal will result in changes to the hydrology such that the area of River-flat Eucalypt Forest within the proposed conservation works area will be indirectly impacted.

With consideration of the mitigation measures recommended, the proposed development works is unlikely to have a significant impact on the local occurrence of River-flat Eucalypt Forest.

8.2.4. Swamp Oak Floodplain Forest

Swamp Oak Floodplain Forest is found on coastal floodplains and has a sparse to dense tree layer typically dominated by *Casuarina glauca* (Swamp Oak). Additional trees sometimes present include *Acmena smithii* (Lilly Pilly), *Glochidion* spp. and *Melaleuca* spp. (paperbarks). The community has a sparse cover of shrubs, but typically has a continuous groundcover comprised of grasses, sedges and forbs. Groundcover species

characteristic of the community within less saline areas include *Centella asiatica* (Indian Pennywort), *Commelina cyanea, Persicaria decipiens* (Slender Knotweed), *Carex appressa* (Tall Sedge) and *Lomandra longifolia* (Spiny-headed Mat-rush). Vines are also frequent within the community including *Parsonsia straminea* (Common Silkpod) and *Geitonoplesium cymosum* (Scrambling Lily).This community occurs on clay and sandy loams within waterlogged or periodically inundated areas (OEH 2018h).

Within the subject site, a total of 10.55 ha of Swamp Oak Floodplain Forest is present of which 3.39 ha is proposed to be removed. Approximately 7.16 ha will be conserved within the Howes Creek Conservation Area and Parks K and L Conservation Area. Additionally, about 5.68 ha will be replanted so that in the long term about 12.84 ha will be conserved on site.

The community is comprised primarily of small, scattered patches located in low-lying or poorly drained areas. It is evident that the vegetation on the subject site has been cleared extensively from historic and on-going land uses from agricultural development and therefore contains a relatively degraded understorey predominantly comprised of exotic species.

Assessment of Significance

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

The total area of Swamp Oak Floodplain Forest present within the subject site is ~10.55 ha, of which ~3.39 ha is proposed to be removed to facilitate the proposed development works. The community to be removed is comprised primarily of isolated patches that in low to moderate condition due to previous disturbances.

Within the subject site, a substantial change will occur to the species composition of the community, as it will be entirely removed. There is potential for changes to species composition in the areas adjacent to the subject site; however, these changes are expected to be localised and overall are not considered to cause a substantial change in species composition.

The proposed development works will remove approximately 3.39 ha of the local occurrence of the community; however, approximately 7.16 ha of the local occurrence will be conserved and managed in perpetuity. In addition, 5.68 ha are proposed to be revegetated, conserved and managed in perpetuity under as set out in VMP 1.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Approximately 3.39 ha of Swamp Oak Floodplain Forest will be removed by the proposed development works, which comprises approximately 30.49% of the community's local occurrence.

Swamp Oak Floodplain Forest occurring within the subject site has previously been fragmented by previous land use. The proposed development works will clear all remaining fragments of this community present. The habitat within the subject site does not join onto any national parks or reserves.

The community within the subject site has already been impacted by previous and current land uses. This has resulted in impacts such as spread of exotic species. Due to the community's generally degraded nature and the areas of the community proposed to become conservation areas, the Swamp Oak Floodplain Forest to be removed is not considered important for the long-term survival of the community in the locality as larger areas will be retained and managed in perpetuity.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There is no critical habitat for this community currently listed by the Director-General of the OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;

2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;

3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program;

4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The Recovery Plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the subject site itself has not been mapped within the boundary of these priority conservation lands. Threats to the community are further loss and fragmentation of habitat, weed invasion, changes in fire regimes and urban run-off.

Within the subject site, the community is not considered to be significant as it is comprised of isolated patches that have little to no connectivity other areas of similar habitat. The proposed development works are not considered to threaten the objectives of the recovery plan as larger patches of the community within the study area will be retained and conserved in perpetuity under a 20-year VMP.

No threat abatement plan is relevant to this community.

g) 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.

The following key threatening processes are relevant to Swamp Oak Floodplain Forest occurring within the subject site:

- Clearing of native vegetation

Approximately 3.39 ha of Swamp Oak Floodplain Forest will be removed for the proposed development works. Although a moderate area of the community will be removed, compensatory measures are proposed that will adequately offset the impacts to the community and ensure that its local occurrence is not placed at risk of extinction. This includes the conservation and management of 7.16 ha of the community within the subject land in perpetuity as well as the revegetation of 5.68 ha that will also be managed under a long-term VMP.

- Invasion of native plant communities by exotic perennial grasses

The proposed development works have the potential to result in the spread of exotic grasses both during clearing and into areas of this community to be retained. In order to mitigate this key threatening process, retained vegetation will be managed initially under a 20-year VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion and establishment of exotic vines and scramblers;

The proposed development works have the potential to result in the spread of exotic weeds both during clearing and into areas of this community to be retained. To mitigate this key threatening process, retained vegetation will be managed under a 20-year VMP that will minimise the key threatening process. Furthermore,

mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The subject site currently contains a high abundance of Lantana in areas, all of which will be cleared both during clearing and into areas of this community to be retained. The proposed development works have the potential to result in the spread of this weed. To mitigate this key threatening process, retained vegetation will be managed initially under a 20-year VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*;

The subject site currently contains a high abundance of African Olive in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into areas of this community to be retained. To mitigate this key threatening process, retained vegetation will be managed initially under a 20-year VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

The proposed development works are unlikely to contribute to high frequency fire further than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'.

Future development the proposed development works will facilitate have the potential to contribute to this key threatening process. In order to mitigate this key threatening process, a long-term VMP will be implemented that will monitor areas of retained vegetation and provide recommendations and/or management actions to minimise the key threatening process.

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

The proposed development works have the potential to alter flow regimes of the study area; however, this key threatening process is expected to be adequately mitigated by the implementation of sediment/erosion and wastewater management plans that will be implemented. Additionally, the majority of Howes Creek will be retained and conserved by the proposed development.

Conclusion

The proposed development works will result in the removal of a limited area of Swamp Oak Floodplain Forest (3.39 ha) from the subject site, while the majority will be conserved in the long term within the Howes Creek Conservation Area. Although some of this vegetation will be removed from the subject site, it is proposed to be offset by the implementation of the VMP for the Howes Creek Conservation Area (see ***Section 7.1***). In this regard, when considered in the context of the community's occurrence in the locality, its condition within the subject site, along with the compensatory measures proposed, the overall impact on the community in the wider context is not considered to be significant.

8.2.5. Freshwater Wetlands

Freshwater Wetlands occurs on low-lying parts of floodplains, alluvial flats, depressions, drainage lines, back swamps, lagoons and lakes. The community is dominated by herbaceous plants including sedges, emergent plants, floating and submerged plants (NSW Scientific Committee 2004a). Species characteristic of the community include *Paspalum distichum* (Water Couch), *Leersia hexandra* (Swamp Rice-grass), *Pseudoraphis spinescens* (Mud Grass), *Carex appressa* (Tall Sedge), *Hydrocharis dubia* (Frogbit), *Philydrum lanuginosum* (Frogsmouth), *Ludwigia peploides* subsp. *montevidensis* (Water Primrose), *Marsilea mutica* (Nardoo) and *Myriophyllum* spp. (OEH 2018f).

Within the subject site, 6.52 ha of Freshwater Wetlands occurs, of which about 0.37 ha will be cleared. The remainder will be conserved within the Howes Creek Conservation Area and will be added to by replanting of a further 1.62 ha to total 7.77 ha in the long term. The community is comprised of the peripherals of larger patches of the community that extend outside of the subject site and is restricted to area adjacent to tributaries. It is evident that the vegetation on the subject site has been cleared extensively from historic and on-going land uses from agricultural development and therefore contains a relatively degraded understorey predominantly comprised of exotic species.

Assessment of Significance

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> *(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The total area of Freshwater Wetlands present within the subject site is 6.52 ha of Freshwater Wetlands occurs, of which about 0.37 ha will be cleared. The remainder will be conserved within the Howes Creek Conservation Area and will be added to by replanting of a further 1.62 ha to total 7.77 ha in the long term. The community to be removed consists of the peripherals of larger patches that are in low to moderate condition due to previous disturbances.

Within the subject site, a substantial change will occur to the species composition of the community, as it will be entirely removed. There is potential for changes to species composition in the areas adjacent to the subject site; however, these changes are expected to be localised as they are limited to the outer boundaries of larger patches and overall are not considered to cause a substantial change in species composition.

The proposed development works will remove approximately 0.37 ha of the local occurrence of the community; however, 6.15 ha will be conserved and managed in perpetuity. In addition, 1.62 ha will be revegetated and conserved under a long-term VMP.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Approximately 0.37 ha of Freshwater Wetland will be removed because of the proposed development works, which comprises 5.4% of the community's local occurrence.

Freshwater Wetlands occurring within the subject site has previously been degraded by previous land uses in surrounding areas. The proposed development works will clear all remaining fragments of this community present. The habitat within the subject site does adjoin larger areas of the community, none of which join onto any national parks or reserves.

The community within the subject site has already been impacted by previous and current land uses. This has resulted in impacts such as spread of exotic species. Due to the community's generally degraded nature and the areas of the community proposed to become conservation areas, the Freshwater Wetland to be removed is not considered important for the long-term survival of the community in the locality as larger areas will be retained and managed in perpetuity.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There is no critical habitat for this community currently listed by the Director-General of the OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The overall objective of the Cumberland Plain Recovery Plan (DECCW (NSW) 2011) is to provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. Specific recovery objectives provided in the plan are:

> *1) To build a protected area network, comprising public and private lands, focused on the priority conservation lands;*
>
> *2) To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation;*
>
> *3) To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program;*
>
> *4) To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.*

The Recovery Plan acknowledges that Campbelltown City Council contains priority conservation lands. However, the subject site itself has not been mapped within the boundary of these priority conservation lands. Threats to the community are further loss and fragmentation of habitat, weed invasion, changes in fire regimes and urban run-off.

Within the subject site, the community is not considered to be significant as it is consists of the peripherals of larger patches that will be retained. The proposed development works are not considered to threaten the objectives of the recovery plan as larger patches of the community within the study area will be retained and conserved in perpetuity under 20-year VMPs.

No threat abatement plan is relevant to this community.

g) 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.

The following key threatening processes are considered to have the potential to impact on Freshwater Wetlands:

- Clearing of native vegetation

Approximately 0.37 ha of Freshwater Wetlands will be removed for the proposed development works. Although areas of the community will be removed, compensatory measures are proposed that will adequately offset the impacts to the community and ensure that its local occurrence is not placed at risk of extinction. This includes the conservation and management of 6.15 ha of the community as well as the revegetation of 1.62 ha within the subject land that will be managed under a 20-year VMP.

- Invasion of native plant communities by exotic perennial grasses

The proposed development works have the potential to result in the spread of exotic grasses both during clearing and into areas of Freshwater Wetland to be retained. In order to mitigate this key threatening process, retained vegetation will be managed under a 20-year VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion and establishment of exotic vines and scramblers;

The proposed development works have the potential to result in the spread of exotic weeds both during clearing and into areas of Freshwater Wetland to be retained. To mitigate this key threatening process, retained vegetation will be managed initially under a 20-year VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)

The subject site currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed into retained areas, as Lantana can dominate around the fringes of Freshwater Wetlands. In order to mitigate this key threatening process, retained vegetation will be managed initially under a 20-year VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*;

The subject site currently contains a high abundance of African Olive in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed during clearing. In order to mitigate this key threatening process, retained vegetation will be managed initially under a 20-year VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

The proposed development works are unlikely to contribute to high frequency fire further than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'.

Future development the proposed development works will facilitate have the potential to contribute to this key threatening process. To mitigate this key threatening process, retained vegetation will be managed under a 20-year VMP that will minimise the key threatening process.

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

The proposed development works have the potential to alter flow regimes of the study area; however, this key threatening process is expected to be adequately mitigated by the implementation of sediment/erosion and wastewater management plans that will be implemented. Additionally, the majority of Howes Creek will be retained and conserved by the proposed development. Activation of 'acid sulphate soils'.

- 'Activation of 'acid sulphate soils'.

The proposed development works have the potential to activate acid sulphate soils within the study area as a result of bulk earthworks and subsequent clearing of native vegetation that are likely to facilitate future development. In order to minimise the risk of acid sulphate soils impacting areas of the study area or being carried off-site, it is expected that soil sampling will occur during the proposed development works. If found to occur, measures will be implemented to mitigate appropriately.

Conclusion

About 6.52 ha of Freshwater Wetlands occurs in the subject site, of which about 0.37 ha will be cleared. The remainder will be conserved within the Howes Creek Conservation Area and will be added to by replanting of a further 1.62 ha to total 7.77 ha in the long term.

The within the development footprint exists as the peripherals of larger patches of the community which are proposed to be retained. When considered in the context of the community's occurrence in the locality, its condition within the proposed development area and conservation areas, along with the compensatory measures proposed, the overall impact on the community in the wider context is not considered to be significant.

8.3. Fauna Species

Sixteen (16) threatened species have been assessed as affected species including birds, microchiropteran bats and the Grey-headed Flying Fox (see ***Section 5.3***). Habitats for these species will remain in the Menangle URA within the proposed conservation works areas. Although areas of suitable habitat for the affected species will be removed, all areas are relatively isolated patches that are highly modified because of a long history of pastoral use. The woodland patches occur amid grasslands within old farmlands. They are currently fragmented with poor prospects to restore connectivity, and many have low native species diversity and an abundance of weeds.

They are also not managed for conservation and so habitats on site are subject to ongoing disturbances and degradation from pastoral land use, weeds and feral animals. In the future conservation areas of the Menangle URA will be actively managed to maintain and improve habitat values for native flora and fauna in perpetuity, with the proposed conservation areas of the Howes Creek and Northern Conservation Area, Stage 6B EBSF Conservation Area, and the Parks K and L Conservation Area, to be managed with VMPs prepared according

to the management and monitoring requirements of a Biodiversity Stewardship Site (BSS) as part of this DA (ref. 17072 RP36 and 17072 RP29). Cleared areas within the conservation areas will be regenerated using local native plant species to replenish local native and threatened vegetation communities historically cleared for farming.

The ~152 ha proposed development works area has been historically cleared for agriculture and now comprises ~122 ha of exotic-dominated grassland and to a lesser extent exotic shrubland (**Table 14**). Patches of native vegetation are scattered across this land, totalling approximately 30 ha (**Figure 15**). The proposed development works will remove these scattered patches of native vegetation However, almost half of that native vegetation (~40% or 11.94 ha) is derived native grassland that has been grazed for many years and has relatively low native species diversity. There are also some limited areas (0.37 ha) of Freshwater Wetlands (**Table 39**).

Forest and woodland patches, which provide potential habitat for most of the affected species total ~17 ha (**Table 39**). All the patches to be removed are relatively isolated from other native vegetation and generally surrounded by grasslands used for grazing for over 100 years and so have little opportunity for restoration of connectivity.

Viable, representative areas of all the habitats known to support threatened species or potential threatened species habitat will be conserved in the proposed conservation works areas. The proposed conservation works areas total ~59.59 ha and comprise a mixture of native vegetation types including EBSF, Shale Plains Woodland, River Flat Eucalypt Forest, Swamp Oak Floodplain Forest and Freshwater Wetlands and exotic vegetation that is proposed for replanting to native plant communities (**Table 32**). Approximately 35 ha of native vegetation will immediately be conserved, including all categories of forest, woodland, wetland and grassland. Of this, ~6.59 ha is grassland or reedland and ~28.92 ha is forest and woodland. Under the three VMPs for the proposed conservation works areas, ~23 ha of existing exotic vegetation will be regenerated to forest, woodland and reedland. This will connect habitats along Howes Creek and form better connections to the Nepean River. It will also reconnect the patches in the Northern Conservation Area. Accordingly, while ~17 ha of woodland will be removed as part of the proposed development works, ~51 ha of woodland and forest will retained, revegetated, and managed within the proposed conservation works areas in the long-run.

Howes Creek Conservation Area is part of a large network of vegetation and links to the extensive native vegetation on the eastern side of the Nepean River (**Figure 15**). The Northern Conservation Area is to the immediate southwest of the Mount Annan botanical gardens, which is in the process of regenerating native woodland vegetation including Shale Hills and Shale Plains Woodland (**Figure 15**).

The in-perpetuity protection of habitat proposed under the Master Plan will mitigate the impacts on threatened species, especially with consideration that:

- Vegetation in conservation areas will be actively managed to maintain and improve habitats for threatened species;
- Appropriate mitigation measures will be implemented to reduce impacts on threatened fauna potentially impacted; and

- All affected species are relatively mobile birds, bats and flying foxes and able to access the conservation areas proposed under the Master Plan, particularly the larger areas of habitat along Howes Creek and in the Northern Conservation Area.

Updated Assessments of Significance for threatened fauna species are provided below in subsequent subsections.

Table 35 Vegetation communities of the study area, subject site and conservation areas based upon mapping by Cumberland Ecology

Vegetation Communities (Mapped by Cumberland Ecology)	TEC Status	Study Area (ha)	Development Works Area (ha)	Howes Creek and Northern Conservation Areas (ha)	Parks K & L Conservation Area (ha)	Stage 6B EBSF Conservation Area (ha)	Total in Subject Site (ha)	Totals Conserved in Subject Site (ha)
Elderslie Banksia Scrub Forest	EBSF	2.50	0.77	0.00	1.51	0.21	2.49	1.72
Elderslie **Banksia Scrub Forest (non-TEC)**	N/A (does not conform)	0.12	0.10	0.00	0.00	0.00	0.10	0.00
Shale Hills Woodland	CPW	7.25	4.80	0.00	0.00	0.00	4.80	0.00
Shale Hills Woodland Derived Native Grassland	CPW	3.48	3.28	0.00	0.00	0.00	3.28	0.00
Shale Hills Woodland Shrubby Regrowth	N/A (does not conform)	1.49	0.49	0.00	0.00	0.00	0.49	0.00
Shale Plains Woodland	CPW	22.61	5.93	11.51	0.08	0.00	17.53	11.59
Shale Plains Woodland Derived Native Grassland	CPW	23.01	8.67	0.43	0.00	0.00	9.09	0.43

Vegetation Communities (Mapped by Cumberland Ecology)	TEC Status	Study Area (ha)	Development Works Area (ha)	Howes Creek and Northern Conservation Areas (ha)	Parks K & L Conservation Area (ha)	Stage 6B EBSF Conservation Area (ha)	Total in Subject Site (ha)	Totals Conserved in Subject Site (ha)
River Flat Eucalypt Forest	RFEF	12.90	1.51	8.10	0.34	0.00	9.96	8.44
River-flat Eucalypt Forest Derived Native Grassland	RFEF	0.19	0.00	0.00	0.00	0.00	0.00	0.00
River Oak Riparian Woodland	N/A	4.62	0.00	0.00	0.00	0.00	0.00	0.00
Swamp Oak Floodplain Forest	SOFF	11.12	3.39	6.88	0.28	0.00	10.55	7.16
Freshwater Wetlands	Freshwater Wetlands	6.86	0.37	6.15	0.00	0.00	6.52	6.15
Total Native		**96.02**	**29.30**	**33.07**	**2.22**	**0.21**	**65.10**	**35.49**
African Olive Dominated Exotic Woody Vegetation	N/A	1.46	1.32	0.01	0.00	0.00	1.33	0.01
Privet Dominated Exotic Woody Vegetation	N/A	6.62	0.00	3.46	0.00	0.00	3.46	3.46

Vegetation Communities (Mapped by Cumberland Ecology)	TEC Status	Study Area (ha)	Development Works Area (ha)	Howes Creek and Northern Conservation Areas (ha)	Parks K & L Conservation Area (ha)	Stage 6B EBSF Conservation Area (ha)	Total in Subject Site (ha)	Totals Conserved in Subject Site (ha)
Exotic Grassland/Cleared Land	N/A	398.91	119.78	18.37	0.56	0.00	138.70	18.93
Other Exotic Dominated Woody Vegetation	N/A	3.08	0.05	0.06	0.00	0.00	0.11	0.06
Dam	N/A	3.29	1.01	0.84	0.00	0.00	1.86	0.84
Cleared for Contamination	N/A	N/A	N/A	0.80	0.04	0.00	N/A	0.84
Total Exotic		**413.37**	**122.16**	**22.75**	**0.56**	**0.00**	**145.44**	**24.14**
Total (Native & Exotic)		**509.39**	**151.53**	**56.60**	**2.78**	**0.21**	**210.33**	**59.59**

8.3.1. Black-necked Stork

The Black-necked Stork has been listed as Endangered under the TSC Act (OEH 2018a). The species is widely distributed across the coastal and sub-coastal northern and eastern regions of Australia extending as far south as central NSW. The species is known to occupy floodplain wetlands such as swamps, billabongs, watercourses and dams within NSW as well as coastal sand plain wetlands and estuaries. The species utilises large trees in close proximity to water as nesting and breeding habitat.

Assessment of Significance

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Very little potential habitat exists for this species within the proposed development works area. The species has not been detected during fieldwork by Cumberland Ecology.

The subject site is considered to provide ~8.38 ha of potential foraging habitat in the form of several farm dam and areas of Freshwater Wetlands. No suitable breeding/nesting habitat is present as no nests were observed and the species has only been recorded breeding as far south as Bulahdelah (located over 200km north of the subject site).

The most suitable roosting habitat present is considered to be within nearby large trees located in the north of the study area that are proposed to be retained. The proposed development works area is considered likely to be utilised only for foraging as part of a larger foraging range. The proposed development works will remove 1.39 ha of potential foraging habitat, however approximately 6.99 ha of potential habitat comprising dams and Freshwater Wetlands will be protected within the proposed conservation areas and a further 1.62 ha will be revegetated. As part of the overall Master Plan, approximately 0.37 ha of Freshwater Wetlands is proposed to be removed by previously approved DAs or currently submitted DAs, and ~7.77 ha is proposed to be immediately protected and managed for conservation in perpetuity.

Due to the small area of potential foraging and roosting habitat proposed to be removed, and the larger areas of better-connected habitat to be protected within conservation areas, the proposed development works are not considered likely to have an adverse effect on the life cycle of the species such that the local population would be placed at risk of extinction as larger areas of suitable habitat will be retained nearby.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> *(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 1.39 ha of potential foraging habitat is to be removed for the proposed development works. Approximately 6.99 ha of potential habitat comprising dams and Freshwater Wetlands will be protected within the proposed conservation works areas as part of the proposed development with a further ~1.63 ha revegetated to Freshwater Wetlands.

As part of the overall Master Plan, ~0.37 ha of Freshwater Wetlands is proposed to be removed by previously approved DAs or currently submitted DAs, and ~7.77 ha is proposed to be protected and managed for conservation in perpetuity.

The habitat present within the study area has been previously exposed to clearing and other disturbances for agricultural purposes. As a result of this, the habitat has already been heavily fragmented, with few remnant patches of suitable vegetation and water courses remaining. The proposed development works will remove several farm dams which will reduce the extent of potential foraging habitat rather than create additional fragmentation of habitat. The species is highly mobile and therefore capable of relocating and flying over disturbed land to access the surrounding suitable habitat.

The Black-necked Stork is considered to have the potential to periodically occupy the proposed development works area as part of a broader range. The habitat to be removed by the proposed development works does not represent a reliable resource for foraging as it is a marginal portion of the species range. Additionally, the high mobility of the species allows accessibility to substantial habitat adjacent to the subject site and throughout the surrounding locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been identified by OEH for the Black-necked Stork.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plans,

No recovery or threat abatement plans have been prepared for the species however, a targeted strategy for managing the species has been developed under the Saving Our Species (*SoS*) program (OEH 2018a). This species has been assigned to the Partnership (range-restricted) management stream and objectives aim to secure critical populations within NSW. The proposed development works will remove a marginal area of the

species broad foraging habitat. However, due to the high mobility of the species, the proposed development works will not threaten the objectives of the targeted management strategies.

g) 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.

The following Key Threatening Processes listed under the TSC Act are likely to affect the Black-necked Stork.

- 'Clearing of native vegetation'

Several farm dams and ~0.37 ha of Freshwater Wetlands that provide potential habitat for this species will be cleared as part of the proposed development works, while ~6.99 ha of additional 'Electrocution on power lines'

The proposed development works has the potential to contribute to electrocution on power lines, as these will need to be installed to support residences that will be built. However, as the subject site likely only constitutes a small area of foraging habitat, any increase in electrocution is considered to be minimal.

- 'Loss of wetland habitat through clearing and draining for development'

The proposed development works will remove several farm dams and a small area of Freshwater Wetland (0.37 ha) that provides suitable foraging habitat for the species. Such removal is not likely to have an adverse impact on the survival of the species. Additionally, the retention of the majority of the Howes Creek riparian corridor as part of the proposed development will ensure the majority of wetland habitat is retained.

- Invasion and establishment of exotic vines and scramblers'

The proposed development works has the potential to result in the spread of exotic weeds. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'

The subject site currently contains Lantana in areas, all of which will be cleared, including within the proposed conservation works area. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Furthermore, retained vegetation will be managed under a BSA or VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)'

The subject site currently contains African Olive in areas, all of which will be cleared, including within the proposed conservation works area. To mitigate this key threatening process, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

Conclusion

The proposed development works will remove several farm dams and ~0.37 ha of Freshwater Wetland that provides potential foraging habitat for this species. Despite the removal of this habitat, the majority of suitable habitat within the study area will be retained. As part of the overall Master Plan, ~0.37 ha of Freshwater Wetlands is proposed to be removed by currently submitted DAs, and approximately ~7 ha is proposed to be immediately protected and managed for conservation in perpetuity with a further 1.62 ha to be revegetated as part of the proposed conservation works. Additionally, suitable habitat exists throughout the local area and beyond that will remain. Given that no nesting habitat is present, and the species is highly mobile and likely to utilise a variety of habitat resources as part of their broader range, the proposed development works is unlikely to have a significant impact on Black-necked Stork.

8.3.2. Woodland Birds

Due to the similarity in habitat requirements, the following woodland birds have been assessed collectively within this Assessment of Significance:

- Brown Treecreeper (*Climacteris picumnus victoriae*);
- Dusky Woodswallow (*Artamus cyanopterus cyanopterus*);
- Varied Sittella (*Daphoenositta chrysoptera*); and
- Little Lorikeet (*Glossopsitta pusilla*).

All these birds inhabit forest and woodland vegetation, though the Dusky Woodswallow can forage on occasion over grasslands (NSW Scientific Committee 2016).

The Brown Treecreeper is listed as Vulnerable under the TSC Act. This species is distributed along the east coast of Australia from Queensland to South Australia. The species nests in tree hollows and is known to occur throughout eucalypt woodlands and coastal regions, including the CPW and particularly inhabits woodlands dominated by stringy bark with open grassy understorey. This species is considered to be a sedentary species and considered to be resident in many locations throughout its range, though some birds disperse locally after breeding. The species disperses locally, with an average recorded dispersal distance of approximately one kilometre, but ranging up to over 2 km (Doerr, 2011). The species has been recorded within the study area by Cumberland Ecology in 2018. Targeted searches were conducted for this species in March 2021, which did not

record any further individuals on the subject site or study area, although potential woodland habitat does occur.

The Dusky Woodswallow is listed as Vulnerable under the TSC Act (OEH 2018c). The species is widely distributed throughout eastern, southern and south-western Australia. The species is found in a variety of habitats, particularly in woodlands and dry open sclerophyll forests that are dominated by eucalypts with a shrubland/heathland understorey. The species is often observed in farmland, usually at the edges of forest or woodland or in roadside remnants. Although the Dusky Woodswallow usually has a large home range, individuals may spend most of their time in about a 2 ha range and defend an area about 50 m around the nest (NSW Scientific Committee 2016). The species has been recorded within the study area by Cumberland Ecology in 2018. Targeted searches were conducted for this species in March 2021, which did not record any individuals on the subject site or study area, although potential habitat does occur.

The Varied Sittella is listed as Vulnerable under the TSC Act (OEH 2018j). The species is sedentary and holds and defends territories between 13 and 20 ha in size (Noske, 1998). It occupies most of the Australian continent except for deserts and open grasslands. This species is known to inhabit eucalypt forest and woodlands, particularly those containing mature rough-barked and smooth-barked gums. The species has been recorded within the study area by Cumberland Ecology in 2018. Targeted searches were conducted for this species in March 2021, which did not record any individuals on the subject site or study area, although potential habitat does occur.

The Little Lorikeet is listed as Vulnerable under the TSC Act (OEH, 2019). The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW the species is found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs. It forages primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in *Angophora, Melaleuca* and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. The species has not been recorded in the study area, though there is potential habitat in the study area due to the presence of forest and woodland vegetation.

Assessment of Significance

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The proposed development works will remove approximately 17 ha of potential nesting and foraging habitat (native woodland, forest and shrubby regrowth) for these woodland bird species. Such habitats are composed of fragmented patches of woodland amid largely exotic grasslands that are used for livestock grazing and not currently managed for conservation. The patches of fragmented remaining woodland habitat have poor prospects for restoration of connectivity, and many have low species diversity and an abundance of weeds.

Viable, representative areas of all the habitats known to support threatened species or potential threatened species habitat will be conserved as part of the proposed development under the two VMPs supporting this SIS for the proposed conservation works areas (ref. 17072 RP24 and 17072 RP29).

Approximately 35 ha of native vegetation will immediately be conserved, including all categories of forest, woodland, wetland and grassland. Of this, ~6.59 ha is grassland or reedland and ~28.92 ha is forest and woodland.

Under the two VMPs for the proposed conservation works areas, ~23 ha of existing exotic vegetation will be regenerated to forest and woodland. This will connect habitats along Howes Creek and form better connections to the Nepean River. It will also reconnect the patches in the Northern Conservation Area. Accordingly, while ~17 ha of woodland will be removed as part of the proposed development works, ~51 ha of woodland and forest will retained, revegetated, and managed within the proposed conservation works areas in the long-run.

Fragmentation and reduction in habitat are known threatening processes for all these species and are implicated in their decline throughout their range. Suitable habitat for these woodland birds in the study area consists of small scattered isolated patches of native woodland that contain hollow-bearing trees but are surrounded by open grassland. All species are highly mobile, with the ability to access substantial breeding and foraging habitat throughout the study area. Although the Brown Treecreeper and Varied Sitella are considered to be sedentary, they are capable of dispersal movements of further than 2 km, and therefore are able to access other resources if required. Larger areas of suitable habitat (woodland/forest) will be retained within the study area. Surrounding areas of retained suitable habitat will provide continuous breeding and foraging habitat for the species. Although the proposed development works will remove areas of potential habitat, including breeding habitat, due to the retention of suitable habitat the proposed development works is not considered to have an adverse effect on the life cycle of the species' such that the local population is placed at risk of local extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

- *(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Approximately 17 ha of potential nesting and foraging habitat (i.e. woodland, forest and shrubby regrowth) is to be cleared by the proposed development works.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future Das, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The habitat of the proposed development works area has been previously exposed to clearing and other disturbances for agricultural purposes. As a result of this, the habitat has already been heavily fragmented, with few remnant patches of suitable vegetation remaining. Most of the subject site is surrounded by extensive grassland areas. The proposed development works will remove and reduce the extent of remaining fragments rather than create additional fragmentation of habitat. These species are all capable of relocating from disturbed land and accessing the surrounding suitable habitat if required.

These species are considered to occupy the subject site as part of their broader range, and due to their conservation status, all areas of habitat are important. However, the habitat to be removed or indirectly impacted by the proposed development works is highly degraded and fragmented. Nonetheless, it is recognised that it contains potential habitat resources that are important for these species including tree hollows, rough barked trees and fallen logs. Larger areas of suitable, less fragmented habitat will be retained within the proposed conservation works area, including the immediate retention of ~29 ha of woodland and forest vegetation and the revegetation of ~22 ha of forest and woodland, for a long-term retention of ~51 ha of forest and woodland as part of the proposed development. Additionally, further vegetation will be retained within the study area and within a 5 km radius of the subject site which will provide continued foraging and nesting habitat for these species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been identified by OEH for the Brown Treecreeper, Dusky Woodswallow, Varied Sittella or Little Lorikeet.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plans,

No recovery or threat abatement plans have been prepared for these species however, a targeted strategy for managing each species has been developed under the Saving Our Species (*SoS*) program (OEH 2018c, j, b). All species have been assigned to the Landscape Species management stream under the *SoS* program. The proposed development works will remove a marginal area of the species' broad nesting and foraging habitat;

however, the proposed development works will not conflict with the objectives of the targeted management strategies for each species.

g) 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.

The following Key Threatening Processes listed under the TSC Act are likely to affect the Brown Treecreeper, Dusky Woodswallow, Varied Sittella and Little Lorikeet.

- 'Clearing of native vegetation'

Approximately 17 ha of potential nesting and foraging habitat (i.e. native woodland, forest and shrubby regrowth) is to be cleared by the proposed development works and ~ 29 ha of native woodland vegetation will be protected within the proposed conservation works areas. A further ~22 ha of native woodland and forest vegetation will be established in the proposed conservation works area as part of the proposed development works.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future Das, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

Although limited patches of woodland habitat will be removed, larger areas ofwithin the Howes Creek riparian corridor

- 'Removal of hollow bearing trees'

The removal of hollow bearing trees is a key threatening process to the Brown Treecreeper only as this is the only woodland bird that utilised hollows for nesting. The proposed development works will remove approximately 17 ha of woodland/forest vegetation that contains hollow bearing trees. Larger areas of forest/woodland containing tree hollows within the study area and wider locality will be retained ensuring that suitable nesting habitat is present for a local population. Furthermore, these species can disperse to other areas of suitable habitat and is known to disperse over 2 km.

- 'Removal of dead wood and dead trees'

The proposed development works will result in the removal of dead wood and dead trees. Although all these items will be removed from the subject site, additional areas containing dead wood and dead trees will be retained in the study area and locality.

- 'Invasion and establishment of exotic vines and scramblers'

The proposed development works has the potential to result in the spread of exotic weeds. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented

include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'

The subject site currently contains Lantana in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigations measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)';

The subject site currently contains African Olive in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic grasses'

Clearing from the proposed development works is unlikely to significantly contribute to the spread of exotic grasses further than current conditions as all areas are currently subject to this process. Nevertheless, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

The proposed development works has the potential to contribute to this key threatening process; however, it is unlikely to contribute significantly as the habitat to be retained is already degraded as a result of surrounding land uses.

Conclusion

The proposed development works will remove 17 ha of potential nesting and foraging habitat (i.e. native woodland, forest and shrubby regrowth) for all woodland bird species assessed. Although areas of suitable habitat will be removed, all areas are fragmented relatively isolated patches that are highly degraded. Approximately 29 ha of native woodland vegetation will be immediately protected within the proposed conservation works areas and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future Das, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

Furthermore, these woodland bird species can access similar areas of habitat the wider locality which will remain. Nevertheless, due to the conservation status of these species and the importance of all areas of remaining habitat, it is concluded that the proposed development works have the potential to have a significant impact on the local populations of these species. Such impacts will be addressed as vegetation is actively managed and regenerated in the larger conservation areas. Also all suitable habitat for these species proposed to be removed will be offset for through the retirement of ecosystem credits as outlined in ***Section 6.4.***

8.3.3. Grey-headed Flying-fox

The Grey-headed Flying-fox is listed as Vulnerable under the TSC Act and the EPBC Act. The species is distributed along the east coast of Australia from Queensland to South Australia and can be found in a variety of habitats including subtropical and temperate Rainforests, tall sclerophyll forest and woodlands, heaths, swamps, gardens, and orchards.

The species roosts in camps that are often close to water and within 20 km of a regular food source. The species is known to travel upwards to 50 km to forage, but more commonly commutes less than 20 km (OEH 2017i).

The nearest Flying-fox camp to the subject site is located at Campbelltown, within 5 km north-east of the subject site. The species could potentially forage in the subject site on occasion as part of a wider foraging range. The species has been recorded flying over the subject site during spotlighting surveys.

Assessment of Significance

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The Grey-headed Flying-fox has previously been recorded flying over the subject site and is likely to forage on the subject site when native trees and shrubs are flowering. The local population of this species is considered to range extensively beyond the study area and would not be heavily dependent on the woodlands within the proposed development works area. No flying fox camp occurs on the subject site or adjacent to it.

The proposal will remove approximately 17 ha of potential foraging habitat for the Grey-headed Flying-fox, comprising native forest, woodland and shrubby regrowth vegetation communities. Approximately 29 ha of

native woodland vegetation will be immediately protected within the proposed conservation works areas and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a 20-year VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

Most of the foraging habitat in the subject site is sub-optimal as limited preferred feed species are present and about 80% of the proposed development works area comprises open grassland. This species is highly mobile and accesses resources from across a wide area and would not depend upon resources contained within the subject site for its survival. Substantial habitat resources occur throughout the locality and wider region. These areas will continue to provide foraging habitat for the Grey-headed Flying-fox. Accordingly, the proposal is not considered to have an adverse effect on the life cycle of this species such that a viable local population is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 17 ha of marginal foraging habitat for the Grey-headed Flying-fox will be removed within the subject site. No roost habitat is present on or near the subject site. Approximately 29 ha of native woodland vegetation will be immediately protected within the proposed conservation works areas and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a 20-year VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The foraging habitat within the subject site has already been subject to clearing and other disturbances and has already fragmented the patches of remnant vegetation. Most of the subject site is surrounded by open grassland. The proposed development works will remove the remaining fragments rather than creating additional fragmented habitat patches. Furthermore, the Grey-headed Flying-fox is a highly mobile species that can fly over disturbed land and accessing fragmented habitats.

No Grey-headed Flying-fox camps are located on the proposed development works area or subject site and the relatively small area of degraded foraging habitat available is likely only utilised periodically as part of a much broader foraging range. The habitat to be removed or indirectly impacted by the proposal is not considered locally important for this species due to the high mobility of the species and occurrence of extensive areas of suitable habitat within .

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat for the Grey-headed Flying-fox has been identified by OEH.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plans,

A National Draft Recovery Plan for the Grey-headed Flying-fox (DECCW 2009a) has been prepared. Several threats to this species are listed in the Plan, including the removal of critical habitat. The proposal will remove a small amount of highly marginal foraging habitat for this species, which is not critical habitat and is well-represented throughout the locality. No roost camps are present on or adjacent to the proposed development works area. Therefore, the proposal is not considered to threaten the objectives of the Recovery Plan.

The Action Plan for Australian Bats provides a recovery outline for the species (Duncan et al. 1999). The proposed development works is consistent with the objectives of the plan for this species as it will retain areas of better condition habitat for the species within the proposed conservation works area to what is being removed.

g) 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.

The following Key Threatening processes listed under the TSC Act are likely to affect the Grey-headed Flying-fox:

- 'Clearing of native vegetation'

Areas of degraded native vegetation suitable for this species will be removed, however such clearing is unlikely to have a significant detrimental impact on Grey-headed Flying-fox due to its broad habitat requirements and ability to forage across a wide territory.

- 'Invasion and establishment of exotic vines and scramblers'

The subject site currently contains exotic vines and scramblers in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)'

The subject site currently contains Lantana in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*')

The subject site currently contains African Olive in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic perennial grasses'

The proposed action is unlikely to cause the spread of exotic grasses other than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

Currently the subject site already contains scattered exotic garden plants, likely from previous illegal dumping on the site. The proposed action would not exacerbate this key threatening process other than existing conditions.

Conclusion

The proposed development works will remove approximately 17 ha of potential foraging habitat for this species within the subject site that is likely only utilised periodically as part of a much broader foraging range. Approximately 29 ha of native woodland and forest vegetation will be protected within the proposed conservation works areas and a further ~22 ha of native vegetation will be revegetated, for a long-term conservation total of ~ 51 ha of native woodland and forest. Additionally, the areas of woodland to be removed occur amid grasslands within old farmlands. They are currently fragmented with poor prospects to restore connectivity, and many have low native species diversity and an abundance of weeds.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a long-term VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

Given that the species is highly mobile and is likely to utilise numerous habitat resources , the species is considered likely to remain viable within the locality and its range. The proposal is not considered likely to have a significant impact on the local population of the Grey-headed Flying-fox.

8.3.4. Greater Broad-nosed Bat

The Greater Broad-nosed Bat (*Scoteanax rueppellii*) occurs from the Atherton Tableland to north-eastern Victoria. It is found in various habitats being most commonly found in tall wet forest and it predominantly roosts in tree hollows, and also roosts in buildings. The Greater Broad-nosed Bat flies approximately 3 to 6 m above creek and river corridors (OEH 2017h). The species is listed as Vulnerable under the TSC Act.

The species was recorded as occurring within the subject site during the recent targeted bat surveys by Cumberland Ecology. The Greater Broad-nosed Bat was also recorded within the study area by Travers Bushfire & Ecology (2013).

Assessment of Significance

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Greater Broad-nosed Bat is known to use the proposed development works area as foraging habitat; however, it would likely do so as part of a much larger foraging range. It is a highly mobile species that would access resources from across a wide area and would not depend upon resources contained within the proposed development works area for its survival. The proposed development works area also provides potential breeding habitat for the species in the form of tree hollows. That notwithstanding, the potential breeding habitat is not considered likely to be important to the species as it occurs in relatively small, highly disturbed fragments of woodland. Similar isolated patches of woodland occur relatively frequently in the locality and the removal of a small area of habitat containing potential breeding resources is not likely to have a significant impact on this species. Larger areas of woodland containing hollow-bearing trees will be retained and conserved within the proposed conservation works area, including ~29 immediately conserved and ~ 22 ha

revegetated to woodland and forest as part of the proposed development. The proposal is not likely to place a viable local population of the Greater Broad-nosed Bat at risk of extinction as only highly marginal known foraging and potential breeding habitat will be removed. The species would also likely utilise much larger areas of intact vegetation including vegetation along riparian corridors in the wider locality, including the Nepean River.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

> *(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposei) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
> *(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable.

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

Approximately 17 ha of marginal foraging habitat for the Greater Broad-nosed Bat will be removed within the subject site, comprising native woodland and forest communities. Potential roosting and breeding habitat is also present within the proposed development works area in the form of hollow-bearing trees. Approximately 29 ha of native woodland and forest vegetation will be protected within conservation areas as part of the proposed development works and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The foraging and potential breeding habitat within the proposed development works area has already been subject to clearing and other disturbances and has already fragmented the patches of remnant vegetation. The fragmented woodland patches occur amid grasslands within old farmlands and have poor prospects to restore connectivity. The majority of the subject site is surrounded by open grassland. The proposed development

works will remove the remaining fragments rather than creating additional fragmented habitat patches. Furthermore, the Greater Broad-nosed Bat is a highly mobile species that is capable of flying over disturbed land and accessing fragmented habitat

The foraging and breeding habitat on the proposed development works area is not important for the species in the locality as it is a relatively small area of highly degraded habitat. Much larger areas of suitable potential habitat occur throughout the wider locality in reserves such as Dharawal National Park and riparian corridors such as Nepean River. The habitat to be removed or indirectly impacted by the proposal is not considered locally important for the species due to the high mobility of the species and occurrence of extensive areas of similar habitat within a 5 km radius of the subject site.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat for the Greater Broad-nosed Bat has been identified by OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The Action Plan for Australian Bats provides a recovery outline for the species (Duncan et al. 1999). The proposed development works is consistent with the objectives of the plan for this species as it will retain areas of better condition habitat for the species within the Howes Creek Riparian Corridor to what is being removed.

g) 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.

The following Key Threatening processes listed under the TSC Act are likely to affect the Greater Broad-nosed Bat:

- 'Clearing of native vegetation'

Areas of degraded native vegetation suitable for this species will be cleared, however such clearing is unlikely to have a significant detrimental impact on this species. Areas of native vegetation will be retained outside the subject site.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

- 'Loss of hollow-bearing trees'

All hollow-bearing trees will be removed within the proposed development works area. However, areas of native vegetation containing hollows will be retained within the proposed conservation works areas and mitigation measures will be implemented to prevent any significant impact to the species.

- Invasion and establishment of exotic vines and scramblers'

The subject site currently contains exotic vines and scramblers in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat)'

The subject site currently contains Lantana in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The subject site currently contains African Olive in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic perennial grasses'

The proposed action is unlikely to cause the spread of exotic grasses other than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

Currently the subject site already contains scattered exotic garden plants, likely from previous illegal dumping on the site. The proposed action would not exacerbate this key threatening process other than existing conditions.

Conclusion

The proposed development works will remove approximately 17 ha of marginal foraging habitat for the Greater Broad-nosed Bat from within the proposed development works area that is likely only utilised periodically as part of a much broader foraging range. Approximately 29 ha of native woodland and forest vegetation will be

protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

Given that the species is highly mobile and is likely to utilise numerous habitat resources , the species is considered likely to remain viable within the locality and its range. That notwithstanding, due to the cumulative removal of habitat as part of the Master Plan, the proposal is considered to have potential to have a significant impact on the local population of the Greater Broad-nosed Bat. All suitable habitat for this species proposed to be removed will be offset for through the retirement of ecosystem credits as outlined in ***Section 6.4.***

8.3.5. Eastern False Pipistrelle

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) is distributed along south-east coast and ranges of Australia. It inhabits moist habitats with trees taller than 20 m. The species generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. It preys on insects above or just below tree canopy and forages up to 12km from roost sites (OEH 2017f). The Eastern False Pipistrelle is listed as Vulnerable under the TSC Act.

This species was recorded as potentially occurring within the subject site during recent targeted bat surveys.

Assessment of Significance

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Eastern False Pipistrelle could potentially use the proposed development works area as foraging habitat as part of a much larger foraging range. It is a highly mobile species that would access resources from across a wide area and would not depend upon resources contained on the subject site for its survival. The proposal is not likely to place a viable local population of the Eastern False Pipistrelle at risk of extinction as while some potential foraging habitat and roosting habitat in the form of hollow-bearing trees will be removed, much larger areas will be retained within the proposed conservation works areas. The species would likely preferentially utilise the much larger areas of intact vegetation such as areas along the Nepean River and Howes Creek corridor.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological commu:

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

Approximately 17 ha of marginal foraging habitat for the Eastern False Pipistrelle will be removed within the subject site, comprising native woodland and forest communities. Potential roosting and breeding habitat is also present within the subject site in the form of hollow-bearing trees. Approximately 29 ha of native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 will revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The potential habitat within the proposed development works area has been subject to clearing and other disturbances and has already fragmented the patches of remnant vegetation. These fragmented patches occur amid grasslands within old farmlands and have poor prospects to restore connectivity. The proposed development works will remove the remaining fragments rather than creating additional fragmented habitat patches. Furthermore, the Eastern False Pipistrelle is a highly mobile species that can fly over disturbed land and accessing fragmented habitats.

Habitat within the proposed development works area is not important for the species in the locality as it is a relatively small area of marginal foraging habitat available on a seasonal basis. Much larger areas of potential habitat occur in reserves such as Dharawal National Park. The habitat to be removed or indirectly impacted by the proposed development works is not considered locally important for the species due to the high mobility of the species and the extensive areas of suitable habitat occuring within other areas of locality. Nevertheless, mitigation measures will be implemented to minimise impacts on the species, including any summer breeding

sites. These include targeted pre-clearance surveys, development of TSRP and specific clearing protocols for identified bat roosts.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat for the Eastern False Pipistrelle has been identified by OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The Action Plan for Australian Bats provides a recovery outline for the species (Duncan et al. 1999). The proposed development works is consistent with the objectives of the plan for this species as it will retain areas of better condition habitat for the species within the Howes Creek Riparian Corridor to what is being removed.

g) 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.

The following Key Threatening processes listed under the TSC Act are likely to affect the Eastern False Pipistrelle:

- 'Clearing of native vegetation'

Areas of degraded native vegetation suitable for this species will be cleared, however such clearing is unlikely to have a significant detrimental impact on this species.

- 'Loss of hollow-bearing trees'

All hollow-bearing trees will be removed within the proposed development works area. However, hollow bearing trees will be retained in areas of vegetation within the proposed conservation works area and mitigation measures will be implemented to prevent any significant impact to the species.

- Invasion and establishment of exotic vines and scramblers'

The subject site currently contains exotic vines and scramblers in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat)'

The subject site currently contains Lantana in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered

when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The subject site currently contains African Olive in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic perennial grasses'

The proposed action is unlikely to cause the spread of exotic grasses other than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

Currently the proposed development works area already contains scattered exotic garden plants, likely from previous illegal dumping on the site. The proposed action would not exacerbate this key threatening process other than existing conditions.

Conclusion

The proposed development works will remove approximately 17 ha of marginal foraging habitat for the Eastern False Pipistrelle from within the proposed development works area that is likely only utilised periodically as part of a much broader foraging range. Approximately 29 ha of native woodland and forest vegetation will be immediately protected within conservation areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated as forest and woodland.

Given that the species is highly mobile and is likely to utilise numerous habitat resources within the locality, the species is considered likely to remain viable within the locality and its range. That notwithstanding, due to the cumulative removal of forest and woodland habitat as part of the Master Plan, the proposal is considered to have potential to have a significant impact on the local population of the Eastern False Pipistrelle. All suitable habitat for this species proposed to be removed will be offset for through the retirement of ecosystem credits as outlined in ***Section 6.4.***

8.3.6. Little Bent-winged Bat

The Little Bent-winged Bat (*Miniopterus australis*) is found from Cape York in Queensland to Wollongong in NSW. It inhabits well-timbered habitats in a variety of vegetation types including moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub (OEH 2018g). Roosting habitat comprises of caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings. The species is listed as Vulnerable under the TSC Act.

This species was tentatively recorded within the subject site by Cumberland Ecology during targeted bat surveys in 2021. This species was recorded within the wider study area by Travers Bushfire & Ecology (2013).

Assessment of Significance

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Little Bent-winged Bat is likely to use the proposed development works area as foraging and roosting habitat as part of a much larger foraging range. It is a highly mobile species that would access resources from across a wide area and would not depend upon resources contained on the proposed development works area for its survival. The proposal is not likely to place a viable local population of the Little Bent-winged Bat at risk of extinction as while some potential habitat will be removed, much larger areas of forest and woodland will be retained long-term within the proposed conservation areas. The species would also likely utilise much larger areas of intact vegetation such within the Howes Creek Conservation Area and the vegetation around the Nepean River. Potential roost habitat may also be removed within the proposed development works area in the form of hollow-bearing trees.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 17 ha of marginal foraging habitat for the Eastern False Pipistrelle will be removed within the proposed development works area, comprising native woodland, forest and shrubby regrowth communities. Potential roosting and breeding habitat is also present within the proposed development works area in the form of hollow-bearing trees. Approximately 29 ha of native woodland and forest vegetation will be

immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a 20-year VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The foraging habitat within the proposed development works area has been subject to clearing and other disturbances that has already fragmented the patches of remnant vegetation. The fragmented woodland patches now occur amid grasslands and old farmlands, with poor prospects to restore connectivity, and many have low native species diversity and an abundance of weeds. The proposed development works will remove the remaining fragments rather than creating additional fragmented habitat patches. Furthermore, the Little Bent-winged Bat is a highly mobile species that can fly over disturbed land and access other areas of habitat, including those areas within the proposed conservation works areas that will retained connectivity along Howes Creek and to the Nepean River.

Habitat within the proposed development works area is not important for the species in the locality as it is a relatively small area of foraging habitat available. Much larger areas of potential habitat beyond the study area in reserves include Dharawal National Park. The habitat to be removed or indirectly impacted by the proposed development works is not considered locally important for the species due to the high mobility of the species and occurrence of extensive areas of suitable habitat within a 5 km radius of the subject site. Nevertheless, mitigation measures will be implemented to minimise impacts on the species, including any summer breeding sites. These include targeted pre-clearance surveys, development of a TSRP and specific clearing protocols for identified bat roosts.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat for the Little Bent-winged Bat has been identified by OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The Action Plan for Australian Bats provides a recovery outline for the species (Duncan et al. 1999). The proposed development works is consistent with the objectives of this plan for this species as it will retain areas of better condition habitat for the species within the Howes Creek Riparian Corridor to what is being removed.

g) 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.

The following Key Threatening processes listed under the TSC Act are likely to affect the Little Bent-winged Bat:

- 'Clearing of native vegetation'

Areas of degraded native vegetation suitable for this species will be cleared, however such clearing is unlikely to have a significant detrimental impact on this species.

- 'Loss of hollow-bearing trees'

All hollow-bearing trees will be removed within the proposed development works area. However, areas of native vegetation to be retained within the proposed conservation works areas that contain hollows and mitigation measures will be implemented to prevent any significant impact to the species.

- Invasion and establishment of exotic vines and scramblers'

The subject site currently contains exotic vines and scramblers in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat)'

The subject site currently contains Lantana in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The subject site currently contains African Olive in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic perennial grasses'

The proposed action is unlikely to cause the spread of exotic grasses other than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

Currently the proposed development works area already contains scattered exotic garden plants, likely from previous illegal dumping on the site. The proposed action would not exacerbate this key threatening process other than existing conditions.

Conclusion

The proposed development works will remove approximately 17 ha of marginal foraging habitat for the Little Bent-winged Bat from within the proposed development works area that is likely only utilised periodically as part of a much broader foraging range. Approximately 29 ha of existing native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated into forest and woodland.

Given that the species is highly mobile and is likely to utilise numerous habitat resources within the locality, the species is considered likely to remain viable within the locality and its range. The proposal is not considered likely to have a significant impact on the local population of the Little Bent-winged Bat.

8.3.7. Eastern Coastal Free-tailed Bat

The Eastern Coastal Free-tailed Bat (*Mormopterus norfolkensis*) is distributed along the east coast from southern Queensland to southern NSW. The species inhabits dry sclerophyll forest and woodland east of the Great Dividing Range. It roosts singly and communally, mainly in tree hollows but will also roost under decorticating bark or in man-made structures (OEH 2017g). The Eastern Coastal Free-tailed Bat is listed as Vulnerable under the TSC Act.

This species has not been positively recorded within subject site during recent targeted bat surveys. This species was recorded within the wider study area by Travers Bushfire & Ecology (2013).

Assessment of Significance

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Eastern Coastal Free-tailed Bat is likely to use the proposed development works area as foraging habitat as part of a much larger foraging range. It is a highly mobile species that would access resources from across a wide area and would not depend upon resources contained on the proposed development works area for its survival. The proposed development works area also provides potential breeding habitat for the species in the form of tree hollows, and the species has potential to breed in the proposed development works area. That notwithstanding, the potential breeding habitat is not considered likely to be important to the species as it occurs in relatively small, highly disturbed fragments of woodland. Similar isolated patches of woodland occur relatively frequently in the locality and the removal of a small area of habitat containing potential breeding resources is not likely to have a significant impact on this species.

The proposal is not likely to place a viable local population of the Eastern Coastal Free-tailed Bat at risk of extinction as only some potential foraging and breeding habitat will be removed, while much larger areas will be retained within the proposed conservation areas. The species would also likely utilise much larger areas of intact vegetation such as areas around the Nepean River.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 17 ha of marginal foraging habitat for the Eastern False Pipistrelle will be removed within the proposed development works area, comprising native woodland and forest communities. Potential roosting and breeding habitat is also present within the proposed development works area in the form of hollow-bearing trees. Approximately 29 ha of native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The habitat within the proposed development works area has been subject to clearing and other disturbances that has already fragmented the patches of remnant vegetation. The fragmented woodland patches now occur amid grasslands and old farmlands, with poor prospects to restore connectivity, and many have low native species diversity and an abundance of weeds. The proposed development works will remove the remaining fragments rather than creating additional fragmented habitat patches. Furthermore, the Eastern Coastal Free-tailed Bat is a highly mobile species that can fly over disturbed land and accessing fragmented habitats.

Habitat within the proposed development works area is not important for the species in the locality as it is a relatively small area of foraging and breeding habitat, and much larger areas of suitable habitat will be retained and restored within the better connected proposed conservation works areas. Much larger areas of potential habitat occur throughout the locality and beyond in reserves such as Dharawal National Park. The foraging and breeding habitat to be removed or indirectly impacted by the proposal is not considered locally important for the species due to the high mobility of the species and occurrence of extensive areas of suitable habitat occur within other areas of locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat for the Eastern Coastal Free-tailed Bat has been identified by OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The Action Plan for Australian Bats provides a recovery outline for the species (Duncan et al. 1999). The proposed development works is consistent with the objectives of the plan for this species as it will retain areas of better condition habitat for the species within the Howes Creek Riparian Corridor to what is being removed.

g) 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.

The following Key Threatening processes listed under the TSC Act are likely to affect the Eastern Coastal Free-tailed Bat:

- 'Clearing of native vegetation'

Areas of degraded native vegetation suitable for this species will be cleared, however such clearing is unlikely to have a significant detrimental impact on this species as large areas of similar habitat will be retained in the study area and beyond.

- 'Loss of hollow-bearing trees'

All hollow-bearing trees will be removed within the proposed development works area. However, hollows will be conserved within the areas of retained native vegetation in the study area and beyond, including within the proposed conservation works areas, and mitigation measures will be implemented to prevent any significant impact to the species.

- Invasion and establishment of exotic vines and scramblers'

The proposed development works area currently contains exotic vines and scramblers in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will

be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat)'

The proposed development works area currently contains Lantana in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The proposed development works area currently contains African Olive in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a 20-year VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic perennial grasses'

The proposed action is unlikely to cause the spread of exotic grasses other than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

Currently the proposed development works area already contains scattered exotic garden plants, likely from previous illegal dumping on the site. The proposed action would not exacerbate this key threatening process other than existing conditions.

Conclusion

The proposed development works will remove approximately 17 ha of marginal foraging habitat for the Eastern Coastal Free-tailed Bat from within the proposed development works area that is likely only utilised periodically as part of a much broader foraging range.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the

long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

Given that the species is highly mobile and is likely to utilise numerous habitat resources within the locality, the species is considered likely to remain viable within the locality and its range and there is unlikely to be a significant impact to the Eastern Coastal Free-tailed Bat

8.3.8. Southern Myotis

The Southern Myotis (*Myotis macropus*) is found from the north-west through to western Victoria along the coast. It forages over pools and streams. The Southern Myotis roosts in groups of 10-15 close to water in caves, but can also roost in mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage (OEH 2017l). The species is listed as Vulnerable under the TSC Act.

This species was recorded as potentially occurring within the proposed development works area during targeted bat surveys. This species was also recorded within the wider study area by Travers Bushfire & Ecology (2013).

Assessment of Significance

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Southern Myotis could potentially use the proposed development works area as foraging habitat as part of a much larger foraging range. The species may utilise the dam present in the east of the proposed development works area. The proposed development works area also provides potential breeding habitat for the species in the form of tree hollows, and the species has potential to breed in the proposed development works area in areas of woodland containing hollow-bearing trees within 200m of the dam. That notwithstanding, the potential breeding habitat is not considered likely to be important to the species as it occurs in relatively small, highly disturbed fragments of woodland. Similar isolated patches of woodland occur relatively frequently in the locality and beyond and the removal of a small area of habitat containing potential breeding resources is not likely to have a significant impact on this species. It is a highly mobile species that would accesses resources from across a wide area and would not depend upon resources contained on the proposed development works area for its survival.

The proposal is not likely to place a viable local population of the Southern Myotis at risk of extinction as only marginal foraging and breeding habitat will be removed. The species would also likely utilise much larger areas of intact vegetation such as those within the proposed Howes Creek Conservation Area and along other riparian corridors in the locality, such as Nepean River.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological community:

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

The area of habitat to be removed within the proposed development works area represents potential, albeit marginal foraging and breeding habitat for the Southern Myotis. This includes ~6.20 ha of potential habitat in the form of native woodland and forest vegetation with hollows within 200 m of a waterbody, and 1.01 ha of foraging habitat comprised of a dam. Although areas of native woodland and forest vegetation are present in the proposed development works area, this species is only likely to utilise woodland areas within 200 m of the dam, which further limits the amount of potential habitat present.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The habitat within the proposed development works area has been subject to clearing and other disturbances that has already fragmented the patches of remnant vegetation. The fragmented woodland patches now occur amid grasslands and old farmlands, with poor prospects to restore connectivity, and many have low native species diversity and an abundance of weeds. Furthermore, the Southern Myotis is a highly mobile species that can fly over disturbed land and accessing fragmented habitats.

Habitat within the proposed development works area is not important for the species in the locality as it is a relatively small area of foraging and breeding habitat. Much larger areas of potential habitat occur that will be retained, including areas along the Nepean River. The habitat to be removed or indirectly impacted by the proposed development works is not considered locally important for the species due to the high mobility of the species and occurrence of extensive areas of suitable habitat within other areas of the locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat for the Southern Myotis has been identified by OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The Action Plan for Australian Bats provides a recovery outline for the species (Duncan et al. 1999). The proposed development works is consistent with the objectives of the plan for this species as it will retain areas of better condition habitat for the species within the Howes Creek Riparian Corridor to what is being removed.

g) 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.

The following Key Threatening processes listed under the TSC Act are likely to affect the Southern Myotis:

- 'Clearing of native vegetation'

Areas of degraded native vegetation will be cleared; however, such clearing is unlikely to have a significant detrimental impact on this species. Areas of native vegetation will be retained in the study area and beyond.

- 'Loss of hollow-bearing trees'

All hollow-bearing trees will be removed within the proposed development works area. However, similar hollows are expected to occur in the many similar isolated patches of vegetation that occur in the locality as well as in the areas of native vegetation to be retained outside of the proposed development works area.

- Invasion and establishment of exotic vines and scramblers'

The proposed development works area currently contains exotic vines and scramblers in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat)'

The proposed development works area currently contains Lantana in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

The proposed development works area currently contains African Olive in areas, all of which will be cleared, including within the proposed conservation works areas. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed under a VMP, following the stringent requirements of a BSA that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic perennial grasses'

The proposed action is unlikely to cause the spread of exotic grasses other than current conditions.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

Currently the proposed development works area already contains scattered exotic garden plants, likely from previous illegal dumping on the site. The proposed action would not exacerbate this key threatening process other than existing conditions.

Conclusion

The proposed development works will remove ~6.20 ha of potential habitat for this species in the form of woodland with hollows within 200 m of a waterbody, as well as 1.01 ha of foraging habitat comprised of dams. This habitat is likely only utilised periodically as part of a much broader foraging range and there is no evidence of breeding in the proposed development works area.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The Howes Creek Conservation Area and areas along the Nepean River have potential breeding habitat within 200 m of water sources. Given that the species is highly mobile and is likely to utilise numerous habitat resources within the locality, the species is considered likely to remain viable within the locality and its range. The proposal is not considered likely to have a significant impact on the local population of the Southern Myotis; however, species credits have been calculated for this species as described in **Chapter 7** to mitigate impacts to breeding habitat.

8.3.9. Large Bent-winged Bat

The Large Bent-winged Bat (*Miniopterus australis*) is distributed along the entire east coast of NSW where it primarily utilises caves for roosting. The species is also known to utilise derelict mines, stormwater tunnels, buildings and other manmade structures for roosting. Foraging primarily occurs in forested areas where it preys on flying insects above the canopy (OEH 2017d). The Large Bent-winged Bat is listed as Vulnerable under the TSC Act.

This species was not recorded within the proposed development works area during recent targeted bat surveys by Cumberland Ecology but was recorded within the wider study area by Travers Bushfire & Ecology (2013).

Assessment of Significance

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Large Bent-winged Bat could potentially use the proposed development works area as foraging habitat as part of a much larger foraging range. It is a highly mobile species that would access resources from across a wide area and would not depend upon resources contained on the proposed development works area for its survival. The proposal is not likely to place a viable local population of the species at risk of extinction as only highly marginal potential habitat will be removed. The species would also likely utilise much larger areas of intact vegetation within vegetation surrounding the Nepean River. No preferred roosting habitat (i.e. caves) may will be removed from the proposed development works area.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological community:

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

The area of habitat to be removed within the proposed development works area represents potential foraging habitat for the Large Bent-winged Bat. This includes 17 ha of vegetation, most of which is sub-optimal foraging habitat. No preferred roost habitat is present within the proposed development works area and no breeding habitat is present.

Approximately 29 ha of native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity either under a VMP or BSA. Further, areas proposed to be managed under a BSA or VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The habitat within the proposed development works area has been subject to clearing and other disturbances that has already fragmented the patches of remnant vegetation. The fragmented woodland patches now occur amid grasslands and old farmlands, with poor prospects to restore connectivity, and many have low native species diversity and an abundance of weeds. Furthermore, the Large Bent-winged Bat is a highly mobile species that can fly over disturbed land and accessing fragmented habitats.

Habitat within the proposed development works area is not considered important for the species in the locality as it is a relatively small area of foraging habitat. Much larger areas of potential habitat occur within the proposed conservation works areas, and within the study area and beyond within vegetated areas of the Nepean River and in reserves such as Dharawal National Park. The habitat to be removed or indirectly impacted by the proposal is not considered locally important for the species due to the high mobility of the species and occurrence of extensive areas of similar suitable habitat beyond the study area.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat for the Large Bent-winged Bat has been identified by OEH.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The Action Plan for Australian Bats provides a recovery outline for the species (Duncan et al. 1999). The proposed development works is consistent with the objectives of the plan for this species as it will retain areas of better condition habitat for the species within the Howes Creek Riparian Corridor to what is being removed.

g) 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.

The following Key Threatening processes listed under the TSC Act are likely to affect the Large Bent-winged Bat:

- Clearing of native vegetation;

Areas of degraded native vegetation suitable for this species will be cleared, however such clearing is unlikely to have a significant detrimental impact on this species. Areas of native vegetation will be retained and managed for conservation in the subject site outside of the proposed development works area.

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;

The proposed development works is unlikely to increase the frequency of fire within the study area.

- Infection of native plant *Phytophthora cinnamomi*; and

The proposed development works is unlikely to introduce *Phytopthora cinnamomi* to native plants within the proposed development works area/study area. Controls will be implemented during the construction phase to minimise the likelihood of the pathogen being carried onto the site by machinery coming from other areas that may contain the pathogen.

- Anthropogenic climate change

The proposed development works is unlikely to contribute to anthropogenic climate change such that this key threatening process would be exacerbated.

Conclusion

The proposed development works will remove approximately 17 ha of marginal foraging habitat for the Large Bent-winged Bat from within the proposed development works area that is likely only utilised periodically as part of a much broader foraging range.

Approximately 29 ha of native woodland and forest vegetation will be protected within conservation areas as part of the proposed development works and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

Given that the species is highly mobile and is likely to utilise numerous habitat resources outside the proposed development works area in the study area and beyond, the species is considered likely to remain viable within the locality and its range. The proposal is not considered likely to have a significant impact on the local population of the Large Bent-winged Bat.

8.3.10. Eastern Cave Bat

The Eastern Cave Bat has been listed as Vulnerable under the TSC Act (OEH 2017e). The species is broadly distributed along the Great Dividing Range from Cape York to Kempsey with records from the New England Table lands and the upper north coast of NSW. The species is known to occur in dry open forest and woodland, near cliffs and rock overhangs and along cliff-lines in wet eucalypt forests. The species utilises caves and disused mine workings as roosting habitat.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The proposed development works will remove approximately 17 ha of suitable foraging habitat (woodland, forest and shrubby regrowth) for this cave roosting microbat species. Additional areas of potential foraging habitat within exotic dominated vegetation communities are present, but this is considered to be non-preferred for this species and would only be utilised occasionally. No suitable roosting habitat is present. The majority of the suitable foraging habitat consists of mature small, isolated patches of woodland/forest that are surrounded by open grassland and have poor prospects of being restored for connectivity. This species is highly mobile, with the ability to access substantial foraging habitat throughout the surrounding locality. Including within the proposed conservation works area. Approximately 29 ha of native woodland and forest habitat for this species will be immediately retained within the proposed conservation works areas and a further ~22 ha of native vegetation will be revegetated to forest and woodland. Surrounding areas, as well as the proposed conservation works areas, will provide continuous foraging habitat for this species. Consequently, the proposed development works is not considered to have an adverse effect on the life cycle of this species such that a local population is placed at risk of local extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 17 ha of potential foraging habitat is to be cleared for the proposed development works.

The foraging habitat of the proposed development works area has been previously exposed to clearing and other disturbances for agricultural purposes. As a result of this, the habitat has already been heavily fragmented, with remnant patches of suitable foraging habitat remaining. The majority of the proposed development works area is surrounded by open grasslands. The proposed development works will remove the remaining fragments rather than create additional fragmentation of habitat.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

This species is highly mobile and are therefore capable of relocating and flying over disturbed land to access suitable foraging habitat elsewhere.

This species has been considered to occupy the proposed development works area as part of their much broader foraging range. The foraging habitat that is to be removed for the proposed development works does not represent an important foraging resource due to its high degree of degradation and surrounding cleared areas. Additionally, the species has the ability to access adjacent suitable foraging is due to its high mobility and ability to fly over disturbed areas.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been identified by OEH for the Eastern Cave Bat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plans,

The Action Plan for Australian Bats provides a recovery outline for this species (Duncan et al. 1999). The proposed development works are consistent with the objectives of this plan.

g) 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.

The following Key Threatening Processes listed under the TSC Act are likely to affect the Cave Bat.

- Clearing of native vegetation

The proposed development works will result in the clearing of approximately 17 ha of potential foraging habitat for this species. The foraging habitat to be removed is unlikely to be important to this species as it would likely only be used on occasion as part of much broader foraging range. Although a moderate area of habitat will be removed, additional areas

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

The proposed development works are unlikely to contribute to high frequency fire as future DAs will require the implementation of bushfire protection setbacks as required.

- Infection of native plant by *Phytopthora cinnamomi*

The proposed development works are unlikely to increase the risk of infection of native plants with *Phytophthora cinnamomi*. Wash-down stations will be established and all construction vehicles entering and leaving the site will be required to be washed down to prevent pathogens entering or leaving the site.

Conclusion

The proposed development works will remove approximately 17 ha of potential foraging habitat for the Eastern Cave Bat. Despite the removal of some foraging habitat, approximately 29 ha of native woodland and forest in the proposed conservation works areas will be retained and conserved in perpetuity and a further ~22 ha of native woodland and forest vegetation will be established in the proposed conservation works areas, predominantly within the Howes Creek and Northern Conservation Areas. Additionally, suitable habitat exists throughout the wider locality.

Given that this species is highly mobile and likely to utilise a variety of habitat resources as part of its broader range, the proposed development works are unlikely to have a significant impact on the local population of this species.

8.3.11. White-bellied Sea Eagle

The White-bellied Sea Eagle has been listed as Vulnerable under the TSC Act (OEH 2019e). The species is distributed along the Australian coastline including Tasmania and extending inland, along rivers and wetlands of the Murray Darling Basin. In NSW, the species is widespread along the east coast and along all major rivers and waterways. The species is known to inhabit areas in the presence of large rivers, swamps, lakes and the ocean. Habitats can range from reefs, lagoons, estuaries and mangroves to coastal dunes, tidal flats, grassland, woodland and forest. The species constructs large stick nests in open forest and tall woodland that is close to foraging habitat.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The White-bellied Sea-Eagle has not been located during surveys by Cumberland Ecology within the study area.

The proposed development works will remove approximately 17 ha of potential nesting habitat (forest and woodland) and 1.39 ha of potential, albeit suboptimal, foraging habitat for the White-bellied Sea Eagle. The potential nesting habitat consists of remnant native woodland, forest and shrubby regrowth vegetation communities that occur in patches among open grassland, while the foraging habitat present is limited to small farm dams and Freshwater Wetlands. None of the foraging habitat present is seen as optimal for this species as it consists of waterbodies in predominantly cleared and degraded farmland areas. It is more likely that the species would utilise areas of the Nepean River for foraging, or larger farm dams present in the wider locality. The species is highly mobile, with the ability to access substantial breeding and nesting habitat throughout the surrounding locality.

Approximately 29 ha of suitable nesting habitat and ~7 ha of potential foraging habitat will be retained within the proposed conservation works areas. A further ~22 ha of native vegetation will revegetated to forest and woodland and ~1.62 ha will be revegetated to Freshwater Wetlands within the proposed conservation works

area. The Howes Creek Conservation Area, which represents the most optimal area of habitat for this species within the subject site, will be retained; providing continued connectivity between the Howes Creek riparian corridor and the Nepean River. Surrounding areas, as well as the proposed conservation works areas, will provide continuous nesting and foraging habitat for the species. Consequently, the proposed development works is not considered to have an adverse effect on the life cycle of the species, such that a local population is placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 17 ha of potential nesting habitat (woodland/forest) and ~1.39 ha of potential foraging habitat (dams and Freshwater Wetland) for the White-bellied Sea Eagle will be removed.

The nesting and foraging habitat of the proposed development works area has been previously exposed to clearing and other disturbances for agricultural purposes. As a result of this, the habitat has already been heavily fragmented, with few remnant patches of suitable vegetation habitat remaining. The majority of the proposed development works area is surrounded open grassland. The proposed development works will remove the remaining fragments rather than create additional fragmentation of habitat as well as retain ~29 ha of suitable nesting habitat and ~7 ha of potential foraging habitat within conservation areas that will be managed in perpetuity. An additional ~22 ha of woodland and forest habitat and ~1.62 ha of Freshwater Wetlands within the proposed conservation areas will also be restored as part of the proposed development. This species is highly mobile and therefore capable of relocating and flying over disturbed land to access the surrounding suitable habitat.

This species has been considered to occupy the proposed development works area as part of a broader range. The habitat to be removed or indirectly impacted by the proposed development works does not represent a reliable resource for nesting and foraging habitat as it is a marginal portion of the species range. Additionally, the high mobility of the species allows for accessibility to adjacent suitable habitat.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been identified by OEH for the White-bellied Sea Eagle.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plans,

No approved recovery or threat abatement plans have been prepared for White-bellied Sea Eagle, however, a Conservation Project under the *SoS* program is currently being developed (OEH 2019e).

g) 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.

The following Key Threatening Processes listed under the TSC Act are likely to affect the White-bellied Sea Eagle.

- Clearing of native vegetation.

Approximately 16.92 ha of potential nesting habitat (woodland/forest) and ~1.39 ha of potential foraging habitat (dams and Freshwater Wetland) for this species will be cleared as part of the proposed development works. Although a moderate area of habitat will be removed, ~29 ha of suitable nesting habitat and ~7 ha of potential foraging habitat further ~22 ha of native woodland and forest vegetation and ~1.62 ha of Freshwater Wetlands will be revegetated within the proposed conservation areas, predominantly around the Howes Creek riparian corridor.

- Removal of dead wood and dead trees.

The proposed development works will result in the removal of dead wood and dead trees, thereby likely reducing the habitat for prey species and altering the suitability of the site for foraging. However, this foraging habitat is not critical to the survival of the species. Additionally, the environmental offset area and surrounding locality will provide continuous suitable habitat for foraging of the species. Mitigation measures such as the salvage of dead wood and dead trees and placement into retained areas will also enhance the habitat values of retained vegetation within the subject land.

- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'

The proposed development works area currently contains a high abundance of Lantana in areas, all of which will be cleared. The proposed development works have the potential to result in the spread of this weed both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed initially under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading

during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

- 'Invasion of native plant communities by African Olive (*Olea europaea* subsp. *cuspidata*)';

The proposed development works area currently contains a high abundance of African Olive in areas, all of which will be cleared both during clearing and into retained areas of vegetation. In order to mitigate this key threatening process, retained vegetation will be managed initially under a VMP that will minimise the key threatening process. Furthermore, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site.

Conclusion

The proposed development works will remove fragmented areas of potential nesting and foraging habitat. Despite the removal of this habitat, the majority of suitable habitat within the subject land will be retained and managed in perpetuity as conservation areas. Additionally, suitable habitat exists throughout the wider locality. Given that the species is highly mobile and likely to utilise a variety of habitat resources as part of their broader range, the proposed development works are unlikely to have a significant impact on the local populations of the White-bellied Sea Eagle.

8.3.12. Little Eagle

This species has been recorded from the study area by Cumberland Ecology in 2018, though has not been recorded from within the subject site. Stick nests have been observed within the proposed development works area; however, none have been observed to be occupied by the species and the Little Eagle has not been recorded again during subsequent site surveys.

The Little Eagle is listed as Vulnerable under the TSC Act (OEH 2017j). The species is distributed throughout most of the Australian mainland. The species occupies habitats rich in prey within open eucalypt forest, woodland, or open woodland, she-oak or acacia woodlands and riparian woodlands of interior NSW are also used. The species utilises large remnant trees for roosting and nesting.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The proposed development works will remove approximately 16.98 ha of potential nesting and foraging habitat (woodland, forest and shrubby regrowth) for this species. Suitable habitat consists of small scattered isolated patches of vegetation that are surrounded by open grassland and provide little connectivity to surrounding habitat. The species is highly mobile, with the ability to access foraging habitat throughout the locality and local area. Larger areas of suitable habitat (woodland/forest) will be retained and revegetated within the proposed conservation works areas in perpetuity. Surrounding areas of retained suitable habitat will provide continuous breeding and foraging habitat for the species. Consequently, the proposed development works is not considered to have an adverse effect on the life cycle of the species such that a local population is placed at risk of local extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 17 ha of potential foraging habitat (i.e. woodland, forest and shrubby regrowth) is to be cleared by the proposed development works. Approximately 29 ha of native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated to forest and woodland. Therefore, in the long-term ~51 ha of native forest and woodland will be conserved in perpetuity as part of the proposed development.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The habitat within the proposed development works area has been subject to clearing and other disturbances that has already fragmented the patches of remnant vegetation. The fragmented woodland patches now occur amid grasslands and old farmlands, with poor prospects to restore connectivity, and many have low native species diversity and an abundance of weeds. The proposed development works will remove and reduce the extent of remaining fragments rather than create additional fragmentation of habitat. This species is highly mobile and can fly over disturbed land and accessing isolated habitat patches.

This species is considered to have potential to occupy the proposed development works area as part of their broader range. However, the potential habitat to be removed or indirectly impacted by the proposed development works is not considered to be important breeding and foraging habitat due its poor condition and the high mobility of the species. Larger areas of suitable less fragmented habitat will be retained within the proposed conservation works area, study area and wider locality which will provide continued foraging habitat for the species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been identified by OEH for the Little Eagle.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plans,

No recovery or threat abatement plans have been prepared for this species however, a targeted strategy for managing the species has been developed under the Saving Our Species (SoS) program (OEH 2016b), which has been assigned to the Landscape Species management stream under the SoS program. The proposed development works will remove a marginal area of the species' potential foraging habitat; however, due to the high mobility of the species, the proposed development works will not conflict with the objectives of the targeted management strategies for the species.

g) 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.

The following Key Threatening Processes listed under the TSC Act are likely to affect the Little Eagle:

- 'Clearing of native vegetation'

Approximately 16.98 ha of native vegetation that provides potential habitat for this species (i.e. woodland and forest vegetation) will be cleared as part of the proposed development works. Approximately 29 ha of native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated as forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

- 'Removal of dead wood and dead trees'

The proposed development works will result in the removal of dead wood and dead trees. Although all of these items will be removed from the proposed development works area, additional areas containing dead wood and dead trees will be retained in the study area and beyond.

- 'Invasion and establishment of exotic vines and scramblers'

The proposed development works has the potential to result in the spread of exotic weeds. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed initially under a VMP that will minimise the key threatening process.

- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'

The proposed development works area currently contains *Lantana* in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed initially under a VMP that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* subsp. *cuspidata)*'

The proposed development works area currently contains African Olive in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed initially under a VMP that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic grasses'

Clearing from the proposed development works is unlikely to significantly contribute to the spread of exotic grasses further than current conditions as all areas are currently subject to this process. Nevertheless, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed initially under a VMP that will minimise the key threatening process.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

The proposed development works has the potential to contribute to this key threatening process; however it is unlikely to contribute significantly as the habitat to be retained is already degraded to some degree as a result of previous and surrounding land uses.

Conclusion

The proposed development works will remove 17 ha of potential foraging habitat (i.e. woodland, forest and shrubby regrowth) for the Little Eagle. Approximately 29 ha of native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated as forest and woodland, predominantly within the Howes Creek riparian corridor.

Although small areas of marginal potential habitat will be removed, all areas are small, isolated patches that may be utilised periodically as part of a broader foraging range. Furthermore, the Little Eagle is highly mobile and capable of accessing habitat in the wider locality, which includes suitable habitat within reserves. Therefore, the proposed development works is unlikely to have a significant impact on the local populations of this species.

8.3.13. Powerful Owl

This species has not been recorded from the study area; however, they are considered to have potential to occur from time to time due to the presence of suitable foraging habitat. Potential breeding habitat is also present in the form of some hollows the size required (greater than 20cm) by these large birds.

The Powerful Owl is listed as Vulnerable under the TSC Act (OEH 2017k). The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well (OEH 2017k). The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The proposed development works will remove approximately 17 ha of potential nesting and foraging habitat (woodland/forest/shrubby regrowth) for the Powerful Owl including five hollows suitable for use by this species. Suitable habitat consists of small scattered isolated patches of vegetation that are surrounded by open grassland and retain little connectivity to areas of intact remnant habitat. This species is highly mobile, with the ability to access foraging habitat throughout the study area and beyond. Larger areas of suitable habitat (woodland/forest) will be retained within the proposed conservation works areas, study area and within a 5 km radius of the proposed development works area. Surrounding areas of retained suitable habitat will provide continuous habitat for the species. Consequently, the proposed development works is not considered likely to have an adverse effect on the life cycle of the species such that a local population is placed at risk of local extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

(d) In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 17 ha of potential foraging and nesting habitat (i.e. woodland, forest and shrubby regrowth) is to be cleared by the proposed development works. Approximately 29 ha of native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated to forest and woodland.

As part of the overall Masterplan, approximately ~52 ha of native vegetation will be removed by previously approved, current, or likely future DAs, while approximately ~45 ha of native vegetation will be retained and managed in perpetuity under a VMP. Further, areas proposed to be managed under a VMP in the Howes Creek and Northern Conservation Area will also include the replanting of native vegetation to be managed in the long-term of approximately ~23 ha, for a cumulative long-term retention of approximately 68 ha of native vegetation.

The habitat within the proposed development works area has been subject to clearing and other disturbances that has already fragmented the patches of remnant vegetation. The fragmented woodland patches now occur amid grasslands and old farmlands, with poor prospects to restore connectivity, and many have low native species diversity and an abundance of weeds. The proposed development works will remove and reduce the extent of remaining fragments rather than create additional fragmentation of habitat. This species is highly mobile and is therefore capable of relocating from disturbed land and accessing the surrounding suitable habitat.

This species is considered to have potential to occupy the proposed development works area as part of their broader range. However, the potential habitat to be removed or indirectly impacted by the proposed development works is not considered to be important breeding and foraging habitat due its poor condition and the high mobility of the species. Larger areas of suitable less fragmented habitat will be retained within the study area and beyond which will provide continued habitat for the species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been identified by OEH for the Powerful Owl.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plans,

A Recovery Plan for the Large Forest Owls (DEC (NSW) 2006) has been prepared which includes the Powerful Owl. In addition, a targeted strategy for managing this species has been developed under the Saving Our Species (SoS) program (OEH 2016b), which has been assigned to the Landscape Species management stream under the SoS program. The proposed development works will remove a marginal area of the species' potential foraging habitat; however, due to the high mobility of the species, the proposed development works will not conflict with the objectives of the Recovery Plan or targeted management strategies for the species.

g) 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.

The following Key Threatening Processes listed under the TSC Act are likely to affect the Powerful Owl:

- 'Clearing of native vegetation'

Approximately 17 ha of native vegetation that provides potential habitat for this species (i.e. woodland and forest) will be cleared as part of the proposed development works. Approximately 29 ha of native woodland and forest vegetation will be protected within conservation areas as part of the proposed development works and a further 22 ha of native woodland and forest vegetation will be established in the conservation areas.

- 'Removal of hollow bearing trees'

The removal of hollow bearing trees is a key threatening process to this species as they utilise hollows for nesting. The proposed development works will remove approximately 17 ha of woodland/forest vegetation that contains some hollows the size required (greater than 20cm) by these large birds. Larger areas of forest/woodland containing tree hollows within the study area and wider locality will be retained ensuring that suitable nesting habitat is present for a local population. Furthermore, the species is highly mobile and able of accessing other areas of suitable habitat.

- 'Removal of dead wood and dead trees'

The proposed development works will result in the removal of dead wood and dead trees. Although all of these items will be removed from the proposed development works area, additional areas containing dead wood and dead trees will be retained in the study area and locality.

- 'Invasion and establishment of exotic vines and scramblers'

The proposed development works has the potential to result in the spread of exotic weeds. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed initially under a VMP that will minimise the key threatening process.

- 'Invasion and spread of Lantana (*Lantana camara* L. Sens lat)'

The proposed development works area currently contains Lantana in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. In order to mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed initially under a VMP that will minimise the key threatening process.

- 'Invasion of native plant communities by African Olive (*Olea europaea* subsp. *cuspidata*)';

The proposed development works area currently contains African Olive in areas, all of which will be cleared. The proposed development works has the potential to result in the spread of this weed. To mitigate this key threatening process mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed initially under a VMP that will minimise the key threatening process.

- 'Invasion of native plant communities by exotic grasses'

Clearing from the proposed development works is unlikely to significantly contribute to the spread of exotic grasses further than current conditions as all areas are currently subject to this process. Nevertheless, mitigation measures will be implemented during clearing works to further minimise the risk of weeds spreading during the proposed development works. Mitigation measures to be implemented include: no mulching of weeds, disposal of all weeds off-site and weeds must be covered when transporting off-site. Furthermore, retained vegetation will be managed initially under a VMP that will minimise the key threatening process.

- 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'

The proposed development works has the potential to contribute to this key threatening process; however, it is unlikely to contribute significantly as the habitat to be retained is already degraded as a result of previous and surrounding land uses.

Conclusion

The proposed development works will remove ~17 ha of potential foraging habitat (i.e. woodland, forest and shrubby regrowth) for the Powerful Owl as well as some hollows that are of a size to be potentially used by this species. Approximately 29 ha of native woodland and forest vegetation will be immediately protected within the proposed conservation works areas as part of the proposed development and a further ~22 ha of native vegetation will be revegetated to forest and woodland and conserved in perpetuity.

Although some areas of potential habitat will be removed, most areas are small, isolated patches that may be utilised periodically as part of a broader foraging range. Furthermore, this species is highly mobile with very large territories and can access habitat in the wider locality, which includes suitable habitat within reserves.

Therefore, the proposed development works is unlikely to have a significant impact on the local populations of this species.

9. Additional Information

This chapter covers the following Chief Executive Requirements:

CER 9 ADDITIONAL INFORMATION

9.1. Qualifications and Experience

DGR 9.1 Qualifications and experience

A species impact statement must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement (Section 110(4)).

The Cumberland Ecology staff involved with the compilation of this SIS have many years of experience in ecology, flora and fauna assessments and threatened species legislation. The SIS project team included the key personnel listed in **Table 38**. Experience and qualification of each team member are provided in **Appendix F**.

Table 36 Key personnel

Personnel	Role	Company	Contact Details
Dr David Robertson	Director	Cumberland Ecology	(02) 9868 1933
Katrina Wolf	Lead Principal Ecologist	Cumberland Ecology	(02) 9868 1933
Mikael Peck	Principal Ecologist	Cumberland Ecology	(02) 9868 1933
Bryan Furchert	Senior Botanist	Cumberland Ecology	(02) 9868 1933
Dr Rohan Mellick	Botanist	Cumberland Ecology	(02) 9868 1933
Heather Gosper	Senior Ecologist	Cumberland Ecology	(02) 9868 1933
Michael Davis	GIS Specialist	Cumberland Ecology	(02) 9868 1933
John Foster	Ecologist	Cumberland Ecology	(02) 9868 1933
Julian Reyes	Research Assistant	Cumberland Ecology	(02) 9868 1933
Matt Freeman	Senior Ecologist	Cumberland Ecology	(02) 9868 1933
Sally Dupont	Ecologist	Cumberland Ecology	(02) 9868 1933
Eleanor Saxon	Research Assistant	Cumberland Ecology	(02) 9868 1933
Jesse Luscombe	GIS Specialist	Cumberland Ecology	(02) 9868 1933
Anna McConville	Ecologist / Director	Echo Ecology	anna@echoecology.com.au

9.2. Other Approvals Required for the Development or Activity

DGR 9.2 Other approvals required for the development or activity

A list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population or ecological community (Section 110(2)(j) and Section 110(3)(g)).

The proposal will be assessed under Part 4 of the EP&A Act. The DA will be lodged concurrently with this SIS to the consent authority (Council). The DA will also require approval under the NSW *National Parks and Wildlife Act 1974* for proposed impacts on Aboriginal Heritage.

A referral to the Commonwealth is also required as significant impacts on MNES listed under the EPBC Act are predicted. It is anticipated that this referral will be prepared following approval under the EP&A Act.

9.3. Licensing Matters Relating to Conducting Surveys

DGR 9.3 Licensing matters relating to the survey

Cumberland Ecology currently holds the following licences:

- Scientific licence (Section 132 C) (*National Parks and Wildlife Act 1974*); and
- Animal Research Authority to undertake fauna surveys (*Animal Research Act 1985*)

9.4. Section 110(5) Reports

DGR 9.4 Section 110(5) Reports

Impact assessment was conducted after due consideration of the Environmental Impact Assessment Guidelines for relevant threatened species and the condition of potential habitats in the study area. Section 110 (5) reports utilised in preparation of this SIS are included in the References section of this SIS.

10. Conclusion

This SIS has assessed the impacts of the proposed development works and the ecological benefit from the proposed conservation works on the biodiversity values of the subject site and study area in accordance with the CERs issued.

The purpose of the proposed works is to facilitate future urban development and conservation outcomes as permitted by the current zoning, the Urban Structure Plan contained in the Campbelltown City Council *Development Control Plan Part 8 – Menangle Park*, and with reference to the Master Plan for the Menangle Park URA.

Vegetation clearing by the proposed works is the major ecological impact of the proposal. It comprises ecologically harmful clearing of native vegetation in the development areas, and ecologically beneficial clearing of exotic vegetation and replanting of native vegetation in the conservation areas.

The proposed development works will clear ~151.58 ha of land that comprises woodland and grassland vegetation and includes ~ 1.01 ha of old farm dams. Most of the vegetation cleared is exotic grassland and shrubland.

The proposed conservation works will clear exotic-dominated vegetation. The five conservation areas comprise about 60 ha of which ~23 ha is currently infested by exotic woody weeds and grasses. These will be progressively cleared and replaced with native woodland, forest and freshwater wetland species.

Within the native vegetation to be cleared, no threatened flora species are likely to occur or be impacted by the proposed development works. Sixteen (16) threatened fauna species would be affected by the works including:

- **Birds**: Black-necked Stork, Brown Treecreeper, Dusky Woodswallow, Varied Sittella and White-bellied Sea-Eagle
- **Microchiropteran bats**: Eastern Cave Bat, Eastern False Pipistrelle, Eastern Coastal Free-tailed Bat, Greater Broad-nosed Bat, Large Bent-winged Bat, Little Bent-winged Bat, Little Eagle, Little Lorikeet, Powerful Owl, Southern Myotis; and
- **Grey-headed Flying-fox**.

Impacts to some TECs and threatened species have been reassessed by completing seven-part tests and the development will technically have significant impacts on local occurrences of some species and TECs. However, in the long term such impacts will be addressed and ameliorated in three ways:

- by the implementation of a suite of mitigation measures within the development areas;
- by the establishment of conservation reserves and restoration of habitats within them; and
- by the purchase and retirement of ecosystem and species credits to address any potential residual impacts of the proposed development.

Permanent conservation areas will protect viable, representative occurrences of flora and fauna including areas of all TECs and threatened species habitats that occur at Menangle Park as follows:

- Howes Creek and the Northern Conservation Areas will conserve areas of Cumberland Plain Woodland (Shale Plains Woodland), River-flat Eucalypt Forest, Freshwater Wetlands and Swamp Oak Floodplain Forest (REF. VMP 17072RP36);
- Stage 6B EBSF Conservation Area will conserve areas of EBSF under a VMP to be prepared as a Condition of Consent; and
- Parks K and L will retain and revegetate areas of EBSF (REF. VMP 17072RP29).

Howes Creek and the Northern Conservation Areas will link to offsite areas and will contribute to substantial corridors of flora and fauna habitat within the locality. This will be further complemented by an additional area of retained EBSF at the Stage 6B Conservation Area, which was not initially proposed.

Compensatory measures include the purchase and retirement of ecosystem and species credits.

The proposed combination of avoidance, mitigation and compensatory measures are highly likely to ameliorate potential impacts of the proposed development works.

With consideration of the above, the proposed combined avoidance, mitigation and compensatory measures are likely to sufficiently ameliorate the impacts of the proposed development works and the future development it will facilitate to the extent that no TECs or local populations of threatened species are likely to become extinct.

This SIS should be read in combination with the VMP 1, VMP 2 and the EBSF Avoidance Memo submitted as part of the DA package.

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APPENDIX A : Chief Executive Requirements

NSW GOVERNMENT | Office of Environment & Heritage

DOC17/542316-2

Mr Kith Clark
Development Manager
Dahua Group Australia
Suite 2, Level 20
201-217 Elizabeth Street
SYDNEY NSW 2000

Dear Mr Clark

Thank you for your letter of 18 October 2017 requesting the requirements of the Chief Executive of the Office of Environment and Heritage (OEH) for a species impact statement (SIS) for various developments within the Menangle Park Urban Release Area.

The Chief Executive's requirements (CERs) have been prepared and are enclosed. These CERs can be applied to any development application within the urban release area submitted by Dahua Group Australia prior to 25 August 2018.

If you require any further information on these requirements please contact Ray Giddins, Biodiversity Conservation Officer, Greater Sydney on 9995 6811.

Yours sincerely

8·11·17

ALEX GRAHAM
Director, Greater Sydney
Regional operations

Contact officer: RAY GIDDINS
(02) 9995 6811

Enclosure

cc: Campbelltown City Council

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CHIEF EXECUTIVE'S REQUIREMENTS FOR PREPARATION OF A SPECIES IMPACT STATEMENT FOR PROPOSED VARIOUS DEVELOPMENTS WITHIN THE MENANGLE PARK URBAN RELEASE AREA

PURPOSE

The purpose of a species impact statement (SIS) is to:

- allow the applicant or proponent to identify threatened species issues and provide appropriate amelioration for adverse impacts resulting from the proposal
- assist consent and determining authorities in the assessment of a development application under Part 4 or request for Part 5 approval under the *Environmental Planning and Assessment Act 1979* (EP&A Act)
- assist the Chief Executive in deciding whether or not concurrence should be granted for the purposes of Parts 4 or 5 of the EP&A Act
- assist the Chief Executive or the Minister for the Environment when consulted for the purposes of Parts 4 or 5 of the EP&A Act
- assist the Chief Executive or the Minister for the Environment when consulted for the purposes of Part 5 of the EP&A Act

DEFINITIONS

The definitions given below are relevant to these requirements:

development has the same meaning as in the EP&A Act.
activity has the same meaning as in the EP&A Act.
proposal is the development, activity or action proposed
threatened species, populations and ecological communities has the same meaning as in the *Biodiversity Conservation Act 2016*
subject site means the area directly affected by the proposal.
study area is the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly
local population, *local occurrence* and *locality* have the same meanings as in the Threatened Species Assessment Guidelines (DECC 2007),
www.environment.nsw.gov.au/resources/threatenedspecies/tsaguide07393.pdf)
subject species means those threatened species that are known or considered likely to occur in the study area.

All other definitions are the same as those contained in the TSC Act.

MATTERS WHICH HAVE BEEN LIMITED

I consider that the following Section 110 matters need not be addressed by your SIS.

- Section 110(2)(g) and 110(3)(d). The matters raised in these sections of the TSC Act have been clarified by the requirements provided here..

I consider that the following matters referred to in Section 110 of the *Threatened Species Conservation Act 1995* need only be addressed where relevant to this proposal:

Recovery plans and management plans

- Recovery Plan for the Bush Stone-Curlew (*Burhinus grallarius*) http://www.environment.nsw.gov.au/research-and-publications/publications-search/recovery-plan-for-the-bush-stone-curlew-burhinus-grallarius
- *Pimelea spicata* R. Br. Recovery Plan http://www.environment.nsw.gov.au/research-and-publications/publications-search/pimelea-spicata-r-br-recovery-plan
- Cumberland Plain Recovery Plan http://www.environment.nsw.gov.au/research-and-publications/publications-search/cumberland-plain-recovery-plan
- Grey-headed Flying-fox draft recovery plan (www.environment.nsw.gov.au/resources/threatenedspecies/08214dnrpflyingfox.pdf)

National recovery plans may also be relevant should the action require approval from the Federal Minister for the Environment under Commonwealth legislation (refer to section 9.2 below). National recovery plans are listed at www.environment.gov.au/cgi-bin/sprat/public/publicshowallrps.pl.

Key threatening processes

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Bushrock removal
- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees.

Threat abatement plans

No threat abatements plans are relevant to this proposal at the time of writing.

Critical habitat

At the time of writing, there are no areas of declared critical habitat relevant to this proposal.

The proponent should be aware that recovery plans may be approved, critical habitat may be declared and key threatening processes may be listed between the issue of these requirements and the granting of consent. Such an occurrence will require the additional matters to be addressed in the SIS and considered by the consent, determining or concurrence authority.

MATTERS TO BE ADDRESSED

The TSC Act provides that the SIS must meet all the matters specified in Sections 109 and 110 of the TSC Act except where those matters have been limited, as detailed above. Further requirements related to the matters specified in Sections 109 and 110 are detailed in the following sections.

1. FORM OF THE SPECIES IMPACT STATEMENT

The SIS must be in writing (*s.109 (1)*).

The SIS must be signed by the principal author of the statement and by:
(a) the applicant for the licence, or
(b) if the species impact statement is prepared for the purposes of the *Environmental Planning and Assessment Act 1979*, the applicant for development consent or the proponent of the activity proposed to be carried out (as the case requires) (*s.109(2)*).

The SIS must include the following declaration which must be signed by the applicant or proponent:

> *"I…[insert name], of .. [insert address], being the applicant for development consent for development application / proponent for activity… [insert DA/proposal id number and name, Lot & DP numbers, street, suburb and LGA] have read and understood this species impact statement. I understand the implications of the recommendations made in the statement and accept that they may be placed as conditions of consent or concurrence for the proposal."*

2. CONTEXTUAL INFORMATION

The description must include information of the following forms or types:

2.1 Description of proposal, subject site and study area

The following are further requirements related to your obligation under Section 110(1) to address the following:

*A species impact statement must include a **full** description of the action proposed, including its nature, extent, location, timing and layout*

A comprehensive description of the nature, extent and timing of all component works and associated or consequent actions of the proposal must be provided, including works or actions that have effects both *on and off* the subject land as a result of the proposal. The works and actions described must include, but are not to be restricted to, construction, provision or ongoing use and maintenance of proposed:

- buildings or other structures
- utilities such as for sewage, electricity, gas or water
- access routes
- dams/ponds, pipes/channels or other infrastructure for drainage, waste water/effluent management or erosion control
- any structure or activity that may change surface or subterranean water movements
- wastewater disposal
- bush fire hazard reduction and protection measures, such inner and outer protection areas of Asset Protection Zones (APZs), other modified fuel zones, access roads or trails, water supplies, etc.
- landscaping.

2.2 Identification of the development/activity and land to which SIS applies

The SIS must identify:

- local government area
- the development application or activity proposal number and name
- the legal description of the land (lot and deposited plan numbers) and information about the land tenure and ownership

to which SIS applies.

2.3 Plans and maps

An aerial photograph or reproduction of such a photograph (preferably in colour) of the locality must be provided, indicating scale, and clearly delineating the subject site.

A map or maps must be provided, showing:

- in the general area (nominally 5 kilometres radius),
  - ➲ land tenures and uses including parks and reserves, and areas of high human activity such as townships, regional centres and major roads
  - ➲ any locally significant areas for threatened biodiversity, such as local or regional corridors

  - ➲ the locations of any previously known threatened species or endangered populations
  - ➲ the locations and types of vegetation and non-vegetated areas (with reference to the description required in section4.1).
- in the study area,
  - ➲ the location, size and dimensions of the study area.
  - ➲ the full extent of the proposed works as described in section 2.1 at a scale of not less than 1:1000
  - ➲ topography of the site and immediate surrounds at a scale of not less than 1:3000
  - ➲ the locations and types of vegetation and non-vegetated areas (with reference to the description required in section4.1)
  - ➲ the current activities/usage of this land.

All maps must indicate scale and have an explanatory legend of any symbols used.

3 INITIAL ASSESSMENT

The following are further requirements related to your obligation under Section 110(2)(a) to address the following:

- *a general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action.*

and the requirements under Section 110(3)(a) to address the following:

- *a general description of the ecological community present in the area that is the subject of the action and in any area that is likely to be affected by the action*

3.1 Assessment of available information

In determining the subject threatened species, populations and ecological communities likely to be present in the study area (the *subject species*), a full list of threatened species, populations and ecological communities that potentially occur must first be compiled. In doing this records in flora and fauna from databases such as the OEH Atlas of NSW Wildlife[1], and those held by local governments, the Australian Museum, the CSIRO, Forests NSW and the Botanic Gardens Trust Sydney must be considered and documented in compiling the list. The distance from which existing records must be considered must be at least 5 km from the boundary of the study area, but may need to be greater depending on the type of organism, its potential habitats and the level of past survey that has been conducted for it.

Habitat assessment in accordance with section 3 of the *Threatened species survey and assessment guidelines* (www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm) should also be undertaken. The habitat assessment should identify the types, locations and conditions of vegetation and key habitat features for both flora and fauna in the study area to assist with predicting the occurrence of threatened species in the study area and to guide the location for subsequent targeted surveys. DECC's Rapid *Fauna Habitat Assessment of the Sydney Metropolitan CMA Area* (DECC 2008, www.environment.nsw.gov.au/surveys/SMCMAFaunaAssessSydMetro.htm) may be of use.
Even if not intending to offset, use of the *Credit Calculator for Major Projects and BioBanking* (www.environment.nsw.gov.au/biobanking/calculator.htm) to predict species by vegetation type is also recommended to supplement the list of threatened species that possibly occur in the study area – see guidelines at www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm).

The SIS must include the compiled list of candidate threatened species, populations and ecological communities that were considered likely to be present in the locality.

[1] Contact the OEH Wildlife Data Unit to obtain a full Atlas report under licence for the locality around the study site. Note that the OEH Atlas only holds records for which the OEH is the custodian and does not include records held in other databases, where the conditions of data licences or data exchange agreements prevent the OEH from distributing such information. In many cases, the OEH Atlas may only contain a small subset of the available data. Hence, other databases must also be consulted to assist in making an adequate determination of subject species.

3.2 Identifying subject threatened species, populations and ecological communities

A list of subject threatened species, populations and ecological communities likely to be present in the study area (*the subject species*) must then be developed from recent records obtained from the data sources above, as well as any other species likely to be present that may not have been recorded. In developing the list of subject species, populations and ecological communities, consideration must be given to the habitat types present within the study area and the known distribution of threatened species, populations and ecological communities in the locality.

The following species, populations and ecological communities should be considered for inclusion in the list of subject threatened species, populations and ecological communities:

Threatened species:

Scientific name	Common name
Artamus cyanopterus cyanopterus	Dusky Woodswallow
Botaurus poiciloptilus	Australasian Bittern
Burhinus grallarius	Bush Stone-curlew
Callocephalon fimbriatum	Gang-gang Cockatoo
Calyptorhynchus lathami	Glossy Black-Cockatoo
Chalinolobus dwyeri	Large-eared Pied Bat
Chthonicola sagittata	Speckled Warbler
Circus assimilis	Spotted Harrier
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)
Daphoenositta chrysoptera	Varied Sittella
Falsistrellus tasmaniensis	Eastern False Pipistrelle
Glossopsitta pusilla	Little Lorikeet
Haliaeetus leucogaster	White-bellied Sea-Eagle
Hieraaetus morphnoides	Little Eagle
Lathamus discolor	Swift Parrot
Litoria aurea	Green and Golden Bell Frog
Lophoictinia isura	Square-tailed Kite
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)
Meridolum corneovirens	Cumberland Plain Land Snail
Miniopterus australis	Little Bentwing-bat
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat
Mormopterus norfolkensis	Eastern Freetail-bat
Myotis macropus	Southern Myotis
Neophema pulchella	Turquoise Parrot
Ninox strenua	Powerful Owl
Petaurus norfolcensis	Squirrel Glider
Petroica boodang	Scarlet Robin
Petroica phoenicea	Flame Robin
Phascogale tapoatafa	Brush-tailed Phascogale
Phascolarctos cinereus	Koala
Pteropus poliocephalus	Grey-headed Flying-fox
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat
Scoteanax rueppellii	Greater Broad-nosed Bat
Stagonopleura guttata	Diamond Firetail
Stictonetta naevosa	Freckled Duck

Tyto novaehollandiae	Masked Owl
Eucalyptus benthamii	Camden White Gum
Genoplesium baueri	Bauer's Midge Orchid
Gyrostemon thesioides	
Pimelea spicata	Spiked Rice-flower
Pomaderris brunnea	Brown Pomaderris
Pterostylis saxicola	Sydney Plains Greenhood
Pultenaea pedunculata	Matted Bush-pea
Thesium australe	Austral Toadflax

Endangered populations

Marsdenia viridiflora subsp. *viridiflora*	Marsdenia viridiflora R. Br. subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas

Endangered or critically endangered ecological communities

The following threatened ecological communities must be considered as subject threatened ecological communities:

- Cumberland Plain Woodland in the Sydney Basin Bioregion
- Elderslie Banksia Scrub Forest)
- Shale Sandstone Transition Forest in the Sydney Basin Bioregion
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Moist Shale Woodland in the Sydney Basin Bioregion
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Shale Gravel Transition Forest in the Sydney Basin Bioregion
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Sydney Freshwater Wetlands in the Sydney Basin Bioregion
- Sydney Turpentine-Ironbark Forest
- Western Sydney Dry Rainforest in the Sydney Basin Bioregion

Given the limitations of existing databases, these lists must not be taken to be exhaustive. One of the roles of the SIS is to determine which species may be utilising and/or be affected within the study area.

The proponent should also be aware that additional species, populations and ecological communities could be added to the schedules of the *Biodiversity Conservation Act 2016* (BC Act) between the issue of these requirements and the granting of consent. Any entities listed as 'critically endangered' or 'endangered'[2] in a final determination by the NSW Scientific Committee made after lodgement of an application for a development under Part 4 needs to be addressed in the SIS and considered by the consent or determining and concurrence authorities. Proponents are therefore advised to take note of preliminary determinations by the Scientific Committee. The NSW legislation website (www.legislation.nsw.gov.au/) provides the most up-to-date information on what is listed in the schedules of the BC Act.

[2] Species, populations or ecological communities listed after lodgement as 'vulnerable' are not subject to impact assessment so long as the application is determined within 12 months of lodgement (s.113C TSC Act, ss.105A and 110D EP&A Act).

4 SURVEY

4.1 Requirement to survey vegetation and ecological communities

4.1.1 General survey requirements

Vegetation and ecological communities must be surveyed, described (including documentation of the areal extent of each vegetation community) and accurately mapped. This should include areas with both introduced and native species, and areas with the potential to regenerate, either naturally or with assistance, to native vegetation.

Vegetation communities identified must be discussed in relation to:

- the plant community type (PCT) classification from the VIS Classification Database (www.environment.nsw.gov.au/research/Visclassification.htm)
- the descriptions of endangered or critically endangered ecological communities (EECs/CEECs), as determined by the Scientific Committee and any mapping of these EECs/CEECs in relevant reports
- condition and the potential of degraded areas to regenerate, either naturally or with assistance, to native vegetation, taking into account site disturbance history (*e.g.* fire, logging, grazing, hydrology) and environmental factors (*e.g.* flooding, drought, extreme heat or cold).

4.1.2 Additional survey requirements for specific ecological communities or vegetation types

Nil

4.2 Requirement to survey for species

4.2.1 General survey requirements for species

Targeted surveys for subject species and their habitats must be undertaken

- within the study area to provide information on distribution, population/sub-population sizes and density, and area of habitat (known and potential), noting variations across the study area.
- across the local extent of the population(s) to provide information on distribution, population/sub-population sizes, and area of habitat (known and potential).

This data is necessary to support the impact assessment requirements of section 5 and of the assessment of significance.

The techniques and timing of these surveys should be commensurate with the biology/ecology of these species and ecological communities in order to maximise the likelihood and accuracy of detection. Guidance on appropriate methodologies and level and timing of survey efforts can be obtained from OEH's website www.environment.nsw.gov.au/threatenedspecies/surveyassessmentgdlns.htm, including requirements for some groups of species detailed in

- the *Threatened species survey and assessment guidelines - field survey methods for fauna: amphibians* (2009)
- the *Guide to Surveying Threatened Plants* (2016), and
- section 3.1.19 and section 5 of OEH's *Threatened Species Survey and Assessment Guidelines* (draft, 2004, www.environment.nsw.gov.au/threatenedspecies/surveyassessmentgdlns.htm).

Environmental impact assessment guidelines and draft or approved recovery plans (see section 9.4) must also be consulted for specific survey requirements for species and ecological communities. Scientific or environmental management journals, biodiversity surveys and other sources. Additional specific survey requirements for certain species, populations and ecological communities are identified in section 4.3.

The key determinant for the level of survey effort required is the information required to identify the type of impacts and assess their significance on the local population(s) threatened species.

Any modifications to the recommended or required survey methods or levels of survey effort require justification of their adequacy. This justification should be scientifically valid and refer to relevant scientific literature. Previous surveys (yours or others) can contribute to fulfilling the requirements of section 4, but only if they have been conducted and documented in accordance with the provisions specified in that section, e.g. with respect to the type, location, duration, spacing/density, appropriate season and weather conditions, etc. of the surveys. Documentation and mapping of these attributes, as required by section 4.2, applies equally to any previous surveys used. The currency of any previous surveys used to fulfill these requirements is a matter that will need to be considered by the consent authority in determining the adequacy of the SIS.

Species of taxonomic uncertainty must have their identification confirmed by a recognised authority such as the Australian Museum or National Herbarium at the Royal Botanic Gardens, Sydney.

4.2.2 Additional survey requirements for specific species

Pimelea spicata

Pimelea spicata is cryptic and difficult to detect, particularly when not in flower, so surveys must be undertaken whilst the species is flowering. *Pimelea spicata* flowers sporadically throughout the year, so survey of other known sites nearby which support *P. spicata* should be used as an indicator of flowering time. Targeted survey should be undertaken using the random meander method, favouring suitable habitat areas (i.e. open areas) and survey effort should be at least one hour per hectare of suitable habitat.

4.3 Documentation

4.3.1 Description of survey techniques and survey locations

Survey technique(s) must be described and, where possible, a reference supporting the survey technique employed is to be provided.

The size, orientation and dimensions of quadrats or length of transects should be clearly documented for each type of survey technique undertaken. Full AMG grid references for the survey site(s) should be noted. Survey site(s) should be shown on a map or maps, which indicate scale and have an explanatory legend of any information showing symbols used.

4.3.2 Documenting survey effort and results

OEH has survey proformas for a range of standard fauna survey techniques. Digital copies of these proformas are available by electronic mail and should be obtained from the nominated contact officer. These proformas should be used by field staff when undertaking fauna surveys and completed data sheets are to be included as an appendix to the SIS.

Name(s) and contact phone number(s) of surveyor(s) and other personnel must be recorded. Other persons who identified records (e.g., by analysis of Anabat recordings, hair tubes, scats) should also be named.

The date and time and environmental conditions experienced during each survey must be documented.

The time invested for each survey technique must be summarised in the SIS, based on completed proformas, e.g. - number of person hours/transect, duration of call playback, number of nights traps

set. It is not sufficient to aggregate all time spent on all survey techniques. Effort must be expressed each time a survey technique is applied.

Any limitations (e.g. denied access to private land) to sampling across the study area are to be documented.

4.3.3 Description and mapping of results of vegetation, flora and fauna surveys

The locations of any newly recorded threatened species, endangered populations or endangered or ecological communities resulting from additional surveys must be mapped and described.

5 ASSESSMENT OF LIKELY IMPACTS ON THREATENED SPECIES AND POPULATIONS

Assessment of impacts must include the assessment of all components and associated actions, including but not restricted to construction, provision and ongoing maintenance of approved or proposed:

- buildings, bridges, walkways and other structures
- associated infrastructure such as for sewage, drainage, electricity, gas or water
- access routes
- drainage infrastructure and changes made to surface water flows
- bush fire hazard reduction and protection measures
- landscaping
- ongoing maintenance.

Assessment must consider the nature, extent, timing (including duration) and intensity of those components. Assessment must include the direct and indirect impacts of these activities which may occur either on or off the subject site. The impact on populations or habitats in any proximate reserved lands must be specifically discussed.

Among other possible causes, the impacts on threatened species and populations from the proposed development may arise from:

- direct injury and deaths of individual plants or fauna
- disturbances that affect breeding success and survival of fauna
- loss or modification causing decline in its quality and extent of habitat for plants and fauna through:
  - clearing
  - fragmentation and isolation
  - edge effects and
  - overshadowing
  - changes to the hydrological regime resulting from altered surface and subterranean flows and groundwater levels
  - increased susceptibility to competition, disease, predation, insect attack and other disturbances due to increased access and a reduction in vegetative cover;
  - deterioration in water quality
  - weed invasion
- indirect effects of ongoing and increased human use of the new infrastructure (e.g. rubbish, vegetation and soil damage.

5.1 Assessment of species likely to be affected

The following are further requirements related to your obligation under Section 110(2)(b) to address the following:

an assessment of which threatened species or population known or likely to be present in the area are likely to be affected by the action.

This requires you to refine the list of subject threatened species and populations (given the outcome of survey and analysis of likely impacts) in order to identify which threatened species or endangered populations may be affected directly or indirectly (including cumulatively), by the proposal. This is to be done taking account of the requirements outlined previously in section 4 above and information in any relevant Scientific Committee determinations, OEH threatened species profiles, recovery plans and draft recovery plans, and vegetation assessment and mapping. Detailed rationale should be provided to demonstrate how the list was derived. If adequate surveys/studies have been undertaken to categorically demonstrate the species does not occur in the study area, or if not resident, will not utilise habitats on site on occasion, or if off-site, be influenced by off-site impacts of the activity, that species does not have to be considered further. Otherwise all species/populations likely to occur in the study area (based on general species distribution information), and known to utilise those habitat types, should be assessed as if present.

The requirements in the remainder of this section need only be addressed for those species that are likely to be affected by the proposal. Subsequently this information should be used in an assessment of significance (as required in section 8) for each of those species or populations.

5.2 Discussion of local and regional abundance and distribution

The following are further requirements related to your obligation under Section 110(2)(d) to address the following:

an estimate for the local and regional abundance of those species or populations

5.2.1 Discussion of regional occurrences and the local population

A discussion of the occurrences of each threatened species or endangered population in the region must be provided and include:

- which occurrences are considered to constitute part of the *local population* and why
- an estimate of the number of individuals of each species in the region, and a comparison of the part of the local population utilising the study area to those outside
- the relative significance of the subject site for each species or population in the *locality* and in the region.

5.3 Assessment of habitat

The following are further requirements related to your obligation under Section 110(2)(f) to address the following:

a full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region.

5.3.1 Description of habitat values

Different types of habitats (e.g. breeding, sheltering, foraging) must be distinguished.

Specific habitat features (frequency and location of stags, hollow bearing trees, culverts, rock shelters, rock outcrops, crevices, caves, drainage lines, soaks, etc.) and the density of understorey vegetation and groundcover must be described in relation to the habitat needs of each species.

The quality and conditions of habitats within the study area for the species must be discussed, and must include:

- remnant sizes, shape, area to perimeter ratio, and connectivity
- species abundances
- disturbances, including:
  - fire (including details of fire history (e.g. frequency, time since last fire, intensity) and the source of such information (e.g. observation, local records), must be provided.
  - weed types and abundances/cover in each vegetation community,
  - trampling or grazing
  - erosion
  - rubbish dumping
  - proximity to disturbances.

5.3.2 Discussion of habitat utilisation

A discussion of how individuals use the area (e.g. residents, transients, adults, juveniles, nesting, foraging) and discussion of the significance of the habitat of the study area to the viability of the threatened species or endangered population *in the locality* must be included.

5.4 Discussion of conservation status

The following are further requirements related to your obligation under Section 110(2)(c) to address the following:

for each species or population likely to be affected, details of its local, regional and State-wide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or threat abatement plan applying to it

and to your obligation under Section 110(2)(e) to address the following:

an assessment of whether those species or populations are adequately represented in conservation reserves (or other similar protected areas) in the region

and to your obligation under Section 110(2)(e1) to address the following:

an assessment of whether any of those species or populations is at the limit of its known distribution

The relative significance of the study area for the threatened species or endangered population must be discussed. Such an assessment must consider and compare the differences in the type, quality, and long-term security with other occurrences and their habitats elsewhere in the *locality* and the region.

The assessment should document and consider other now-extinct or diminished populations of each threatened species or endangered population in the locality and region and the fragmentation, decrease in extent or degradation of their habitats.

5.5 Discussion of the likely effect of the proposal at local and regional scales

The following are further requirements related to your obligation under Section 110(2)(g) to address the following:

a full assessment of the likely effect of the action on those species and populations, including, if possible, the quantitative effect of local populations in the cumulative effect in the region

5.5.1 Significance within a local context

Provision of information to allow adequate determination of the significance of the effect of the proposal in accordance with Section 5A of the EP&A Act (see section 8 of these requirements below) is required. For each affected threatened species or endangered population the impacts of the proposal on that part of the *local population* within the study area must be considered in determining the significance of effect on the *local population* and this must take into account the differences between the type, condition and long-term security of local populations and habitats within the study area to those elsewhere within the *locality*.

5.5.2 Extent of habitat removal or modification

The assessment must consider the location, nature, extent and proportion of removal and modification of habitat of the *local population* and the effects of this on its viability. Consideration must include the cumulative impacts which will or may result from the proposal or any other approved or identified developments, activities or actions.

5.5.3 Discussion of connectivity

The impact of the proposal on connectivity must also be discussed. This must include examination of the potential of the proposal to:

- increase fragmentation
- reduce remnant size of the habitat
- decrease the ability for movement of individuals and/or gene flow between habitats or within the local population (or sub-populations) or between the local population and other populations.

5.5.4 Consideration of threatening processes

Assessment of effects must not be limited only to threats that are recognised as key threatening processes, but must include other threatening processes that are generally accepted by the scientific community as affecting the species or population and are likely to be caused or exacerbated by the proposal.

5.6 Description of feasible alternatives

The following are further requirements related to your obligation under Section 110(2)(h) to address the following:

> *a description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development.*

The SIS must demonstrate what alternatives have been considered and purposeful efforts made to purposefully avoid and minimise the impacts on a local occurrence of any threatened species, population or ecological community to ensure that it remains viable in the long term.

The SIS must include details of the condition and use of other parts of the subject area and why these can or cannot be considered as feasible alternatives.

Where a Statement of Environmental Effects, Environmental Impact Statement or Review of Environmental Factors deals with these matters, the SIS may refer to the relevant section of the SEE, EIS or REF, as long as the document referred to is provided with the SIS.

6 ASSESSMENT OF LIKELY IMPACTS ON ENDANGERED ECOLOGICAL COMMUNITIES

Assessment of impacts must include the assessment of all components and associated actions, including but not restricted to construction, provision and ongoing maintenance of approved or proposed:

- buildings, bridges, walkways and other structures
- associated infrastructure such as for sewage, drainage, electricity, gas or water
- routes for access and egress
- drainage infrastructure and changes made to surface water flows
- bush fire hazard reduction and protection measures
- landscaping
- ongoing maintenance.

Assessment must consider the nature, extent, timing (including duration) and intensity of those components. Assessment must include the **direct and indirect** impacts of these activities which may occur either on or **off** the subject site. The impact on populations or habitats in any proximate reserved lands must be specifically discussed.
Among other possible causes, the impacts on threatened species and populations from the proposed development may arise from:

- direct injury and deaths of individual plants or fauna that form part of an ecological community and its habitat
- loss or modification causing decline in its quality and extent of habitat for an ecological community through:
  - clearing and other disturbances
  - fragmentation and isolation
  - edge effects
  - overshadowing
  - changes to the hydrological regime resulting from altered surface and subterranean flows and groundwater levels
  - increased susceptibility to competition, disease, predation, insect attack and other disturbances due to increased access and a reduction in vegetative cover;
  - deterioration in water quality
  - weed invasion
- indirect effects of ongoing and increased human use of the new infrastructure (e.g. rubbish, vegetation, soil damage, disturbances).

6.1 Assessment of endangered ecological communities likely to be affected

The following are further requirements related to your obligation under Section 110(3)(a) to address the following:

a general description of the ecological community present in the area that is the subject of the action and in any area that is likely to be affected by the action.

This requires you to refine the list of subject ecological communities (given the outcome of survey and analysis of likely impacts) in order to identify which EECs/CEECs may be affected, directly or indirectly (including cumulatively), by the proposal. This must include reference to the EECs/CEECs as described by the NSW Scientific Committee, and to the requirements outlined previously in section 4, and take into account information in any relevant recovery plans or draft recovery plans and vegetation assessment and mapping. Adequate rationale should be provided to demonstrate how the list was derived. If adequate surveys/studies have been undertaken to categorically demonstrate the (C)EEC does not occur in the study area, or will not utilise habitats on site, or if off-site, be influenced by off-site impacts of the activity, that (C)EEC does not have to be considered further. Otherwise all EECs/CEECs likely to occur in the study area (based on general distribution information), and known to occupy those habitat types, should be assessed as if present.

The requirements in the remainder of this section need only be addressed for those EECs/CEECs that are likely to be affected by the proposal. Subsequently this information should be utilised in an Assessment of Significance (as required in section 8) for each of those EECs/CEECs.

6.2 Description of habitat

The following are further requirements related to your obligation under Section 110(3)(c) to address the following:

a full description of the type, location, size and condition of the habitat of the ecological community and details of the distribution and condition of similar habitats in the region.

6.2.1 Description of ecological community and habitat

Descriptions of occurrences of each EEC/CEEC is required and must include:

- a description of each EEC/CEEC, including:
  - comparison of the affected community with the EECs/CEECs as determined by the NSW Scientific Committee
  - reference to any relevant available recovery plans or draft recovery plans and vegetation assessment and mapping
  - maps, consistent with the descriptions provided, showing the extent and condition of the EEC/CEEC.
- location and distribution, remnant sizes, shape, area to perimeter ratio, and connectivity
- condition compared to benchmarks
- those areas where the community may only be represented by soil stored seed with no or few above-ground components
- details of disturbances, including:
  - fire (including details of fire history (e.g. frequency, time since last fire, intensity) and the source of such information (e.g. observation, local records), must be provided.
  - weed types and abundances/cover in each vegetation community,
  - trampling or grazing
  - erosion
  - rubbish dumping
  - proximity to disturbances.
- If the site shows signs of disturbance, details should be provided of the capacity of the EEC/CEEC to recover. This assessment will include consideration of the site's in-situ and migratory resilience and is to be accompanied by a map of the recovery capacity of the EECs/CEECs across the site. When assessing its recovery capacity consideration should be given to the results (preliminary or otherwise) of restoration projects being undertaken at other sites that contain the EECs/CEECs.

6.2.2 Discussion of regional occurrences and the local occurrence

A discussion of the occurrences of each EEC/CEEC in the region must be provided and include:

- which occurrences are considered to constitute part of the *local occurrence* and why
- the area of each EEC/CEEC in the region, and a comparison of the part of the local occurrence within the study area to that outside
- the relative significance of the subject site for each EEC/CEEC in the *locality* and in the region.

6.3 Discussion of conservation status

The following are further requirements related to your obligation under Section 110(3)(b) to address the following:

for each ecological community present, details of its local, regional and State-wide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or any threat abatement plan applying to it.

The following are further requirements related to your obligation under Section 110(3)(b1) to address the following:

an assessment of whether those ecological communities are adequately represented in conservation reserves (or other similar protected areas) in the region.

The following are further requirements related to your obligation under Section 110(3)(b2) to address the following:

an assessment of whether any of those ecological communities is at the limit of its known distribution.

The relative significance of the subject site for each EEC/CEEC in the locality must be discussed. Such an assessment must consider and compare the differences in the type, extent, quality and long-term security with other known occurrences and habitats in the *locality* with those in the study area.

The assessment should document and consider other now-extinct or diminished populations of each EEC/CEEC in the locality and region and the fragmentation, decrease in extent or degradation of their habitats.

6.4 Discussion of the likely effect of the proposal at local and regional scales

The following are further requirements related to your obligation under Section 110(2)(g) to address the following:

a full assessment of the likely effect of the action on those species and populations, including, if possible, the quantitative effect of local populations in the cumulative effect in the region.

6.4.1 Significance within a local context

Provision of information to allow adequate determination of the significance of the effect of the proposal in accordance with Section 5A of the EP&A Act (see section 8 of these requirements below) is required. For each affected EEC/CEEC the impacts of the proposal on that part of the *local occurrence* within the study area must be considered in determining the significance of effect on the *local occurrence* and this must take into account the differences between the type, size, connectivity, condition and long-term security of local occurrences within the study area to those elsewhere in the *locality*.

6.4.2 Extent of habitat removal or modification

The assessment must consider the location, nature, extent and proportion of removal and modification of habitat of the *local occurrence* and the effects of this on its viability. Consideration must include the cumulative impacts which will or may result from the proposal or any other approved or identified developments, activities or actions.

6.4.3 Discussion of connectivity

The impact of the proposal on connectivity must also be discussed. This must include examination of the potential of the proposal to:

- increase fragmentation of an EEC/CEEC or fragment it from other native vegetation
- reduce remnant size
- exacerbate edge effects
- decrease the ability for movement of individual components (organisms) of the EEC/CEEC and/or decrease gene flow between occurrences or habitats (including potential habitats) of the EEC/CEEC.

6.4.4 Consideration of threatening processes

Assessment of effects must not be limited to threats that are recognised as key threatening processes, but must include threatening processes that are generally accepted by the scientific community as affecting the EEC/CEEC and are likely to be caused or exacerbated by the proposal.

6.5 Description of feasible alternatives

The following are further requirements related to your obligation under Section 110(3)(e) to address the following:

a description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development.

The SIS must demonstrate what alternatives have been considered and efforts made to purposefully avoid and minimise the impacts on a local occurrence of any threatened species, population or ecological community to ensure that it remains viable in the long term.

The SIS must include details of the condition and use of other parts of the subject area and why these can or cannot be considered as feasible alternatives.

Where a Statement of Environmental Effects, Environmental Impact Statement or Review of Environmental Factors deals with these matters, the SIS may refer to the relevant section of the SEE, EIS or REF as long as the document referred to is provided with the SIS.

7 AMELIORATIVE MEASURES

7.1 Description of ameliorative measures

The following are further requirements related to your obligation under Sections 110(2)(i) and 110(3)(f) to address the following:

a full description and justification of the measures proposed to mitigate any adverse effect of the action on the species and populations [s.110(2)(i)] [or] ecological community [s.110(3)(f)] including a compilation (in a single section of the statement) of those measures.

The SIS must next consider measures to minimise or mitigate those impacts that remain unavoided, with the purpose of ensuring that that the local occurrence of any threatened species, population or ecological community continues to remain viable in the long term.

The proponent should be aware that any measures proposed in the SIS as reducing the level of impact may be formalised into the conditions of consent or approval for the proposal. Consequently, such measures should only be considered where they are practical and realistic, can be shown to have been successful in a similar situation elsewhere, and will be funded. The likely efficacy of such measures with respect to the current proposal must be assessed in detail.

7.1.1 Long term management strategies

Consideration must be given to developing long term management strategies to protect areas within the study area which are of particular importance for the threatened species or endangered populations likely to be affected. This may include proposals to restore or improve habitat on site where possible.

7.1.2 Compensatory measures

Where significant modification of the proposal to minimise impacts on threatened species or endangered communities is not possible then compensatory measures should be considered. These may include other off-site or local area proposals that contribute to long term conservation of the threatened species, population or ecological community. Compensatory measures are not considered to reduce the impact of effect of the proposal.

The proponent should be aware that any compensatory measures proposed may be formalised into the conditions of consent or approval for the proposal. Consequently, such measures should only be considered where they are practical and realistic, can be shown to have been successful in a similar situation elsewhere, and will be funded. The likely efficacy of such measures with respect to the current proposal, along with a discussion of mechanisms of how they be achieved and secured, must be assessed in detail.

Any proposed offsetting measures should be developed in accordance with the "*OEH Principles for the Use of Biodiversity Offsets in NSW*" (http://www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.htm) . The Biodiversity Assessment Method (http://www.environment.nsw.gov.au/resources/bcact/biodiversity-assessment-method-170206.pdf) could also be used to assess the adequacy of any proposed offsetting measures.

Where such proposals involve land under third party ownership or depend on the involvement of other parties, e.g. community groups, they should contain evidence of consultation with and support from such stakeholders.

7.1.3 Ongoing monitoring

Any proposed pre-construction monitoring plans or on-going monitoring of the effectiveness of the mitigation measures must be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency. Generally, ameliorative strategies which have not been proved effective should be undertaken under experimental design conditions and appropriately monitored.

7.1.4 Translocation

The OEH does not consider that translocation of threatened species, populations and ecological communities is an appropriate ameliorative strategy for the purposes of considering impacts of a particular development/activity. OEH strongly supports the view that development proposals which may have significant impact on a local occurrence of threatened species, populations or ecological communities, as determined by the SIS, should aim to ensure that the local occurrence continues to persist and remain viable in the long term *in situ*. The translocation of threatened species, populations and ecological communities is only supported by the OEH in specific conservation programs (e.g. recovery planning) and as a last resort, and only when *in situ* conservation options have been exhausted. Such programs should only be considered following extensive investigation of a demonstrated long-term financial commitment on behalf of the applicant.

8 ASSESSMENT OF SIGNIFICANCE OF LIKELY EFFECT OF PROPOSED ACTION

Based on the detailed SIS assessment and its consideration of alternatives and/or ameliorative measures (but not including compensatory), a re-assessment of the significance of impact (section 5A EP&A Act) is to be carried out for each of the threatened species, populations and ecological communities that are identified in the SIS as being likely to be affected. This assessment must be carried out in accordance with the *Threatened species assessment guidelines: the assessment of significance* (DECCW 2007, www.environment.nsw.gov.au/threatenedspecies/tsaguide.htm) and must incorporate the relevant information from sections 5.1 to 7.1.1 of these SIS requirements. For each

entity an overall conclusion must be drawn as to whether the proposal is still considered likely to have a significant effect.

9 ADDITIONAL INFORMATION

9.1 Qualifications and experience

The following is your obligation under Sections *110(4)* to address the following:

a species impact statement must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement

9.2 Other approvals required for the development or activity

The following are further requirements related to your obligation under Sections *110(2)(j) and 110(3)(g))* to address the following:

a list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population or ecological community

Other approvals under NSW law

In providing a list of other approvals the following must be included:

- where a consent is required under Part 4 of the *Environmental Planning and Assessment Act 1979*, the name of the consent authority and the timing of the development application should be included; or
- where an approval(s) is required under Part 5 of the *Environmental Planning and Assessment Act 1979*, the name of the determining authority(ies), the basis for the approval and when these approvals are proposed to be obtained should be included.

Approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

An action will require referral to, and may require the approval of, the Commonwealth Minister for the Environment (in addition to any local or state government consent or approval) if that action will have, or is likely to have, a significant impact on the environment or on a matter of National Environmental Significance (NES). Threatened species and communities listed in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are considered to be matters of national environmental significance, as are migratory species and a number of other matters. Information regarding NES matters may be obtained from the website of the Commonwealth Department of the Environment www.environment.gov.au/epbc or by contacting that department on 1800 803 772.

9.3 Licensing matters relating to conducting surveys

Persons conducting flora and fauna surveys must have appropriate licences or approvals under relevant legislation. The relevant legislation and associated licences and approvals that may be required are listed below:

Biodiversity Conservation Act 2016:

- Scientific Licence to authorise the carrying out of actions for scientific, educational or conservation purposes.
  http://www.environment.nsw.gov.au/wildlifelicences/scientificresearchlicences.htm

Animal Research Act 1985:

- Animal Research Authority to undertake fauna surveys.

9.4 Section 110 (5) reports

Section 110(5) of the Threatened Species Conservation Act 1995 has the effect of requiring OEH to provide any information regarding the State-wide conservation status of the subject species as it has available, in order to satisfy ss.110(2) & (3) of the Act. To this end, OEH has published profiles for threatened species, populations and ecological communities on the OEH website (www.environment.nsw.gov.au/threatenedSpeciesApp/). These profiles also include links to NSW Scientific Committee determinations, NSW recovery plans, environmental impact assessment guidelines and other resources. Some of these may be relevant to the subject species for this development proposal.

Proponents and consultants should note that OEH has no further published information available to satisfy s.110(5) of the Act and that use of the above profiles and linked information can be taken to have satisfied the requirements of ss.110(2) & (3) in relation to the State-wide conservation status of the listed species, populations and ecological communities.

APPENDIX B :
Likelihood of Occurrence Tables

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Threatened ecological communities likely of occurrence within the subject site

Community Name	TSC Act Status	EPBC Act Status	Source	Likelihood of Occurrence	Subject Ecological Community	Affected Ecological Community
Cumberland Plain Woodland in the Sydney Basin Bioregion	CEEC	CEEC	CER, OEH	Present	Yes	Yes
Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion	CEEC	-	CER, OEH	Present	Yes	Yes
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC	-	CER, OEH	Present	Yes	Yes
Moist Shale Woodland in the Sydney Basin Bioregion	EEC	CEEC	CER, OEH	Unlikely. Not recorded during surveys.	Yes	No
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC	-	CER, OEH	Present	Yes	Yes
Shale Gravel Transition Forest in the Sydney Basin Bioregion	EEC	CEEC	CER	Unlikely. Not recorded during surveys.	Yes	No
Shale Sandstone Transition Forest in the Sydney Basin Bioregion	CEEC	CEEC	CER, OEH	Unlikely. Not recorded during surveys.	Yes	No

Community Name	TSC Act Status	EPBC Act Status	Source	Likelihood of Occurrence	Subject Ecological Community	Affected Ecological Community
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC	EEC	CER, OEH	Present	Yes	Yes
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	EEC	-	CER	Unlikely. Not recorded during surveys.	Yes	No
Sydney Turpentine-Ironbark Forest	EEC	CEEC	CER	Unlikely. Not recorded during surveys.	Yes	No
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	EEC	CEEC	CER	Unlikely. Not recorded during surveys.	Yes	No

TSC Act/EPBC Act Status Key: EEC=endangered ecological community, CEEC=critically endangered ecological community

Source Key: CER=chief executive requirement, OEH=atlas of NSW wildlife

Threatened flora likelihood of occurrence within the subject site

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Apocynaceae	*Acacia bynoeana*	Bynoe's Wattle	E	V	PMST, BioB	Found in heath and woodland on sandy soils. Prefers open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include *Corymbia maculata* (Red Bloodwood), *Eucalyptus haemastoma* (Scribbly Gum), *Eucalyptus parramattensis* (Parramatta Red Gum), *Banksia serrata* (Saw Banksia) and *Angophora bakeri* (Narrow-leaved Apple).	Unlikely. No records from the locality and no suitable habitat is present.
Apocynaceae	*Cynanchum elegans*	White-flowered Wax Plant	E	E	PMST, BioB	Usually associated with dry rainforest vegetation and in coastal communities. Can occur in clay influenced woodland associated with *Eucalyptus tereticornis* and *Corymbia maculata*.	Unlikely. Only one record from the locality and minimal suitable habitat is present. Species was not recorded during surveys.
Apocynaceae	*Marsdenia viridiflora subsp. viridiflora*	*Marsdenia viridiflora* R. Br. subsp. *viridiflora* population in the Bankstown, Blacktown, Camden,	E	-	BioB, CER	Found in open shale woodland in vine thickets.	Unlikely. Low number of records from the locality and no suitable habitat is present.

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
		Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas					
Campanulaceae	*Wahlenbergia multicaulis - endangered population*	*Wahlenbergia multicaulis* (Tadgells Bluebell) population, Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield local government areas	E	-	BioB	Found in a variety of habitats including forest, woodland, scrub, grassland and the edges of watercourses and wetlands in disturbed areas. Within Western Sydney, the species is closely aligned with the Villawood Soil Series, which is a poorly drained, yellow podsolic extensively permeated with fine, concretionary ironstone (laterite).	Unlikely. No records from the locality and no suitable habitat is present.
Casuarinaceae	*Acacia pubescens*	Downy Wattle	V	V	PMST	Occurs on alluviums, shales and at the intergrade between shales and sandstones. Occur in open woodland and forest, including Cooks River/Castlereagh Ironbark Forest,	Unlikely. No records from the locality and no suitable habitat is present.

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						Shale/Gravel Transition Forest and Cumberland Plain Woodland.	
Casuarinaceae	*Allocasuarina glareicola*		E	E	PMST, BioB	Grows in Castlereagh woodland on lateritic soil with *Eucalyptus parramattensis, Eucalyptus fibrosa, Angophora bakeri*, *Eucalyptus sclerophylla* and *Melaleuca decora*. Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool.	Unlikely. No records from the locality and no suitable habitat is present.
Dilleniaceae	*Hibbertia sp. Bankstown*		CE	CE	BioB	Occurs as one population at Bankstown Airport, within very modified habitat on sandy alluvium soil with a high content of silt.	Unlikely. No records from the locality and no suitable habitat is present. Species only known from one population in Bankstown.
Fabaceae (Faboideae)	*Cryptostylis hunteriana*	Leafless Tongue-orchid	V	V	PMST	Occur in a wide variety of habitats including heathlands, heathy woodlands, sedgelands, *Xanthorrhoea* spp. plains, dry sclerophyll forests (shrub/grass sub-formation and shrubby sub-formation), forested wetlands, freshwater wetlands, grasslands, grassy woodlands, rainforests and wet sclerophyll forests. Soils are generally considered to be	Unlikely. No records from the locality and no suitable habitat is present.

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						moist and sandy, however, this species is also known to grow in dry or peaty soils. Is associated with the community Bloodwood / Scribbly Gum / Silver-top Ash Forest on the South Coast. Species is known to have occurrence associated with other *Cryptostylis* species. Flowering occurs generally from November to February.	
Fabaceae (Faboideae)	*Dillwynia tenuifolia (a shrub) population, Kemps Creek*		V	-	BioB	Occurs within an area bound by Western Road, Elizabeth Drive, Devonshire Road and Cross Street, Kemps Creek in the Liverpool Local Government Area.	Unlikely. No records from the locality and no suitable habitat is present. Study area is not located within the Liverpool LGA
Fabaceae (Faboideae)	*Dillwynia tenuifolia*		V	-	BioB	Locally abundant particularly within scrubby/dry heath areas 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. Typically *Eucalyptus fibrosa* is the dominant canopy species where *Dillwynia tenuifolia* occurs.	Unlikely. No records from the locality and no suitable habitat is present.

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Fabaceae (Faboideae)	*Pultenaea parviflora*		E	V	BioB	Endemic to the Cumberland Plain. Core distribution is from Windsor to Penrith and east to Dean Park. Found in scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays and in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland.	Unlikely. No records from the locality and no suitable habitat is present.
Fabaceae (Faboideae)	*Pultenaea pedunculata*	Matted Bush-pea	E	-	OEH, BioB, CER	Species is restricted to the Woronora Plateau and occurs in dry sclerophyll woodland or wet heath on sandstone.	Unlikely. Low number of records from the locality and no suitable habitat is present.
Gyrostemonaceae	*Gyrostemon thesioides*		E	-	CER	Found on hillsides and riverbanks and may be restricted to fine sandy soils.	Unlikely. No records from the locality and no suitable habitat is present.
Malvaceae	*Commersonia prostrata*	Dwarf Kerrawang	E	E	BioB	Grows in a variety of habitats on sandy, as well as peaty soils mainly within gullies.	Unlikely. No records from the locality and no suitable habitat is present.
Marsileaceae	*Pilularia novae-hollandiae*	Austral Pillwort	E	-	BioB	Found in shallow swamps and waterways, usually growing among sedges and grasses.	Unlikely. No records from the locality and no suitable habitat is present.
Myrtaceae	*Eucalyptus benthamii*	Camden White Gum	V	V	OEH, PMST,	Occurs on the alluvial flats of the Nepean River and its tributaries. Requires deep alluvial sands and a	Unlikely. High number of records from the locality, but species was not recorded during surveys. If

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
					BioB, CER	flooding regime that permits seedling establishment.	present, would likely be within areas along the Nepean River outside of the subject site.
Myrtaceae	*Genoplesium baueri*	Yellow Gnat-orchid	E	E	PMST, CER	Grows in dry sclerophyll forest and moss gardens over sandstone.	Unlikely. No records from the locality and no suitable habitat is present.
Myrtaceae	*Haloragis exalata subsp. exalata*	Wingless Raspwort	V	V	PMST, BioB	Species requires protected and shaded damp situations in riparian habitats.	Unlikely. No records from the locality and no suitable habitat is present.
Myrtaceae	*Micromyrtus minutiflora*		E	V	BioB	Grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, open forest on tertiary alluvium and consolidated river sediments.	Unlikely. No records from the locality and no suitable habitat is present.
Orchidaceae	*Thelymitra kangaloonica*	Kangaloon Sun Orchid	CE	CE	PMST	Species is only known to occur on the southern tablelands of NSW in the Moss Vale / Kangaloon / Fitzroy Falls area at 550-700 m above sea level. It is found in swamps and in sedgelands over grey silty grey loam soils. It is thought to be a short-lived perennial, flowering in late October and early November.	Unlikely. No records from the locality and no suitable habitat is present.

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Poaceae	*Pelargonium sp. striatellum (G.W.Carr 10345)*	Omeo Stork's-bill	E	E	PMST	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.	Unlikely. No records from the locality and no suitable habitat is present.
Polygonaceae	*Persicaria elatior*	Tall Knotweed	V	V	BioB	Found in damp places, especially beside streams and lakes	Unlikely. No records from the locality and species was not recorded during surveys. Potential habitat is present within riparian areas outside of the subject site.
Proteaceae	*Grevillea juniperina subsp. juniperina*	Juniper-leaved Grevillea	V	-	BioB	Found in Cumberland Plain Woodland and Castlereagh Woodland often in small populations on road verges. Grows on reddish clay to sandy soils typically containing lateritic gravels.	Unlikely. No records from the locality and although marginal suitable habitat is present the species has not been recorded during surveys.
Proteaceae	*Grevillea parviflora subsp. parviflora*	Small-flower Grevillea	V	V	OEH, PMST	Grows in light sandy or clay soils over thin shales, often with lateritic ironstone gravels and nodules. Is known to occur in Shale/Sandstone Transition Forest.	Unlikely. Low number of records from the locality and no suitable habitat is present.
Proteaceae	*Persoonia bargoensis*	Bargo Geebung	E	V	BioB	Species is restricted to the western edge of the Woronora Plateau and the northern edge of the Southern	Unlikely. No records from the locality and no suitable habitat is present.

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						Highlands. Occurs in woodland or dry sclerophyll forest on sandstone and on heavy, well drained, loamy, gravelly soils of the Wianamatta Shale and Hawkesbury Sandstone.	
Proteaceae	*Persoonia nutans*	Nodding Geebung	E	E	BioB	Northern populations are confined to aeolian and alluvial sediments and occur in a range of sclerophyll forest and woodland vegetation communities, with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland and some in Cooks River / Castlereagh Ironbark Forests. Southern populations also occupy tertiary alluvium, but extend onto shale sandstone transition communities and into Cooks River / Castlereagh Ironbark Forest.	Unlikely. No records from the locality and no suitable habitat is present.
Rhamnaceae	*Pomaderris brunnea*	Brown Pomaderris	E	V	OEH, PMST, BioB, CER	Species is only known from one site at Sublime Point, north of Wollongong. Occurrence is on a sandy loam over sandstone associated with *Eucalyptus sieberi* (Silver-top Ash) - *Corymbia gummifera* (Red Bloodwood) forest	Unlikely. High number of records from the locality, including one record from the study area. Species was not recorded during surveys and is unlikely to occur within the subject site.

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						with occasional *Hakea salicifolia* (Willow-leaved Hakea).	
Rhamnaceae	*Pterostylis saxicola*	Sydney Plains Greenhood	E	E	OEH, PMST, BioB, CER	The species occurs in small pockets of shallow soil in flat areas on top of sandstone rock shelves above cliff lines, or on mossy rocks in gullies. Sclerophyll forest/woodland often occurs growing above where the species occurs, on shale or shale/sandstone transition soils. Flowering time is from October to December. It is currently only known to occur at five locations within western Sydney: Georges River National Park, close to Yeramba Lagoon, Peter Meadows Creek, and St Marys Towers.	Unlikely. High number of records from the locality, but no suitable habitat is present.
Santalaceae	*Thesium australe*	Austral Toadflax	V	V	PMST, CER	Found in very small populations scattered across eastern NSW. Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass (*Themeda australis*).	Unlikely. No records from the locality and no suitable habitat is present.
Thymelaeaceae	*Pimelea spicata*	Spiked Rice-flower	E	E	OEH, PMST,	On the Cumberland Plain sites it is associated with Grey Box communities	Unlikely. Although a very high number of records from the

Family Name	*Scientific Name*	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
					BioB, CER	(particularly Cumberland Plain Woodland variants and Moist Shale Woodland) and in areas of ironbark. In the coastal Illawarra it occurs commonly in Coast Banksia open woodland with a better developed shrub and grass understorey. Coastal headlands and hilltops are the favoured sites.	locality, no individuals have been recorded within the study area during targeted surveys.
Zannichelliaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	E	V	PMST	On south coast of NSW occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	Unlikely. No records from the locality and no suitable habitat is present.

Key: V=vulnerable, E=endangered, CE=critically endangered

Source Key: CER=chief executive requirement, OEH=atlas of NSW wildlife, PMST=protected matters search tool, BioB=BioBanking calculator

Threatened fauna likelihood of occurrence within the subject site

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Actinopteri	*Macquaria australasica*	Macquarie Perch	-	E	PMST	Species occurs in the Murray-Darling Basin and parts of south-eastern coastal NSW, including the Hawkesbury/Nepean catchment.	Unlikely. No records from the locality and subject site lacks suitable habitat.
Actinopteri	*Prototroctes maraena*	Australian Grayling	-	V	PMST	Species occurs in coastal streams and rivers on the eastern and southeastern flanks of the Great Dividing Range.	Unlikely. No records from the locality and subject site lacks suitable habitat.
Amphibia	*Heleioporus australiacus*	Giant Burrowing Frog	V	V	PMST, BioB	Occurs in heath, woodland and open dry sclerophyll forest on a variety of soil types. Breeding habitat for this species usually contains soaks or pools within first of second order streams.	Unlikely. No records from the locality and subject site offers only small areas of potential habitat.
Amphibia	*Litoria aurea*	Green and Golden Bell Frog	E	V	OEH, BioB, CER	The species is found in a wide range of water bodies except fast moving streams. It commonly inhabits disturbed sites such abandoned quarries and mines, though generally breeds in habitats that include still, shallow, unpolluted water bodies, that are unshaded, contain aquatic plants are free of Mosquito fish and other predators, with a range of diurnal shelter sites (emergent aquatic vegetation).	Unlikely. No suitable habitat is present within the subject site.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Amphibia	*Litoria raniformis*	Growling Grass Frog	E	V	PMST	Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. Also occur in irrigated rice crops.	Unlikely. No records from the locality and the subject site lacks preferred habitat.
Aves	*Anthochaera phrygia*	Regent Honeyeater	E	CE	OEH, BioB	Inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes.	Unlikely. Only one record from the locality with the latest record occurring in 1984. The subject site lacks preferred habitat.
Aves	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	V	-	OEH, CER	This species is considered to be a woodland dependent bird, but is found in a variety of habitats. The species is most commonly found in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, and in shrubland and heathlands.	Potential. Species was recorded in the study area and suitable habitat is present.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Aves	*Botaurus poiciloptilus*	Australasian Bittern	E	E	PMST, CER	Occurs in freshwater wetlands, and more rarely, estuarine wetlands. It favours wetlands with tall, dense vegetation, and forages in shallow water up to a depth of 0.3m. It nests in deep vegetative cover over shallow pools.	Unlikely. No records from the locality and the subject site lacks preferred habitat.
Aves	*Burhinus grallarius*	Bush Stone-curlew	E	-	CER, BioB	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.	Unlikely. No records from the locality and the subject site contains only small area of potential habitat for the species.
Aves	*Calidris acuminata*	Sharp-tailed Sandpiper	-	Mig.	OEH	Species prefers muddy edges of shallow fresh or brackish wetlands with inundated or low vegetation. Known to occur lagoons, swamps, lakes, dams, and other waterbodies. Roosts at the edges of wetlands.	Unlikely. Only one record from the locality and the subject site lacks preferred habitat.
Aves	*Calidris canutus*	Red Knot	-	Mig.	OEH	Found on the coast in sandy estuaries with tidal mudflats.	Unlikely. Moderate number of records from the locality but the subject site lacks preferred habitat.
Aves	*Calidris ferruginea*	Curlew Sandpiper	E	CE	PMST	The Curlew Sandpiper is found in coastal areas with intertidal mudflats, including estuaries, inlets and lagoons,	Unlikely. No records from the locality and the subject site lacks suitable habitat.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						and ponds in saltworks. The species have also occasionally been recorded inland around lakes, dams and waterholes with mud or sand present. Main requirements for feeding habitats are the presence of mudflats or shallow water up to 60mm. The Curlew Sandpiper may also forage in saltmarsh environments and flooded paddocks.	
Aves	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V	-	OEH, BioB, CER	Occurs within a variety of forest and woodland types. Usually frequents forested areas with old growth attributes required for nesting and roosting purposes. Also utilises less heavily timbered woodlands and urban fringe areas to forage, but appears to favour well-timbered country through which it habitually flies as it moves about.	Unlikely. Only one record from the locality and the subject site lacks preferred habitat.
Aves	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V	-	BioB, CER	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of She-Oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur.	Unlikely. Only one record from the locality and the subject site lacks preferred foraging habitat.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Aves	*Chthonicola sagittata*	Speckled Warbler	V	-	BioB, CER	Occurs in communities dominated by Eucalyptus, with a grassy understorey, most commonly occurring on rocky ridges and 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. This species is most frequently reported from the hills and tablelands of the Great Dividing Range and rarely from the coast.	Unlikely. No records from the locality and only a small area of potential habitat is present.
Aves	*Circus assimilis*	Spotted Harrier	V	-	OEH, BioB, CER	Occurs throughout mainland Australia except in densely forested or wooded habitats of the coast, escarpment, and ranges. It inhabits open grassy woodland, shrubland, and grassland. It nests in trees and preys on terrestrial mammals, birds, and reptiles, and will occasionally consume carrion.	Unlikely. Only one record from the locality and the subject site contains a very small area of potential foraging habitat.
Aves	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V	-	OEH, BioB, CER	The eastern subspecies occurs in eucalypt woodlands and in coastal areas with drier open woodlands, including the Cumberland Plains. Species mainly inhabits woodlands	Potential. Species was recorded within the study area and areas of suitable habitat are present.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						dominated by stringy barks or other rough-barked eucalypts, usually with an open grassy understorey.	
Aves	*Cuculus optatus*	Oriental Cuckoo	-	Mig.	PMST	Non-breeding visitor to Australia who is a brood parasite. Usually inhabits forested areas and can be found at all levels of the canopy and at a range of elevations.	Unlikely. No records from the locality and only a small area of potential habitat within the subject site.
Aves	*Daphoenositta chrysoptera*	Varied Sittella	V	-	OEH, BioB, CER	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Inhabits most of mainland Australia except the treeless deserts and open grasslands.	Potential. High number of records from the locality and species was recorded within the study area. Suitable habitat is present within the study area.
Aves	*Dasyornis brachypterus*	Eastern Bristlebird	E	E	PMST	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.	Unlikely. No records from the locality and the subject site provides only a small area of sub-optimal habitat.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Aves	*Ephippiorhynchus asiaticus*	Black-necked Stork	E	-	OEH	Occurs in floodplain wetlands of major coastal rivers along with minor floodplains, coastal sandplain wetlands and estuaries. Species builds nest in high in trees close to water.	Potential. Species was recorded within the study area and areas of suitable habitat are present.
Aves	*Epthianura albifrons*	White-fronted Chat	V	-	BioB	Found foraging on bare or grassy ground in wetland areas, singly or in pairs. Builds nest in low vegetation, as well as within low isolated mangroves.	Unlikely. No records from the locality and the subject site lacks preferred habitat.
Aves	*Gallinago hardwickii*	Latham's Snipe	-	Mig.	OEH	Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. They are found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration. They also use crops and pasture.	Unlikely. Moderate number of records from the locality, but the subject site lacks preferred habitat.
Aves	*Glossopsitta pusilla*	Little Lorikeet	V	-	OEH, CER, BioB	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophoras, Melaleucas and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Also utilises isolated flowering trees in open	Unlikely. Moderate number of records in the locality, but the subject site lacks habitat preferred by this species.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						country, e.g. paddocks, roadside remnants and urban trees. Roosts in treetops, often distant from feeding areas. Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts.	
Aves	*Grantiella picta*	Painted Honeyeater	V	V	PMST, BioB	Occurs in Boree, Brigalow and Box-Gum Woodlands and Box-Ironbarks. Feeds primarily on mistletoe fruit and insects.	Unlikely. No records from the locality and the subject site lacks preferred habitat.
Aves	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V	Mig.	OEH, CER	The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the Sea-Eagle are characterised by the presence of large areas of open water.	Potential. Moderate number of records from the locality and the species was recorded within the study area.
Aves	*Hieraaetus morphnoides*	Little Eagle	V	-	OEH, BioB, CER	The Little Eagle occupies habitats rich in prey within open eucalypt forest, woodland, or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch.	Potential. Moderate number of records from the locality and the species was recorded within the study area. Habitat within the subject site would likely only be utilised on

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
							occasion as part of a much broader foraging range.
Aves	*Hirundapus caudacutus*	White-throated Needletail	-	Mig.	OEH	Almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. Occur over most types of habitat, particularly above wooded areas including open forest and rainforest, between trees or in clearings and below the canopy.	Potential. Species has potential to fly overhead of the development footprint on occasion. Species is almost exclusively aerial and the habitat within the development footprint itself is unlikely to be utilised be the species.
Aves	*Irediparra gallinacea*	Comb-crested Jacana	V	-	BioB	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.	Unlikely. No records from the locality and the subject site lacks suitable habitat.
Aves	*Ixobrychus flavicollis*	Black Bittern	V	-	BioB	Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation.	Unlikely. No records from the locality and the subject site contains no suitable habitat.
Aves	*Lathamus discolor*	Swift Parrot	E	CE	OEH, PMST, BioB	In NSW mostly occurs on the coast and south west slopes. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as *Eucalyptus robusta, Corymbia maculata,*	Unlikely. Low number of records from the locality; however, the subject site lacks preferred habitat for this species. Furthermore, most recent record is from 1996.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						C. gummifera, E. sideroxylon, and *E. albens*. Breeds in Tasmania in spring and summer.	
Aves	*Limosa limosa*	Black-tailed Godwit	V	Mig.	BioB	Occurs along the coast in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats.	Unlikely. No records from the locality and the subject site lacks preferred habitat.
Aves	*Lophoictinia isura*	Square-tailed Kite	V	-	OEH, BioB, CER	Found in a variety of timbered habitats including dry woodlands and open forests. It is a specialist hunter preying on passerine birds, especially honeyeaters and targets predominately nestlings and insects occurring in the tree canopy. It nests in tree forks or on large horizontal tree limbs located mostly along or near watercourses.	Unlikely. Low number of records from the locality and the subject site only contains a small area of potential foraging habitat.
Aves	*Melanodryas cucullata cucullata*	Hooded Robin (south eastern form)	V	-	BioB, CER	Occurs in lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearing or open areas. Requires structurally diverse habitat featuring mature eucalypts, saplings, small shrubs and a ground layer of moderately tall native grasses.	Unlikely. No records from the locality and the subject site lacks structurally diversity required for the species.
Aves	*Melithreptus gularis gularis*	Black-chinned Honeyeater	V	-	BioB, CER	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts,	Unlikely. No records from the locality and the subject site

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
		(eastern subspecies)				especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*) and Forest Red Gum (*E. tereticornis*). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees. In NSW it is widespread, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas.	only offers small areas of potential habitat.
Aves	*Monarcha melanopsis*	Black-faced Monarch	-	Mig.	PMST	Found along the coast of eastern Australia, becoming less common further south. The Black-faced Monarch is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	Unlikely. No records from the locality and only a small area of potential habitat within the subject site.
Aves	*Monarcha trivirgatus*	Spectacled Monarch	-	Mig.	PMST	Found along the entire eastern seaboard of Australia. More often found where there is thick understorey in	Unlikely. No records from the locality and only a small area of

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						rainforests, wet gullies, waterside vegetation and also in mangroves.	potential habitat within the subject site.
Aves	*Motacilla flava*	Yellow Wagtail	-	Mig.	PMST	Species is believed to be a regular summer visitor to NSW, preferring open grassy flats near water.	Unlikely. No records from the locality and only a very small area of potential habitat is present.
Aves	*Myiagra cyanoleuca*	Satin Flycatcher	-	Mig.	PMST	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.	Unlikely. No records from the locality and the subject site provides only a small area of potential habitat that would be utilised on occasion during migration.
Aves	*Neophema pulchella*	Turquoise Parrot	V	-	OEH, BioB, CER	Found at the edges of eucalypt woodland adjacent to clearings, timbered ridges and creeks in farmland. Associated with coastal scrubland, open forest and timbered grassland. Nests in hollow-bearing trees, logs or posts.	Unlikely. Only one record from the locality and the development footprint lacks preferred habitat.
Aves	*Ninox connivens*	Barking Owl	V	-	OEH, BioB	Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting. Nests in hollows of large, old eucalypts. Requires	Unlikely. No records from the locality and only a small area of suitable habitat is present.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						very large permanent territories in most habitats due to sparse prey densities.	
Aves	*Ninox strenua*	Powerful Owl	V	-	OEH, BioB, CER	In NSW the Powerful Owl lives in forests and woodlands occurring in the coastal, escarpment, tablelands and western slopes environments. Specific habitat requirements include eucalypt forests and woodlands on productive sites on gentle terrain; a mosaic of moist and dry types, with mesic gullies and permanent streams; presence of leafy sub canopy trees or tall shrubs for roosting; presence of large old trees to provide nest hollows. Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal marsupials.	Potential. Species has not been recorded within the study area, but there are a moderate number of records from the locality. Species has a large foraging range and may utilise the development footprint periodically as part of a much broader foraging range.
Aves	*Numenius madagascariensis*	Eastern Curlew	-	CE	PMST	Prefers sheltered coasts, especially estuaries, bays, harbours, inlets and lagoons. Also known to occur in sewage farms, wetlands and mangroves. Species roosts on sandy spits and in low Saltmarsh or mangroves.	Unlikely. No records from the locality and the subject site lacks preferred habitat.
Aves	*Pandion cristatus*	Eastern Osprey	V	-	BioB	Found in littoral and coastal habitats and terrestrial wetlands. They generally are found in coastal areas though will	Unlikely. No records from the locality and the subject site lacks preferred habitat.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						travel inland along major water courses. They visit a wide range of wetland habitats including inshore waters, reefs, bays, coastal cliffs, estuaries, mangrove swamps, broad rivers, reservoirs, large lakes, and water holes. Nest in trees or dead trees, generally within one kilometre of the ocean.	
Aves	*Petroica boodang*	Scarlet Robin	V	-	OEH, BioB, CER	Occurs in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Habitat usually contains abundant logs and fallen timber: these are important components of its habitat. Nests are often found in a dead branch in a live tree, or in a dead tree or shrub.	Unlikely. Moderate number of records from the locality but the most recent is from 1998. The subject site lacks preferred habitat as abundant logs and fallen timber are absent.
Aves	*Petroica phoenicea*	Flame Robin	V	-	BioB, CER	Breeds in upland tall, moist, eucalypt forests and woodlands, often on ridges and slopes. Groundlayer of breeding habitat is dominated by native grasses. It occasionally occurs in herbfields,	Unlikely. No records from the locality and the subject site lacks preferred habitat.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						heathlands, shrublands, and sedgelands at high altitudes. In winter the species migrates to drier, more open habitats in the lowlands. The species forages from low perches, pouncing on small invertebrates on the ground or off logs, and other coarse woody material.	
Aves	*Rhipidura rufifrons*	Rufous Fantail	-	Mig.	PMST	Found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground.	Unlikely. Species was recorded within the study area during surveys, but the subject site lacks preferred habitat.
Aves	*Rostratula australis*	Australian Painted Snipe	E	E	PMST, BioB	Inhabits fringes of shallow inland wetlands, swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Unlikely. No records from the locality and the subject site lacks preferred habitat.
Aves	*Stagonopleura guttata*	Diamond Firetail	V	-	OEH, BioB, CER	Occurs in grassy eucalypt woodland, open forest and riparian areas.	Unlikely. Low number of records from the locality and the subject site only offers a small area of degraded habitat.
Aves	*Stictonetta naevosa*	Freckled Duck	V	-	OEH, BioB, CER	This species occurs primarily in southeastern and south-western Australia and occurs as a vagrant elsewhere. It breeds in large, temporary swamps created during flood events in the Bulloo and Lake Eyre's basins and	Unlikely. Only one record from the locality and the subject site lacks preferred habitat.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						along the Murray-Darling river system. During inland droughts the species disperses to wetlands in the Murray River basin, and occasionally to coastal areas. The species prefers permanent freshwater swamps and creeks heavy with shrub, sedge, and rush growth. It rests in dense cover during the day, usually in deep water and feeds at dusk and sawn on algae, seeds, and vegetative parts of aquatic sedges and grasses. It nests generally during October to December in dense vegetation near to the water level.	
Aves	*Tyto novaehollandiae*	Masked Owl	V	-	OEH, BioB, CER	Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats.	Unlikely. Only one record from the locality and no preferred habitat is present.
Gastropoda	*Meridolum corneovirens*	Cumberland Plain Land Snail	E	-	OEH, BioB, CER	Primarily inhabits Cumberland Plain Woodland. Lives under litter of bark,	Unlikely. Although a high number of records from the

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						leaves and logs, or shelters in loose soil around grass clumps. Lives in a very small area on the Cumberland Plain west of Sydney, from Richmond and Windsor south to Picton and from Liverpool west to the Hawkesbury and Nepean Rivers at the base of the Blue Mountains.	locality, only a very small area of suitable habitat is present within the subject site. No individuals were recorded by targeted surveys undertaken by Cumberland Ecology. The exotic Common Garden Snail was recorded.
Gastropoda	*Pommerhelix duralensis*	Dural Land Snail	E	E	OEH	Species occurs under rocks or inside curled-up bark within communities in the interface region between sandstone-derived and shale-derived soils.	Unlikely. Only one record from the locality and only a very small area of suitable habitat is present. No individuals were recorded by targeted surveys undertaken by Cumberland Ecology for the Cumberland Plain Land Snail.
Mammalia	*Cercartetus nanus*	Eastern Pygmy-possum	V		OEH	Species is found in a broad range of habitats from rainforest to wet and dry sclerophyll forests through to woodland and heath. Woodland and heath habitats are preferred. The species feeds on pollen and nectar from banksias, eucalypts, and bottlebrushes, though will eat soft fruits when flowers are unavailable, and will also eat insects throughout the year. They shelter in	Unlikely. No records from the locality and only a very small area of isolated habitat is present.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						tree hollows, rotten stumps, holes in the ground, abandoned birds nests and Ringtail Possum dreys, and thickets of vegetation. Tree hollows are preferred for nesting but the species will also nest under tree bark and shredded bark in tree forks.	
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	OEH, BioB, CER	The species is associated with areas dominated by sandstone escarpments; sandstone cliffs and fertile woodland valley habitat occurring in close proximity to each other is important for the species. It roosts in cliff/escarpment areas and forages in fertile forest. Roosting is predominately in arch caves with dome roofs, but has been observed in disused mines shafts, overhangs, and disused Fairy Martin nests.	Unlikely. Low number of records from the locality and the subject site lacks preferred habitat. Species was not recorded through survey.
Mammalia	*Dasyurus maculatus (SE mainland population)*	Spot-tailed Quoll	V	E	PMST, BioB	Recorded across 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,	Unlikely. No records from the locality and no preferred habitat is present.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						small caves, rock outcrops and rocky-cliff faces as den sites.	
Mammalia	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V	-	OEH, BioB, CER	Prefers moist habitats containing trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	Potential. Moderate number of records from the locality and species was recorded within the study area. Species may utilise grasslands near treed areas for foraging. Such areas would likely only be utilised on occasion as part of a broader foraging range. Potential roosting habitat is also present within tree hollows.
Mammalia	*Miniopterus australis*	Little Bent-winged Bat	V	-	OEH, CER	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.	Potential. Moderate number of records from the locality and species was recorded within the study area. Species may utilise grasslands near treed areas for foraging. Such areas would likely only be utilised on occasion as part of a broader foraging range. Non-preferred roosting habitat is present within tree hollows.
Mammalia	*Miniopterus orianae oceanensis*	Large Bent-winged Bat	V	-	OEH, CER	Forages above the canopy and eats mostly moths. Caves are the primary	Potential. High number of records from the locality and

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	the species was recorded within the study area. Suitable foraging habitat is present, but suitable roosting habitat is absent.
Mammalia	*Mormopterus norfolkensis*	Eastern Freetail-bat	V	-	OEH, CER, BioB	Found in dry sclerophyll forest, woodland, swamp forest and mangrove forests east of the Great Dividing Range. Primarily roosts in tree hollows but will also utilise man-made structures.	Potential. High number of records from the locality and species was recorded within the study area. Species may utilise grasslands near treed areas for foraging. Such areas would likely only be utilised on occasion as part of a broader foraging range. Potential roosting habitat is also present within tree hollows.
Mammalia	*Myotis macropus*	Southern Myotis	V	-	OEH, CER	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. Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	Potential. High number of records from the locality and species was recorded within the study area. Potential foraging habitat is present and potential roosting habitat is also present within tree hollows.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Mammalia	*Petaurus norfolcensis*	Squirrel Glider	V	-	OEH, BioB, CER	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Widely, though sparsely, distributed in eastern Australia, from northern Queensland to western Victoria.	Unlikely. Low number of records from the locality and no preferred habitat is present.
Mammalia	*Phascogale tapoatafa*	Brush-tailed Phascogale	V	-	CER	Prefers dry sclerophyll open forest with a sparse groundcover of herbs, grasses, shrubs or leaf litter. Occasionally inhabits rainforest and heath. Nests and shelters in tree hollows.	Unlikely. No records from the locality and subject site offers only a small area of sub-optimal habitat.
Mammalia	*Phascolarctos cinereus*	Koala	V	V	OEH, BioB, CER	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred feed species. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.	Unlikely. High number of records from the locality but the subject site has minimal potential habitat that has no connectivity to preferred habitat.
Mammalia	*Pseudomys novaehollandiae*	New Holland Mouse	-	V	PMST	Occurs in open habitats (heathland, woodland and forest) with a heath understorey and vegetated sand dunes. The species prefers deep soft top soils in order to burrow.	Unlikely. No records from the locality and not suitable habitat is present.

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
Mammalia	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	OEH, CER	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 generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	Potential. High number of records from the locality and species was recorded within the study area. Limited foraging habitat is present for this species, but the species may utilise this habitat on occasion as part of a much broader foraging range.
Mammalia	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	V	-	OEH, BioB, CER	Occurs in tall, mature eucalypt forest, mostly in areas with high rainfall and soil nutrients. Forest types include mixed coastal forests, dry escarpment forests, moist coastal gullies and creek flats, to tall montane forests. Feeds primarily on plant and insect exudates, including nectar, sap, honeydew, and manna, supplemented with insects to provide protein. The species dens in family groups, in hollows in large trees.	Unlikely. Low number of records from the locality and no preferred habitat is present.
Mammalia	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V	-	OEH, BioB, CER	Found mainly in the gullies and river systems that drain the Great Dividing Range. Usually roosts in tree hollows and buildings. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 -	Potential. Moderate number of records from the locality and species was recorded within the study area. Species may utilise grasslands near treed areas for foraging. Such areas

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Source	Habitat Requirements	Likelihood of Occurrence
						6 m. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects.	would likely only be utilised on occasion as part of a broader foraging range. Potential roosting habitat is also present within tree hollows.
Mammalia	*Vespadelus troughtoni*	Eastern Cave Bat	V	-	Survey	Occurs on both sides of the Great Dividing Range from Cape York to Kempsey. Species has been recorded in southern NSW. Little is known about the biology of this species, but it is a cave roosting species that is also known to utilise disused mines.	Potential. Species was recorded within the study area during surveys and may utilise the subject site for foraging on occasion as part of a broader foraging range. No suitable roosting habitat is present.
Reptilia	*Hoplocephalus bungaroides*	Broad-headed Snake	E	V	PMST	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in crevices or hollows in large trees within 500m of escarpments in summer.	Unlikely. No suitable habitat is present within the subject site.

Key: V=vulnerable, E=endangered, CE=critically endangered, Mig=migratory

Source Key: CER=chief executive requirement, OEH=atlas of NSW wildlife, PMST=protected matters search tool, BioB=BioBanking calculator

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APPENDIX C :
Survey Proformas

Date: 22/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 1	Start:	01	292823	226466	
Photos: 6168-6170	Orientation (°): 325	End:	02	292811	226501	
Dimensions: ☐20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus moluccana	30	14			C.Sc.S	
2	Olea europaea subsp cospidata	10	20				
3	Einadia nutans subsp. nutans	0.8	120				
4	Ehrharta erecta	1	100				
5	Aristida ramosa	20	1000				
6	Microlaena stipoides var. stipoides	10	1000				
7	Cyperus gracilis	0.2	20				
8	Dichondra repens	0.2	40				
9	Oxalis perennans	0.1	10				
10	Solanum prinophyllum	0.2	10				
11	Lycium ferocissimum	0.2	1				
12	Sida rhombifolia	0.2	40				
13	Cirsium vulgare	0.1	5				
14	Eucalyptus tereticornis	10	10			C.Sc.S	
15	Asparagus asparagoides	0.1	10				
16	Plantago lanceolata	0.1	5				
17	Glycine tabacina	0.1	20				
18	Conyza bonariensis	0.1	5				
19	Lepidium didymum	0.1	2				
20	cotula australis	0.1	10				
21	Grona varians *	0.1	5				
22	Geranium solandri	0.1	1				
23	Einadia nutans subsp. linifolia	0.1	1				
24	Veronica plebeia	0.1	5				
25	Sida corrugata	0.1	5				
26	Glycine microphylla	0.1	5				
27	Modiola caroliniana	0.1	10				
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22.9.2021	Personnel: RM	Project no: 17072	Site:	Plot: 1

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euca tere
	Euca molu

Fallen Logs Data	
Log #	Log Length (m)
1	12
2	6
3	3
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Euca molu	20	51	R				
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 1

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	X						X	X						X	X		X	4	X		X	X		X	
NGCS Native Shrubs																									
NGCO Other Natives			X	X	X		X													X	X				
EPC(a) Exotics (groundcover/shrubs)									X	X		X	X			X									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	30 %	20 %	10 %	20 %	10 %
NMS Mid-Storey Cover Native	%	%	10 %	10 %	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses		X	X	X	X	X			X	X		X	X		^					X	X	X		X	X
NGCS Native Shrubs																									
NGCO Other Natives																	X		X						X
EPC(a) Exotics (groundcover/shrubs)								X			X			X		X		X					X		

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	10 %	10 %	30 %	%	30 %
NMS Mid-Storey Cover Native	%	%	10 %	20 %	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	52	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	18	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 22+0+0 ÷3	7.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	17	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	5	Add **NMS** values and divide by 10

NTH: 1 FL: 21

Date: 22/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 2	Start:	6	292637	226241	
Photos: 6179 - 6182	Orientation (°): 90	End:	7	292680	226240	
Dimensions: ☑20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus tereticornis	30	7			C	
2	Eucalyptus Moluccana	10	4			C.Sc	
3	Ligustrum lucidum	0.4	5				
4	Chloris gayana	0.4	20				
5	Olea europaea subsp. cuspidata	15	20				
6	Cynodon dactylon	30	2000				
7	Ehrharta erecta	5	500				
8	Sida rhombifolia	0.4	40				
9	Rubus fruticosus	1	20				
10	Juncus usitatus	1	15				
11	Asparagus asparagoides	0.2	20				
12	Cirsium vulgare	0.1	10				
13	Plantago lanceolata	0.2	20				
14	Cenchrus clandestinus	10	500				
15	Hypochaeris radicata	0.1	20				
16	Dichondra repens	0.1	40				
17	Rumex conglomeratus	0.4	60				
18	Romulea rosea	0.1	5				
19	Carex appressa	0-8	10				
20	Euphorbia peplus	0.2	40				
21	Anagallis arvensis	10	1			Sc	
22	Rumex brownii	0.1	10				
23	Lysimachia ferociissimum	5	40				
24	Microlaena stipoides var. stipoides	5	500				
25	Lysimachia arvensis	0.2	40				
26	Paspalum dilatatum	0.4	40				
27	Modiola caroliniana	0.2	20				
28	Solanum nigrum	0.1	10				
29	Aristida ramosa	1	100				
30	Bromus catharticus	0.4	40				
31	Einadia nutans subsp linifolia	0.1	10				
32	Galium aparine	0.1	10				
33	Saponaria officinalis	0.1	10				
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22.9.21	Personnel: RM	Project no: 17072	Site:	Plot: 2

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euca molu

Fallen Logs Data	
Log #	Log Length (m)
1	3
2	3
3	2
4	5
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 2

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses			X	X	X	X	X	X	X			X				X	X	X		X			X		
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X											X	X	X				X		X	X		X	X

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	20 %	5 %	20 %	50 %	60 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses							X		X		X			X	X			X			X			X	X
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X	X		X		X		X	X			X	X		X	X		X	X		

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	66 %	50 %	40 %	5 %	10 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses 22	44	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	0	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 26x2+(0)1(0)÷3	17.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	106.66	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

FL: 13 NTH: 0

Date: 22/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM, __	Plot ID: P 3	Start:	08	292695	225938	
Photos: 6183-6186	Orientation (°): 225	End:	09	292652	225923	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus tereticornis	40	15			C. Sc	
2	Cynodon dactylon	30	1500				
3	Lysimachia ferodissimum	1	20				
4	Eragrostis cervula.	30	800				
5	Ehrharta erecta	5	500				
6	Sida rhombifolia	0.4	40				
7	Microlaena stipoides v stipoides	5	500				
8	Einadia nutans subsp. nutans	0.4	40				
9	Conyza sumatrensis	0.1	10				
10	Hypochaeris radicata	0.2	20				
11	Senecio madagascariensis	0.2	20				
12	Cotula australis	0.2	40				
13	Euchiton sphaericus	0.4	80				
14	Cyperus gracilis	0.2	20				
15	Taraxacum officinale	0.1	10				
16	Cirsium vulgare	0.2	20				
17	Bromus catharticus	0.2	20				
18	Solanum sisymbriifolium	0.1	2				
19	Onopordum acanthium	0.1	1				
20	Sonchus asper	0.1	2				
21	Sporobolus creber	0.2	20				
22	Modiola caroliniana	0.1	10				
23	Lysimachia arvensis	0.1	5				
24	Gamochaeta purpurea	0.2	20				
25	Verbena bonariensis	0.1	5				
26	Wahlenbergia gracilis	0.1	2				
27	Bromychia brasiliana	0.1	5				
28	Rumex brownii	0.1	2				
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22.9.21	Personnel: RM	Project no: 17072	Site:	Plot: 3

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	10
2	10
3	5
4	5
5	6
6	3
7	4
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 3

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	X			X	X	X														X				X	
NGCS Native Shrubs																									
NGCO Other Natives																	X	X	X		X	X			X
EPC(a) Exotics (groundcover/shrubs)			X				X	X	X	X	X	X	X	X	X	X							X		

Projective Foliage Cover (5m interval)	5		10		15		20		25	
NOS Canopy Cover Native	40	%	20	%	10	%	5	%	5	%
NMS Mid-Storey Cover Native		%		%		%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)		%		%		%		%		%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	X	X		X	X	X	X	X	X			X	X	X							X	X		X	X
NGCS Native Shrubs																									
NGCO Other Natives															X		X	X					X		
EPC(a) Exotics (groundcover/shrubs)			X							X	X					X			X	X					

Projective Foliage Cover (5m interval)	30		35		40		45		50	
NOS Canopy Cover Native		%		%		%		%	5	%
NMS Mid-Storey Cover Native		%		%		%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		
EPC(b) Exotics (mid storey)		%		%		%		%		%

Class	Value	Calculations
NGCG Native Grasses 21	42	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives 10	20	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 18+2+(0)+(0)÷3=	12	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	2.5	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

NPS - NTH 0 OR FL → 43

Date: 23/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: LM, __	Plot ID: P 5	Start:	25	292578	225671	
Photos: 6250-6253	Orientation (°): 355	End:	26	292566	225718	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Paspelum dilatatum	10	500				
2	Plantago lanceolata	0.4	60				
3	Aristida ramosa	0.1	5				
4	Romulea rosea	0.2	40				
5	Taraxacum officinale	0.4	80				
6	Bromus catharticus	70	3500				
7	Cynodon dactylon	3	300				
8	Acetosella vulgaris	3	200				
9	Lolium perenne	10	1000				
10	Senecio madagascariensis	0.1	16				
11	Heliocharis radicanta	0.2	40				
12	Verbena bonariensis	0.1	16				
13	Poa annua	5	500				
14	Conochaeta pensylvanica	0.1	20				
15	Cirsium vulgare	0.2	2				
16	Avena sativa	5	500				
17	Echium plantagineum	0.1	2				
18	Facelis retusa	0.2	40				
19	Rumex brownii	0.1	5				
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 23.9.21	Personnel: RM	Project no: 7072	Site:	Plot: 5

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 23.9	Personnel: RM	Project #: 17072	Site:	Plot: 5

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																	X	X						X	X
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	Y	Y		

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses															X	X						X			X
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X					X	X	X	X	X			X	X	X	X	X		X	X	

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	16	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 76+0÷3	25.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	0	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

FL:0 TH:0

Date: 22/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, __, __	Plot ID: P 6	Start:				
Photos: ____ - ____	Orientation (°): ___	End:				
Dimensions: □20x20, □10x40	PCT: CPW					Sheet: 2 of 2

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Veronica arvensis	0.1	5				
2	Polycarpon tetra	0.1	20				
3	Verbena bonar.	0.1	2				
4	Carex inversa	0.1	30				
5	Solanum nigrum	0.1	2				
6	Eragrostis leptostachya	1	100				
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF.	Plot ID: P 6	Start:	94	293447	6225519	
Photos: 987 - 990	Orientation (°): 72	End:	95	293494	6225533	
Dimensions: ☒20x20, ☐10x40	PCT: CPW					Sheet: 1 of 2

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Micro. stip stip.	50	5000				
2	Eucalyptus tereticornis	30	9				
3	Lycium ferocissimum	20	20				
4	Solanum sisymbriifolium	0.3	2				
5	Einadia trigonos	0.25	100				
6	Sida rhombifolia	0.1	30				
7	Modiola caroliniana	0.2	100				
8	Senecio madagasc.	0.1	10				
9	Gamochaeta americana	0.1	20				
10	Cynodon dactylon	20	2000				
11	Cotula australis	0.1	50				
12	Plantago debilis	0.1	20				
13	Hypolaena micro	0.1	2				
14	Paronychia brasil	0.1	20				
15	Pseudognaphalium luteoalb.	0.1	2				
16	Facelis retusa	0.1	20				
17	Plantago lanc.	0.1	10				
18	Sporobolus creber	2	200				
19	Lysimachia arvensis	0.1	20				
20	Conyza sumatrensis	0.1	5				
21	Cirsium vulgare	0.1	10				
22	Glycine tabacina	0.1	5				
23	Pennicum effus.	0.1	1				
24	~~Modiola caroli.~~						
25	Rumex brownii	0.1	10				
26	Dichondra repens	0.1	50				
27	Ehrharta erecta	5	500				
28	Cyperus gracilis	0.2	200				
29	Tetrarrhena distichophylla	1	100				
30	Oxalis perennans	0.1	10				
31	Asparagus asparagoides	0.2	5				
32	Araujia sericifera	0.1	1				
33	Cirsium diffusum	0.3	50				
34	Glycine micro.	0.1	5				
35	Urtica urens	0.1	3				
36	Solanum radicans	0.1	1				
37	Olea europaea subsp cuspid.	0.5	1				
38	Gamp fruticosus	0.2	3				
39	Gamochaeta pensylvanica	0.1	10				
40	Sonchus asper	0.1	1				

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22/9/21	Personnel: DF	Project no: 17072	Site:	Plot: 6

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euc. tereticornis

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	E. tereticornis	20	86		1			
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

see BAM sheet

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 22/9/21	Personnel: BF	Project #: 17072	Site:	Plot: 6

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	1				1				1	1				1	1		1		1	1	1	1	1	1	1
NGCS Native Shrubs																									
NGCO Other Natives																									1
EPC(a) Exotics (groundcover/shrubs)														1	1	1									1

Projective Foliage Cover (5m interval)	5		10		15		20		25	
NOS Canopy Cover Native	60	%	20	%	10	%		%		%
NMS Mid-Storey Cover Native		%		%		%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)		%		%		%		%		%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	1	1	1	1	1	1		1	1	1		1	1								1				
NGCS Native Shrubs																									
NGCO Other Natives		1									1													1	
EPC(a) Exotics (groundcover/shrubs)							1						1	1								1	1		

Projective Foliage Cover (5m interval)	30		35		40		45		50	
NOS Canopy Cover Native	20	%	35	%	10	%	30	%	70	%
NMS Mid-Storey Cover Native		%		%		%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		
EPC(b) Exotics (mid storey)		%		%	70	%	85	%	40	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 23/9/2021	Project #: 17077	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: R.M.	Plot ID: P 7	Start:	20	292503	225481	
Photos: 6228-6235	Orientation (°): 210	End:	21	292474	225453	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Cascuriera glauca	80	50			C,SC,S	
2	carex appressa	10	100				
3	Ligustrum sinense	5	40				
4	Rumex conglomeratus	1	200				
5	Modiola caroliniana	0.2	40				
6	Lysimachia arvensis	0.4	80				
7	Ranunculus sceleratus	1	100				
8	Asparagus officinalis	0.1	5				
9	Isolepis inundata	0.2	28				
10	Ligustrum lucidum	0.2	1				
11	Schoenus apogon	0.1	5				
12	Taraxacum officinalis	0.1	10				
13	Callitriche stagnalis	0.4	200				
14	Rubus fruticosus	0.2	2				
15	Verbena bonariensis	0.2	20				
16	Asparagus asparagoides	0.2	40				
17	Senecio hispidulus	0.1	5				
18	Atriplex prostrata	0.2	60				
19	Solanum pseudo	1	80				
20	Modiola caroliniana	0.2	40				
21	Cirsium vulgare	0.2	10				
22	Microlaena stipoides v. stipoides	40	2000				
23	Sida rhombifolia	0.1	10				
24	Phragmites australis	0.8	40				
25	Gomphocarpus fruticosus	0.2	20				
26	Euphorbia peplus	0.2	40				
27	Passiflora subpeltata	0.1	5				
28	Rumex crispus	0.1	2				
29	Ehrharta erecta	5	500				
30	Datura stram	0.1	1				
31	Persicaria decipiens	0.1	5				
32	Glyceria australis	0.2	20				
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: **TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: **C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 23.9.21	Personnel: RM	Project no:	Site:	Plot: 7

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Casu glau

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 23.9.21	Personnel: RM	Project #: 17072	Site:	Plot: 7

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses		X									X								X	X					
NGCS Native Shrubs																									
NGCO Other Natives						X	X																	X	X
EPC(a) Exotics (groundcover/shrubs)	X		X	X	X			X	X	X		X	X		X	X	X				X	X	X		

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	20 %	40 %	40 %	20 %	20 %
NMS Mid-Storey Cover Native	10 %	%	20 %	20 %	40 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives		X									X	X	X	X	X	X	X	X	X	X	X	X			X
EPC(a) Exotics (groundcover/shrubs)			X	X	X	X	X		X	X													X	X	

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	10 %	20 %	5 %	20 %	20 %
NMS Mid-Storey Cover Native	10 %	10 %	%	10 %	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	8	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	36	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 48+0=3	16	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	21.5	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	12	Add **NMS** values and divide by 10

NRS: FL: 0 TH: 0

Date: 24/09/2021	Project #: 17012	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, ___, ___	Plot ID: P 8	Start:				
Photos: ____ - ____	Orientation (°): ___	End:				
Dimensions: □20x20, □10x40	PCT: 82W					Sheet: 2 of 2

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Romulea rosea aust.	0.25	1000				
2	Aristida ramosa	1	100				
3	Verbena quad.	0.1	5				
4	Asperula conf. A.	0.1	20				
5	Einadia nut. nut.	0.1	5				
6	Detorhagia dubia	0.1	1				
7	Wahlenbergia gracilis	0.1	3				
8	Carex inversa	0.1	10				
9	Geranium solanderi	0.1	10				
10	Gamochaeta ameri'c	0.1	5				
11	Pichinia repens	0.1	20				
12	Lepidium aff. campm	0.1	2				
13	Poa annua	0.1	10				
14	Verbena rigida	0.1	3				
15	Bapsella bursa-pastor. s	0.1	2				
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
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31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 24/09/2021	Project #: 1072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BP, __, __	Plot ID: P 8	Start:	122	293634	6225370	
Photos: 47 - 50	Orientation (°): 92	End:	123	293689	6225379	
Dimensions: ☐20x20, ☐10x40	PCT: cPW					Sheet: 1 of 2

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Euc. crebra	15	1				
2	Euc. moluc.	5	1				
3	Lysimachia arvensis	0.2	50				
4	Bidens tabaeinu	0.1	20				
5	Senecio macf.	5	500				
6	Sida rhomb.	1	200				
7	Micro. stip stip	35	3500				
8	Sporobolus creber	10	1000				
9	Vulpes brom	0.1	20				
10	Solivia sessilis	0.25	1000				
11	Sherardia arvensis	0.1	30				
12	Olea europaea cupp.	2	5				
13	Lycium ferociss	2	10				
14	Cotula australis	0.1	100				
15	Gamochaeta pensyl.	0.1	30				
16	Cynodon dactylon	40	4000				
17	Oxalis perennans	0.1	100				
18	Plantago lanceolata	1	200				
19	Verbena bonariensis	0.2	5				
20	Cyperus gracilis	0.1	100				
21	Polycarpon tetraph.	0.1	30				
22	Cerastium glomerat.	0.1	20				
23	Modiola caroliniana	0.25	100				
24	Rumex brownii	0.1	5				
25	Einadia trigonos	0.1	20				
26	Euchiton sphaer. (ex	0.1	2				
27	Cyclospermum leptophyllum	0.1	50				
28	Hedis retusa	0.1	100				
29	Sonchus asper	0.1	10				
30	Hordeum leporinum	5	500				
31	Paronychia brass.	0.1	100				
32	Arctotheca calendula	0.1	10				
33	Veronica arvensis	0.1	20				
34	Erag ost. cuvvula	1	100				
35	Lomandra fil. fil.	0.1	30				
36	medicago polymorph.	0.1	5				
37	Malva parv.	0.1	3				
38	Erodium cicutarium	0.1	1				
39	Paspalum dilatatum	0.1	20				
40	Solanum nigrum	0.1	2				

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.
GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 25/1/21	Personnel: BF	Project no: 17072	Site:	Plot: 8

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	E. creb
	E. molucc.

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

See BAM sheet

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 24/9/21	Personnel: BF	Project #: 17072	Site:	Plot: 8

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 24/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF. . . .	Plot ID: P 10	Start:	120	292994	6225116	
Photos: 42 - 45	Orientation (°): 85	End:	121	293034	6225119	
Dimensions: □20x20, □10x40	PCT: 50%					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Casuarina glauca	65	60				
2	Araujia sericif.	5	200				
3	Ehrharta erecta	65	6500				
4	Verbena quadrang	0.2	5				
5	Sida rhomb.	1	100				
6	Asparagus asparag	10	1000				
7	Plantago major	0.2	20				
8	Cyperus sumatrensis	0.1	5				
9	Cirsium vulgare	0.2	5				
10	Gamochaeta americana	0.1	10				
11	Euphorbia peplus	0.1	20				
12	Modiola caroliniana	0.1	10				
13	Ligustrum lucidum	3	20				
14	Lycium ferocissimum	2	20				
15	Datura stramo	1	100				
16	Lonicera japonica	2	200				
17	Bidens pilosa	0.1	10				
18	Oxalis corn.	0.1	5				
19	Oplismenus aemulus	5	500				
20	Lysimachia arvensis	0.1	10				
21	Olea europaea sub. cuspf.	5	30				
22	Solanum pinnatisect.	0.2	3				
23	Micro stip stip	10	1000				
24	Ligustrum sinense	2	30				
25	Isolepis sp. Cernua	0.1	90				MP05
26	Steph. japon disc	0.2	1				
27	Rubus fruticosus	0.2	1				
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 24/9/21	Personnel: BF	Project no: 17072	Site:	Plot: 10

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
R	Cas. glauc

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

See BAM sheet

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 24/9/21	Personnel: BT	Project #: M072	Site:	Plot: 10

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses				1					1								1								
NGCS Native Shrubs						1								1											
NGCO Other Natives										1											1				
EPC(a) Exotics (groundcover/shrubs)	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1			1					

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	10 %	30 %	75 %	30 %	60 %
NMS Mid-Storey Cover Native	/ %	/ %	/ %	/ %	/ %
EPC(c) Exotics (canopy)	/ %	/ %	/ %	/ %	/ %
EPC(b) Exotics (mid storey)	50 %	5 %	/ %	/ %	/ %

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs						1	1												1						
NGCO Other Natives						1						1													
EPC(a) Exotics (groundcover/shrubs)				1				1			1				1	1	1	1	1			1	1	1	1

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	60 %	35 %	25 %	90 %	80 %
NMS Mid-Storey Cover Native	/ %	/ %	/ %	/ %	/ %
EPC(c) Exotics (canopy)	/ %	/ %	/ %	/ %	/ %
EPC(b) Exotics (mid storey)	80 %	/ %	40 %	20 %	70 %

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 23/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
RM Personnel: ~~6211 - 6214~~	Plot ID: P_11	Start:	15	291822	225173	
Photos: 6211 - 6214	Orientation (°): 355	End:	16	291809	225216	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Casuarina cunninghamiana	60	28			C,SC,S	
2	Kunzea ambigua	15	15				
3	Microlaena stipoides var. stipoides	70	3500				
4	Senecio madagascariensis	0.1	5				
5	Conyza bonariensis	0.1	16				
6	Solanum pseudocapsicum	0.2	10				
7	Facelis retusa	0.1	20				
8	Evergreosis brownii	0.2	20				
9	Ligustrum sinense	0.4	20				
10	Centella asiatica	0.1	10				
11	Themeda triandra	0.2	10				
12	Juncus acutus	0.2	2				
13	Passiflora suberosa	0.1	10				
14	Convolvulus erubescens	0.1	10				
15	Austrostipa ventricilleta	1	25				
16	Lobelia purpurascens	0.2	40				
17	Solanum pinnatifidum	0.4	20				
18	Conyza sumatrensis	0.1	20				
19	Cochlidium aspera *	0.2	5				
20	Gonocharete peresiana	0.2	40				
21	Lomandra longifolia ssp. longifolia	0.4	5				
22	Leptospermum polygalifolium	10	10				
23	Melia azedarach	0.1	1				
24	Cirsium vulgare	0.2	10				
25	Oplismenus aemulus	0.6	60				
26	Eucalyptus botryoides	5	0			C.	
27	Ligustrum lucidum	0.1	1				
28	Oxalis perennans	0.1	10				
29	Eragrostis nutans subsp. nutans	0.1	10				
30	Melaleuca armillaris ssp. armillaris	1	0			SC	
31	Amyema cambagei	0.1	5				
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: **TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: **C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 23.9.21	Personnel: RM	Project no: 17072	Site:	Plot: 11

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Casu cunn

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

↳ prefer to BAM from now on

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 11

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	x	x	x		x	x		x		x	x	x	x		x		x	x	x	x	x			x	x
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)														x		x									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	20 %	5 %	%	%	20 %
NMS Mid-Storey Cover Native	20 %	5 %	10 %	10 %	10 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
NGCS Native Shrubs																									
NGCO Other Natives																x									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	10 %	%	%	40 %	%
NMS Mid-Storey Cover Native	%	10 %	%	2 %	5 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses 42	84	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs 0	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives 1	2	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 24 + 0 + 0	1.33 MG	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	9.5	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	7.2	Add **NMS** values and divide by 10

NPS

Date: 24/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, ..., ...	Plot ID: P 12	Start:	112	292882	6225081	
Photos: 27 - 30	Orientation (°): 237	End:	113	292857	6225126	
Dimensions: ☐20x20, ☐10x40	PCT: Fresh wetland					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	~~Ischaem aust~~ Isachne globosa	5	200				MP02
2	Phragmites aust.	80	~~800~~ 800				
3	Rubus fruticosa	215	200				
4	Carex appressa	5	500				
5	Persicaria decip.	1	100				
6	Hall ~~leptostachya~~ machaerina rubig	10	500				MP03
7	Juncus ~~spp.~~ usitatus	0.5	100				MP04
8	Melaleuca linar.	2	2				
9	Senecio hispidi	0.1	1				
10	Cynoglossum micranth.	0.25	20				
11	Typha orient.	1	20				
12	~~Isolepis spp~~ cernua	0.2	3				MP05
13	Isolepis prolifer	5	500				
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 24/9/21	Personnel: BF	Project no: 17072	Site:	Plot: 12

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
R	Mel. linar.

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 24/9/21	Personnel: BF	Project #: 17072	Site:	Plot: 12

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 24/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF. . . .	Plot ID: P 13	Start:	106	293201	6224948	
Photos: 16 - 19	Orientation (°): 321	End:	107	293157	6224978	
Dimensions: ☑20x20, ☐10x40	PCT: 50FF					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Casuarina glauca	50	60				
2	Cirsium vulgare	0.2	10				
3	Ehrharta erecta	50	5000				
4	Cynodon dactylon	5	500				
5	Solanum radicans	0.3	50				
6	Lycium ferocissimum	0.4	10				
7	Olea europaea sub cuspidata	0.75	20				
8	Sida rhombifolia	0.1	20				
9	Solanum mauritianum	0.2	2				
10	Modiola caroliniana	0.5	50				
11	Micro stip stip	5	500				
12	Phytolacca octandra	0.2	3				
13	Sonchos asper	0.1	10				
14	Solanum pinnatifidum	0.25	4				
15	Apium graveolens	0.1	10				
16	Atriplex prostrata	0.1	10				
17	Taraxacum officinale	0.1	3				
18	Conyza sumatrensis	0.1	5				
19	Centhium clandestinum	0.1	10				
20	Bidens pilosa	1	100				
21	Linadia tisonos	0.1	10				
22	Lactuca sativa	0.1	2				
23	Parthenium hysterophorus	0.1	5				
24	Linadia hastata	0.1	1				
25	Cyperus eragrostis	0.1	10				
26	Panicum crispus	0.1	1				
27	Asparagus asparagoides	0.2	5				
28	Plantago lanceolata	0.1	2				
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 24/9/21	Personnel: BE	Project no: 7072	Site:	Plot: 13

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
R	Cas - glauc

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
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4	
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19	
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See BAM sheet

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 24/09/21	Personnel: BF	Project #: 17072	Site:	Plot: 13

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	70 %	50 %	80 %	65 %	20 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	60 %	75 %	80 %	95 %	85 %
NMS Mid-Storey Cover Native	%	%	%	20 %	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 29/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM, RV	Plot ID: P 14	Start:	127	293104	224789	
Photos: 6355-358	Orientation (°): 240	End:	128	293065	224766	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Angeplora subveletina	60	22			C,SCS	
2	Pteris escalentum	5	500				
3	Hibbertia diffusa	1	100				
4	Imperata cylindrica	2	200				
5	Oxalis perennans	0.1	20.				
6	Microlaena stipoides v. stipoides	1	100				
7	Cynodon dactylon	2	200				
8	Acetosella vulgaris	0-2	40				
9	Einadia hastata	0-2	5				
10	Senecio madagascariensis	0.2	10				
11	Oporatia stricta	0-2	2.				
12	Asparagus asparagoides	10	1000				
13	Eragrostis curvula	1	50				
14	Phytolacca octandra	0-2	10				
15	Einadia trigonos	0.4	25.				
16	Glycine tabacina	0.1	20				
17	Solanum pinnatifidum	0-2	10				
18	Glycine clandestina	0.1	20				
19	Rumex brownii	0-1	5.				
20	Brachychiton acerifolius	0.4	6				
21	Dichondria repens	0-2	40				
22	Bursaria spinosa	0.4	2				
23	Ehrharta erecta	1	100				
24	Olea europaea ssp cuspidata	1	10				
25	Sida rhombifolia	0.2	20				
26	Araujia sericifera	0-2	40.				
27	Malva arborea	0.1	1				
28	Gomphocarpus fruticosus	0.1	1				
29	Oplismenus aemulus	0-2	20.				
30	Pittosporum undulatum	0.6	1				
31	Ligustrum lucidum	0-1	1				
32	Cyclum ferocissimum	0.2	1				
33	Solanum sisymbriifolium	0.2	1				
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 29/9	Personnel:	Project no:	Site:	Plot: 14

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Angs subv
	Pitt undu.

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
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18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Angs subv	10	108					1
2	" "	25	117		III		1	II
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Refer to BAM sheet.

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 29/9	Personnel: RM RV	Project #: 17072	Site:	Plot: 14

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	X	X			X				X																
NGCS Native Shrubs																									
NGCO Other Natives			X	X				X					X	X			X	X		X		X	X	X	
EPC(a) Exotics (groundcover/shrubs)						X				X		X			X		X				X				

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	40 %	40 %	40 %	40 %	%
NMS Mid-Storey Cover Native	10 %	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	10 %	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives	X		X										X			X	X		X	X		X			
EPC(a) Exotics (groundcover/shrubs)		X					X	X		X	X	X			X			X			X		X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	5 %	20 %	40 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	8	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	38	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 36+1=37	12.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	22.5	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	1	Add **NMS** values and divide by 10

NHR 2 BL: 0

Date: 23/09/2021	Project #: 17078	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF	Plot ID: P 15	Start: 100	293507	6224707		
Photos: 4 - 7	Orientation (°): 326	End: 101	293474	6224745		Sheet: 1 of 1
Dimensions: ☐20x20, □10x40	PCT: CPW					

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus tereticornis	35	12				
2	olea europaea subsp cuspidata	60	1000				
3	Asparagus asparagoides	5	200				
4	Lycium ferocissimum	0.1	10				
5	Solanum nigrum	0.1	2				
6	Sonchus asper	0.1	4				
7	Opuntia stricta	0.25	3				
8	Eragrostis curvula	3	50				
9	~~Asparagus asparagoides~~						
10	Solanum pr. nigrum	0.25	4				
11	Dichondra repens	0.1	100				
12	Themeda triandra	1	~~80~~				
13	Microlaena stipoides	1	100				
14	Hydrocotyle laxiflora	0.1	10				
15	Glycine tabacina	0.1	10				
16	Cirsium vulgare	0.1	2				
17	Bursaria spinosa	0.1	2				
18	Pomaderris ferruginea	0.1	20				
19	Carex inversa	0.1	10				
20	Oxalis perennans	0.1	10				
21	Sida rhombifolia	0.1	5				
22	~~Glycine tabacina~~						
23	~~Pomaderris ferruginea~~						
24	Lomandra filiformis	0.1	1				
25	Araujia sericifera	0.1	1				
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 23/5/21	Personnel: BP	Project no: 17072	Site:	Plot: 15

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
L	Euc. tent.

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	E. tent	35	162			111		
2	E. tent	35	121		1	1	11	1
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

See BAM sheet.

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 23/9/21	Personnel: BF	Project #: 17072	Site:	Plot: 15

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses							/															1			
NGCS Native Shrubs									/		/		/	/				/	/						/
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	1	1	1	1	1	1		1		1		1			1	1	1		1	1	1		1	1	

Projective Foliage Cover (5m interval)	5		10		15		20		25	
NOS Canopy Cover Native	90	%	70	%	65	%	40	%	45	%
NMS Mid-Storey Cover Native	/	%	/	%	/	%	/	%	/	%
EPC(c) Exotics (canopy)	/	%	/	%	/	%	/	%	/	%
EPC(b) Exotics (mid storey)	80	%	/	%	40	%	/	%	/	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	1		1				1	1			1				1	1		1	1	1	1	1	1		
NGCS Native Shrubs		/		/		/			/	/			/	/			/								
NGCO Other Natives												1	/	/											1
EPC(a) Exotics (groundcover/shrubs)	1	/		/	1	/			/	/			/	/			/	1				1	1	1	1

Projective Foliage Cover (5m interval)	30		35		40		45		50	
NOS Canopy Cover Native	55	%	70	%	50	%	60	%	55	%
NMS Mid-Storey Cover Native	/	%	/	%	/	%	/	%	/	%
EPC(c) Exotics (canopy)	/	%	/	%	/	%	/	%	/	%
EPC(b) Exotics (mid storey)	/	%	/	%	/	%	/	%	/	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 23/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE.	Plot ID: P 16	Start:	102	293441	6224699	
Photos: 498 - 511	Orientation (°): 5	End:	103	293419	6224746	
Dimensions: □20x20, □10x40	PCT: Freshwater Wetland.					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eleocharis cylindr.	20	2000				
2	Typha orient.	2	50				
3	Potamogeton tricu.	0.5	50				
4	Cyenotes micro tuber.	0.5	100				
5	Myriophyllum Intifl	0.5	200				
6	Alisma plantago-aquat.	0.2	20				
7	Juncus usitat	10	1000 500				
8	Olea europ cusp	5	30				
9	Rubus frutic	5	20				
10	Eragrostis curv.	20	1000				
11	Eucalypt amp. amp.	2	0				
12	Alternanthera denic	0.5	200				
13	Persic decip decip	2	100				
14	Paspalum distichum	2	100				
15	Rumex crispus	0.2	30				
16	Asparag. aspar.	0.5	20				
17	Gomphr. prutic.	0.2	2				
18	Cyperus grac.	0.1	30				
19	Cirsium vulg	0.2	4				
20	Micro stip stip	25	2500				
21	Cynodon dact.	5	500				
22	Verben bonar.	0.2	10				
23	Plantag lanc.	0.1	20				
24	Paspalum dil.	1	100				
25	Verbascum virg.	0.1	2				
26	Carex inversa	0.1	20				
27	Cyperus eragrost.	1	50				
28	Callitriche stagnalis	0.25	300				
29	Lysimachia arvensis	0.1	10				
30	Juncus subsecundus	5	300				
31	Verbena quad	0.2	10				
32	Euphorbia peplus	0.1	5				
33	Veron. fru agrest	0.1	10				
34	Agrostella hyalard	0.1	20				
35	Lactuca serriola	0.1	1				
36	Verbena rigida	0.1	5				
37	Carex appressa	0.2	10				
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 23/9/21	Personnel: BF	Project #: 17072	Site:	Plot: 16

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10

Date: 29/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM RV	Plot ID: P 17	Start:	131	293198	224535	
Photos: 6364 - 6369	Orientation (°): 175	End:	132	293213	224487	
Dimensions: ☐20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Angophora subvelutina	50	7			C, Sc	
2	Eriocalis trigonos	0.2	20				
3	Asparagus asparagoides	10	1000				
4	Entolasia erecta	10	1000				
5	Hydrocotyle laxiflora	0.2	40				
6	Micraelaena stipoides v. stipoide	40	4000				
7	Pteridium esculentum	3	150				
8	Cynodon dactylon	0.4	40				
9	Sida rhombifolia	0.2	20				
10	Senecio madagascariensis	0.2	10				
11	Eragrostis curvula	10	100				
12	Gahnia aspera	0.1	1				
13	Dodonaea myoporoides	20	12			Sc, S	
14	Lantana camara	10	40				
15	Solanum prinophyllum	0.2	20				
16	Phytolacca octandra	0.2	10				
17	Lycium ferocissimum	2	20				
18	Solanum nigrum	0.1	5				
19	Passiflora suberosa	1	20				
20	Parsonsia straminea	0.1	20				
21	Dichondra repens	0.2	60				
22	Schinus molle	0.4	1				
23	Ajuga australis	0.1	1				
24	Silene gallica	0.2	40				
25	Echium plantagineum	0.1	1				
26	Oxalis perennans	0.2	60				
27	Conyza sumatrensis	0.1	10				
28	Heliotropium amplexicaule	0.2	20				
29	Cestrum parqui	0.2	1				
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 29/9/21	Personnel: RM RV	Project no: 12072	Site:	Plot: 17

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Dubsmop m/op

Fallen Logs Data	
Log #	Log Length (m)
1	28
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
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15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Angophora Sub	19	80		2	1		
2	" "	25	70					1
3	" "	20	50					1
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot:
7/21	RM/RV	17072		17

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	X	X	X							X	X	X	X	X	X	X									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)				X	X	X	X	X	X		X								X	X	X	X	X	X	

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	20 %	30 %	10 %	15 %	15 %
NMS Mid-Storey Cover Native	30 %	%	%	5 %	5 %
EPC(c) Exotics (canopy)	10 %	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses															X	X	X	X							
NGCS Native Shrubs																									
NGCO Other Natives					X																				
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X		X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	10 %	20 %	20 %	%	20 %
NMS Mid-Storey Cover Native	%	5 %	5 %	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 23/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, __, __	Plot ID: P 18	Start:	98	293533	6224431	
Photos: 995 - 998	Orientation (°): 304	End:	99	293541	6224444	
Dimensions: □20x20, □10x40	PCT: CPW					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Olea europaea subsp. cusp	50	1000				
2	Eucalyptus tereticornis	30	9				
3	Eucalyptus ~~[illegible]~~ moluccana	10	6				
4	Ligust. lucid.	3	20				
5	Verbena bonariensis	0.2	20				
6	Asparagus asparagoides	1	30				
7	Sonchus asper	0.1	3				
8	Micro stip. stip.	0.2	50				
9	Solanum pinnatifidum	0.1	1				
10	Solanum nigrum	0.1	2				
11	Eragrostis curvula	1	30				
12	Chloris gayana	1	40				
13	Brunoniella australis	0.1	5				
14	Lomandra fil. fil.	0.1	30				
15	Dichondra repens	0.1	20				
16	Rubus fruticosus agg.	0.1	1				
17	Oxalis perennans	0.1	5				
18	Modiola caroliniana	0.1	4				
19	Phytolacca octandra	0.2	2				
20	Cirsium vulgare	0.1	2				
21	Euphorbia peplus	0.1	20				
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m².*

Date: 23/9/21	Personnel: BF	Project no: 17072	Site:	Plot: 18

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euc tent.

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Euc tent	18	120		11	1	1	
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

check BBM sheet

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 23/9/21	Personnel: BF	Project #: 17072	Site:	Plot: 18

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses												1													
NGCS Native Shrubs						1																			
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)		1							1	1			1			1									1

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	65 %	45 %	48 %	80 %	35 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	90 %	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs		1																	1						
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)				1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1		1

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	75 %	50 %	80 %	85 %	90 %
NMS Mid-Storey Cover Native	%	%	1 %	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	10 %	%	20 %	35 %	10 %

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 29/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM RV	Plot ID: P 19	Start:	135	293019	224325	
Photos: 6376 - 79	Orientation (°): 185	End:	136	292996	224284	
Dimensions: ☒20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus tretricornis	40	8			C,Sc,S	
2	Eucalyptus amplifolia	5	3			Sc,S	
3	Olea europeaea ssp. cuspidata	2	10				
4	Sida rhombifolia	0.2	10				
5	Persicaria decipiens	5	500				
6	Paspalum dilatatum	1	50				
7	Glyceria australis	2	100				
8	Cynodon dactylon	60	3000				
9	Juncus usitatus	0.2	20				
10	Entolasia marginata	10	500				
11	Ehrharta erecta	2	200				
12	Hydrocotyle tripartita	0.4	80				
13	Isolepis inundata	5	200				
14	Ageratina riparia	0.2	1				
15	Onopordum acanthium	0.2	5				
16	Cachnegrostis filiformis	1	100				
17	Juncus acutus	0.8	5				
18	Sonchus asper	0.2	10				
19	Cyperus polystachyos	0.2	10				
20	Casuarina glauca	5	20			Sc,S	
21	Amsinckia calycina	0.1	1				
22	Plantago lanceolata	0.2	20				
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 29/9/21	Personnel: RM RV	Project no: 07072	Site:	Plot: 19

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Eucalyptus
	Casuarina glauca

Fallen Logs Data	
Log #	Log Length (m)
1	log
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Euc. tereticornis	22	51		1		1	
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 29/9/21	Personnel: RM/RV	Project #: 17072	Site:	Plot: 19

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses		x	x				x	x	x	x	x	x	x	x					x	x	x	x	x		
NGCS Native Shrubs																									
NGCO Other Natives				x	x																			x	x
EPC(a) Exotics (groundcover/shrubs)	x					x																			

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	20 %	15 %	10 %	20 %	15 %
NMS Mid-Storey Cover Native	5 %	%	40 %	10 %	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																								x	x
NGCS Native Shrubs																									
NGCO Other Natives	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	5 %	0 %	0 %	5 %	10 %
NMS Mid-Storey Cover Native	%	%	5 %	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	40 %	5 %

Class	Value	Calculations
NGCG Native Grasses	34	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	54	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 4+4.5-3	2.83	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	10	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	5	Add **NMS** values and divide by 10

1M:1

FL:65

Date: 29/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM RV	Plot ID: P 21	Start:	133	293023	6224244	
Photos: 6370-6373	Orientation (°): 25	End:	134	293050	6224283	Sheet: __ of __
Dimensions: ☑20x20, ☐10x40	PCT:					

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Cascoriva glauca	60	37			C,Se,S	
2	Olea europaea ssp. cospidata	2	10				
3	Commelina cyan	0.4	40				
4	Modiola caroliniana	0.6	60				
5	Sida rhombifolia	2	200				
6	Glycera australis	1	50				
7	Sonchus oleraceus	0.4	20				
8	Amyema cambagei	0.2	5				
9	Lachnagrostis filiformis	2	200				
10	Cyperus polystachyos	5	150				
11	Setaria parviflora	1	100				
12	Isolepis inundata	2	200				
13	Plantago erecta	2	200				
14	Juncus acutus	0.4	4				
15	Sonchus asper	0.2	10				
16	Asparagus asparagoides	1	100				
17	Galium aparine	0.4	40				
18	Cynodon dactylon	50	2500				
19	Cirsium vulgare	0.4	20				
20	Aster subulatus	0.2	20				
21	Rumex conglomeratus	0.4	40				
22	Cyperus polystachyos	5	150				
23	Araujia sericifera	0.8	40				
24	Juncus usitatus	0.4	10				
25	Verbena bareriensis	0.2	16				
26	Carex appressa	0.2	2				
27	Hedrocotyle tripartita	0.2	60				
28	Plantago lanceolata	0.2	20				
29	Lycium ferocissimum	0.4	2				
30	Bromus catharticus	0.6	60				
31	Phytolacca octandra	0.2	5				
32	Solanum prinophyllum	0.2	5				
33	Senecio hispidulus	0.2	5				
34	Melaleuca linariifolia	1	1			Sc.	
35	Oplismenus aemulus	0.2	20				
36	Paspalum dilatatum	0.1	16				
37	Conchres clandestinus	1	50				
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 29/09/21	Personnel: RM/RV	Project no: 7072	Site:	Plot: 21

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Casuarina glauca

Fallen Logs Data	
Log #	Log Length (m)
1	32
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 29/09/2021	Personnel: RM/RV	Project #: 17072	Site:	Plot: 21

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	X	X			X	X	X	X									X	X	X	X					
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)			X	X					X	X	X	X	X	X	X	X					X	X	X	X	X

Projective Foliage Cover (5m interval)	5		10		15		20		25	
NOS Canopy Cover Native	40	%	20	%	30	%	30	%	30	%
NMS Mid-Storey Cover Native		%		%		%	20	%	10	%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)		%		%		%		%		%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses															X			X	X					X	
NGCS Native Shrubs																									
NGCO Other Natives												X		X											
EPC(a) Exotics (groundcover/shrubs)	X		X				X	X	X	X	X		X			X	X			X	X	X			X

Projective Foliage Cover (5m interval)	30		35		40		45		50	
NOS Canopy Cover Native	20	%	20	%		%	20	%	40	%
NMS Mid-Storey Cover Native	20	%		%	30	%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		
EPC(b) Exotics (mid storey)		%		%		%		%		%

Class	Value	Calculations
NGCG Native Grasses	28	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	4	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 28+0÷3	10.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	25	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	7	Add **NMS** values and divide by 10

NMS: 0 FL: 32

Date: 30/9/2021	Project #: L7022	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: __.__.__	Plot ID: P 22	Start:	139	292649	224095	
Photos: 6389-6392	Orientation (°): 270	End:	140	292607	224107	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus teret. cornis	25	12			C, Sc	
2	Eucalyptus crebra	20	15			C, Sc, S	
3	olea europaea ssp. cuspidata	1	5				
4	Asparagus asparagoides	0.2	20				
5	Ehrharta erecta	1	100				
6	Einadia nutans ssp linifolia	5	500				
7	Senecio madagascariensis	0.1	5				
8	Dichondra repens	4	1000				
9	Hypericum perforatum	0.2	20				
10	Glycine tabacina	0.1	10				
11	Themeda triandra	2	100				
12	Cyperus gracilis	1	200				
13	Microlaena stipoides v stipoides	2	200				
14	Lycium ferocissimum	0.1	5				
15	Oxalis perennans	0.2	40				
16	Lysimachia arvensis	0.2	40				
17	Lomandra filiformis subsp filiformis	0.2	30				
18	Einadia nutans ssp. nutans	0.4	80				
19	Chloris ventricosa	1	100				
20	Sida rhombifolia	0.2	20				
21	Briza varians *	0.1	10				
22	Paronychia brasiliana	0.1	5				
23	Opuntia stricta	0.2	10				
24	Solanum prinophyllum	0.2	5				
25	Bromeliella artificic	0.2	40				
26	Hydrocotyle laxiflora	0.1	10				
27	Araujia sericifera	0.1	5				
28	Entolasia stricta	0.2	20				
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: **TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: **C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 30/9/21	Personnel: RV/RM	Project no: 17072	Site:	Plot: 22

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Eucalyptus

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 30/9/21	Personnel:	Project #: 17072	Site: 30/9/21	Plot: 22

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																							X		
NGCS Native Shrubs																									
NGCO Other Natives	X	X	X	X	X	X	X			X			X	X					X	X		X		X	
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	20 %	20 %	10 %	20 %	10 %
NMS Mid-Storey Cover Native	10 %	20 %	%	10 %	10 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses					X	X	X	X	X							X					X		X	X	X
NGCS Native Shrubs																									
NGCO Other Natives			X							X	X	X		X					X			X			
EPC(a) Exotics (groundcover/shrubs)																		X		X	X				

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	5 %	5 %	30 %	10 %	2 %
NMS Mid-Storey Cover Native	%	%	20 %	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	22	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	42	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 4 ÷ 3	1.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	13.2	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	7	Add **NMS** values and divide by 10

Date: 30/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM, RV	Plot ID: P 23	Start:	144	292477	223865	
Photos: 6399 - 6402	Orientation (°): 10	End:	146	292479	223912	
Dimensions: ☐20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus crebra	30	40			C, S, S	
2	Bursaria spinosa	4	6				
3	Lycium ferocissimum	8	16				
4	Cyperus gracilis	5	500				
5	Microlaena stipoides v. stipoides	20	2000				
6	Lida rhombifolia	10	200				
7	Modiola caroliniana	0.2	20				
8	Oxalis perennans	0.2	100				
9	Eragrostis nutans ssp. nutans	5	500				
10	Ehrharta erecta	1	50				
11	Lomandra filiformis ssp. filiformis	0.2	20				
12	Cotula australis	0.1	10				
13	Asparagus asparagoides	0.2	20				
14	Lysimachia arvensis	0.1	10				
15	Trachymene repens	0.2	80				
16	Echium plantagineum	0.1	10				
17	Veronica persica	0.1	5				
18	Galium gaudichaudii ssp gaudichaudii	0.1	10				
19	Sonchus asper	0.1	2				
20	Gamochaeta pensylvanica	0.1	10				
21	Oxalis perennans	0.2	100				
22	Veronica plebeia	0.1	10				
23	Cirsium vulgare	0.2	10				
24	Eucalyptus tereticornis	10	3			Sc, S	
25	Glycine tabacina	0.1	10				
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 20/09/2021	Personnel: RV KRM	Project no: 17072	Site:	Plot: 23

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euc. viburna
	Euc. tessellaris

Fallen Logs Data	
Log #	Log Length (m)
1	14
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 30/09/2021	Personnel: RV/RM	Project #: 17072	Site:	Plot: 23

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																			X	X	X	X	X		
NGCS Native Shrubs																								X	
NGCO Other Natives			X	X	X		X	X	X		X	X		X			X	X							
EPC(a) Exotics (groundcover/shrubs)	X	X			X	X							X			X									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	40 %	40 %	30 %	10 %	30 %
NMS Mid-Storey Cover Native	10 %	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses															X										
NGCS Native Shrubs																		X							X
NGCO Other Natives	X			X				X	X		X	X	X									X	X	X	
EPC(a) Exotics (groundcover/shrubs)			X																						

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	40 %	20 %	%	%	%
NMS Mid-Storey Cover Native	%	%	30 %	40 %	5 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	12	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	8	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	42	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 20+0 ÷3	6.66	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	20	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	8.5	Add **NMS** values and divide by 10

FL: 14 NTH: 0

30/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM, RV	Plot ID: P 25	Start:	147	292434	223457	
Photos: 6404 - 6407	Orientation (°): 220	End:	148	292407	223430	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus tereticornis	15	7			C, Sc, S	
2	Lycium ferocissimum	40	400				
3	Eragrostis curvula	1	50				
4	Senecio madagascariensis	0.4	40				
5	Sida rhombifolia	0.4	80				
6	Microlaena stipoides v stipoides	60	3000				
7	Lolium perenne	0.2	20				
8	Taraxacum officinale	0.1	10				
9	Conyza sumatrensis	0.2	20				
10	Cotula australis	0.6	100				
11	Tricoryne elatior ssp. elatior	1	400				
12	Cirsium vulgare	0.2	20				
13	Erechtites valerianifolia *	0.2	40				
14	Glycine tabacina	0.1	16				
15	Pennisetum macrophyllum	0.2	20				
16	~~Cyperus eragrostis~~	~~0.8~~	~~200~~				
17	Cyperus gracilis	0.8	200				
18	Vittadinia muelleri	0.4	40				
19	Sonchus oleraceus	0.1	10				
20	Oxalis perennans	0.2	60				
21	Bursaria spinosa	0.4	5				
22	Cynodon dactylon	0.8	80				
23	Ehrharta erecta	2	100				
24	Dichondra repens	0.4	80				
25	Asparagus asparagoides	0.2	20				
26	Sonchus asper	0.1	10				
27	Modiola caroliniana	0.1	20				
28	Araujia sericifera	0.2	20				
29	Eucalyptus polycarpa	10	2			Sc, S	
30	Lepidium africanum	0.1	10				
31	Cirsium vulgare	0.2	20				
32	Vittadinia cuneata ssp cuneata	0.1	10				
33	Plantago lanceolata	0.4	40				
34	Cerastium glomeratum	0.2	20				
35	Verbena bonariensis	0.1	10				
36	Solanum nigrum	0.1	5				
37	Solanum prinophyllum	0.1	5				
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 30/09/21	Personnel: RV, RM	Project no: 17072	Site:	Plot: 25

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euc. tereticornis
	Euc. moluccana

Fallen Logs Data	
Log #	Log Length (m)
1	38 3
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Euc tereticornis	20	99			X		
2	Euc moluccana	15	69	2		1		1
3	Euc tereticornis	25	80		2			
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 30/09/2021	Personnel: RV, RM	Project #: 17072	Site:	Plot: 25

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	X	X	X		X	X	X											X	X	X	X		X	X	X
NGCS Native Shrubs																									
NGCO Other Natives								X	X	X	X	X													
EPC(a) Exotics (groundcover/shrubs)				X						X		X	X	X	X	X	X					X			

Projective Foliage Cover (5m interval)	5		10		15		20		25	
NOS Canopy Cover Native	20	%	5	%	20	%	20	%	20	%
NMS Mid-Storey Cover Native		%		%		%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)		%		%		%		%		%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	X				X	X	X	X		X						X									
NGCS Native Shrubs																									
NGCO Other Natives																	X	X							
EPC(a) Exotics (groundcover/shrubs)		X	X	X		X	X	X	X		X	X	X	X	X				X	X	X	X	X	X	X

Projective Foliage Cover (5m interval)	30		35		40		45		50	
NOS Canopy Cover Native	20	%	20	%	40	%	20	%	40	%
NMS Mid-Storey Cover Native		%		%		%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)		%		%		%		%		%

Class	Value	Calculations
NGCG Native Grasses	40	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	7	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 5 of 0 ; 3	18.66	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	22.5	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

WTH: 3 TL: 38

Date: 5/10/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 26	Start:	157	293067	222821	
Photos: 6460-6464	Orientation (°): 100	End:	158	293114	222804	
Dimensions: ☐20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Poa siberiana v. siberiana	40	800				
2	Verbena bonariensis	0.2	20				
3	Plantago lanceolata	0.4	100				
4	Paspalum dilatatum	5	250				
5	Cynodon dactylon	20	1500				
6	Sonchus asper	0.1	10				
7	Cirsium vulgare	0.1	5				
8	Hypericum perforatum	0.1	5				
9	Geranium solanderi v. solanderi	0.1	5				
10	Oxalis corniculata	0.1	20				
11	Eragrostis cervula	30	600				
12	Microlaena stipoides v. stipoides	5	500				
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: 0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²

Date: 5/10/21	Personnel: RM	Project no: 17072	Site:	Plot: 26

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	0
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 5/10/21	Personnel: RM	Project #: 17072	Site:	Plot: 26

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	X	X	X				X	X	X		X					X	X						X		
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)				X	X	X				X		X	X	X	X			X	X	X	X	X		X	X

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	X											X	X	X	X	X	X			X					
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)		X	X	X	X	X	X	X	X	X	X							X	X		X	X	X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 30/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM RV	Plot ID: P 27	Start:	150	292323	222669	
Photos: 6411-6415	Orientation (°): 45	End:	151	292364	222692	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Cascarina cunninghamiana	20	3			C	
2	Ligustrum lucidum	40	150				
3	~~Melichrus urceolatus~~	~~0.4~~	~~2~~				
4	Ehrharta erecta	20	1000				
5	Solanum radicans	0.4	60				
6	Cardiospermum grandiflorum	0.8	200				
7	Oxalis perennans	0.1	10				
8	Cirsium vulgare	0.2	5				
9	Modiola caroliniana	0.1	10				
10	Tradescantia fluminensis	0.8	80				
11	Atriplex prostrata	0.8	80				
12	Ageratina Adenophora	0.2	20				
13	Microlaena stipoides v.stipoides	20	2000				
14	Oplismenus aemulus	0.2	40				
15	Ligustrum sinense	2.8	10				
16	Carlochlaena dubia	0.4	40				
17	Adiantum aethiopicum	0.4	80				
18	~~Asp~~ Parantheria Microphylla	0.2	20				
19	Ageratina riparia	0.1	10				
20	Solanum nigrum	0.2	20				
21	Euphorbia peplus	0.2	20				
22	Melicytus dentatus	0.4	2				
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 30/09/2021	Personnel: RV/RM	Project no: 7072	Site:	Plot: 27

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Eucalyptus Curtisii	30	92	1	2			
2	" "	20	65		1			1
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	51
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 30/09/2021	Personnel: RV/RM	Project #: 17072	Site:	Plot: 27

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X		X	X	X	X	X	X				X			X	X	X	X	X	X	X

Projective Foliage Cover (5m interval)	5		10		15		20		25	
NOS Canopy Cover Native	10	%		%	20	%	20	%	40	%
NMS Mid-Storey Cover Native		%		%		%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)	40	%	60	%	40	%	20	%	40	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses											X	X						X	X						X
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X							X					X	X	X	X	X			X	X	X		X	

Projective Foliage Cover (5m interval)	30		35		40		45		50	
NOS Canopy Cover Native	40	%	20	%	20	%	20	%	20	%
NMS Mid-Storey Cover Native		%		%		%		%		%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)	50	%	40	%	80	%	80	%	80	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 30/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM. KV	Plot ID: P 28	Start:	152	292647	222615	
Photos: 6420 - 6425	Orientation (°):	End:	153	292601	222619	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus botryoides	40	1			C	
2	Bachhousia myrtifolia	5	20			Sc.	
3	Austrostipa ventricillata	2	100				
4	Melichrus dentatus	10	20				
5	Eragrostis curvula	40	900				
6	Cynodon dactylon	0.2	20				
7	Dichondra repens	0.2	60				
8	Glycine microphylla	0.1	10				
9	Microlaena stipoides ustipoides	10	1000				
10	Einadia hastata	0.2	20				
11	Ehrharta erecta	0.4	40				
12	Ligustrum lucidum	40	100				
13	Oxalis perennans	0.2	40				
14	Gonocharta pensylvanica	0.2	60				
15	Conyza sumatrensis	0.1	10				
16	Cyclospermum leptophyllum	0.1	20				
17	Cycimedia arvorensis	0.1	40				
18	Medicago polymorpha	0.2	80				
19	Lactuca saligna	0.1	20				
20	Parentucellia viscosa	0.1	10				
21	Cerastium glomeratum	0.1	20				
22	Solanum pinnatifidum	0.2	5				
23	Eucalyptus elata	10	4			Sc, S	
24	Saponaria officinalis	0.1	10				
25	Einadia hastata	0.2	20				
26	Senecio madagascariensis	0.1	10				
27	Fraxinus sp.	10	1				
28	Hydrocotyle bonariensis	0.1	10				
29	Bursaria spinosa	0.4	5				
30	Clematis glycinoides	0.1	2				
31	Aristida ramosa	0.4	20				
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 30/09/2021	Personnel: RN/RV	Project no: 17072	Site:	Plot: 28

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euc latta

Fallen Logs Data	
Log #	Log Length (m)
1	70
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Euc Botryoides	30	180			3		
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 30/09/2021	Personnel: RM/RV	Project #: 17072	Site:	Plot: 28

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses						X	X	X	X	X		X		X	X	X	X	X	X				X	X	X
NGCS Native Shrubs													X							X					
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X																	X			

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	60 %	20 %	%	%	%
NMS Mid-Storey Cover Native	%	10 %	20 %	%	10 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	40 %	%	10 %	5 %

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	X	X	X			X	X	X				X				X			X		X		X	X	X
NGCS Native Shrubs																									
NGCO Other Natives				X	X												X					X			
EPC(a) Exotics (groundcover/shrubs)									X		X			X	X										

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	5 %	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	10 %	20 %
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	20 %	20 %	40 %	20 %

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 5/10/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 29	Start:	154	292953	222494	
Photos: ____-____	Orientation (°): 275	End:	155	292909	222507	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Cascerina cunninghamiana	45	10				
2	Kunzea ambigua	30	12				
3	Chiolantes sieberi	0.2	25				
4	Ehegrostis cerula	20	450				
5	Solanum prinophyllum	0.2	10				
6	Microlaena stipoides v stipoides	30	1500				
7	Cantana cunonea	0.4	5				
8	Cangza sumatrensis	0.1	10				
9	Baekhaesia myrtifolia	0.1	5				
10	Solanum sisymbriifolium	0.2	10				
11	Austrostipa verticillata	0.4	20				
12	Entratta erecta	1	50				
13	Dichondria repens	0.2	80				
14	Ligustrum lucidum	2.8	20				
15	Oxalis perennans	0.1	20				
16	Olea europaea ssp. cospidata	0.1	20				
17	Ehrharta erecta	1	50				
18	Glycine microphylla	0.1	20				
19	Oplismenus aemulus	0.4	40				
20	Lysimachia arvensis	0.1	16				
21	Verbena bonariensis	0.1	20				
22	Hypochaeris radicata	0.2	20				
23	Sonchus oleraceus	0.1	10				
24	Facelis retusa	0.1	20				
25	Cotula australis	0.1	5				
26	Soliva sessilis	0.1	10				
27	Verbascum virgatum	0.1	2				
28	Cangza bonariensis	0.1	5				
29	Cynodon dactylon	1	100				
30	Polycarpon tetraphyllum	0.1	20				
31	Hydrocotyle laxiflora	0.1	20				
32	Cirsium vulgare	0.1	5				
33	Lycium ferocissimum	1	4				
34	Erodia hastata	0.1	2				
35	Eucalyptus elata	1	0 *				
36	Callistemon salignus	1	1				
37	Pseudognaphalium luteoalbum	0.1	5				
38	Veronica plebeia	0.1	5				
39	Conrocheeta panglobanica	0.2	40				
40	Cissonthe strigosa subsp strigosa	0.1	1				

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 5/10/21	Personnel: RM	Project no: 17072	Site:	Plot: 29

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Casuarina cunn

Fallen Logs Data	
Log #	Log Length (m)
1	8
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 22/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM, ___	Plot ID: P 30	Start:	03	293085	226382	
Photos: 6172 - 6178	Orientation (°): 230	End:	04	293049	226356	
Dimensions: ☐20x20, ☐10x40	PCT:					Sheet: ___ of ___

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus moluccana	50	10			c. sc s	
2	Acacia implexa	5	2			sc, s	
3	Olea europaea subsp. cuspidata	30	40				
4	Euphorbia peplus	0.2	20				
5	Aristida ramosa	10	500				
6	Modiola caroliniana	0.2	40				
7	Asperula conferta	0.1	10				
8	Crena varians	0.1	5				
9	Brunoniella australis	0.2	20				
10	Eragrostis curvula	2	100				
11	Sida rhombifolia	0.2	40				
12	Microlaena stipoides stipoides	20	2000				
13	Cyperus gracilis	0.2	30				
14	Senecio madagascariensis	0.1	5				
15	Verbena bonariensis	0.1	5				
16	Asparagus asparagoides	0.2	20				
17	Glycine tabacina	0.1	5				
18	Cirsium vulgare	0.4	15				
19	Lesimachia arvensis	2	100				
20	Fibelia retusa	0.1	10				
21	Einhardia erecta	5	500				
22	Sonchus asper	0.2	20				
23	Solanum sisymbriifolium	0.2	10				
24	Carex appressa	5	150				
25	Phytolacca octandra	0.4	10				
26	Dichondria repens	0.1	20				
27	Oxalis perennans	0.1	5				
28	Einadia nutans subsp. nutans	0.1	10				
29	Lysium ferocissimum	1	10				
30	Cymbopogon pencyllenica	0.1	5				
31	Araujia sericifera	0.1	2				
32	Saponaria officinalis	0.1	10				
33	~~Acacia binervata~~	0.1	1			s.	
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22.9.21	Personnel: RM	Project no: 17072	Site:	Plot: 30

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Eucs molu
	Acac impl

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Eucs molu	20	40		1			
2	" "	25	80+		4	4	2	
3	" "	"	"		6		2	
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	1
2	2
3	2
4	5
5	5
6	5
7	3
8	3
9	6
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 22.9.21	Personnel: RM	Project #: 17072	Site:	Plot: 30

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																					X				X
NGCS Native Shrubs																									
NGCO Other Natives											X	X	X	X											
EPC(a) Exotics (groundcover/shrubs)		X	X		X			X		X					X		X		X		X		X		

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	30 %	40 %	40 %	%	20 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	10 %

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses			X													X		X							
NGCS Native Shrubs																									
NGCO Other Natives				X	X																				
EPC(a) Exotics (groundcover/shrubs)	X	X			X	X	X			X				X	X				X	X	X	X	X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	10 %	10 %	40 %	50 %	50 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	10 %	40 %	20 %	20 %

Class	Value	Calculations
NGCG Native Grasses	10	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	12	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 50+ 33.3	83.3	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	29	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

FL = 32 N/H : 3

Date: 22/9/2021	Project #: 17012	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM.	Plot ID: P 31	Start:	13	293115	226197	
Photos: 6199-6202	Orientation (°): 100	End:	14	293164	226196	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Verbena bonariensis	0.8	100				
2	Eragrostis curvula	90	4000				
3	Plantago lanceolata	0.2	20				
4	Senecio madagascariensis	1	80				
5	Cirsium vulgare	0.2	10				
6	Briza subaristata	0.2	20				
7	Vicia sativa	0.4	60				
8	Aristida ramosa	4	200				
9	Paspalum dilatatum	1	50				
10	Geranium solanderi	0.2	20				
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22.9.21	Personnel: RM	Project no: 17072	Site:	Plot: 31

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #: 17072	Site:	Plot: 31

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																					X	Y	X		
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses		X	X		X	X		X	X									X	X		X	X	X		
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X			X			X			X	X	X	X	X	X	X	X			X				X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses 14	28	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs 0	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives 0	0	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 37 X2 10 10 3	24.66	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	0	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

Date: 22/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 32	Start:	11	292816	226079	
Photos: 6195-6196	Orientation (°): 45	End:	12	292846	226108	
Dimensions: ☐20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Cascarina glauca	60	15			C Sc	
2	Solanum sisymbriifolium	0.2	15				
3	Olea europaea subsp cospidata	20	20				
4	Senecio madagascariensis	0.2	20				
5	Sonchus asper	0.1	5				
6	Lysimachia arvensis	0.2	40				
7	Linum marginale	0.1	10				
8	Oxalis corniculatem	0.1	20				
9	Hibiscus trionum	5	500				
10	Plantago lanceolata	0.2	20				
11	Lycium ferocissimum	5	50				
12	Asparagus asparagoides	0.2	20				
13	Eragrostis curvula	1	50				
14	Modiola caroliniana	0.1	10				
15	Vicia sativa	0.2	20				
16	Cotula australis	0.1	10				
17	Sida rhombifolia	0.1	20				
18	Solanum nigrum	0.2	10				
19	Veronica plebeia	0.1	5				
20	Gamochaeta pensylvanica	0.1	10				
21	Cyperus gracilis	0.1	5				
22	Crassula sieberiana	0.1	10				
23	Stellaria media	0.1	20				
24	Cirsium vulgare	0.2	20				
25	Ligustrum lucidem	1	10				
26	Triglochin microtuberosum	0.1	1				
27	Conyza bonariensis	0.1	1				
28	Anyema cambagei	0.1	5				
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22/9/2021	Personnel:	Project no:	Site:	Plot: 32

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Casu glau

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Casu glau	20	49		1			
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	6
2	5
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 22.9.21	Personnel:	Project #: 17072	Site:	Plot: 32

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)		X		X	X	X	X		X	X						X						X		X	

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	40 %	20 %	10 %	5 %	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	20 %	10 %	%	%	%
EPC(b) Exotics (mid storey)	%	%	20 %	10 %	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)					X	X				X	X	X	X		X	X	X	X		X		X	X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	20 %
NMS Mid-Storey Cover Native	%	%	%	20 %	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	10 %	10 %	25 %	%	%

Class	**Value**	**Calculations**
NGCG Native Grasses	0	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	0	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics (25x2)+(7.5)+(3.3	20.16	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	9.5	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	2	Add **NMS** values and divide by 10

BNPS INTH: 1 / OR FL: 11

Date: 22/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE. __.__	Plot ID: P33	Start:	89	293553	6226027	
Photos: 977 - 980	Orientation (°): 13	End:	90	6226077	293558	
Dimensions: □20x20, □10x40	PCT: CPW					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus tereticornis	30	2				
2	Olea europaea subsp. cuspid.	55	100				
3	Asparagus asparagoides	15	500				
4	Modiola caroliniana	0.5	200				
5	Phytolacca octandra	0.5	20				
6	Microlaena stip. stipoides	20	4000				
7	Cyperus gracilis	5	1000				
8	Cirsium vulgare	0.1	3				
9	Verbena bonariensis	0.25	20				
10	Euphorbia peplus	0.1	30				
11	Glycine tabacina	0.1	3				
12	Dichondra repens	0.1	100				
13	Oxalis perennans	0.1	20				
14	Solanum nigrum	0.1	2				
15	Dichondra repens						
16	Gomphocarpus fruticosus	0.2	10				
17	Sida rhombifolia	0.1	30				
18	Ingiosachia arensis	0.1	20				
19	Brunoniella australis	0.1	3				
20	Rumex brownii	0.1	4				
21	Parentucellia latifolia	0.1	20				
22	Cerastium glomeratum	0.1	2				
23	Ehrharta erecta	1	200				
24	Lycium ferocissimum	0.5	2				
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22/9/21	Personnel: BF	Project no: 17072	Site:	Plot: 33

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Eucalyptus tereticornis.

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Euc. tereticornis	25	133			11		
2	E. tereticornis	25	159		1	11	1	
3	E. tereticornis.	20	127		1	11		
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

See BAM sheet

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 22/9/21	Personnel: BF	Project #: 17612	Site:	Plot: 3:3

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	40 %	80 %	55 %	35 %	%
NMS Mid-Storey Cover Native	%	84 %	%	%	%
EPC(c) Exotics (canopy)	%	%	00 %	%	%
EPC(b) Exotics (mid storey)	70 %	85 %	36 %	%	5 %

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	70 %	90 %	80 %	75 %	35 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	75 %	10 %	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 22/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BT, __, __	Plot ID: P 34	Start:	97	293177	6225437	
Photos: 993-994 - 991-992	Orientation (°): 225	End:	96	293135	6225407	
Dimensions: ⊡20x20, □10x40	PCT: Grassland w/ some natives					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Both. deep deep	15	1500				
2	Cynodon dact.	60	7000				
3	Plantago lanc.						
4	Geranium soland.	0.3	40				
5	Verbena bonar.	0.3	30				
6	Plantago lanceolata	0.2	100				
7	Senecio Madagase.	0.25	30				
8	Gamph. particosus	0.1	1				
9	Microlaena stip. stip.	20	2000				
10	Sporobolus creber	5	500				
11	Hypericum perfor.	0.25	50				
12	Lolium perenne	2	200				
13	Verbena quadr.	0.1	5				
14	Medicla carsoliniana	0.1	10				
15	Lysimachia arvensis	0.1	20				
16	Asperula conferta	0.1	30				
17	Paspalum dil.	5	500				
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22/09/21	Personnel: DF	Project no:	Site:	Plot: 34

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 22/9/21	Personnel: BF	Project #: 11072	Site:	Plot: 34

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses		1	1	1	1			1		1			1	1	1			1					1		
NGCS Native Shrubs																									
NGCO Other Natives														1											
EPC(a) Exotics (groundcover/shrubs)	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	1	1		1	1					1				1	1				1	1	1	1	1	1	
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 23/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 35	Start:	23	292250	225492	
Photos: 6246-6249	Orientation (°): 285	End:	24	292201	225494	
Dimensions: ☒20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Carex appressa	70	500				
2	Ligustrum sinense	30	100				
3	Sonchus asper	0.1	10				
4	Verbena bonariensis	0.2	40				
5	Rumex conglomeratus	0.4	60				
6	Datura stram	0.1	5				
7	Pennisetum decipiens	0.1	10				
8	Phytolacca octandra	0.1	5				
9	Lepidium ferocissimum	1	20				
10	Paspalum dilatatum	1	100				
11	Juncus usitatus	1	40				
12	Briza subaristata	0.2	20				
13	Eragrostis curvula	2	100				
14	Triglochin *	0.2	10				
15	Plantago major	0.1	5				
16	Bromus catharticus	0.1	5				
17	Plantago lanceolata	0.2	20				
18	Poa annua	0.2	20				
19	Rumex brownii	0.1	5				
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 23.9.21	Personnel: RM	Project no:	Site:	Plot: 35

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 23.9.21	Personnel: RM	Project #: 17072	Site: ~~17072~~	Plot: 35

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives	X	X	X	X	X	X	X	X	X			X	X	X	X	X		X	X	X	X	X	X		
EPC(a) Exotics (groundcover/shrubs)											X						X							X	X

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives	X		X													X	X	X	X	X	X	X	X	X	X
EPC(a) Exotics (groundcover/shrubs)		X		X	X	X	X	X	X	X	X	X	X	X	X										

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	0	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	64	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 34 ÷ 3	11.3	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	0	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

42.0 47.0

Date: 23/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 36	Start:	17	291582	225163	
Photos: 6222 - 6226	Orientation (°): S	End:	18	291587	225207	
Dimensions: ☐20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus botryoides	35	6			C. Sc.	
2	Eucalyptus fecticornis	30	5			C. Sc	
3	Eragrostis curvula	10	100				
4	Ligistrum lucidum	10	20				
5	Ligustrum sinense	30	40				
6	Microlaena stipoides var. stipoides	40	4000				
7	Olea europaea ssp. cuspidata	10	20				
8	Gamochaeta pensylvanica	0.4	100				
9	Conyza sumatrensis	0.2	20				
10	Wahlenbergia gracilis	0.1	5				
11	Cheilanthes sieberi	0.1	16				
12	Oplismenus aemulus	1	100				
13	Verbena bonariensis	0.2	40				
14	Clematis glycinoides	0.1	5				
15	Parantlera microphylla	0.1	10				
P 16		0.6	1				
17	Veronica plebeia	0.1	10				
18	Oxalis perennans	0.1	20				
19	Cotula australis	0.1	20				
20	Facelis retusa	0.1	20				
21	Lobelia purpurascens	0.1	10				
22	Glycine clandestina	0.1	5				
23	Centaurium erythraea	0.1	2				
24	Ajuga australis	0.1	10				
25	Eucalyptus elata	.5	1			Sc	
26	Sonchus asper	0.1	10				
27	Plantago lanceolata	0.1	20				
28	Smilax glyciphylla	0.1	5				
29	Solanum radians	0.1	20				
30	Saponaria officinalis	0.1	15				
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: **TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: **C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 23/9/21	Personnel: RM	Project no: 17072	Site:	Plot: 36

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euca botr
	Euca tere

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 23.9.21	Personnel: KM	Project #:	Site:	Plot: 36

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses						X				X		X	X												
NGCS Native Shrubs																									
NGCO Other Natives																						X	X		
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X			X	X		X			X		X			X	X	X			X	X

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	30 %	10 %	20 %	20 %	%
NMS Mid-Storey Cover Native	%	%	20 %	10 %	50 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses						X	X	X	X	X		X	X							X				X	
NGCS Native Shrubs																									
NGCO Other Natives														X											
EPC(a) Exotics (groundcover/shrubs)	X			X	X						X				X	X	X	X			X	X	1		X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	10 %	40 %	10 %	20 %
NMS Mid-Storey Cover Native	10 %	%	%	40 %	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	26	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	6	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 54.0 ÷3	18	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	16	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	13	Add **NMS** values and divide by 10

NPS: FL: 0 TH: 0

Date: 24/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BK. . .	Plot ID: P 37	Start:	108	293007	6225053	
Photos: 20 - 23	Orientation (°): 151	End:	109	293020	6225012	
Dimensions: □20x20, □10x40	PCT: RFEF					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Cynodon dactylon	70	7000				
2	Poa sp. labill.	10	1000				MP01
3	Cirsium vulgare	1	30				
4	Plantago lanc	1	200				
5	Rumex crispus	0.5	30				
6	Eucalyptus tamplifol. Imp	45	40				
7	Sida rhomb.	0.25	20				
8	Juncus usit.	1	50				
9	Carex appressa	2	50				
10	Hemarthria uncinata	1	100				
11	Modiola caroliniana	0.25	20				
12	Lactuca saligna	0.1	5				
13	Sporob. elongatus	0.1	3				
14	Asparagus asparagoides	0.5	20				
15	Cyperus eragrost.	0.5	40				
16	Olea europ. cusp.	3	20				
17	Ehrharta erecta	10	1000				
18	Persicaria decipiens	0.25	20				
19	Arrayja sericiferen	0.1	2				
20	Lycium ferociss.	1	10				
21	Verbena bonariensis	0.2	5				
22	Bromus catharticus	1	100				
23	Lythrum hyss.	0.1	2				
24	Hypochaeris microcaph.	0.1	1				
25	Solanum nigrum	0.1	2				
26	Bursaria spinosa	0.5	4				
27	Solanum linnaeanum	0.25	2				
28	Senecio hispidul.	0.1	1				
29	Asparagus aff. ic	0.1	1				
30	Lachnagrost fil.	0.25	20				
31	melaleuca linar	0.3	1				
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 24/9/21	Personnel: BF	Project no: 17072	Site:	Plot: 37

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
R	Eue. amp amp.

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Eue. amp amp.	25	123	1		1		
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

See BAM sheet

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 24/9/21	Personnel: BF	Project #: 17072	Site:	Plot: 37

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses			1																		1				
NGCS Native Shrubs																									
NGCO Other Natives																								1	
EPC(a) Exotics (groundcover/shrubs)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	35 %	45 %	15 %	80 %	10 %
NMS Mid-Storey Cover Native	20 %	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses				1																					
NGCS Native Shrubs																									
NGCO Other Natives															1	1	1			1	1			1	1
EPC(a) Exotics (groundcover/shrubs)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	50 %	15 %	10 %	65 %	75 %
NMS Mid-Storey Cover Native	10 %	50 %	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 29/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: R.M.	Plot ID: P 38	Start:	125	292797	224945	
Photos: 6349 - 6352	Orientation (°): 330	End:	126	292770	224986	
Dimensions: ☒20x20, ☐10x40	PCT:					Sheet: ___ of ___

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Angophora subvelutina	40	5			C, S, S	
2	Eragrostis curvula	15	80				
3	Conyza sumatrensis	0.2	20				
4	Silene gallica	0.1	5				
5	Senecio madagascariensis	2	60				
6	Cenchrus clandestinus	5	250				
7	Cyperus gracilis	0.2	40				
8	Solanum prinophyllum	0.1	5				
9	Cynodon dactylon	10	1000				
10	Polycarpon tetraphyllum	0.2	20				
11	Acetosella vulgaris	10	2000				
12	Pteridium esculentum	0.2	5				
13	Cynodon dactylon	10	1000				
14	Panicum amplex	0.1	5				
15	Eviton sphaericos	0.1	5				
16	Ehrharta erecta	2	200				
17	Oxalis perennans	0.1	10				
18	Sida rhombifolia	0.2	20				
19	Pavonia bras	0.2	40				
20	Leptochloa aveneis	0.2	40				
21	Juncus bufonius	0.2	80				
22	Pseudognaphalium luteoalbum	1	200				
23	Carex appressa	0.4	10				
24	Einadia hastata	0.2	5				
25	Cotula australis	0.1	10				
26	Solanum nigrum	0.2	20				
27	Paspalum dilatatum	1	50				
28	Phytolacca octandra	0.1	5				
29	Vulpia bromoides	0.2	20				
30	Juncus acutus	0.4	2				
31	Geranium glomeratum	0.2	40				
32	Cyperus polystachyos	0.2	20				
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 29/9	Personnel: RM	Project no:	Site:	Plot: 38

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Angp subv

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Angp subv	20	+50	1	1			
2	〃 〃	〃	〃	1				
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 38

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives											X		X		X									X	
EPC(a) Exotics (groundcover/shrubs)		X		X	X	X		L		X							2	X	X	X	X				L

Projective Foliage Cover (5m interval)	5		10		15		20		25	
NOS Canopy Cover Native	5	%	40	%	10	%	20	%	20	%
NMS Mid-Storey Cover Native		%		%		%	20	%		%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)		%		%		%		%		%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives				X							X	X													
EPC(a) Exotics (groundcover/shrubs)		L			X	X				X			X	X	X	X		X		X	X		X	X	L

Projective Foliage Cover (5m interval)	30		35		40		45		50	
NOS Canopy Cover Native	20	%	20	%	30	%	10	%	10	%
NMS Mid-Storey Cover Native		%	20	%		%	20	%	20	%
EPC(c) Exotics (canopy)		%		%		%		%		
EPC(b) Exotics (mid storey)		%		%		%		%		%

Class	Value	Calculations
NGCG Native Grasses	0	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	14	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 5.2+(2+0)=3	18	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	13.5	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	8	Add **NMS** values and divide by 10

NH=2 FL: 0

Date: 23/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, __, __	Plot ID: P 39	Start:	104	293244	6224829	
Photos: 12 - 15	Orientation (°): 326	End:	105	293206	6224856	
Dimensions: □20x20, □10x40	PCT: 30F+					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Casuarina glauca	50	30				
2	Ehrharta erecta	2	200				
3	Ligust. lucid	10	40				
4	Ligust. sinense	20	300				
5	Lycium ferocissc.	30	100				
6	Solanum prin.	0.3	10				
7	Oplismenos imbecillis	10	1000				
8	Solanum mauritianum	0.2	1				
9	Pyracantha angust.	0.5	1				
10	Asparagus asparagoides	0.5	30				
11	Sida rhombifolia	0.5	200				
12	Araujia sericifera	0.2	20				
13	Solanum radicans	0.1	5				
14	Olea europea subsp. cuspi	20	50				
15	Lestrum parqui	0.2	1				
16	Carex appressa	1	150				
17	Carex longebrach.	0.2	5				
18	"Casuarina montana" Amyema cambagei	0.2	10				
19	Paspalum stramineum	0.1	1				
20	Lobelia purpurascens	0.1	30				
21	Rubus fruticosus	0.2	1				
22	Persicaria decipiens	1	100				
23	~~Sida rhombifolia~~						
24	Rumex crispus	0.2	10				
25	Cyperus eragrostis	0.1	2				
26	Micro stig stip.	30	3000				
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 29/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM RV	Plot ID: P 40	Start:	129	293000	224562	
Photos: 6359 - 6362	Orientation (°): 10	End:	130	293023	224605	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus tereticornis	40	7			C,Sc,S	
2	Casuarina glauca		9			Sc	
3	Grevillea robusta	0.4	1				
4	Olea europaea ssp. cuspidata	2	10				
5	Eragrostis curvula	10	100				
6	Solanum prinophyllum	0.6	50				
7	Sonchus asper	0.2	10				
8	Pteridium esculentum	10	150				
9	Asparagus asparagoides	5	500				
10	Hibbertia erecta	2	200				
11	Paspalum dilatatum	1	100				
12	Trichodesma repens	0.2	60				
13	Cyclospermum leptophyllum	0.1	10				
14	Cynodon dactylon	1	100				
15	Verbena bonariensis	0.2	20				
16	Sida rhombifolia	0.2	20				
17	Juncus acutus	0.2	5				
18	Araujia sericifera	0.1	10				
19	Setaria parviflora	0.2	20				
20	Rumex brownii	0.1	10				
21	Conyza sumatrensis	0.1	5				
22	Lycium ferocissimum	0.4	1				
23	Cirsium vulgare	0.2	2				
24	Onopordum acanthium	0.4	5				
25	Capparis polystachyos	0.2	10				
26	Gompholobium fruticosum	0.1	5				
27	Angophora subvelutina	1	1				
28	Nicotiana stipitata v. stipitata	10	1000				
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: **TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: **C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel:	Project no:	Site:	Plot: 40

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euca tere
	Casu glau

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Euca tere	35	65				1	
2	"	25	81		1			
3	"	25	99				1	
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 40

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	✓	X	X				X		X												X				
NGCS Native Shrubs																									
NGCO Other Natives				X		X																			
EPC(a) Exotics (groundcover/shrubs)					X			X		X	X	X	✓	X	X	X	X	X	✓	X		+	X	X	

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	20 %	10 %	20 %	20 %	20 %
NMS Mid-Storey Cover Native	%	10 %	%	%	10 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																						X	X	X	
NGCO Other Natives						X	X																		
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	✓				X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	10 %	5 %	10 %	20 %	20 %
NMS Mid-Storey Cover Native	20 %	%	%	%	10 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses	12	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	14	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 20+10=3	23.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	15.5	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	5	Add **NMS** values and divide by 10

4+2=3

Date: __/__/____	Project #: _____	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: ___,___,___	Plot ID: P 41 (cont)	Start:	_____	_____	_____	
Photos: _____–_____	Orientation (°): ____	End:	_____	_____	_____	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Cynodon dactylon	2	200				
2	Elyna variani	0.2	40				
3	Salix sessilis	0.1	10				
4	Entolasia stricta	0.4	40				
5	~~Leonardia filiformis ssp. filiformis~~						
6	~~Cotula australis~~						
7	~~Asparagus asparagoides~~						
8							
9	Isotoma fluviatilis ssp. fluviatilis	0.1	5				
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 30/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM RV	Plot ID: P 41	Start:	137	262612	224198	
Photos: 6380 - 385	Orientation (°): 270	End:	138	262577	224211	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus crebra	25	8			C,SC,S	
2	Eucalyptus tereticornis	10	1			C,	
3	Onopordum acanthium	0.4	10				
4	Ehrharta erecta	40	2000				
5	Solanum sisymbriifolium	0.4	20				
6	Einadia hastata	1	100				
7	Einadia nutans ssp. linifolia	0.4	40				
8	Eragrostis cerrula	0.2	20				
9	Dichondria repens	3	500				
10	Lysimachia arvensis	0.2	40				
11	Microlaena stipoides v stipoides	20	2000				
12	Wahlenbergia gracilis	0.1	10				
13	Veronica plebeia	0.1	10				
14	Ehrharta longiflora	1	150				
15	Chelanthes sieberi	0.1	10				
16	Conyza sumatrensis	0.4	40				
17	Cyperus gracilis	0.2	20				
18	Sonchus asper	0.2	20				
19	Crassula sieberiana	0.1	10				
20	Cotula australis	0.2	40				
21	Araujia sericifera	0.2	20				
22	Einadia nutans ssp. nutans	0.6	60				
23	Glycine microphylla	0.1	10				
24	Phytolacca octandra	0.2	20				
25	Centrum parqua	0.8	80				
26	Olea europaea ssp. cuspidata	0.2	40				
27	Oxalis perennans	0.6	120				
28	Modiola caroliniana	0.2	40				
29	Sida rhombifolia	10	400				
30	Stellaria media	0.2	40				
31	Lysimachia arvensis	0.2	40				
32	Solanum nigrum	0.4	60				
33	Solanum radicans	0.4	80				
34	Senecio madagascariensis	0.2	20				
35	Centaurium erythraea	0.1	10				
36	Asparagus asparagoides	0.2	40				
37	Cereus hexagonus	0.8	2				
38	Commelina cyanea	1	100				
39	Glycine clandestina	0.4	60				
40	Acetosella vulgaris	0.2	20				

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 30/09/2021	Personnel: RN/RM	Project no: 17072	Site:	Plot: 41

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Euc. wibra

Fallen Logs Data	
Log #	Log Length (m)
1	FL8
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 30/09/2021	Personnel: RG/RM	Project #: 17072	Site:	Plot: 41

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses														X						X					
NGCS Native Shrubs																									
NGCO Other Natives	X				X		X		X	X	X						X								
EPC(a) Exotics (groundcover/shrubs)		X	X	X		X		X				X	X		X	X		X	X		X	X	X	X	X

Projective Foliage Cover (5m interval)	5		10		15		20		25	
NOS Canopy Cover Native	20	%	10	%	10	%	20	%		%
NMS Mid-Storey Cover Native		%		%		%		%	20	%
EPC(c) Exotics (canopy)		%		%		%		%		%
EPC(b) Exotics (mid storey)		%		%		%		%		%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses					X				X																
NGCS Native Shrubs																									
NGCO Other Natives											X				X			X	X						
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X		X	X	X		X		X	X							X	X	X	X	X	X

Projective Foliage Cover (5m interval)	30		35		40		45		50	
NOS Canopy Cover Native	20	%	40	%	40	%	20	%		%
NMS Mid-Storey Cover Native	20	%	5	%	5	%	5	%	20	%
EPC(c) Exotics (canopy)		%		%		%		%		
EPC(b) Exotics (mid storey)		%		%		%		%		%

Class	Value	Calculations
NGCG Native Grasses	8	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	22	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 64+0=3	21.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	18	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	7.5	Add **NMS** values and divide by 10

14.00 FL 28

.e: 30/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM RV	Plot ID: P 42	Start:	141	292723	224023	
Photos: 6393 - 6396	Orientation (°): 0	End:	142	292729	224070	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Acacia implexa	20	35			Sc, S	
2	Sida rhombifolia	10	1000				
3	Microlaena stipoides v. stipoides	30	1500				
4	Echium plantagineus	0.2	30				
5	Senecio madagascariensis	0.4	60				
6	Sonchus asper	0.2	20				
7	Modiola caroliniana	0.1	10				
8	Rumex brownii	0.2	40				
9	Einadia nutans ssp nutans	0.4	60				
10	Oxalis perennans	0.2	100				
11	Solanum nigrum	0.1	5				
12	Grona varians	0.1	10				
13	Glycine tabacina	0.2	20				
14	Parentucellia viscosa	0.2	40				
15	Dichondra repens	0.4	100				
16	Einadia trigonos	0.2	20				
17	Stellaria media	0.4	100				
18	Cyperus gracilis	0.2	20				
19	Solanum nigrum	0.2	20				
20	Lycium ferocissimum	10	10				
21	Conyza sumatrensis	0.2	10				
22	Pseudognaphalium luteoalbum	0.1	5				
23	Centaurium erythraea	0.1	10				
24	Themeda triandra	2	200				
25	Eragrostis curvula	0.8	20				
26	Sporobolus creber	5	250				
27	Aristida ~~vag~~ ramosa	0.2	20				
28	Cynodon dactylon	0.2	20				
29	Digitaria divaricatissima	0.1	10				
30	Veronica persica	0.1	10				
31	Festuca arundinacea	0.2	20				
32	Vulpia bromoides	0.2	20				
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: **TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: **C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 30/09/2021	Personnel: RV RM	Project no: 17072	Site:	Plot: 4Z

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Acacia implexa

Fallen Logs Data	
Log #	Log Length (m)
1	60
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 30/09/2021	Personnel: RV / RM	Project #: 17072	Site:	Plot: 42

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses			X		X	X			X																
NGCS Native Shrubs																									
NGCO Other Natives								X								X								X
EPC(a) Exotics (groundcover/shrubs)	X	X		X			X			X	X	X	X	X	X		X	X	X	X	X	X	X	X	

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	30 %	5 %	5 %	5 %	40 %
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses									X			X		X	X										
NGCS Native Shrubs																									
NGCO Other Natives	X	X	X	X		X	X																		
EPC(a) Exotics (groundcover/shrubs)					X			X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	30 %	10 %	5 %	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	5 %	%

Class	Value	Calculations
NGCG Native Grasses	16	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	18	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 66+05=3	22.14	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	0	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	13	Add **NMS** values and divide by 10

FL 37 TH: 3

Date: 30/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: EM RV	Plot ID: P 43	Start:	143	292644	224014	
Photos: 6397-8[redacted]	Orientation (°): 190	End:	145	292626	223968	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Acacia decurrens	10	10			Sc, S	
2	Olea europaea ssp. cuspidata	5	10				
3	Polygala virgata	20	400				
4	Plantago lanceolata	0.2	20				
5	Themeda triandra	20	1000				
6	Hypericum perforatum	0.2	20				
7	Geranium solanderi	1	400				
8	Senecio madagascariensis	0.2	20				
9	Asparagus confertus	0.5	1000				
10	Microlaena stipoides var stipoides	10	1000				
11	Cirsium vulgare	0.2	10				
12	~~Erodium cicutarium~~						
13	Wahlenbergia communis	0.1	20				
14	Oxalis perennans	0.2	40				
15	Vicia sativa	0.2	40				
16	Rubus fruticosus	0.8	10				
17	Cymbopogon refractus	2	200				
18	Dataecas monogyna	1	1				
19	Verbena bonariensis	0.2	20				
20	Rumex brownii	0.1	10				
21	Poa sieberiana	0.2	20				
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 30/09/21	Personnel: RN KRM	Project no: 7072	Site:	Plot: 43

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Acacia dealbata

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 30/09/2021	Personnel: RV/RM	Project #: 17072	Site:	Plot: 43

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses							X		X	X	X	X								X					
NGCS Native Shrubs																									
NGCO Other Natives			X		X								X	X											
EPC(a) Exotics (groundcover/shrubs)	X	X		X		X		X					X			X	X	X	X		X	X	X	X	X

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	2 %	40 %	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	5 %	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses						X		X							X										
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X	·			X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	40 %	10 %	%	%	%

Class	Value	Calculations
NGCG Native Grasses	18	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	8	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 72 + 05+5 - 3	25.83	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	0	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	4.2	Add **NMS** values and divide by 10

NH 0 BL: 28

Date: 22/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 1a	Start:	10	292619	226034	
Photos: 6188 - ~~6188~~	Orientation (°): 45	End:	Track	292651	226078	
Dimensions: ☐20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Juncus acutus	20	80				
2	Cynodon dactylon	60	3000				
3	Rumex conglomeratus	0.4	40				
4	Cotula coronopifolia	0.2	30				
5	Ranunculus sceleratus	1	50				
6	Typha orientalis	2	80				
7	Persicaria decipiens	0.2	20				
8	Juncus usitatus	0.2	2				
9	~~Rumex sagittatos~~	~~0.1~~	~~5~~				
10	Datura stramonium	0.1	2				
11	Plantago major	0.1	5				
12	Sonchus asper	0.1	5				
13	Paspalum dilatatum	1	50				
14	Isolepis inundata	0.2	20				
15	Triglochin microtuberosum	0.1	5				
16	Plantago lanceolates	0.1	10				
17	Atriplex prostrata	0.1	5				
18	Spergularia rubra	0.1	2				
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22.9.21	Personnel: RM	Project no: 17072	Site:	Plot: 1a

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
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12	
13	
14	
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16	
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18	
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20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 22/9/21	Personnel: RM	Project #: 17072	Site:	Plot: 1a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses				x	x	x	x	x	x	x				x				x	x	x					
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	x	x	x							x	x	x	x		x	x	x				x	x	x	x	x

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses					x	x				x										x			x	x	
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	x	x	x	x			x	x	x		x	x	x	x	x	x	x	x	x		x	x			

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses 17	34	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	0	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	0	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics (33x2)+0+0 =	22	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	0	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

NPS NTH: 0 OR FL: 0

Date: 22/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF.	Plot ID: P 18	Start:	91	293958	6225897	
Photos: 181 - 184	Orientation (°): 88	End:	92	294002	6225913	
Dimensions: ☑20x20, ☐10x40	PCT: CPW					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus moluccana	25	7				
2	Olea europ cusp.	65	200				
3	Cyperus gracilis	1	500				
4	Micro stip. stip.	15	3000				
5	Dichondra repens	0.2	200				
6	Modiola caroliniana	0.2	20				
7	Verbena bonariensis	0.25	30				
8	Cirsium vulgare	0.1	5				
9	Wahlenbergia gracilis	0.1	30				
10	Oxalis perennans	0.1	20				
11	Pseudogn. luteoalb.	0.1	10				
12	Plantago debilis	0.1	30				
13	Hemarthria uncinata	5	200				
14	Fuerdia retusa	0.1	10				
15	Lysimachia arvensis	0.1	20				
16	Cerastium glomerat	0.1	20				
17	Hypericum perforat.	1	100				
18	Geranium solander.	0.3	40				
19	Brunoniella australis	0.1	3				
20	Aristida ramosa	1	50				
21	Verbena rigida	0.1	10				
22	Solanum ptinophyllum	0.1	1				
23	Solanum sisymbrii	0.5	5				
24	Lycium ferocissi	5	15				
25	Anagallis miquel.	2	15				
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 22/09/21	Personnel: BF	Project no: 17072	Site: 17072	Plot: 1B

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
R	E. mol.

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	E. mol.	20	110		11	111		1
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								?
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
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15	
16	
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See BAM sheet.

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 22/9/21	Personnel: BF	Project #: 17072	Site:	Plot: B

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	/	/	/	/	/	/	/	/	/	/		/	/		/	/			/	/	/		/	/	
NGCS Native Shrubs	/	/	/	/	/	/	/	/	/	/									/	/	/		/	/	
NGCO Other Natives	/	/	/	/	/	/	/	/	/	/															1
EPC(a) Exotics (groundcover/shrubs)							/	/			1	/	/	1	/	/	1	1	/	/		1		/	

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	35 %	60 %	40~~45~~ %	50 %	/ %
NMS Mid-Storey Cover Native	/ %	/ %	/ %	/ %	/ %
EPC(c) Exotics (canopy)	/ %	/ %	/ %	/ %	/ %
EPC(b) Exotics (mid storey)	50 %	80 %	85 %	70 %	/ %

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses		/	/	/	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	
NGCS Native Shrubs		/	/	/																			/		/
NGCO Other Natives	1	/	/	/																					/
EPC(a) Exotics (groundcover/shrubs)												1		1									/		/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	/ %	/ %	/ %	/ %	/ %
NMS Mid-Storey Cover Native	40 %	50 %	/ %	/ %	/ %
EPC(c) Exotics (canopy)	/ %	/ %	/ %	/ %	/ %
EPC(b) Exotics (mid storey)	/ %	/ %	/ %	/ %	/ %

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 29/9/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 2a	Start:	123	293602	225445	
Photos: 6343-6346	Orientation (°): 90	End:	124	293651	225446	
Dimensions: □20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Bursaria spinosa	30	30				
2	Olea europaea ssp. cuspidata	10	8				
3	Sporobolus creber	2	200				
4	Themeda triandra	1	100				
5	Lamium amplex	0.2	40				
6	Medicago polymorpha	0.2	80				
7	Sida rhombifolia	0.1	20				
8	Plantago lanceolata	0.8	230				
9	Verbena bonariensis	0.1	20				
10	Gamochaeta pensylvanica	0.4	180				
11	Paspalum dilatatum	10	1000				
12	Asperula conferta	0.2	200				
13	Lolium perenne	5	500				
14	Oxalis perennans	0.2	100				
15	Cynodon dactylon	10	1000				
16	Galium gaudichaudii ssp. gaudichaudii	0.2	100				
17	Lotus sp.	0.1	10				
18	Cyclospermum lepto	0.1	20				
19	Senecio madagascariensis	0.1	5				
20	Aristida ramosa	5	500				
21	Wahlenbergia gracilis	0.1	5				
22	Salvia sessilis	0.2	40				
23	Lysimachia arvensis	0.1	10				
24	Cirsium vulgare	0.1	5				
25	Dichondria repens	0.2	80				
26	Crona varians	0.2	40				
27	Petrorhagia dubia	0.1	16				
28	Vulpia bromoides	0.2	20				
29	Conyza sumatrensis	0.1	10				
30	Hypericum perforatum	0.2	20				
31	Facelis retusa	0.1	10				
32	Paronychia brasiliana	0.1	20				
33	Glycine tabacina	0.2	60				
34	Bothriochloa macra	1	100				
35	Microlaena stipoides var. stipoides	1	100				
36	Briza subaristata	0.2	20				
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 29.9.21	Personnel: RM	Project no: 17072	Site:	Plot: 2a

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 2a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses			✓		✓		✓	X															✓		
NGCS Native Shrubs													X	X							X		X		
NGCO Other Natives												X			✓			X		X				X	
EPC(a) Exotics (groundcover/shrubs)	X	X		X		X			X	X	✓		✓	✓		✓	✓		X		X	X			✓

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses						X	X	X		X	X		X	X			X	X							
NGCS Native Shrubs										X										X					
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	X	X	X	X	X				X			X		X	X	X			X	X	X	X	X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses 14	28	Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs	12	Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives	10	Add total **NGCO** 'hits' and multiply by 2
EPC Exotics 32x2+0+0 ÷3	21.33	[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native	0	Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native	0	Add **NMS** values and divide by 10

Date: 08/10/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, JE, __	Plot ID: P 2B	Start:	267	293549	6225990	
Photos: 94 - 97	Orientation (°): ___	End:	268	293594	6225948	
Dimensions: ☒20x20, ☐10x40	PCT: LDDW G					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Spolob creb.	30	3000				
2	Senecio mad.	1	40				
3	Verbena bonariensis	10	400				
4	Modiola caroliv.	5	500				
5	Micrairen stip. stip.	30	3000				
6	~~Senecio mad~~						
7	Carex inversa	1	1000				
8	Geranium solanderi	0.5	100				
9	Cirsium vulgare	0.1	5				
10	Conyza sumatrensis	0.1	10				
11	Polygala virgata	0.25	3				
12	Cymbodon / dactylon	5	500				
13	Paspalum dilatatum	5	500				
14	B.oth. maced	10	1000				
15	Sida rhomb.	1	100				
16	Sisymbrium irio	2	100				
17	Plantag lanceolata	0.1	20				
18	Oxalis perennans	0.1	20				
19	Sonchus asper	0.2	20				
20	Solanum nigrum	0.1	2				
21	Hypochaeris aveusis	0.25	100				
22	Verbascum virgatum	0.2	30				
23	Eragrost. curvula	1	20				
24	Chloris ventricosa	1	100				
25	Hypericum perfor.	0.5	50				
26	Paronych. ? brasil.	0.1	30				
27	Cynod. brownii	0.1	5				
28	~~Petrorhagia~~ Erodium cicutum	0.1	2				
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 8/10/2021	Personnel: JF, BF	Project no: 17072	Site: Menangle Pk.	Plot: 2B

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
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12	
13	
14	
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Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of trees with hollows

Date: 8/10/2021	Personnel: JF, BF	Project #: 17072	Site: Menagle Pk	Plot: 2B

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	0 %	%	%	%	%
NMS Mid-Storey Cover Native	0 %	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

BAM PLOTS

Date: 5/10/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P 3a	Start:	159	292843	222819	
Photos: 6466 - 6469	Orientation (°): 5	End:	160	292854	222869	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Poa sieberiana v. sieberiana	40	800				
2	Paspalum dilatatum	10	500				
3	Plantago lanceolata	0.4	80				
4	Rubus fruticosus	3	20				
5	Oxalis corniculata	0.4	120				
6	Lysimachia arvensis	0.4	110				
7	Lotus uliginosus	0.2	20				
8	Verbena bonariensis	0.2	20				
9	Hypericum perforatum	0.1	20				
10	Aristida ramosa	II	100				
11	Conyza sumatrensis	0.1	10				
12	Hypochaeris radicata	0.2	40				
13	Microlaena stipoides v. stipoides	5	500				
14	Cynodon dactylon	20	1000				
15	Lolium perenne	5	500				
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc., up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: **TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: **C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel: RM	Project no:	Site:	Plot: 32

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	0
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 5/10/21	Personnel: RM	Project #: 1702	Site:	Plot: 3a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses		X	X	X		X	X		X				X	X	X	X			X	X	X	X	X	X	
NGCS Native Shrubs																									
NGCO Other Natives								·																	
EPC(a) Exotics (groundcover/shrubs)	X				X			X		X	X	X					X	X							X

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	X		X	X		X	X			X	X			X		X	X		X			X			
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)		X			X			X	X			X	X		X			X		X	X		X	X	X

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 09/10/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF. JF.	Plot ID: P 36	Start:	269	293818	6225741	
Photos: 98 - 101	Orientation (°): 65	End:	270	293818	6225843	
Dimensions: □20x20, □10x40	PCT: ONG (LO)					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Verbena bonariensis	15	1000				
2	Gomphocarpus fruti c.	0.3	5				
3	Senecio madagas C.	10	1000				
4	M. clo. stip. stip	25	2500				
5	Plantago lan'c.	0.25	40				
6	Eragrostis leptostach	5	500				
7	Modiola caroliniana	0.5	50				
8	Both. massa	5	500				
9	Verbascum virgatum	1	50				
10	Sida rhomb.	1	100				
11	Lysimachia arvensis	0.5	100				
12	Stachys arvensis	1	40				
13	Eragrostis trigonos	0.1	10				
14	Themeda triandra	5	300				
15	Carex inversa	0.5	500				
16	~~Plantago lanceolata~~						
17	Cyperus gracilis	0.1	10				
18	Olea europaea cuspi	0.4	1				
19	Eragrostis curvula	1	50				
20	Hyperi. cum perforatum	0.5	35				
21	Cynodon dactylon	5	500				
22	Desmodium varians	0.1	3				
23	Eriochloa pseudoac.	0.1	10				
24	Aristida ramosa	0.3	80				
25	Chloris ventricosa	1	100				
26	Paspalum dilatatum	1	100				
27	Verbena rigida	0.2	10				
28	Geranium solander.	0.25	20				
29	Both dwip dwip.	30	3000				
30	Sporob creber	30	3000				
31	Dichelachne micrantha	0.1	5				
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 08/10/2021	Personnel: JF, BF	Project no: 17072	Site: Menangle Pk	Plot: 3B

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 08/10/2021	Personnel: JF, BF	Project #: 17072	Site: Macaugle Pk	Plot: 3B

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 05/11/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, SR, __	Plot ID: P 4A	Start:	1085	_____	_____	
Photos: 106 - 109	Orientation (°): 280	End:	1086	_____	_____	
Dimensions: □20x20, □10x40	PCT: Freshwater Wetland					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Galium aparine	1.5	50				
2	Typha orientalis	15	1000				
3	Salix euroaea subsp cuyp.	1	2				
4	Apium graveolens	0.5	100				
5	Bromus hordeaceus	1	100				
6	Rumex conglomeratus	2	100				
7	Bromus catharticus	1	160				
8	Juncus acutus	30	100				
9	Vicia sativa	0.1	10				
10	~~Rumex conglomeratus~~						
11	Plantago major	0.2	20				
12	Atriplex prostrata	0.1	20				
13	Cyperus eragrostis	0.1	10				
14	Schoenoplectus acutus	0.1	5				
15	Cynodon dactylon	30	3000				
16	Isolepis cernua	0.1	5				MP02
17	Poly. cristatum (s)	0.2	20				MP01
18	Lolium perenne	1	100				
19	Stellaria media	0.1	10				
20	Paspalum dilatatum	5	500				
21	Other evergreen or Rubus fruticosus	10	100				
22	~~Galium aparine~~						
23	~~Schoenoplectus acutus~~						
24	Trema tomentosa	0.25	1				
25	Lythrum hyssopifolia	0.2	30				
26	Lysimachia arvensis	0.1	10				
27	~~Vicia sativa~~						
28	Cenchrus clandestinus	1	100				
29	Hypochaeris radicata	0.1	10				
30	Festuca sp.	0.5	30				MP03
31	Asparagus officinalis	0.1	1				
32	Medicago polymorpha	0.1	20				
33	Cirsium vulgare	1	20				
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 15/11/21	Personnel: HG/JF	Project no: 17072	Site: Menangle Park	Plot: 4a

CUMBERLAND ECOLOGY

Freshwater Wetlands

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 15/11/2021	Personnel: HG/JF	Project #: 17072	Site: Morongla Park	Plot: 4A

CUMBERLAND ECOLOGY

Freshwater Wetlands

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses				/	/								/		/	/			/		/		/		/
NGCS Native Shrubs																									
NGCO Other Natives	/								/																
EPC(a) Exotics (groundcover/shrubs)	/	/	/			/	/	/		/	/	/		/		/	/	/		/	/	/		/	

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	/			/		/		/			/	/						/			/		/		
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/		/		/		/	/			/	/	/	/	/		/	/		/		/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 09/10/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE. JE.	Plot ID: P 43	Start:	271	293891	6225847	
Photos: 102 - 105	Orientation (°): 331	End:	272	293872	6225893	
Dimensions: ☑20x20, ☐10x40	PCT: DNG					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Verbena bonariensis	3	300				
2	Lysimachia arvensis	1	50				
3	Lemeda triandra	70	5000				
4	Senecio madagasc.	1	100				
5	Olea europaea cuspidata	0.25	1				
6	Sonchus asper	0.2	5				
7	Sida rhombifolia	1	100				
8	Setaria parviflora	1	100				
9	Dichondra repens	0.1	20				
10	Oxalis penerrans	0.1	10				
11	Verbena rigida	0.5	50				
12	Paronychia brasil.	0.1	10				
13	Sherardia arvensis	0.1	30				
14	Wahlenbergia gracilis	0.1	5				
15	Facelis retusa	0.1	10				
16	Plantago lanceolata.	0.2	30				
17	Hypericum perforatum	0.5	50				
18	Zornia dyctio.	0.1	1				
19	Cynodon dactylon	1	100				
20	Cyperus gracilis	0.1	20				
21	Plantago debilis	0.1	3				
22	Desmodium varians	0.1	2				
23	Romulea rosea var. aust.	0.1	20				
24	Richardia stellaris	0.1	10				
25	Panicum effusum	0.1	5				
26	Aristida ramosa	1	100				
27	Sida corrugata	0.1	10				
28	Chloris ventricosa	5	500				
29	Carex inversa	0.1	30				
30	Verbena quadrangul.	0.1	1				
31	Glycine tabacina	0.1	3				
32	Medicia carolin:ana	0.3	50				
33	Linum trigynum	0.1	10				
34	Eragrostis curvula	2	100				
35	Nicotiana stip stip.	20	2000				
36	Sporobolus creber	5	300				
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 08/10/2021	Personnel: JF, BF	Project no: 17072	Site: Menangle Pk	Plot: ~~B~~ 4B

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of trees with hollows

Date: 08/10/2021	Personnel: JF, BF	Project #: 17072	Site: Menangle PK	Plot: 4B

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 5/11/2021	Project #: 17022	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF, SR, __	Plot ID: P 5A	Start:	108	_____	_____	
Photos: ~~088~~ 110 - ~~092~~ 113	Orientation (°): 286	End:	107	_____	_____	
Dimensions: □20x20, □10x40	PCT: Swamp Oak					Sheet: 1 of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Ligust. sinense	15	200				
2	Rumex conglem	0.2	3				
3	Verbena bonar.	0.1	2				
4	Carex appressa	35	2000				
5	Phalaris aquat	0.1	1				
6	Callitriche stagn	0.5	200				
7	Eleocharis sp.	25	2500				MP04
8	Rubus fruticc.	0.2	3				
9	~~Ligustrum sinense~~						
10	~~Eleocharis~~ Isolepis prolif.	0.1	5				
11	Winter cress	0.1	10				
12	Persicaria decipiens	0.5	20				
13	Isolepis cernua	0.1	50				MP02
14	Ehrharta erecta	20	2000				
15	Cyperus multiflorus	0.2	5				
16	Juncus usitatus	0.1	1				
17	Ligustrum lucidum	10	10				
18	Bromus cathart.	1	100				
19	Hachnagrostis fil	0.1	5				
20	Olea europaea subsp. cusp.	0.75	5				
21	Asparagus asparagoides	0.2	10				
22	Lactuca saligna	0.1	1				
23	Apium graveolens	0.2	20				
24	Cirsium vulgare	0.1	1				
25	Araujia sericifera	0.2	5				
26	Galium aparine	0.1	2				
27	Poly. cristat.	0.1	5				
28	Casuarina glauca	55	60				
29	Ba-like	0.25	30				MP05
30	Euphorbia peplus	0.1	2				
31	Solanum pseudo capsicum	1	20				
32	Modiola caroli.	0.1	5				
33	Asparagus officinalis	0.1	1				
34	Ulmus glabra	3	1				MP06
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel:	Project no: 17072	Site: Menangle Park	Plot: 59 SOIF

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	Casuarina

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	Stag	8	35	1	1			
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	1
2	1
3	7.5
4	2.5
5	5
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel: HG	Project #: 17072	Site: Menangle Park	Plot: 5a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives		/																							
EPC(a) Exotics (groundcover/shrubs)	/			/		/			/			/			/			/	/		/				/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	0 %	0 %	10 %	40 %	55 %
NMS Mid-Storey Cover Native	0 %	0 %	0 %	0 %	0 %
EPC(c) Exotics (canopy)	0 %	0 %	0 %	0 %	0 %
EPC(b) Exotics (mid storey)	90 %	90 %	90 %	80 %	5 %

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses					/	/									/			/	/	/					
NGCS Native Shrubs																									
NGCO Other Natives															/	/					/		/		
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/									/	/							/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	80 %	70 %	20 %	90 %	60 %
NMS Mid-Storey Cover Native	0 %	0 %	0 %	0 %	5 %
EPC(c) Exotics (canopy)	0 %	0 %	0 %	0 %	0 %
EPC(b) Exotics (mid storey)	40 %	0 %	0 %	0 %	5 %

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 08/09/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF, JE, __	Plot ID: P B5B	Start:	273	293131	6226291	
Photos: 106 - 109	Orientation (°): ___	End:	274	293180	6226274	
Dimensions: □20x20, □10x40	PCT: DNE - low native coverage/diversity					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Aristida ramosa	20	2000				
2	Paspalum dilatatum	20	2000				
3	Briza subaristata	30	3000				
4	Hypericum gramineum	0.25	100				
5	Verbena bonar. ensis	0.2	10				
6	Plantago lanceolata	1	200				
7	Atonopus fissifolius	5	500				
8	Briza minima	1	100				
9	Cynodon dactylon	10	1000				
10	Conyza sumatrensis	0.1	20				
11	Linum trigynum	0.1	100				
12	Poa sieberiana	1	100				
13	Lysimachia arvensis	0.25	100				
14	Verbena rigida	0.25	20				
15	Paspalum dilatatum	15	1500				
16	Cirsium vulgare	0.1	10				
17	Setaria parv. flora	1	100				
18	Oxalis perennans	0.1	20				
19	Sporobolus creber						
20	Lemeda triandra	3	200				
21	Carex inversa	1	1000				
22	Asplenia confert	0.1	20				
23	Medicago minima	0.1	10				
24	Sporobolus creber	5	500				
25	Vicia sativa	0.1	10				
26	Micro stip stip	20	3000				
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 08/10/2021	Personnel: JF, BF	Project no: 17072	Site: Menangle Pk.	Plot: 5B.

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of trees with hollows

Date: 08/10/2021	Personnel: JF, BF.	Project #: 17072	Site: Menangle Pk	Plot: 5B

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 05/11/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF FR	Plot ID: P 6A	Start:	109			
Photos: 114 - 117	Orientation (°): 130	End:	110			
Dimensions: ☒20x20, ☐10x40	PCT: DNG					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Glycine tab.	0.1	10				
2	Sida corrugata	0.1	20				
3	Plantag lanceolata	0.2	100				
4	Desmodium varians	0.1	30				
5	Micro chip chip	65	6500				
6	Oxalis perenn.	0.1	10				
7	Galium aparine	0.1	5				
8	Brunoniella australis	0.1	10				
9	Hypericum perforatum	0.3	50				
10	Briza subaristata	10	1000				
11	Vulpia bromoides	1	100				
12	Eragrostis curvula	1	50				
13	Bromus hordeaceus	5	500				
14	Verbena bonariensis	0.2	3				
15	Rumex brownii	0.2	20				
16	Anthosachne scab.	1	100				
17	Carex inversa	0.5	1600				
18	Themeda triandra	10	1000				
19	Poa sieberiana	1	100				
20	Aperula conferta	0.1	20				
21	Dichelachne micrantha	0.5	50				
22	Paspalum dilatatum	10	1000				
23	Bothriochloa macra	5	500				
24	Cynodon dactylon	10	1000				
25	Linum marginale	0.1	5				
26	Aristida ramosa	15	1500				
27	Einadia trigonos	0.1	10				
28	Sida rhombifolia	0.1	20				
29	Einadia nutans	0.1	2				
30	Cheilanthes sieberi	0.1	10				
31	Brachyscome microphylla	0.1	5				
32	Linum trigynum	0.1	20				
33	Eragrostis leptostachya	1	100				
34	Lysimachia arvensis	0.1	20				
35	Hypericum gramineum	0.1	20				
36	Bursaria spinosa	0.75	1				
37	Sonchus asper	0.1	5				
38	Hypochaeris radicata	0.1	20				
39	Both. deip deip	0.1	10				
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 15/11/2021	Personnel: JF/HG	Project no: 17072	Site: Mona Vale Park	Plot: 6a

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 15/11/21	Personnel: JF/MG.	Project #: 1707a	Site: Menangle Park	Plot: 69

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	/	/				/	/							/	/	/					/		/		
NGCS Native Shrubs																					/		/		
NGCO Other Natives	/		/			/	/	/		/	/	/	/	/						/	/	/			
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses					/									/			/								
NGCS Native Shrubs																									
NGCO Other Natives							/				/														
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 08/12/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, JE, __	Plot ID: P 66	Start:	276	292819	6226361	
Photos: 110 - 113	Orientation (°): 109	End:	275	292867	6226350	
Dimensions: ☑20x20, ☐10x40	PCT: PNG					Sheet: 1 of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Avistida ramosa	25	2500				
2	Tremeda triandra	10	1000				
3	Plantago lanc.	20	2000				
4	Cirsium vulgare	0.25	10				
5	Vicia sativa	0.1	10				
6	Senecio mad.	1	100				
7	Verbena bonariensis	0.25	10				
8	Hypericum perforatum	1	100				
9	Asperula conferta	0.1	20				
10	Wahlenbergia gracilis	0.1	10				
11	~~Asperula conferta~~						
12	Bromus hord.	20	2000				
13	Lolium perenne	10	1000				
14	Linum trigynum	0.1	50				
15	Setaria pal.	10	1000				
16	Lysimachia arensis	0.3	50				
17	Verbena quadrang.	0.2	10				
18	Bath. dulc / dulc.	1	100				
19	Briza subar.	1	100				
20	Evax sp. cnVV.	0.5	20				
21	Spergh. creber	1	100				
22	Oxalis perenn	0.1	10				
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 08-10-2021	Personnel: BF, JF	Project no: 17072	Site: Menangle Pk	Plot: 6B

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 08-10-2021	Personnel: JF, BF.	Project #: 17072	Site: Menangle Pk	Plot: 6B

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 05/11/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF, SR, __	Plot ID: P 74	Start:	111	_____	_____	
Photos: 118 - 121	Orientation (°): 103	End:	112	_____	_____	
Dimensions: □20x20, □10x40	PCT: Tot Grass.					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Plantago lanc.	5	5000				
2	Rosa rubiginosa var. aust.	0.1	100				
3	Bromus hordeaceus	40	40000				
4	Senecio madagascariensis	0.5	100				
5	Oxalis perrieri	0.1	30				
6	Paspalum dilatatum	50	5000				
7	Verbena bonariensis	0.2	5				
8	Carex inversa	0.1	20				
9	Sida rhomb.	0.2	50				
10	Cirsium vulgare	0.3	5				
11	Conyza bonar.	0.1	3				
12	Verbena rigida	0.2	20				
13	Hypericum perfor.	0.5	100				
14	Petrorhagia dubia	0.1	30				
15	Hypochaeris radic.	0.1	20				
16	Lysimachia arvensis	0.1	30				
17	Cyclospermum leptophy	0.1	20				
18	Aristida ramosa	2	100				
19	Briza subaristata	5	500				
20	Holcus perenne	5	500				
21	Muhlenbergia gracilis	0.1	10				
22	Gamochaeta americ.	0.1	20				
23	Lotus uliginosus	0.2	100				
24	Vicia sativa	0.1	10				
25	~~Eragrostis curvula~~						
26	Poa sieberiana	0.2	20				
27	Cynodon dactylon	10	1000				
28	Medicago polymorpha	0.1	10				
29	Nassella hebeclada	1	50				
30	Conyza sumatrensis	0.2	20				
31	Setaria parviflora	0.1	20				
32	Eragrostis curvula	1	50				
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel: HG	Project no: 17073	Site: Nerang le Park	Plot: 74 Exotic Grassland.

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
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12	
13	
14	
15	
16	
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18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel: HC	Project #: 17073	Site: Menagle Park	Plot: 7a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses		/								/		/	/								/				
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses									/	/	/				/								/		
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 08/10/2024	Project #: 17077	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF. JE.	Plot ID: P7B	Start:	278	292888	6226414	
Photos: 114 - 117	Orientation (°): 109	End:	277	292937	6226403	
Dimensions: □20x20, □10x40	PCT: DNG (very LO)					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Sporob. actes	5	500				
2	Hypericum perf.	0.5	40				
3	Plantago lanc.	1	1000				
4	Bromus hord.	30	3000				
5	Sporobolus Vulpes brom	1	300				
6	Setaria parv	10	1000				
7	Dactis perenn	0.1	10				
8	Senecio madagasc.	3	100				
9	Lysimachia arvensis	0.25	50				
10	Geranium Solander?	0.25	30				
11	Faeelis retro?	0.1	20				
12	Sonchos oleer	0.1	5				
13	Cirs.um vulgare	0.5	20				
14	Avistida ram	20	2000				
15	Carex inuncl	1	1000				
16	Micro stip stip.	20	2000				
17	Vicia sativa	0.1	20				
18	Both. deeip deeip.	1	100				
19	Eragrostis curvula	10	1000				
20	Carthamus lanatus	0.1	1				
21	Medicago arrab.	0.1	20				
22	Cynodon dact	1	100				
23	Paspalum dil.	1	100				
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 08-10-2021	Personnel: JF, BF	Project no: 17072	Site: Menangle Pk	Plot: 7B

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
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13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of trees with hollows

Date: 08-10-2021	Personnel: JF, BF.	Project #: 17072	Site: Menangle PK	Plot: 7B

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 05/11/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE, SR,	Plot ID: P 8A	Start:	113			
Photos: 122 - 125	Orientation (°): 184	End:	114			
Dimensions: ☒20x20, ☐10x40	PCT: Exot grass					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Briza subaris.	65	6500				
2	Senecio madagasc.	1	100				
3	Rubus fruti.	4	30				
4	Nassella neesiana	5	500				
5	Verbena rigida	0.25	30				
6	Verbena bonariensis	0.2	20				
7	Plantag lanceolata	1	200				
8	Chloris gayana	1	40				
9	Gamochaeta americanum	0.1	10				
10	Cirsium vulgare	0.1	2				
11	Hypochaeris radic.	0.1	30				
12	Hypericum gramineum	0.1	20				
13	Hypochaeris micro.	0.1	2				
14	Bidgstrum sinense	0.1	1				
15	Lolium perene	5	500				
16	Paspalum dilatatum	20	2000				
17	Vicia sativa	0.1	30				
18	~~Verbena bonariensis~~						
19	Both. decip decip.	0.1	10				
20	Cynodon dactylon	1	100				
21	Bromus hordaceus	1	100				
22	Axonopus fissifol.	0.3	50				
23	Asperula conferta	0.1	10				
24	Vulpia bromoides	0.3	100				
25	Eragrostis curvula	1	~~100~~ 50				
26	Sporobolus creb.	0.5	50				
27	Poa sieberiana	1	160				
28	Oxalis perennans	0.1	20				
29	Cerastium sumatrense	0.1	10				
30	Briza minor	0.1	2				
31	Carex inversa	0.1	20				
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel: MG	Project no: 17072	Site: Menangle Park	Plot: 89

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
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13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel: MC	Project #: 17072	Site: Menangle Park	Plot: 89

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	/	/		/							/					/	/				/	/	/		/
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses					/	/		/				/						/					/	/	
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 05/11/2021	Project #: L7022	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF, SR.	Plot ID: P 9A	Start:	115			
Photos: 126 - 127	Orientation (°): 100	End:	116			
Dimensions: ☐20x20, ☐10x40	PCT: Exot. grass					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Briza subalst.	70	7000				
2	Senecio mad.	1	100				
3	Geranium solanderi	0.2	10				
4	Verbena bonariensis	0.25	10				
5	Paspalum dilatatum	15	1500				
6	Plantago lanc.	1	200				
7	Spotob. creber	1	100				
8	Setaria parv.	0.1	10				
9	Hypericum perfor.	0.1	10				
10	Cirsium vulgare	0.1	3				
11	Vicia sativa	0.1	50				
12	Verbena rigida	0.1	10				
13	Hypochaeris radicata	0.5	200				
14	Vulpia bromoides	2	500				
15	Themeda triandra	0.5	50				
16	Bromus hordaceus	10	1000				
17	Conyza sumatrensis	0.1	20				
18	Carex inversa	0.1	50				
19	Nassella neesiana	5	500				
20	Oxalis perennans	0.1	10				
21	Hypochaeris micro.	0.1	5				
22	Medicago polym.	0.1	20				
23	Gamochaeta ? americ	0.1	20				
24	Lotus uliq.	0.1	50				
25	Lolium perenne	1	100				
26	Poa sieberiana	0.5	30				
27	Romulea rosea	0.1	50				
28	Centaurium tenuif.	0.1	10				
29	Micro stig. stig.	2	200				
30	Aristida ramosa	1	50				
31	Eragrostis curvula	0.5	20				
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel: HG	Project no: 17072	Site: Manangle Park	Plot: 9a Exotic grassland

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
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18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel: UC	Project #: 17071	Site: Menagle Park Exotic Grassland	Plot: 94

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses					/	/		/		/	/						/								
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses		/			/							/	/						/						
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 05/11/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: JF, BF, JR	Plot ID: P 10a	Start:	164	222496	293098	
Photos: 001 - 004	Orientation (°): 273	End:	165	222501	293098	
Dimensions: ☑20x20, ☐10x40	PCT: Exotic grassland.					Sheet: 1 of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Ligustrum lucidum	20	12				
2	Eragrostes curvular	30	250				
3	Verbena rigida	5	120				
4	Briza minor.	0.5	100				
5	lycimachia arvensis.	0.5	100				
6	Conchus clandestinus.	5	50				
7	cynodon dactylon.	10	1000				
8	Senecio madagascarensis.	0.2	50				
9	Conyza bonariensis.	0.2	50				
10	Oxalis. perenens.	0.1	50				
11	Plantago lanceolata.	0.1	30				
12	Cirsium vulgar.	0.2	50				
13	Vicia sativa.	0.1	50				
14	Sida rhombifolia.	0.2	40				
15	Modiola caroliniana.	0.1	30				
16	Nassela neesiana.	0.2	20				
17	Bromus hordeaceus	0.1	30				
18	Hypochaeris radicata.	0.1	20				
19	Solanum sisymbifolia.	0.1	10				
20	cheilanthes sieberi	0.5	60				
21	Cyperus gracilis.	0.2	20				
22	Ligustrum sinense.	0.1	5				
23	Gamochaeta americana.	0.2	100				
24	microlaena stipoides.	0.1	50				
25	Lantana camara.	0.2	10				
26	nassella hyalina	0.2	50				
27	Rubus fruticosus.	0.1	5				
28	sonchus oleraceus.	0.1	10				
29	Gamphocarpus fruticosus.	0.1	1				
30	Olea europea cusp.	0.1	5				
31	Acacia decurrens	0.1	1				
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: **TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: **C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 15/11/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: JE, HG, __	Plot ID: P 11a	Start:	001	0291800	6225606	
Photos: _____-_____	Orientation (°): 91	End:	002	0291853	6225603	
Dimensions: ⊟20x20, □10x40	PCT:					Sheet: __ of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Ligustrum lucidum	50	120				
2	Ligustrum sinense	5	40				
3	Ulmus glabra	30	10				
4	Gleditsia triacanthos	0.1	1				
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel:	Project no:	Site:	Plot: 11a

CUMBERLAND ECOLOGY

No natives.

Regenerating Canopy Species	
R	Species
	L.lucidum
	L.sinense.
	U.glabra.
	Acacia sp.

Fallen Logs Data	
Log #	Log Length (m)
1	3
2	2.5
3	1
4	3.5
5	2
6	1
7	4.5
8	5
9	2
10	3
11	1.5
12	
13	
14	
15	
16	
17	
18	
19	
20	

29m

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4	No natives							
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 11a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)					1		1			1															

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	90 %	80. %	70 %	80 %	85 %
EPC(b) Exotics (mid storey)	10 %	20 %	10 %	10 %	10 %

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	1	1		1						1						1		1		1			1		

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	85 %	90 %	20 %	60 %	80
EPC(b) Exotics (mid storey)	10 %	10 %	80. %	40 %	10 %

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 15/11/2021	Project #:	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: JF.	Plot ID: P 12 a	Start:	003	0292311	6225588	
Photos: 5 - 8	Orientation (°): 129	End:	004	0292340	6225546	
Dimensions: ☑20x20, □10x40	PCT: RFEF.					Sheet: 1 of

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus amplifolia.	30	3				
2	Allocasuarina cunninghamiana.	5	1				
3	Nassella neesiana.	10	500				
4	Vicia sativa.	0.5	50				
5	Ligustrum sinense.	0.2	50				
6	Ligustrum lucidum	0.1	5				
7	Plantago lanceolata.	0.1	20				
8	Sonchus oleraceus.	0.1	20				
9	Poa labil labil	0.2	100				
10	Taraxacum officinale.	0.1	20				
11	Rumex crispus.	0.2	50				
12	Asparagus asparagus.	0.1	20				
13	Araujia sericifera.	0.1	10				
14	sida rhombifolia	0.2	50				
15	Olea europea cosp.	0.1	5				
16	Cirsium vulgare	0.1	10				
17	Senecio vsitatus.	0.2	10				
18	Bromus catharticus.	0.1	50				
19	~~Asparagus asparagoides~~	~~0.1~~	~~5~~				
20	Asparagus officinalis	0.1	5				
21	grass sp.1 blueish Phalaris paradoxa	10.	1500				
22	glycine sp. dark	0.1	30				
23	Briza minor	0.1	50				
24	Eragrostis curvula.	0.1	20				
25	Verbena bonariensis.	0.1	10				
26	conchus clandestinus.	0.1	20				
27	Cyperus eragrostis.	0.1	20				
28	medicago polymorpha.	0.2	50				
29	Rubus fruticosus.	0.1	5				
30	Conyza bonariensis.	0.1	10				
31	Modiola caroliniana	0.1	30				
32	Cynodon dactylon.	0.2	100				
33	Carex appressa.	0.1	40				
34	Ulmus glabra.	0.1	1				
35	Brassica rapa.	0.1	5				
36	Geranium solandra.	0.1	10				
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel:	Project no:	Site:	Plot: 129

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
	casuarina coming.

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1	casuarina coming							
2								
3								
4								
5								
6	None.							
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel:	Project #:	Site:	Plot: 12a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses								1	1							1	1								
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	1	1	1	1	1	1	1			1	1	1	1	1	1			1	1	1	1	1	1	1	1

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	5 %	50 %	%	%
NMS Mid-Storey Cover Native	%	5 %	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses									1			1											1		
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	1	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1	1	1	1	1		1	1

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	55 %	60 %	5 %
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: __/__/____	Project #: _____	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: JF, HG, __	Plot ID: P 139	Start:	005	0292523	6225919	
Photos: 9 - 12	Orientation (°): 71	End:	006	0292574	6225931	
Dimensions: □20x20, □10x40	PCT: Exotic grassland.					Sheet: 1 of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Plantago lanceolata	20	1500				
2	Taraxicum officionale	15	1000				
3	Senecio madagascariensis.	0.5	100				
4	Bromus ~~arbaricus~~ hordeaceus.	20	1000				
5	Vicia sativa.	0.1	50				
6	cynodon dactylon.	0.5	500				
7	Hypochoeris radicata.	0.1	50				
8	paspalum dilatatum	20	1000				
9	Briza minor	2	1000				
10	rumex crispus.	0.1	20				
11	Conyza bonariensis.	0.1	50				
12	Verbena rigida	0.2	100				
13	gamochaeta americana	0.1	20				
14	oxalis corniculata.	0.1	20				
15	Hypochoeris radicata.	5	150				
16	Verbena bonariensis.	0.5	40				
17	Microlaena stipoides	05	50				
18	Eragrostis curvula.	0.5	10				
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel: HG	Project no: 17072	Site: Menangle Park	Plot: 13a Exotic Grassland in CA

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel: HC/JF	Project #: 17072	Site: Menangle Park	Plot: 13a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)																									

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: __/__/____	Project #: _____	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: JF, MG, __	Plot ID: P 1Ha	Start:	009	0293562	6224638	
Photos: 17 - 20	Orientation (°): 0	End:	010	~~6224638~~	6224623	
Dimensions: ☑20x20, ☐10x40	PCT: Exotic grassland. 029351 4					Sheet: 1 of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Themeda triandra.	15	800.				
2	Briza minor.	20	2000				
3	Verbena bonariensis.	5	150.				
4	Rubus fruticosus.	1	50				
5	Eragrostis curvular	3	50				
6	Verbena rigida.	10	500				
7	Paspalum dilatatum	10	1000				
8	Cynodon dactylon.	5	500				
9	Hypericum gramineum	5	600				
10	Cirsium vulgare	0.1	20				
11	Plantago lanceolata.	5	500				
12	Onopordum acanthium	0.1	5				
13	Lythimachia arvensis.	0.1	10				
14	~~Climbing groundcover sp. sample+photo~~	~~0.1~~	~~10~~				
15	~~grass sp. sample not ID~~	~~0.1~~	~~50~~				
16	~~Stackhousia viminea~~						
17	Stackhousia viminea	0.1	10				
18	Phalaris paradoxa	0.1	50				
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel: MG/JT	Project no: 17072	Site: Menang'e Park	Plot: 14a

CUMBERLAND ECOLOGY

Exotic Grassland in CE

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel: JF/MG	Project #: 17072	Site: Menangle Park	Plot: 10a (10m)

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	/			/	/		/	/		/	/										/				
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/		/	/	/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: __/__/____	Project #: _____	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: JF, HG, __	Plot ID: P 15a	Start:	011	0293288	6229565	
Photos: 21 - 24	Orientation (°): 155	End:	012	0293296	6229518	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: 1 of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eragrostis curvular.	60	400				
2	Verbena rigida.	5	300				
3	Senecio madagascariensis	0-5	50				
4	~~Centella asiatica hookerlike sp.~~		~~160~~				
5	Hibbertia, ~~procumbens~~ diffusa	5	160				
6	Verbena bayariensis.	2	150				
7	Themeda triandra	3	60				
8	Conyza bonariensis.	0-5	50				
9	~~sml. spikey ground cover sp.~~	~~0-1~~	~~20~~				
10	Oxalis. corniculata.	0-2	50				
11	Rumex acetosella.	2	200				
12	Lycium ferocissimum.	0-1	20				
13	Verbascum virgatum	0-1	40				
14	Hydrocotyle. hirta.	2	50				
15	~~Aloe (Verbena?) sp. sample plot~~	~~0-1~~	~~20~~				
16	Cynodon dactylon.	0-2	150				
17	Opuntia stricta.	0-1	5				
18	Gonocarpus. penn.	0-1	10				
19	Heliotropium amplexicaule	0.1	20				
20	Stackhousia viminea	0.1	20				
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel: HL	Project no: 17072	Site: Menangle Park	Plot: 159

CUMBERLAND ECOLOGY

Exotic next to Park K
EBSF

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel: HG/JF	Project #: 17072	Site: Menangle Park	Plot: 15a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	/					/	/			/															
NGCS Native Shrubs																									
NGCO Other Natives		/														/	/	/					/		/
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses		/						/		/															
NGCS Native Shrubs																									
NGCO Other Natives				/	/							/	/												
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: __/__/____	Project #: _____	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: JF, HG.	Plot ID: PLEa	Start:	013	~~0292788~~ ✓	~~6225376~~ 6225376	
Photos: 25 - 28	Orientation (°): 0	End:	014	~~6225376~~	6225419	
Dimensions: ☒20x20, ☐10x40	PCT: Exotic grassland			0292758		Sheet: 1 of __

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	cynodon dactylon.	5	250				
2	cenchrus clandestinus.	20	1000				
3	Taraxicum officinale	5	800				
4	Hypocharis radicata.	1	200				
5	gras sp. 1 sample + photo. Eng. cuvula	1	50				
6	~~grass sp. 2. lolium perenne~~	~~1~~	~~50~~				
7	Plantago lanceolata.	5	250				
8	lolium perene.	5	500				
9	gras sp 3 poa annua	1	50				
10	Trifolium repens.	5	250				
11	Ehrharta erecta.	1	50				
12	Rubus. fruticosus.	0.5	10				
13	senecio madagascariensis.	0.1	40				
14	Cyperus aggregatus.	0.1	50				
15	Rumex crispus.	0.5	50				
16	Verbena bonariensis.	0.5	50				
17	Bromus catharticus.	2	250				
18	medicago polymorpha.	5	500				
19	Rosa sp. canina	0.1	5				
20	Lycimachia arvensis.	0.1	50				
21	Geranium solanderi	0.2	50				
22	Hypericum perforatum	0.1	20				
23	Sparaxis creber.	0.1	20				
24	Bromus hordeaceus.	0.5	100				
25	Cirsium vulgare.	0.1	10				
26	Microlaena stipoides.	0.1	20				
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**

Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other

Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date:	Personnel: HG/JF	Project no: 17072	Site: Menangle Park	Plot: 16a

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date:	Personnel: MG/JT	Project #: 17072	Site: Menangle Park	Plot: 16a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses																									
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 03/11/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE.	Plot ID: P17a 1	Start:	86	292646	6224076	
Photos: 66 - 69	Orientation (°): 281	End:	87	292594	6224081	
Dimensions: □20x20, □10x40	PCT: Western Grassland - Low Tussocks					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Themeda triand.	50	5000				
2	Sonchus asper	0.1	5				
3	Paspalum dilatatum	20	2000				
4	Hypericum perf.	0.5	200				
5	Oxalis perennans	0.1	30				
6	Lysimachia arvensis	0.2	100				
7	Carex inversa	0.1	50				
8	Geranium soland.	0.5	40				
9	Linum trigynum	0.1	50				
10	Centaurium tenuif.	0.1	20				
11	Vulpia bram	6.1	10				
12	Sida rhomb.	0.1	20				
13	Lolium perenne	6.1	20				
14	Bhreviopon tetraphyllum	0.1	10				
15	Erhyostis curvula	5	500				
16	Briza minor	0.1	20				
17	~~Asperula conf~~						
18	Briza subaristata	5	500				
19	Romulea rosea	0.1	10				
20	Trifolium campest.	0.1	5				
21	Asperula cortes	0.1	20				
22	Senecio madagasc.	0.1	5				
23	Pichandra nyps	0.1	50				
24	Plantago lanc.	0.1	10				
25	Cyperus gracilis	0.1	10				
26	Eur. tenel.	0.1	1				
27	Sonchus oleraceus	0.1	1				
28	Verbena bonariensis	0.1	2				
29	Lactuca serriola	0.1	3				
30	Conyza sumatrensis	0.1	4				
31	Erharta brownii	0.1	20				
32	Cynodon dactylon	1	100				
33	Bromus hordeaceus	0.1	10				
34	Vicia sativa	0.1	5				
35	Mill stip stip	5	500				
36	Rytido cuesp.	0.2	20				
37	Desmodium varians	0.1	10				
38	Anthosachne scab.	1	100				
39	Wahlen gra.	0.1	3				
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

Date: 05/11/2021	Personnel: ~~[redacted]~~ MG	Project no: 17072	Site: Menangle Park	Plot: 18a

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species
R	E. tenuicornis

Fallen Logs Data	
Log #	Log Length (m)
1	6
2	2
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 15/4/2021	Personnel: ~~EG~~	Project #: 17072	Site: Menangle Park	Plot: 17a

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	/	/	/	/	/	/	·	/	/	/	/	/	/	/	/	/	/	·	/	/	/	/	/	/	
NGCS Native Shrubs																									
NGCO Other Natives											/														
EPC(a) Exotics (groundcover/shrubs)		/	/	/		/	/			/	/		/		/	/		/			/	/	/		/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	/	/	/	/	·		/	/	/		/	/	/			/		/		/	/	/	/	·	/
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)		/	/		/	/			/	/			/	/	/		/		/	/		/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 03/11/2021	Project #: 17022	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BF, ___, ___	Plot ID: P 18a 2	Start:	R8	292569	6223984	
Photos: 70 - 73	Orientation (°): 284	End:	R9	292517	6223995	
Dimensions: □20x20, □10x40	PCT: Western Grassland - lots M. ciliatum					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eragrostis curv.	5	400				
2	Verbena rigida	0.2	10				
3	Hypericum perforatum	0.1	20				
4	Geranium solanderi	3	200				
5	Sonchus oleraceus	0.1	10				
6	Asperula conferta	0.7	100				
7	micro stip stip.	35	2000				
8	Carex inversa	0.1	50				
9	Bromus hordeaceus	5	500				
10	Nassella neesiana	5	400				
11	Lolium perenne	1	100				
12	Cirsium vulgare	0.1	4				
13	Hydrocotyle	0.5	50				
14	~~Eragrostis curvula~~						
15	Anthoxanthum scab.	2	200				
16	Sonchus asper	0.1	5				
17	Verbena bonariensis	0.1	10				
18	Briza subaristata	20	2000				
19	Paspalum dilatatum	38	3800				
20	Sida rhombifolia	0.25	70				
21	Galium aparine	0.1	10				
22	Linum trigynum	0.1	50				
23	~~Hypericum perfor.~~						
24	~~Plantago lanceolata~~						
25	Hydrocotyle	5	380				
26	Trifolium campestre	0.1	10				
27	~~Verbena bonariensis~~	0.1	2				
28	~~Lolium perenne~~						
29	Medicago ciliaris	0.2	20				
30	Lysimachia arvensis	0.1	30				
31	Dactylis glomerata	0.1	2				
32	Oxalis perennans	0.1	5				
33	Hordeum secalinum	0.1	3				
34	Poa sieberiana	0.1	10				
35	Rumex brownii	0.1	3				
36	Conyza sumatrensis	0.1	5				
37	Dichelachne micrantha	0.1	10				
38	Bromus diandrus	0.1	2				
39	Cynodon dactylon	5	500				
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: 0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²

Date: 05/11/2021	Personnel: ~~[redacted]~~ LC	Project no: 17072	Site: Merangle Park	Plot: 19a

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 15/11/2021	Personnel: BG	Project #: 17072	Site: Monaroo Park	Plot: 184

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses	/	.	/	/	/	.	/		/	/	.	/			/	/		/	/	/		/			/
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)		/	/		/	/		/	/		/	/	/	/		/	/	/		/	/	/	/		/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses		/		/			/	/	/	/	/			/			/	/	/		/		/		/
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/		/		/	/	/	/	/			/	/	/		/	/	/		/		/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

Date: 03/11/2021	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: BE.	Plot ID: P 19a 3	Start:	91	292528	6224073	
Photos: 74 - 77	Orientation (°): 204	End:	90	292520	6224021	
Dimensions: ☐20x20, ☐10x40	PCT: western grassland - lots Millglaena					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Orobanche minor	0.1	1				
2	Eragrost. curv.	10	700				
3	Micro stip. stip.	60	6000				
4	Lysimachia arvensis	3	300				
5	Silene gallica	0.1	1				
6	Petrorhagia dubia	0.1	100				
7	Paspalum dilatatum	10	1000				
8	Briza subaristata	5	500				
9	Vulpia bromoides	10	1000				
10	Bromus hordeac.	10	1000				
11	Trifolium campestre	0.1	30				
12	Verbena rigida	0.1	295				
13	Anthoxanthum aristatum	1	100				
14	Oxalis perennans	0.1	10				
15	Vicia sativa	0.1	5				
16	Hypericum perforatum	0.5	200				
17	Senecio madagase.	0.1	10				
18	Centaurium tenuif.	0.1	30				
19	Polygala viregt	0.1	2				
20	Cynodon dactylon	1	100				
21	Bromus perenne	1	100				
22	Sonchus asper	0.1	2				
23	Verbascum virgatum	0.2	3				
24	Rumex brownii	0.1	2				
25	Brassica rapa	0.1	1				
26	Paronychia brasil.	0.1	10				
27	Sonchus oleraceus	0.1	5				
28	Carex inversa	0.1	30				
29	Echium plant.	0.1	1				
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.

GF Group: TG=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Stratum: C = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: 0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²

Date: 15/11/2021	Personnel: HC	Project no: 17072	Site: Marongole Park	Plot: 19

CUMBERLAND ECOLOGY

Regenerating Canopy Species	
R	Species

Hollow Data								
Tree #	Species	Height	DBH	0-5	5-10	10-15	15-20	20+
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fallen Logs Data	
Log #	Log Length (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Class	Value	Calculation
OR Regenerating canopy species		See other quadrats within vegetation zone. Value for all quadrats will be % of canopy species regenerating within the vegetation zone.
FL Fallen log length		Total length of fallen logs
NTH Trees with hollows		Total number of **trees** with hollows

Date: 15/11/2021	Personnel: HG.	Project #: 17072	Site: Merongle Park	Plot: 199

CUMBERLAND ECOLOGY

Presence/Absence (1m interval)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NGCG Native Grasses			/	/		/				/	/			/			/	/	/		/		/		/
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)	/	/	/	/	/	.	/	/	/		/	/	/	.	/	/	/	/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	5	10	15	20	25
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	%
EPC(b) Exotics (mid storey)	%	%	%	%	%

Presence/Absence (1m interval)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
NGCG Native Grasses	/			/		/		/		/			/							/		/	.	
NGCS Native Shrubs																									
NGCO Other Natives																									
EPC(a) Exotics (groundcover/shrubs)		/	/		/	.	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/

Projective Foliage Cover (5m interval)	30	35	40	45	50
NOS Canopy Cover Native	%	%	%	%	%
NMS Mid-Storey Cover Native	%	%	%	%	%
EPC(c) Exotics (canopy)	%	%	%	%	
EPC(b) Exotics (mid storey)	%	%	%	%	%

Class	Value	Calculations
NGCG Native Grasses		Add total **NGCG** 'hits' and multiply by 2
NGCS Native Shrubs		Add total **NGCS** 'hits' and multiply by 2
NGCO Other Natives		Add total **NGCO** 'hits' and multiply by 2
EPC Exotics		[(Add **EPC(a)** 'hits' and multiply by 2)+(Add **EPC(b)** values/10)+(Add **EPC(c)** values/10)] and divided by 3
NOS Canopy Cover Native		Add **NOS** values and divide by 10
NMS Mid-Storey Cover Native		Add **NMS** values and divide by 10

APPENDIX D :
Flora Species List

Table 37 Flora Species List

Scientific Name	Exotic	Common Name
Acacia decurrens		Black Wattle
Acacia implexa		Hickory Wattle
Acetosella vulgaris	*	Sheep Sorrel
Adiantum aethiopicum		Common Maidenhair
Ageratina adenophora	*	Crofton Weed
Ageratina riparia	*	Mistflower
Ajuga australis		Austral Bugle
Alisma plantago-aquatica		Water Plantain
Alternanthera denticulata		Lesser Joyweed
Amyema cambagei		Needle-leaf Mistletoe
Amyema miquelii		Box Mistletoe
Andropogon virginicus	*	Whisky Grass
Angophora floribunda		Rough-barked Apple
Angophora subvelutina		Broad-leaved Apple
Anthosachne scabra		Wheatgrass, Common Wheatgrass
Apium graveolens	*	Celery
Araujia sericifera	*	Moth Vine
Arctotheca calendula	*	Capeweed
Aristida ramosa		Purple Wiregrass
Asparagus asparagoides	*	Bridal Creeper
Asparagus officinalis	*	Asparagus
Asperula conferta		Common Woodruff
Aster subulatus	*	Wild Aster
Atriplex prostrata	*	
Austrostipa verticillata		Slender Bamboo Grass
Avena sativa	*	Oats
Axonopus fissifolius	*	Narrow-leafed Carpet Grass
Backhousia angustifolia		Narrow Leaf Myrtle
Backhousia myrtifolia		Grey Myrtle
Barbarea verna	*	Wintercress
Baumea rubiginosa		
Bidens pilosa	*	Cobbler's Pegs
Bothriochloa decipiens var. decipiens		Pitted Bluegrass
Bothriochloa macra		Red Grass

Scientific Name	Exotic	Common Name
Brachychiton acerifolius		Illawarra Flame Tree
Brassica rapa	*	Turnip
Briza minor	*	Shivery Grass
Briza subaristata	*	
Bromus catharticus	*	Praire Grass
Bromus hordeaceus	*	Soft Brome
Brunoniella australis		Blue Trumpet
Bursaria spinosa		Native Blackthorn
Callistemon salignus		Willow Bottlebrush
Callitriche stagnalis	*	Common Starwort
Calochlaena dubia		Rainbow Fern
Capillipedium spicigerum		Scented-top Grass
Capsella bursapastoris	*	Shepherd's Purse
Cardiospermum grandiflorum	*	Balloon Vine
Carex appressa		Tall Sedge
Carex inversa		Knob Sedge
Carex longebrachiata		
Carthamus lanatus	*	Saffron Thistle
Casuarina cunninghamiana		River Oak
Casuarina glauca		Swamp Oak
Cenchrus clandestinus	*	Kikuyu Grass
Centaurium erythraea	*	Common Centaury
Centaurium tenuiflorum	*	Branched Centaury, Slender centaury
Centella asiatica		Indian Pennywort
Cerastium glomeratum	*	Mouse-ear Chickweed
Cereus uruguayanus	*	Apple Cactus
Cestrum parqui	*	Green Cestrum
Cheilanthes sieberi		Rock Fern
Chloris gayana	*	Rhodes Grass
Chloris ventricosa		Tall Chloris
Cirsium vulgare	*	Spear Thistle
Clematis glycinoides		Headache Vine
Commelina cyanea		Native Wandering Jew
Convolvulus erubescens		Pink Bindweed
Conyza bonariensis	*	Flaxleaf Fleabane

Scientific Name	Exotic	Common Name
Conyza sumatrensis	*	Tall fleabane
Cotula australis		Common Cotula
Cotula coronopifolia	*	Water Buttons
Crassula sieberiana		Australian Stonecrop
Crataegus monogyna	*	Hawthorn
Cyclospermum leptophyllum	*	Slender Celery
Cycnogeton microtuberosum		
Cymbopogon refractus		Barbed Wire Grass
Cynodon dactylon		Common Couch
Cyperus aggregatus	*	
Cyperus difformis		Dirty Dora
Cyperus eragrostis	*	Umbrella Sedge
Cyperus gracilis		Slender Flat-sedge
Cyperus polystachyos		
Dactylis glomerata	*	Cocksfoot
Datura stramonium	*	Common Thornapple
Desmodium varians		Slender Tick-trefoil
Dichelachne micrantha		Shorthair Plumegrass
Dichondra repens		Kidney Weed
Duboisia myoporoides		Corkwood
Echium plantagineum	*	Patterson's Curse
Ehrharta erecta	*	Panic Veldtgrass
Ehrharta longiflora	*	Annual Veldtgrass
Einadia hastata		Berry Saltbush
Einadia nutans subsp. linifolia		Climbing Saltbush
Einadia nutans subsp. nutans		Climbing Saltbush
Einadia polygonoides		Knotweed Goosefoot
Einadia trigonos		Fishweed
Eleocharis cylindrostachys		
Eleusine tristachya	*	Goose Grass
Elymus scaber		Wheatgrass, Common Wheatgrass
Entolasia marginata		Bordered Panic
Entolasia stricta		Wiry Panic
Eragrostis brownii		Brown's Lovegrass
Eragrostis cilianensis	*	Stinkgrass

Scientific Name	Exotic	Common Name
Eragrostis curvula	*	African Lovegrass
Eragrostis leptostachya		Paddock Lovegrass
Eragrostis leptostachya		Paddock Lovegrass
Eriochloa pseudoacrotricha		Early Spring Grass
Erodium crinitum		Blue Crowfoot
Eucalyptus amplifolia		Cabbage Gum
Eucalyptus amplifolia subsp. amplifolia		
Eucalyptus botryoides		Bangalay
Eucalyptus crebra		Narrow-leaved Ironbark
Eucalyptus elata		River Peppermint
Eucalyptus moluccana		Grey Box
Eucalyptus tereticornis		Forest Red Gum
Euchiton sphaericus		Star Cudweed
Euphorbia peplus	*	Petty Spurge
Facelis retusa	*	
Festuca arundinacea	*	Tall Fescue
Fraxinus spp.	*	
Gahnia aspera		Rough Saw-sedge
Galium aparine	*	Goosegrass
Galium gaudichaudii		Rough Bedstraw
Gamochaeta americana	*	Purple Cudweed
Gamochaeta pensylvanica	*	Cudweed
Gamochaeta purpurea	*	Purple Cudweed
Geranium solanderi		Native Geranium
Geranium solanderi var. solanderi		
Gleditsia triacanthos	*	Honey Locust
Glyceria australis		Australian Sweetgrass
Glycine clandestina		Twining glycine
Glycine microphylla		Small-leaf Glycine
Glycine tabacina		Variable Glycine
Gomphocarpus fruticosus	*	Narrow-leaved Cotton Bush
Gomphrena celosioides	*	Gomphrena Weed
Grevillea robusta		Silky Oak
Heliotropium amplexicaule	*	Blue Heliotrope
Hemarthria uncinata		Matgrass

Scientific Name	Exotic	Common Name
Herbertia lahue	*	
Hibbertia diffusa		Wedge Guinea Flower
Hordeum leporinum	*	Barley Grass
Hydrocotyle hirta		Hairy Pennywort
Hydrocotyle laxiflora		Stinking Pennywort
Hydrocotyle tripartita		Pennywort
Hypericum gramineum		Small St John's Wort
Hypericum perforatum	*	St. Johns Wort
Hypochaeris microcephala	*	White Flatweed
Hypochaeris microcephala var. albiflora	*	White Flatweed
Hypochaeris radicata	*	Catsear
Imperata cylindrica		Blady Grass
Isachne globosa		Swamp Millet
Isolepis cernua		Nodding Club-rush
Isolepis inundata		Club-rush
Isolepis prolifera	*	
Isotoma fluviatilis subsp. fluviatilis		
Juncus acutiflorus	*	
Juncus bufonius	*	Toad Rush
Juncus cognatus	*	
Juncus homalocaulis		
Juncus subsecundus		Finger Rush
Juncus usitatus		
Kunzea ambigua		Tick Bush
Lachnagrostis filiformis		
Lactuca saligna	*	Willow-leaved Lettuce
Lactuca serriola	*	Prickly Lettuce
Lamium amplexicaule	*	Dead Nettle
Lantana camara	*	Lantana
Lepidium africanum	*	Common Peppercress
Lepidium bonariense	*	Argentine Peppercress
Lepidium didymum	*	Lesser Swinecress
Leptospermum polyanthum		
Ligustrum lucidum	*	Large-leaved Privet
Ligustrum sinense	*	Small-leaved Privet

Scientific Name	Exotic	Common Name
Linum marginale		Native Flax
Linum trigynum	*	French Flax
Lissanthe strigosa subsp. strigosa		
Lobelia purpurascens		whiteroot
Lolium perenne	*	Perennial Ryegrass
Lomandra filiformis		Wattle Matt-rush
Lomandra filiformis subsp. filiformis		
Lomandra longifolia var. longifolia		Spiny-headed Mat-rush
Lonicera japonica	*	Japanese Honeysuckle
Lotus uliginosus	*	Birds-foot Trefoil
Lycium ferocissimum	*	African Boxthorn
Lysimachia arvensis	*	Scarlet Pimpernel
Lythrum hyssopifolia		Hyssop Loosestrife
Malva parviflora	*	Small-flowered Mallow
Medicago arabica	*	Spotted Burr Medic
Medicago minima	*	Woolly Burr Medic
Medicago polymorpha	*	Burr Medic
Melaleuca armillaris subsp. armillaris		Bracelet Honey-myrtle
Melaleuca linariifolia		Flax-leaved Paperbark
Melia azedarach		White Cedar
Melicytus dentatus		Tree Violet
Microlaena stipoides var. stipoides		Weeping Grass
Modiola caroliniana	*	Red-flowered Mallow
Myriophyllum integrifolium	*	
Nassella hyalina	*	
Nassella neesiana	*	Chilean Needle Grass
Nassella trichotoma	*	Serrated Tussock
Olea europaea subsp. cuspidata	*	African Olive
Onopordum acanthium	*	Scotch Thistle
Oplismenus aemulus		
Oplismenus imbecillis		
Opuntia stricta	*	Common Prickly Pear
Orobanche minor	*	Broomrape
Oxalis corniculata	*	Creeping Oxalis
Oxalis perennans		

Scientific Name	Exotic	Common Name
Panicum effusum		Hairy Panic
Paronychia brasiliana	*	Chilean Whitlow Wort, Brazilian Whitlow
Parsonsia straminea		Common Silkpod
Paspalidium distans		
Paspalum dilatatum	*	Paspalum
Passiflora suberosa	*	Cork Passionfruit
Persicaria decipiens		Slender Knotweed
Petrorhagia dubia	*	
Phalaris aquatica	*	Phalaris
Phalaris paradoxa	*	Paradoxa Grass
Phragmites australis		Common Reed
Phytolacca octandra	*	Inkweed
Pittosporum undulatum		Sweet Pittosporum
Plantago debilis		Shade Plantain
Plantago lanceolata	*	Lamb's Tongues
Plantago major	*	Large Plantain
Poa annua	*	Winter Grass
Poa labillardierei var. labillardierei		Tussock
Poa sieberiana		Snowgrass
Poa sieberiana var. sieberiana		Snowgrass
Polycarpon tetraphyllum	*	Four-leaved Allseed
Polygala virgata	*	
Poranthera microphylla		Small Poranthera
Potamogeton tricarinatus		Floating Pondweed
Pseudognaphalium luteoalbum		Jersey Cudweed
Pteridium esculentum		Bracken
Pyracantha angustifolia	*	Orange Firethorn
Ranunculus sceleratus	*	Celery Buttercup
Richardia stellaris	*	
Romulea rosea	*	Onion Grass
Romulea rosea var. australis	*	Onion Grass
Rosa canina	*	Dog Rose
Rubus fruticosus	*	Blackberry complex
Rumex acetosella	*	Sheep Sorrel
Rumex brownii		Swamp Dock

Scientific Name	Exotic	Common Name
Rumex conglomeratus	*	Clustered Dock
Rumex crispus	*	Curled Dock
Rytidosperma caespitosum		Ringed Wallaby Grass
Rytidosperma racemosum		Wallaby Grass
Saponaria officinalis	*	Soapwort
Schinus molle	*	Pepper Tree
Senecio hispidulus		Hill Fireweed
Senecio madagascariensis	*	Fireweed
Setaria parviflora	*	
Sherardia arvensis	*	Field Madder
Sida corrugata		Corrugated Sida
Sida rhombifolia	*	Paddy's Lucerne
Silene gallica	*	French Catchfly
Silybum marianum	*	Variegated Thistle
Sisymbrium irio	*	London Rocket
Smilax glyciphylla		Sweet Sarsparilla
Solanum linnaeanum	*	Apple of Sodom
Solanum mauritianum	*	Wild Tobacco Bush
Solanum nigrum	*	Black-berry Nightshade
Solanum prinophyllum		Forest Nightshade
Solanum pseudocapsicum	*	Madeira Winter Cherry
Solanum radicans	*	Cusmayllo
Solanum sisymbriifolium	*	
Soliva sessilis	*	Bindyi
Sonchus asper	*	Prickly Sowthistle
Sonchus oleraceus	*	Common Sowthistle
Spergularia rubra	*	Sandspurry
Sporobolus actinocladus		Katoora Grass
Sporobolus africanus	*	Parramatta Grass
Sporobolus creber		Slender Rat's Tail Grass
Sporobolus elongatus		Slender Rat's Tail Grass
Stachys arvensis	*	Stagger Weed
Stackhousia viminea		Slender Stackhousia
Stellaria media	*	Common Chickweed
Stephania japonica var. discolor		Snake Vine

Scientific Name	Exotic	Common Name
Tagetes minuta	*	Stinking Roger
Taraxacum officinale	*	Dandelion
Themeda triandra		
Tradescantia fluminensis	*	Wandering Jew
Trema tomentosa		Native Peach
Trifolium campestre	*	Hop Clover
Trifolium repens	*	White Clover
Triglochin microtuberosa		
Triglochin microtuberosa		
Typha orientalis		Broad-leaved Cumbungi
Ulmus glabra	*	
Urtica urens	*	Small Nettle
Verbascum virgatum	*	Twiggy Mullein
Verbena bonariensis	*	Purpletop
Verbena quadrangularis	*	
Verbena rigida	*	Veined Verbena
Veronica arvensis	*	Wall Speedwell
Veronica persica	*	Creeping Speedwell
Veronica plebeia		Trailing Speedwell
Vicia sativa	*	Common vetch
Vittadinia cuneata var. cuneata		
Vittadinia muelleri		
Vulpia bromoides	*	Squirrel Tail Fesque
Wahlenbergia communis		Tufted Bluebell
Wahlenbergia gracilenta		Annual Bluebell
Zornia dyctiocarpa		Zornia

APPENDIX E :
Fauna Species List

Table 38 Fauna species recorded within the study area by Cumberland Ecology

Family	Common Name	Scientific Name	Exotic (*)	TSC Act Status	EPBC Act Status	Detection Methodology
Amphibia						
Hylidae	Eastern Dwarf Tree Frog	*Litoria fallax*		-	-	Incidental observation
Aves						
Acanthizidae	Yellow Thornbill	*Acanthiza nana*		-	-	Diurnal bird survey
Accipitridae	Collared Sparrowhawk	*Accipiter cirrocephalus*		-	-	Diurnal bird survey
Anatidae	Australian Wood Duck	*Chenonetta jubata*		-	-	Diurnal bird survey
Apodidae	Welcome Swallow	*Hirundo neoxena*		-	-	Diurnal bird surveys
Ardeidae	Cattle Egret	*Ardea ibis*		-	-	Incidental observation
Ardeidae	White-necked Heron	*Ardea pacifica*		-	-	Incidental observation
Artamidae	Australian Magpie	*Cracticus tibicen*		-	-	Diurnal bird survey, Incidental observation
Artamidae	Dusky Woodswallow	*Artamus cyanopterus*		V	-	Diurnal bird survey
Artamidae	Grey Butcherbird	*Cracticus torquatus*		-	-	Diurnal bird survey
Artamidae	Pied Currawong	*Strepera graculina*		-	-	Diurnal bird survey
Cacatuidae	Galah	*Eolophus roseicapillus*		-	-	Diurnal bird survey
Cacatuidae	Little Corella	*Cacatua sanguinea*		-	-	Diurnal bird survey, Incidental observation
Cacatuidae	Sulphur-Crested Cockatoo	*Cacatua galerita*		-	-	Diurnal bird survey, Incidental observation
Campephagidae	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		-	-	Diurnal bird survey
Climacteridae	Brown Treecreeper	*Climacteris picumnus victoriae*		V	=	Diurnal bird survey
Columbidae	Crested Pigeon	*Ocyphaps lophotes*		-	-	Diurnal bird survey, Incidental observation

Family	Common Name	Scientific Name	Exotic (*)	TSC Act Status	EPBC Act Status	Detection Methodology
Corvidae	Australian Raven	*Corvus coronoides*		-	-	Diurnal bird survey
Estrildidae	Double-Barred Finch	*Stizoptera bichenovii*		-	-	Incidental observation
Estrildidae	Red-browed Finch	*Neochmia temporalis*		-	-	Diurnal bird survey
Maluridae	Superb Fairy-wren	*Malurus cyaneus*		-	-	Diurnal bird survey
Monarchidae	Magpie-lark	*Grallina cyanoleuca*		-	-	Diurnal bird survey, Incidental observation
Meliphagidae	Lewin's Honeyeater	*Meliphaga lewinii*		-	-	Diurnal bird survey
Meliphagidae	Little Wattlebird	*Anthochaera chrysoptera*		-	-	Diurnal bird survey
Meliphagidae	White-plumed Honeyeater	*Ptilotula penicillata*		-	-	Diurnal bird survey
Meliphagidae	Bell Miner	*Manorina melanophrys*		-	-	Diurnal bird survey, Incidental observation
Meliphagidae	Noisy Miner	*Manorina melanocephala*		-	-	Diurnal bird survey, Incidental observation
Meliphagidae	Red Wattlebird	*Anthochaera carunculata*		-	-	Incidental observation
Motacillidae	Australasian Pipit	*Anthus novaeseelandiae*		-	-	Incidental observation
Oriolidae	Olive-backed Oriole	*Oriolus sagittatus*		-	-	Diurnal bird survey
Neosittidae	Varied Sittella	*Daphoenositta chrysoptera*		V	-	Diurnal bird survey
Pachycephalidae	Rufous Whistler	*Pachycephala rufiventris*		-	-	Diurnal bird survey
Podargidae	Tawny Frogmouth	*Podargus strigoides*		-	-	Diurnal bird survey
Psittacidae	Eastern Rosella	*Platycercus eximius*		-	-	Diurnal bird survey, Incidental observation
Psittacidae	Australian King Parrot	*Alisterus scapularis*		-	-	Diurnal bird survey

Family	Common Name	Scientific Name	Exotic (*)	TSC Act Status	EPBC Act Status	Detection Methodology
Psittacidae	Musk Lorikeet	*Glossopsitta concinna*		-	-	Diurnal bird survey
Psittacidae	Rainbow Lorikeet	*Trichoglossus haematodus*		-	-	Diurnal bird survey, Incidental observation
Psittacidae	Red-rumped Parrot	*Psephotus haematonotus*		-	-	Diurnal bird survey
Pycnonotidae	Red-whiskered Bulbul	*Pynonotus jocosus*	*	-	-	Diurnal bird survey
Rallidae	Purple Swamphen	*Porphyrio porphyrio*		-	-	Diurnal bird survey, Incidental observation
Rhipiduridae	Grey Fantail	*Rhipidura albiscapa*		-	-	Diurnal bird survey, Incidental observation
Rhipiduridae	Rufous Fantail	*Rhipidura rufifrons*		-	Mig.	Diurnal bird survey
Rhipiduridae	Willie Wagtail	*Rhipidura leucophrys*		-	-	Diurnal bird survey, Incidental observation
Sturnidae	Common Myna	*Acridotheres tristis*	*	-	-	Diurnal bird survey, Incidental observation
Sturnidae	Common Starling	*Sturnus vulgaris*	*	-	-	Diurnal bird survey
Timaliidae	Silvereye	*Zosterops lateralis*		-	-	Diurnal bird survey
Turdidae	Common Blackbird	*Turdus merula*	*	-	-	Incidental observation
Mammalia						
Miniopteridae	Little Bent-winged Bat	*Miniopterus australis*		V	-	Bat detector
Molossidae	White-Striped Freetail-Bat	*Austronomus australis*		-	-	Bat detector
Molossidae	Ride's Free-tailed Bat	*Mormopterus ridei*		-	-	Bat detector
Pteropodidae	Grey-headed Flying-fox	*Pteropus poliocephalus*		V	V	Spotlighting incidental
Vespertilionidae	Gould's Wattled Bat	*Chalinolobus gouldii*		-	-	Bat detector
Vespertilionidae	Chocolate Wattled Bat	*Chalinolobus morio*		-	-	Bat detector

Family	Common Name	Scientific Name	Exotic (*)	TSC Act Status	EPBC Act Status	Detection Methodology
Vespertilionidae	Greater Broad-nosed Bat	*Scoteanax rueppellii*		V	-	Bat detector
Vespertilionidae	Little Forest Bat	*Vespadelus vulturnus*		-	-	Bat detector
Vespertilionidae	Lesser Long-eared Bat	*Nyctophilus geoffroyi*		-	-	Bat detector
Vespertilionidae	Gould's Long-eared Bat	*Nyctophilus gouldi*		-	-	Bat detector
Vespertilionidae	Eastern Broad-nosed Bat	*Scotorepens orion*		-	-	Bat detector

APPENDIX F :

Staff CV's

Dr David Robertson

Director

Experience

Dr David Robertson is a senior ecologist with more than 30 years' experience in ecological survey, impact assessment, and research. David is the director of Cumberland Ecology.

David has managed and participated in numerous small- to large-scale projects across a variety of sectors and has extensive experience undertaking terrestrial and aquatic surveys, ecological impact assessments, biodiversity monitoring,

Recent consultancy work has included:

- Senior consultant for numerous mining projects in Australia and in the Philippines;
- Court appointed expert for the NSW Land and Environment Court;
- Flora and fauna investigations for Environmental Impact Assessments;
- Development of ecological management plans and habitat reconstruction;
- Negotiations about the level of mitigation and offset measures required for flora and fauna impacts.

David is an Accredited Assessor for the Biodiversity Assessment Method.

Key Industry Sectors

- Residential development;
- Extractive industry;
- Renewable energy;
- Water; and
- Transport.

Relevant Experience

Environmental Impact Assessment

Directed numerous large ecological assessments for major projects in a variety of service sectors in Australia and internationally. These include the power industry, water supply, road construction and mining. David is required to frequently consult with local, state and federal government agencies as part of the environmental impact assessment process.

Threatened Species Assessments

Directed or managed numerous threatened species assessments in Australia and overseas to address legislative requirements. Projects were conducted in numerous jurisdictions. Work on threatened species has included preliminary survey and impact assessment, detailed impact assessment and mitigation, monitoring and plans of management.

Provision of Strategic Ecological Advice

Strategic ecological advice has been provided to aid the selection of potential development sites in Australia, Hong Kong, Philippines, Thailand, Sri Lanka and China.

Statements of Evidence and Expert Testimony

Dr David Robertson is a highly experienced and credible expert witness and is capable of providing expert evidence in both terrestrial and aquatic areas of ecology. David has provided expert evidence for Australian Senate Select Committees, Australian Heritage Commission, Commissions of Inquiry, Land and Environment Court hearings and at Mining Wardens inquiries.

Education

- Bachelor of Science (Honours), Ecology. University of Melbourne, 1980.
- Doctor of Philosophy, Ecology. University of Melbourne, 1986.
- BioBanking Assessors Training Course. TAFE Northern Sydney Institute, 2009 (Accredited September 2009)
- BAM Accredited Assessor Training. Muddy Boots, 2017 (Accredited August 2017)

Professional Affiliations

- Ecological Society of Australia (ESA),
- Certified Environmental Practitioner Scheme (CEnvP), and
- Environment Institute of Australia and New Zealand (EIANZ).

Katrina Wolf

Principal

Experience

Katrina Wolf is a Principal at Cumberland Ecology, with over 14 years' of ecological consulting experience. She has managed and participated in numerous small- to large-scale projects and has extensive experience undertaking flora and fauna surveys, ecological impact assessment, ecological monitoring, and peer reviews. Katrina is an Accredited Assessor for the Biodiversity Assessment Method (BAAS18010).

Katrina has routinely been involved in ecological impact assessments of threatened species, populations and ecological communities, and routinely assesses projects in response to State and Commonwealth legislation. This has included projects within the urban, industrial, infrastructure and extraction sectors.

Project Management

Katrina has managed the ecological components of a suite of projects, including residential development applications, rezoning proposals, and State Significant Developments. She often manages large teams of staff.

In her role at Cumberland Ecology she has also consulted with a number of local and government agencies. Katrina has also undertaken independent peer reviews on behalf of local council.

Report Preparation

Katrina has been the primary or contributing author on a variety of documents including:

- Biodiversity Development Assessment Reports / Biodiversity Stewardship Site Assessment Reports;
- Ecological impact assessments;
- EPBC Act referrals;
- Biodiversity management plans;
- Biodiversity monitoring reports;
- Threatened species survey reports;
- Peer reviews; and
- Audit reports.

Katrina has also been a key author in the preparation of Statements of Evidence and Expert Reports for NSW Land and Environment Court proceedings.

Field Surveys

Katrina is actively involved in undertaking field surveys, with extensive experience in designing and undertaking flora and fauna surveys. In NSW, Katrina's field experience is within the Sydney Region, Hunter Valley, Western Blue Mountains, Gunnedah Basin, Central Coast and Mid North Coast. Katrina has also undertaken field surveys within the Bowen Basin and Galilee Basin in Queensland, and Groote Eylandt and the Gove Peninsular in the Northern Territory.

Field surveys have included:

- Impact surveys (vegetation mapping, quadrat surveys, plot-based surveys, fauna surveys);
- Monitoring surveys (targeted threatened flora and fauna surveys, vegetation condition assessments);
- Offset surveys (preliminary site inspections, vegetation mapping, plot-based surveys, detailed fauna surveys); and
- Research projects (long term floristic analysis, targeted small mammal investigations).

Education

- Bachelor of Science (Environmental). The University of Sydney, 2007.
- BioBanking Assessors Training Course. TAFE Ryde, 2010 (Accredited May 2013).
- BAM Accredited Assessor Training. Greencap (Accredited to February 2025).

Professional Affiliations

- Environmental Institute of Australia and New Zealand (Member) and Certified Environmental Practitioner.
- Ecological Consultants Association of NSW (Practising Ecological Consultant Member).

Mikael Peck

Senior Project Manager / Ecologist

Experience

Mikael Peck is a Senior Project Manager / Ecologist at Cumberland Ecology, with over eight years of experience. He has managed a number of small- to large-scale projects throughout NSW for the urban, industrial, extraction and infrastructure sectors. Mikael is an Accredited Assessor for the Biodiversity Assessment Method (BAAS18010).

Mikael has extensive experience undertaking ecological impact assessments for threatened flora and fauna species, threatened ecological communities, and routinely assesses projects in response to NSW and Commonwealth legislation.

Project Management

Mikael has managed the ecological components of a suite of projects, including small- to large- scale residential developments, major linear infrastructure projects and mining projects, and biodiversity monitoring programs.

Mikael has also managed a number of monitoring projects including feral species, nest-box, vegetation and threatened species monitoring.

Mikael is also responsible for the management of other staff members in the Sydney office. This includes providing strategic advice, determining resourcing requirements and document reviews. In his role at Cumberland Ecology Mikael also regularly consults with government agencies.

Report Preparation

Mikael has been the primary or contributing author of a variety of documents for both State and Commonwealth assessments including:

- Pre-clearing and clearing supervision reports;
- Species impact statements;
- Biodiversity Development Assessment Reports and waivers;
- Ecological impact assessments;
- EPBC Act referrals;
- Preliminary Documentation for EPBC referrals;
- Preliminary BAM assessments;
- Ecological constraints assessments;
- Vegetation and biodiversity management plans;
- Biodiversity monitoring reports; and
- Peer reviews.

Field Surveys

Mikael has extensive experience in designing and undertaking flora and fauna surveys within the Sydney Region, Hunter Valley, Gunnedah Basin, Central Coast and South Coast regions of NSW.

Field surveys have included:

- Pre-clearing and clearing supervision surveys (aquatic and terrestrial);
- Fauna habitat assessments and vegetation condition assessments;
- Targeted threatened species surveys (arboreal and terrestrial mammals, microchiropteran bats, amphibians, birds and reptiles) utilising motion-sensor cameras, pit-fall traps, hair tubes, cage traps, echolocation detectors, harp traps, and nest boxes;
- Threatened and feral fauna monitoring surveys;
- Targeted threatened flora monitoring surveys; and
- Research projects (bandicoot population monitoring involving microchipping individuals).

Education

- Bachelor of Science. Washington State University, 2005.
- Master of Marine Science and Management. Macquarie University, 2013.
- BAM Accredited Assessor Training. Greencap (Accredited to February 2025).

Bryan Furchert

Project Manager / Botanist

Experience

Bryan Furchert is a Project Manager and Botanist at Cumberland Ecology, with over eight years of ecological consulting experience. Bryan also has extensive previous experience in bushland restoration. Bryan is an Accredited Assessor for the Biodiversity Assessment Method.

Bryan has routinely been involved in the botanical components of ecological impact assessments of threatened flora and fauna species and threatened ecological communities, and routinely assesses projects in response to State and Commonwealth legislation. This has included projects within the urban, industrial, infrastructure, and extraction sectors.

Bryan regularly undertakes botanical surveying and reporting, with a focus on applying the Biodiversity Assessment Method. This has included identification of Plant Community Types and threatened ecological communities, and mapping occurrences of threatened flora species and habitat. Bryan has also undertaken flora monitoring and reporting for long term restoration projects for urban bushland remnants, and large biodiversity offset areas.

Project Management

Bryan has managed the ecological components of a broad range of projects, including residential development applications, small infrastructure projects, and major projects. Bryan has also managed a number of projects with post-approval requirements. In his role at Cumberland Ecology has consulted with a number of local and government agencies.

Bryan is also responsible for the management and training of other botanical staff members in the Sydney office.

Report Preparation

Bryan has been the primary and contributing author on a variety of documents including:

- Biodiversity Development Assessment Reports;
- Ecological impact assessments;
- Ecological constraints assessments;
- EPBC Act referrals;
- Biodiversity offsets reports;
- Biodiversity monitoring reports;
- Vegetation management plans; and
- Bushland management plans.

Field Surveys

Bryan is actively involved in undertaking field surveys, with extensive experience in designing and undertaking flora surveys. In NSW, Bryan's field experience is within the Sydney Region, Central Coast, Hunter Valley, Western Blue Mountains, Gunnedah Basin, South Coast, Central Tablelands, Southern Tablelands, and Mid North Coast. Bryan has also undertaken botanical surveys in Queensland.

Field surveys have included:

- Vegetation mapping and classification, including extensive experience with assigning Plant Community Types (PCTs);
- Quadrat / plot-based surveys, including BAM plots;
- Targeted threatened flora surveys;
- Monitoring surveys (targeted threatened flora and vegetation condition assessments);
- Offset surveys (preliminary site inspections, vegetation mapping, plot-based surveys); and
- Research projects (long term floristic analysis).

Education

- Bachelor of Biodiversity and Conservation.
  Macquarie University, 2012.
- Diploma of Conservation and Land Management
  Belmont TAFE, 2009.
- BAM Accredited Assessor Training.
  Muddy Boots, 2017 (Accredited 2018).

Heather Gosper

Project Manager / Ecologist

Experience

Heather Gosper is a Project Manager / Ecologist at Cumberland Ecology, with over seven years of experience gained through working in a variety of ecological and environmental roles in mining and infrastructure projects throughout NSW and Queensland.

Heather has previously worked training employees in fauna handling and relocation skills, with a focus on ecologists employed in the mining, construction and consultancy sectors. Heather also assists on training courses for snake, spider and fauna handling and safety in the workplace, as well as being an assistant teacher for a university fauna course.

She has extensive experience undertaking ecological impact assessments for threatened flora and fauna species and threatened ecological communities, and routinely assesses projects in response to NSW and Commonwealth legislation. Heather is an Accredited Assessor for the Biodiversity Assessment Method (BAAS19028).

Project Management

Heather has managed the ecological components of a suite of projects including residential development applications, state significant developments and biodiversity monitoring programs. This has included work within the urban, agricultural and extraction sectors.

Heather has also managed monitoring projects such as vegetation and threatened species annual monitoring, and has managed a range of projects being assessed utilising the BAM methodology and associated assessment pathways.

Report Preparation

Heather has been the primary or contributing author of a variety of documents for both State and Commonwealth assessments including:

- Biodiversity Development Assessment Reports / Biodiversity Stewardship Site Assessment Reports;
- Ecological impact assessments;
- Species Impact Statements;
- Ecological constraints analysis:
- Pre-clearing assessment and clearing supervision for residential and mining projects;
- Vegetation management plans; and
- Biodiversity monitoring reports.

Field Surveys

Heather is actively involved in undertaking field surveys, and has extensive experience in designing and undertaking fauna surveys. In NSW, Heather's field experience is within the Sydney Region, Hunter Valley, Gunnedah Basin, Central Coast and South Coast. Heather has also undertaken field surveys within south-east Queensland.

Field surveys have included:

- Pre-clearing and clearing supervision surveys;
- Fauna habitat assessments and vegetation condition assessments;
- Targeted threatened species surveys (arboreal, terrestrial and aquatic vertebrate fauna);
- Vegetation mapping;
- Plot-based floristic surveys (BAM and BioBanking);
- Targeted threatened flora surveys; and
- Threatened and feral fauna monitoring surveys utilising motion-sensor cameras.

Education

- Bachelor of Environmental Science and Management. The University of Newcastle. 2013.
- BAM Accredited Assessor Training. Muddy Boots, 2018 (Accredited to June 2022).

Jesse Luscombe

Project Manager / GIS Specialist

Experience

Jesse Luscombe is a Project Manager / GIS Specialist at Cumberland Ecology, with over four years of experience.

Jesse has detailed technical knowledge and experience in the interpretation and production of mapping products, including topographic modelling as well as classification and feature extraction using aerial photography and satellite imagery.

At Cumberland Ecology, Jesse is closely involved in both small and large scale projects and is responsible for GIS development, mapping and analyses.

Project Management

Jesse has undertaken project management of small and large scale development projects in New South Wales. This has included the management of the ecological components of a suite of residential development projects. This has included coordinating teams of staff through field work, data analysis and report preparation.

In his role at Cumberland Ecology he has also consulted with a number of local and both state and federal government agencies.

Report Preparation

Jesse has been the primary or contributing author of a variety of documents including:

- Biodiversity Development Assessment Reports;
- Ecological impact assessments;
- Ecological constraints analysis:
- Biodiversity management plans; and
- EPBC Act referrals.

Geographic Information Systems

Jesse has extensive experience in Geographic Information Systems on the ESRI ArcGIS platform. He is experienced in utilising GIS for vegetation mapping, threatened species mapping, production of field maps and image analysis.

Recent GIS consultancy work has included:

- Vegetation and threatened flora and fauna mapping for large – and small – scale projects;
- GIS mapping for Biodiversity Assessment Method assessments, Environmental Impact Assessments, Species Impact Statements, and Biodiversity Management Plans; and
- Mapping and interpretation of LiDAR systems for vegetation and watercourse analysis.

Jesse has undertaken GIS for a range of project types, and has included projects in New South Wales and Queensland. He has also prepared figure for use in position papers and Statements of Evidence for NSW Land and Environment Court proceedings.

Field Surveys

Jesse is involved in undertaking field surveys, and has experience in designing and undertaking both flora and fauna surveys. Jesse's field experience is within the Sydney Region.

Field surveys have included:

- Targeted threatened species surveys (arboreal, terrestrial and aquatic vertebrate fauna);
- Vegetation mapping;
- Plot-based floristic surveys (BAM and BioBanking); and
- Targeted threatened flora surveys.

Education

- Bachelor of Marine Science. Macquarie University,2013.
- Certificate III: Conservation and Land Management, TAFE NSW Ryde, 2016.
- BAM Accredited Assessor Training. Muddy Boots, 2018.

John Foster

Project Manager / Botanist

Experience

John Foster is a Project Manager / Ecologist Botanist at Cumberland. John has worked as an ecological consultant since 2019. He has worked on a number of small- to large-scale projects in NSW for the urban and extraction sectors.

She has experience undertaking ecological impact assessments for threatened flora and fauna species and threatened ecological communities, and assesses projects in response to NSW legislation.

John regularly undertakes botanical surveying and reporting, recently with a focus on the Biodiversity Assessment Method. This has included identification of Plant Community Types, threatened ecological communities and mapping occurrence of threatened flora species and habitat.

John has been involved in numerous field surveys across NSW and routinely works on projects requiring site-specific inductions and a WorkCover White Card.

Project Management

John has managed the ecological components of a number of residential development applications. This has included coordinating of staff for fieldwork and preparation of reports. John has also assisted in the management of ecological monitoring and management projects.

Report Preparation

John has been the primary or contributing author on a variety of documents for State assessments, including:

- Biodiversity Development Assessment Reports;
- Ecological impact assessments;
- Ecological constraints assessments;
- Biodiversity monitoring reports;
- Vegetation management plans;
- Biodiversity management plans
- Aquatic monitoring reports; and
- Forestry Operation Plans.

Field Surveys

John is actively involved in undertaking field surveys. In NSW, John's field experience is within the Sydney Region, including the Blue Mountains, Central Coast and Hunter Valley.

Field surveys have included:

- Vegetation mapping;
- Plant Community Type and threatened ecological community classification
- Quadrat / plot-based surveys, including plots following the Biodiversity Assessment Method;
- Fauna habitat assessments and vegetation condition assessments;
- Aquatic monitoring of riparian and stream health;
- Targeted threatened flora surveys; and
- Monitoring surveys (targeted threatened flora and vegetation condition assessments).

John is involved in the analysis of field survey data, including the preparation of vegetation maps, assessment of Plant Community Types and development of flora species polygons.

Education

- Bachelor of Arts - Graphic Design, Charles Sturt University 1996.
- Bachelor of Science - Biology, Macquarie University, 2019.

Matthew Freeman

Senior Project Manager / Ecologist

Experience

Matthew Freeman is a Senior Project Manager/ Ecologist at Cumberland Ecology, with over eight years of experience. He has managed a number of small to large-scale projects throughout NSW for the urban, industrial, extraction and infrastructure sectors.

Matthew has extensive experience undertaking ecological impact assessments for threatened flora and fauna species and threatened ecological communities, and routinely assesses projects in response to NSW and Commonwealth legislation. Matthew is an Accredited Assessor for the Biodiversity Assessment Method (BAAS19019).

Matthew has been responsible for managing and undertaking surveys for projects in NSW, Queensland and the Northern Territory, as well as projects in the United Kingdom. This has included projects within the urban, industrial, infrastructure and extraction sectors.

Project Management

Matthew has managed the ecological components of a suite of projects including residential development applications, State Significant Developments, mining projects and biodiversity monitoring programs.

Matthew has done extensive project management work for a large mining project in NSW, which has included management of a large team of staff (>20) for post approval ecological works. Matthew also assists with project management of a large extraction project in the Northern Territory.

Matthew has also managed a number of monitoring projects including feral monitoring, nest-box monitoring, and threatened species monitoring.

In his role at Cumberland Ecology he has also consulted with a number of local and government agencies.

Report Preparation

Matthew has been the primary or contributing author of a variety of documents for both State and Commonwealth assessments including:

- Biodiversity Development Assessment Reports;
- Ecological impact assessments;
- Ecological constraints analyses;
- Biodiversity management plans;
- Vegetation management plans; and
- Biodiversity monitoring reports.

Field Surveys

Matthew is actively involved in undertaking field surveys, and has extensive experience in designing and undertaking flora and fauna surveys. In NSW, Matthew's field experience is within the Sydney Region, Hunter Valley, Gunnedah Basin, Central Coast and South Coast. Matthew has also undertaken field surveys within the Bowen Basin in Queensland and Groote Eylandt in the Northern Territory.

Field surveys have included:

- Pre-clearing and clearing supervision surveys (aquatic and terrestrial);
- Fauna habitat assessments and vegetation condition assessments;
- Vegetation mapping;
- Quadrat and plot-based flora surveys, targeted threatened species surveys;
- Threatened and feral fauna monitoring surveys; and
- Research projects (bandicoot population monitoring, microchiropteran bat radio-tracking, threatened small mammal investigations).

Education

- Bachelor of Natural Science (Nature Conservation). University of Western Sydney, 2012.
- BAM Accredited Assessor Training. Muddy Boots, 2018 (Accredited April 2019).

Michael Davis

Project Manager / GIS Specialist

Experience

Michael Davis is a Project Manager / GIS Specialist at Cumberland Ecology, with five years of consulting experience. Michael has detailed technical knowledge and experience in the interpretation and production of mapping products, including topographic modelling as well as classification and feature extraction using aerial photography and satellite imagery.

At Cumberland Ecology, Michael is closely involved in both small and large scale projects and is responsible for GIS development, mapping and analyses. Michael has managed and been involved in a numerous assessments utilising the Biodiversity Assessment Method (BAM), BioBanking and Biocertification.

Project Management

Michael has undertaken project management of small and large scale development projects in NSW. This has included the management of the ecological components for a suite of residential development applications, including State Significant Development projects. This has included coordinating teams of staff through field work, data analysis, biodiversity credit calculations and report preparation. Michael also has experience relating to consultation with local and government agencies associated with biodiversity assessment.

Report Preparation

Michael has been the primary or contributing author of a variety of documents including:

- Biodiversity Development Assessment Reports;
- Ecological impact assessments;
- Ecological constraints analysis: and
- Biodiversity and vegetation management plans.

Geographic Information Systems

Michael has extensive experience in Geographic Information Systems on the ESRI ArcGIS platform. He is experienced in utilising GIS for vegetation mapping, threatened species occurrence mapping, production of field maps and image analysis.

Recent GIS consultancy work has included:

- Vegetation and threatened flora and fauna mapping for large – and small – scale projects;
- GIS mapping for Biodiversity Assessment Method assessments; and
- GIS mapping and analysis for BAM, Species Impact Statements, and Biodiversity Management Plans.

Michael has undertaken GIS for a range of biodiversity assessments including projects in NSW, Queensland and the Northern Territory. He has also prepared figures and credit calculations to support position papers and Statements of Evidence for NSW Land and Environment Court proceedings.

Field Surveys

Michael is involved in undertaking field surveys, and has substantial experience in designing and undertaking flora and fauna surveys. Michael's field experience is within the Sydney Region, South West Slopes and North West Slopes.

Field surveys have included:

- Vegetation mapping;
- Plot-based floristic surveys in accordance with the BAM and BioBanking methodology; and
- Targeted threatened flora and fauna surveys.

Education

- Bachelor of Biodiversity and Conservation, Macquarie University, 2015.
- Statement of Attainment in ArcGIS & Reporting for Environmental Resource Management, TAFE NSW Ryde, 2017.
- BAM Accredited Assessor Training. Muddy Boots, 2017.

Sally Dupont

Project Manager / Ecologist

Experience

Sally Dupont is a Project Manager / Ecologist at Cumberland Ecology, with four years of experience. She has managed a number of small- to large-scale projects in NSW for the urban and infrastructure sectors.

She has experience undertaking ecological impact assessments for threatened flora and fauna species and threatened ecological communities, and routinely assesses projects in response to NSW and Commonwealth legislation.

Sally has been involved in numerous field surveys within NSW as well as the Northern Territory. She routinely works on projects requiring site-specific inductions, and has obtained her WorkCover White Card, Rail Industry Safety Induction and has a Working at Heights Permit.

Project Management

Sally has managed the ecological component of a suite of projects including small- to large-scale residential, industrial, and State Significant development in NSW. This has included coordinating teams of staff through fieldwork, data analysis and report preparation. She has also assisted in the supervision of large teams of staff (>15) on a large-scale mining project in NSW. This included organising fieldwork plans for survey teams, liaising with site personnel and preparation of safety documentation.

In her role at Cumberland Ecology she has also consulted with a number of local and government agencies.

Report Preparation

Sally has been the primary or contributing author of a variety of documents for both State and Commonwealth assessments including:

- Biodiversity Development Assessment Reports;
- Ecological impact assessments;
- Ecological constraints analyses;
- Pre-clearing and clearing supervision reports; and
- Biodiversity management plans.

Field Surveys

Sally is actively involved in undertaking field surveys and has experience in designing and undertaking fauna surveys. In NSW, Sally's field experience is within the Sydney Region, Hunter Valley, Gunnedah Basin, Central Coast and South Coast. Sally has also undertaken field surveys within the Brigalow Belt in Queensland and on Groote Eylandt in the Northern Territory.

Field surveys have included:

- Pre-clearing and clearing supervision surveys (aquatic and terrestrial);
- Fauna habitat assessments and vegetation condition assessments;
- Targeted threatened species surveys (arboreal and terrestrial mammals, microchiropteran bats, birds, reptiles and amphibians);
- Threatened and feral fauna monitoring surveys utilising motion-sensor cameras;
- Targeted threatened flora surveys;
- Aquatic monitoring of riparian and stream health;
- Vegetation mapping and flora monitoring surveys, including riparian vegetation assessments;
- Fauna monitoring surveys, including nest-box monitoring; and
- Research projects (microchiropteran bat radio tracking).

Education

- Bachelor of Science, Western Sydney University, 2012.
- Master of Research (Marine Biology), Macquarie University, 2016.
- BAM Accredited Assessor Training. Muddy Boots, 2019.

APPENDIX G :
BioBanking Calculations

G.1. Introduction

This BioBanking assessment follows BioBanking Assessment Methodology 2014 (BBAM) (OEH 2014a) under the *Threatened Species Conservation Act*. The purpose of this assessment is to calculate the offset liability for the clearing of Threatened Ecological Communities (TECs) and the proportion of these offsets being achieved by on-site conservation areas. The BBAM assessment was undertaken for areas of the subject land as identified in **Figure 19** (hereafter referred to as the 'BBAM Area').

Elderslie Banksia Scrub Forest (EBSF), one of the TECs proposed to be impacted, has previously been excluded from the BBAM assessment as the proposed offset for this community has been negotiated with Council. However, based on the updated vegetation mapping there are additional small areas of EBSF that are mapped, including 0.10 ha of EBSF (non-TEC) that has been combined with the CEEC EBSF within the BBAM calculations. For this reason the impact liabilities for a portion of this community are now included in the calculations.

The BBAM Area of ~486.95 ha comprises three management areas being:

- ~151.58 ha of impact area to be cleared for development;
- ~56.60 ha of offset area to be conserved in perpetuity in the Conservation Area of Howes Creek Corridor (including 0.84 ha comprising dams that is not included in vegetation calculations);
- ~0.21 ha of offset area to be conserved in perpetuity in the Conservation Area of the Stage 6B EBSF;
- ~2.78 ha of area to be conserved in perpetuity in Parks K and L and managed under a Vegetation Management Plan (VMP); and
- ~274.94 ha of land retained in current condition and not included in this assessment as it is not currently proposed for development or offsetting under this Development Application, or is outside the proponent's land holding.

Table 41 shows the vegetation communities, the BVTs, threat status and areas included in the calculations.

Table 39 Details of vegetation included within the BioBanking calculations

Vegetation Community	BVT	TEC	Impact Area	Offset Area (Extant)	Offset Area (Revegetation)	Offset Area (Combined)
River-flat Eucalypt Forest	HN526	Yes	1.51	8.44	3.84	12.28
Shale Hills Woodland	HN529	Yes	4.80	0	0	0
Shale Hills Woodland (shrubby regrowth)	HN529	No	0.49	0	0	0
Shale Hills Woodland (derived native grassland)	HN529	Yes	3.28	0	0	0

Vegetation Community	BVT	TEC	Impact Area	Offset Area (Extant)	Offset Area (Revegetation)	Offset Area (Combined)
Shale Plains Woodland	HN528	Yes	5.94	11.57	11.55	23.12
Shale Plains Woodland (derived native grassland)	HN528	Yes	8.67	0.43	0	0.43
Freshwater Wetlands	HN630	Yes	0.37	6.15	1.62	7.77
Swamp Oak Floodplain Forest	HN674	Yes	3.39	7.16	5.68	12.84
Elderslie Banksia Scrub Forest	HN635	Yes	0.87*	0.21	0	0.00
Total			**29.32**	**34.83**	**23.25**	**58.73****

** Total clearing area is 0.87 ha including the 0.10 ha of EBSF (non-TEC); however, removal of 0.56 ha already been negotiated with Council as retained in Parks K and L.*

***Total Conservation Area is 59.59 due to 0.84 ha of dams not included in BioBanking calculations*

G.2. Methodology

The BBAM has been designed to address the loss of biodiversity in NSW by enabling landowners in NSW to establish BioBanking sites to secure conservation outcomes and offset impacts on biodiversity values, based on an improve or maintain outcome. Landowners can create BioBanking credits by committing to improve and/or increase the habitat of threatened species and ecological communities. Developers can buy the credits to offset impacts from their development. They will need to source particular types of credits in accordance with the offset rules in the BBAM (OEH 2014a).

There are two types of BioBanking Credits:

- Ecosystem credits can only be used to offset biodiversity impacts on the same ecological community, or on another community of the same formation that has an equal or greater percentage of land cleared and the same predicted threatened species; and
- Species credits can only be used to offset biodiversity impacts on the same threatened species.

Ecological communities are used in the BBAM as a surrogate for general biodiversity values. They are referred to as Plant Community Types (PCTs) and should be the vegetation type assumed to have originally occurred at the site. The names used for PCTs in a BioBanking assessment are selected from the Office of Environment and Heritage (OEH) Vegetation Information Systems (VIS) database (OEH 2016c). The names available differ to some extent from those used in other existing vegetation maps and also from names used for Commonwealth and State Endangered Ecological Communities (EECs). The selection of PCTs influences the outcome of the assessment because different PCTs produce different credit calculations, due to some plant communities supporting more threatened flora/fauna species than others. PCTs within a Catchment Management Area (CMA) are then assigned a Biometric Vegetation Type (BVT) code that is used within the Online BioBanking Credit Calculator (BBCC) (OEH 2014b).

PCTs for the BBAM Area were selected based on the best-fit PCT from the VIS database using the floristic data collected during field surveys. The landscape position and soil type were also used in determining the best-fit PCT for the vegetation communities within the BBAM Area. Once the PCTs were selected, they were input into the BBCC along with the plot and transect data, in accordance with the BBAM, in order to calculate the credit requirement for the impacts within the BBAM Area.

Southern Myotis (*Myotis macropus*) species polygons were created based on areas of native woodland vegetation within 200 m of a waterbody with a width of at least 3 m, as required by the BBAM, and input into the BBCC, to calculate the credit requirements for impacts to this species.

The results of these calculations are presented in ***Section G.4***.

G.3. Assumptions and Limitations

Although BioBanking methodology is systematic, there is scope for "professional judgement" to be applied; meaning different operators may arrive at differing credit calculations. Thus, several assumptions have been made throughout the assessment process and include the following:

It has been assumed that all areas identified as 'impact area' will be cleared. If some vegetation within the BBAM Area is retained, the number of ecosystem credits generated for the affected PCTs may change slightly. Nevertheless, credits generated for retention of street trees and/or asset protection zones, will not equate to credits generated by larger patches of fully conserved and maintained ecological communities.

This assessment is intended to be indicative only and does not include an official BioBanking Statement application, which requires additional field work and reporting.

While the total number of flora plots conducted within each vegetation zone is according to the requirements under the BBAM (OEH 2014a), there might not be sufficient plots within exotic vegetation areas of the offset area according to their future assigned vegetation zone as a revegetated area of a given community once all areas are divided. Plot data within exotic vegetation areas of the offset area were therefore re-used in the BBCC, though not all were selected for each future revegetation zone; only those most suitable were selected based on proximity to the revegetation area and similarity in topography and habitat to the future zone. This is considered to be appropriate as the general condition of all exotic vegetation in the offset area was similar, and a suitable number of plots were collected based on the exotic vegetation original categorisation as one vegetation zone.

G.4. Results

G.4.1. Impact Area

The vegetation communities within the impact area are approximately as follows:

- 1.51 ha of HN526, River-flat Eucalypt Forest;
- 5.94 ha of HN528, Shale Plains Woodland
- 8.67 ha HN528, Shale Plains Woodland Derived Native Grassland (DNG);

- 4.80 ha of HN529 Shale Hills Woodland;
- 3.28 ha of HN529 Shale Hills Woodland DNG;
- 0.49 ha of HN529, Shale Hills Woodland shrubby regrowth;
- 3.39 ha of HN674, Swamp Oak Floodplain Forest;
- 0.37 ha of HN630, Freshwater Wetlands; and
- 0.87 ha of HN635, EBSF.

The remaining areas are comprised of either vegetation communities that are not native, or areas comprising cleared land or dams.

All areas of woodland and DNG are in moderate to good condition. The DNG does not fit the definition of "low" condition under the BBAM (OEH 2014a), due to the percent foliage cover of indigenous ground cover species being greater than 50%.

The BBAM calculations rely on locality, landscape values, connectivity, patch size, as well as floristic composition of each vegetation zone.

G.4.1.1. Assessment Circles

The BBAM Area does not fit into a 1,000 ha outer assessment circle, which under strict BBAM rules is required. For the purpose of this assessment a 2,000 ha outer assessment circle was used, which covers the entire BBAM Area. The inner assessment circle has to be in a 1:10 ratio of the outer assessment circle and is therefore 200 ha.

G.4.1.2. Landscape Values

Catchment Management Area (CMA) = Hawkesbury/Nepean

Local Government Area (LGA) = Campbelltown

IBRA Sub-region = Cumberland

Dominant Mitchell Landscape = Cumberland Plain

Connectivity width of woody vegetation before development = >5 to 30m

Connectivity width of woody vegetation after development = 0 to 5m

Patch Size = 183 ha (the patch size is the area of contiguous native vegetation within and outside the development footprint)

G.4.1.3. Native Vegetation

The extent of native vegetation within the inner and outer assessment circles is shown in **Table 43** below. The source of the vegetation layer outside the BBAM Area comprises all woody vegetation as mapped by OEH (CumberlandPlainWest_2013_E_4207) and Sydney Metropolitan mapping V2 2013 (VISmap_E_3817).

Table 40 Extent of native vegetation within the inner and outer assessment circle

Assessment Circle	Before Development		After Development	
Outer (2,000 ha)	486.95 ha	24.3% (i.e. 21-25%)	457.71 ha	22.9% (i.e. 21-25%)
Inner (200 ha)	39.59 ha	19.8% (i.e. 16-20%)	25.12 ha	12.6% (i.e. 11-15%)

It is important to note that percent native vegetation cover in the BBCC is entered in categories. The fact that the data for this assessment does not change categories between the before and after clearing in the outer assessment circle, is purely coincidental. The extent of native vegetation influences the landscape value, which in turn has an impact on the number of ecosystem credits generated.

G.4.1.4. Geographic/Habitat Features

Geographic habitat features describe micro-habitats used by certain threatened species, some of which do not exist within the BBAM Area and can be "turned off" during an assessment. The following geographic habitat features were included in the BBCC are assumed to be present for the purpose of this assessment:

- Land containing bark or leaf litter accumulation;
- Land within 100 m of emergent aquatic or riparian vegetation;
- Wet and damp areas;
- Alluvial soils;
- Land situated in damp, disturbed sites;
- Land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation;
- Periodically waterlogged sites (including table drains and farm dams);
- Land within 40 m of heath, woodland or forest;
- Land containing brackish or freshwater wetlands; and
- Land situated in damp, disturbed sites.
- The following geographic habitat features were "turned off", since they are absent from the BBAM Area:
- Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels;
- Land within 250 m of termite mounds or rock outcrops;
- 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; and
- Land within 40 m of permanent wetlands with a good surface cover of floating vegetation.

G.4.1.5. Ecosystem Credits

A total of 1,004 ecosystem credits are required to offset the impact by the proposed clearing within the BBAM Area. **Table 43** shows the vegetation zone included in the BBAM impact calculations, as well as the number of ecosystem credits generated by each zone.

Table 41 Details of ecosystem credits generated for each vegetation zone to be impacted

Vegetation Community/Zone	BVT	Impact Area	Ecosystem Credits Generated
River-flat Eucalypt Forest	HN526	1.51	68
Shale Hills Woodland	HN529	4.80	237
Shale Hills Woodland (shrubby regrowth)	HN529	0.49	10
Shale Hills Woodland (derived native grassland)	HN529	3.28	55
Shale Plains Woodland	HN528	5.94	271
Shale Plains Woodland (Derived Native Grassland)	HN528	8.67	146
Freshwater Wetlands	HN630	0.37	10
Swamp Oak Floodplain Forest	HN674	3.39	161
Elderslie Banksia Scrub Forest	HN635	0.87	47
Total		**29.32**	**1,005**

Figure 19 shows the vegetation communities within the BBAM Area.

The ecosystem credits include threatened species, which are assumed to occur within the impact area without requiring surveys. They are listed in **Table 44** below.

Table 42 Threatened species predicted to occur within the impact area

Common Name	Scientific Name
Australian Painted Snipe	*Rostratula australis*
Barking Owl	*Ninox connivens*
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis subsp. gularis*
Black-tailed Godwit	*Limosa limosa*
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus subsp. victoriae*
Bush Stone-curlew	*Burhinus grallarius*
Diamond Firetail	*Stagonopleura guttata*
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*
Eastern Freetail-bat	*Mormopterus norfolkensis*
Flame Robin	*Petroica phoenicea*

Common Name	Scientific Name
Freckled Duck	*Stictonetta naevosa*
Gang-gang Cockatoo	*Callocephalon fimbriatum*
Glossy Black-Cockatoo	*Calyptorhynchus lathami*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Hooded Robin (south-eastern form)	*Melanodryas cucullata subsp. cucullata*
Little Eagle	*Hieraaetus morphnoides*
Little Lorikeet	*Glossopsitta pusilla*
Masked Owl	*Tyto novaehollandiae*
Painted Honeyeater	*Grantiella picta*
Powerful Owl	*Ninox strenua*
Scarlet Robin	*Petroica boodang*
Speckled Warbler	*Chthonicola sagittata*
Spotted Harrier	*Circus assimilis*
Spotted-tailed Quoll	*Dasyurus maculatus*
Square-tailed Kite	*Lophoictinia isura*
Swift Parrot	*Lathamus discolor*
Turquoise Parrot	*Neophema pulchella*
Varied Sittella	*Daphoenositta chrysoptera*
White-fronted Chat	*Epthianura albifrons*
Yellow-bellied Glider	*Petaurus australis*
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*

G.4.1.6. Species Credits

Under the BBAM (OEH 2014a), threatened species have to be assessed for a development site where they are not included in ecosystem credits, i.e. they cannot be reliably predicted to use an area of land based on habitat surrogates. A candidate list of threatened species must be identified depending on geographic distribution, preferred habitat features and known occurrences of each threatened species with potential to occur. A subsequent site assessment allows the assessor to determine the likelihood of occurrence for each candidate threatened species.

The BBCC generates a list of candidate species, which includes survey times, i.e. the months during which each species is most likely to be detected and during which the survey has to be done. **Table 45** below shows the candidate list of threatened species with potential habitat on the BBAM Area.

Table 43 Candidate threatened species with potential habitat within the impact area

Common name	Scientific name
Allocasuarina glareicola	*Allocasuarina glareicola*
Austral Pillwort	*Pilularia novae-hollandiae*
Australasian Bittern	*Botaurus poiciloptilus*
Bargo Geebung	*Persoonia bargoensis*
Black Bittern	*Ixobrychus flavicollis*
Brown Pomaderris	*Pomaderris brunnea*
Bynoe's Wattle	*Acacia bynoeana*
Camden White Gum	*Eucalyptus benthamii*
Cumberland Plain Land Snail	*Meridolum corneovirens*
Dillwynia tenuifolia	*Dillwynia tenuifolia*
Dillwynia tenuifolia (a shrub) population, Kemps Creek	*Dillwynia tenuifolia - endangered population Kemps Creek*
Downy Wattle	*Acacia pubescens*
Dwarf Kerrawang	*Commersonia prostrata*
Eastern Osprey	*Pandion cristatus*
Eastern Pygmy-possum	*Cercartetus nanus*
Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	*Callocephalon fimbriatum population in the Hornsby and Ku-ring-gai Local Government Areas*
Giant Burrowing Frog	*Heleioporus australiacus*
Green and Golden Bell Frog	*Litoria aurea*
Gyrostemon thesioides	*Gyrostemon thesioides*
Hibbertia sp. Bankstown	*Hibbertia sp. Bankstown*
Hypsela sessiliflora	*Hypsela sessiliflora*
Juniper-leaved Grevillea	*Grevillea juniperina subsp. juniperina*
Koala	*Phascolarctos cinereus*
Marsdenia viridiflora subsp. viridiflora in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	*Marsdenia viridiflora subsp. viridiflora - endangered population*
Matted Bush-pea	*Pultenaea pedunculata*
Micromyrtus minutiflora	*Micromyrtus minutiflora*
Nodding Geebung	*Persoonia nutans*
Pimelea curviflora subsp. curviflora	*Pimelea curviflora subsp. curviflora*
Pultenaea parviflora	*Pultenaea parviflora*
Regent Honeyeater	*Anthochaera phrygia*
Small-flower Grevillea	*Grevillea parviflora subsp. parviflora*

Common name	Scientific name
Spiked Rice-flower	*Pimelea spicata*
Squirrel Glider	*Petaurus norfolcensis*
Sydney Plains Greenhood	*Pterostylis saxicola*
Tall Knotweed	*Persicaria elatior*
Wahlenbergia multicaulis (Tadgells Bluebell) population, Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield local government areas	*Wahlenbergia multicaulis - endangered population*
White-flowered Wax Plant	*Cynanchum elegans*

Only one species credit species, the Southern Myotis (*Myotis macropus*) has been considered as present and species credits have been calculated as part of this assessment. Although the species was not in the list of predicted species credit species, it was recorded within the BBAM Area in March 2018 and breeding habitat occurs for the species within the subject site. The species polygon included all native woodland occurring in the impact area that falls within a 200 m radius of waterbodies of at least 3 m width. These areas are shown in **Table 46** below.

Table 44 Vegetation communities within the Southern Myotis species polygon

Vegetation Community	BVT	Area (ha)	Total Species Credits
Elderslie Banksia Scrub Forest	HN635	0.29	**136**
River Flat Eucalypt Forest	HN526	0.23	
Shale Plains Woodland	HN528	3.04	
Swamp Oak Floodplain Forest	HN674	2.63	
Total Area		**6.20**	

G.4.2. Offset Areas

The vegetation communities within the offset area are:

- 8.44 ha of HN526, River-flat Eucalypt Forest;
- 11.57 ha of HN528, Shale Plains Woodland
- 0.43 ha of Shale Plains Woodland DNG;
- 7.16 ha of HN674, Swamp Oak Floodplain Forest; and
- 6.15 ha of HN630, Freshwater Wetlands.

Additionally, a further 23.25 ha of exotic grassland will be revegetated into the associated vegetation communities. For this assessment all exotic grassland areas are considered to be in low condition. The ecosystem credits are calculated by assuming that the exotic grassland will ultimately reach benchmark conditions of the associated vegetation community, for which the calculator default increments were accepted.

The BBAM calculations rely on locality, landscape values, connectivity, patch size, as well as floristic composition of each vegetation zone.

G.4.2.1. Assessment Circles

As for the impact area, a 2,000 ha outer assessment circle was used for the offset, which covers the entire BBAM Area. The inner assessment circle of 200 ha covers the main area of where the offset occurs.

G.4.2.2. Landscape Values

The landscape values are the same as for the impact area, except for the patch size. Since the offset area is connected to the riparian area along the Nepean River, the patch size is much larger. A maximum value of 1,001 ha is assumed in the calculator.

G.4.2.3. Native Vegetation

The extent of native vegetation within the inner and outer assessment circles is shown in **Table 47** below. The source of the vegetation layer outside the BBAM Area comprises all woody vegetation as mapped by OEH (CumberlandPlainWest_2013_E_4207) and Sydney Metro mapping V2 2013 (VISmap_E_3817). The before offset assumes all native vegetation within the impact area has been removed following development approval.

Table 45 Extent of native vegetation within the inner and outer assessment circle

Assessment Circle	Before Offset		After Offset	
Outer (2,000 ha)	450.17 ha	22.5% (i.e. 21-25%)	469.62 ha	23.5% (i.e. 21-25%)
Inner (200 ha)	28.13 ha	14.1% (i.e. 11-15%)	38.06 ha	19.0% (i.e. 16-20%)

G.4.2.4. Geographic/Habitat Features

Geographic habitat features describe micro-habitats used by certain threatened species, some of which do not exist within the BBAM Area and can be "turned off" during an assessment. The following geographic habitat features were included in the BBCC are assumed to be present for the purpose of this assessment:

- Land containing bark or leaf litter accumulation;
- Land within 100 m of emergent aquatic or riparian vegetation;
- Wet and damp areas;
- Alluvial soils;
- Land situated in damp, disturbed sites;

- Land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation;
- Periodically waterlogged sites (including table drains and farm dams);
- Land within 40 m of heath, woodland or forest;
- Land containing brackish or freshwater wetlands; and
- Land situated in damp, disturbed sites.
- The following geographic habitat features were "turned off", since they are absent from the BBAM Area:
- Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels;
- Land within 250 m of termite mounds or rock outcrops;
- 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; and
- Land within 40 m of permanent wetlands with a good surface cover of floating vegetation.

G.4.2.5. Ecosystem Credits

A total of 674 ecosystem credits are generated by the offset area, assuming that the exotic grassland will be replanted/regenerated into the associated vegetation community. **Table 48** shows the vegetation zones included in the BBAM offset calculations, as well as the number of ecosystem credits generated by each zone.

Table 46 Details of ecosystem credits generated from each vegetation zone to be offset

Vegetation Community	BVT	Offset Extant Area (CA)		Offset Revegetation Area (CA)		Offset Combined (CA)	
	BVT	Area (ha)	Ecosystem Credits	Area (ha)	Ecosystem Credits	Area (ha)	Ecosystem Credits
River-flat Eucalypt Forest	HN526	8.44	102	3.84	39	12.28	141
Shale Hills Woodland	HN529	0	0	0	0	0	0
Shale Hills Woodland (shrubby regrowth)	HN529	0	0	0	0	0	0
Shale Hills Woodland (derived	HN529	0	0	0	0	0	0

Vegetation Community	BVT	Offset Extant Area (CA)		Offset Revegetation Area (CA)		Offset Combined (CA)	
native grassland)							
Shale Plains Woodland	HN528	11.57	132	11.55	127	23.12	259
Shale Plains Woodland (derived native grassland)	HN528	0.43	6	0	0	0.43	6
Freshwater Wetlands	HN630	6.15	86	1.62	18	7.77	104
Swamp Oak Floodplain Forest	HN674	7.16	104	5.68	58	12.84	162
Elderslie Banksia Scrub Forest	HN635	0.21*	2	0.56**	30**	0.21	2
Total		**34.83**	**432**	**23.25**	**242**	**59.59**	**674**

**0.56 ha of Elderslie Banksia Scrub removal has already been negotiated with Council based on the proposed retention in Parks K and L. Therefore, credit calculations only considered the additional 0.21 ha of removal proposed in this updated SIS. This 0.56 ha was not included in total calculations for the "Offset Combined (CA)" area.*

***These credits were not calculated based on BBAM, these are based on the change in credit liability calculated for the removal of 0.87 ha compared to 0.31 ha of EBSF.*

The ecosystem credits include threatened species, which are assumed to occur within the offset area without requiring surveys. They are shown in **Table 49** below.

Table 47 Threatened species predicted to occur within the offset area

Common Name	Scientific Name
Australian Painted Snipe	*Rostratula australis*
Barking Owl	*Ninox connivens*
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis subsp. gularis*
Black-tailed Godwit	*Limosa limosa*
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus subsp. victoriae*
Bush Stone-curlew	*Burhinus grallarius*
Diamond Firetail	*Stagonopleura guttata*

Common Name	Scientific Name
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*
Eastern Freetail-bat	*Mormopterus norfolkensis*
Flame Robin	*Petroica phoenicea*
Freckled Duck	*Stictonetta naevosa*
Gang-gang Cockatoo	*Callocephalon fimbriatum*
Glossy Black-Cockatoo	*Calyptorhynchus lathami*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Hooded Robin (south-eastern form)	*Melanodryas cucullata subsp. cucullata*
Little Eagle	*Hieraaetus morphnoides*
Little Lorikeet	*Glossopsitta pusilla*
Masked Owl	*Tyto novaehollandiae*
Painted Honeyeater	*Grantiella picta*
Powerful Owl	*Ninox strenua*
Scarlet Robin	*Petroica boodang*
Speckled Warbler	*Chthonicola sagittata*
Spotted Harrier	*Circus assimilis*
Spotted-tailed Quoll	*Dasyurus maculatus*
Square-tailed Kite	*Lophoictinia isura*
Swift Parrot	*Lathamus discolor*
Turquoise Parrot	*Neophema pulchella*
Varied Sittella	*Daphoenositta chrysoptera*
White-fronted Chat	*Epthianura albifrons*
Yellow-bellied Glider	*Petaurus australis*
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*

G.4.2.6. Species Credits

A candidate list of threatened species with potential habitat within the offset area are shown in **Table 50** below. No species credits have been generated as part of the BBAM calculations for the Offset Area.

Table 48 Candidate threatened species with potential habitat within the offset area

Common name	Scientific name
Allocasuarina glareicola	*Allocasuarina glareicola*
Austral Pillwort	*Pilularia novae-hollandiae*
Australasian Bittern	*Botaurus poiciloptilus*
Bargo Geebung	*Persoonia bargoensis*

Common name	Scientific name
Black Bittern	*Ixobrychus flavicollis*
Brown Pomaderris	*Pomaderris brunnea*
Bynoe's Wattle	*Acacia bynoeana*
Camden White Gum	*Eucalyptus benthamii*
Cumberland Plain Land Snail	*Meridolum corneovirens*
Dillwynia tenuifolia	*Dillwynia tenuifolia*
Dillwynia tenuifolia (a shrub) population, Kemps Creek	*Dillwynia tenuifolia - endangered population Kemps Creek*
Downy Wattle	*Acacia pubescens*
Dwarf Kerrawang	*Commersonia prostrata*
Eastern Osprey	*Pandion cristatus*
Eastern Pygmy-possum	*Cercartetus nanus*
Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	*Callocephalon fimbriatum population in the Hornsby and Ku-ring-gai Local Government Areas*
Giant Burrowing Frog	*Heleioporus australiacus*
Green and Golden Bell Frog	*Litoria aurea*
Gyrostemon thesioides	*Gyrostemon thesioides*
Hibbertia sp. Bankstown	*Hibbertia sp. Bankstown*
Hypsela sessiliflora	*Hypsela sessiliflora*
Juniper-leaved Grevillea	*Grevillea juniperina subsp. juniperina*
Koala	*Phascolarctos cinereus*
Marsdenia viridiflora subsp. viridiflora in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	*Marsdenia viridiflora subsp. viridiflora - endangered population*
Matted Bush-pea	*Pultenaea pedunculata*
Micromyrtus minutiflora	*Micromyrtus minutiflora*
Nodding Geebung	*Persoonia nutans*
Pimelea curviflora subsp. curviflora	*Pimelea curviflora subsp. curviflora*
Pultenaea parviflora	*Pultenaea parviflora*
Regent Honeyeater	*Anthochaera phrygia*
Small-flower Grevillea	*Grevillea parviflora subsp. parviflora*
Spiked Rice-flower	*Pimelea spicata*
Squirrel Glider	*Petaurus norfolcensis*
Sydney Plains Greenhood	*Pterostylis saxicola*
Tall Knotweed	*Persicaria elatior*

Common name	Scientific name
Wahlenbergia multicaulis (Tadgells Bluebell) population, Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield local government areas	*Wahlenbergia multicaulis - endangered population*
White-flowered Wax Plant	*Cynanchum elegans*

G.4.3. Summary

Table 51 includes the offset liability for the proposed clearing with consideration of the credits generated by the proposed offset.

A like-for-like offset for credits includes the same credits from Cumberland, Sydney Cataract, Burragorang, Wollemi, Yengo or Pittwater IBRA subregions. Alternatively, an Assessment of Reasonable Equivalence can be sought to convert the BBAM credits into Biodiversity Assessment Method (BAM) credits, which would allow payment into the Biodiversity Conservation Fund (BCF) to cover all remaining credit liability.

Table 49 Credit surplus/deficit for the BBAM Area

		Offset Extant Area (CA)		Offset Revegetation Area (CA)		Offset Combined (CA)		Credit Surplus/ Deficit
Vegetation Community	BVT	Area	Ecosystem Credits	Area	Ecosystem Credits	Area	Ecosystem Credits	Ecosystem Credits
River-flat Eucalypt Forest	HN526	8.44	102	3.84	39	12.28	141	73
Shale Hills Woodland	HN529	0	0	0	0	0	0	-237
Shale Hills Woodland (shrubby regrowth)	HN529	0	0	0	0	0	0	-10
Shale Hills Woodland (derived native grassland)	HN529	0	0	0	0	0	0	-55
Shale Plains Woodland	HN528	11.57	132	11.55	127	23.12	259	-12
Shale Plains Woodland (derived	HN528	0.43	6	0	0	0.43	6	-140

		Offset Extant Area (CA)		Offset Revegetation Area (CA)		Offset Combined (CA)		Credit Surplus/ Deficit
native grassland)								
Freshwater Wetlands	HN630	6.15	86	1.62	18	7.77	104	94
Swamp Oak Floodplain Forest	HN674	7.16	104	5.68	58	12.84	162	1
Elderslie Banksia Scrub Forest	HN635	0.21*	2	0.56**	30**	0.21	2	-15
Total		**34.83**	**432**	**23.25**	**242**	**59.59**	**674**	**-301**

BioBanking credit report

This report identifies the number and type of credits required at a DEVELOPMENT SITE.

Date of report: 30/07/2024 Time: 9:16:23AM Calculator version: v4.0

Development details

Proposal ID:	0057/2021/5125D
Proposal name:	Menangle Park - Site-wide Bulk Earthworks DA - 2022
Proposal address:	1 Mountain Street Epping NSW 2121
Proponent name:	Cumberland Ecology
Proponent address:	1 Mountain Street NSW 2121
Proponent phone:	02 9868 1933
Assessor name:	David Robertson
Assessor address:	PO BOX 2474 Carlingford Court NSW 2118
Assessor phone:	02 9868 1933
Assessor accreditation:	0057

Improving or maintaining biodiversity

An application for a red flag determination is required for the following red flag areas

Red flag	Reason
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Vegetation type being > 70% cleared; or it contains an endangered ecological community;
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Vegetation type being > 70% cleared; or it contains an endangered ecological community;
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Vegetation type being > 70% cleared; or it contains an endangered ecological community;
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion	Vegetation type being > 70% cleared; or it contains an endangered ecological community;
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Vegetation type being > 70% cleared; or it contains an endangered ecological community;

The application for a red flag determination should address the criteria set out in the BioBanking Assessment Methodology. Please note that a biobanking statement cannot be issued unless the determination is approved.

Additional information required for approval:

- ☐ Change to percent cleared for a vegetation type/s
- ☐ Use of local benchmark
- ☐ Change negligible loss
- ☐ Expert report...
- ☐ Request for additional gain in site value
- ☐ Predicted threatened species not on site

Australian Painted Snipe	Rostratula australis
Barking Owl	Ninox connivens
Black-chinned Honeyeater (eastern subspecies)	Melithreptus gularis subsp. gularis
Black-tailed Godwit	Limosa limosa
Bush Stone-curlew	Burhinus grallarius
Diamond Firetail	Stagonopleura guttata
Flame Robin	Petroica phoenicea
Freckled Duck	Stictonetta naevosa
Gang-gang Cockatoo	Callocephalon fimbriatum
Glossy Black-Cockatoo	Calyptorhynchus lathami
Hooded Robin (south-eastern form)	Melanodryas cucullata subsp. cucullata
Masked Owl	Tyto novaehollandiae
Painted Honeyeater	Grantiella picta
Powerful Owl	Ninox strenua
Scarlet Robin	Petroica boodang
Speckled Warbler	Chthonicola sagittata
Spotted Harrier	Circus assimilis
Spotted-tailed Quoll	Dasyurus maculatus
Square-tailed Kite	Lophoictinia isura
Swift Parrot	Lathamus discolor
Turquoise Parrot	Neophema pulchella
White-fronted Chat	Epthianura albifrons
Yellow-bellied Glider	Petaurus australis
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris

☐ Change threatened species response to gain (Tg value)

Ecosystem credits summary

Plant Community type	Area (ha)	Credits required	Red flag
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion	0.31	17.07	Yes
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	1.51	67.80	Yes
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	8.67	146.22	No
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	5.94	271.25	Yes
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	3.77	65.32	No
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	4.80	237.48	Yes
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	0.37	10.06	No
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	3.39	160.60	Yes
Total	28.76	976	

Credit profiles

1. Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)

Number of ecosystem credits created 417

IBRA sub-region Cumberland - Hawkesbury/Nepean

Offset options - vegetation types	Offset options - CMA sub-regions
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)

Number of ecosystem credits created 303

IBRA sub-region Cumberland - Hawkesbury/Nepean

Offset options - vegetation types	Offset options - CMA sub-regions
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion, (HN635)

Number of ecosystem credits created 17

IBRA sub-region Cumberland - Hawkesbury/Nepean

Offset options - vegetation types	Offset options - CMA sub-regions
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion, (HN635)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion, (HN630)

Number of ecosystem credits created 10

IBRA sub-region Cumberland - Hawkesbury/Nepean

Offset options - vegetation types	Offset options - CMA sub-regions
Phragmites australis and Typha orientalis coastal freshwater wetlands of the	Cumberland - Hawkesbury/Nepean

Sydney Basin Bioregion, (HN630) Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion, (HN520)	and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)

Number of ecosystem credits created	68
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - vegetation types	Offset options - CMA sub-regions
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

6. Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley, (HN674)

Number of ecosystem credits created	161
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - vegetation types	Offset options - CMA sub-regions
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley, (HN674)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Species credits summary

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Southern Myotis	Myotis macropus	6.20	136

BioBanking credit report

This report identifies the number and type of credits required at a BIOBANK SITE

Date of report: 30/07/2024 Time: 9:17:23AM Calculator version: v4.0

Biobank details

Proposal ID: 0057/2021/5126B

Proposal name: Menangle Park - Site-wide Bulk Earthworks DA - 2022 - OFFSET

Proposal address: 1 Mountain Street Epping NSW 2121

Proponent name:

Proponent address: 1 Mountain Street NSW 2121

Proponent phone: 02 9868 1933

Assessor name: David Robertson

Assessor address: PO BOX 2474 Carlingford Court NSW 2118

Assessor phone: 02 9868 1933

Assessor accreditation: 0057

Additional information required for approval:

- ☐ Use of local benchmark
- ☐ Expert report...
- ☐ Request for additional gain in site value

Ecosystem credits summary

Plant Community type	Area (ha)	Credits created
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion	0.77	8.00
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	12.28	141.00
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	23.55	265.00
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	7.77	104.00
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	12.84	162.00
Total	57.21	680

Credit profiles

1. Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)

Number of ecosystem credits created	138
IBRA sub-region	Cumberland - Hawkesbury/Nepean

2. Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)

Number of ecosystem credits created	127
IBRA sub-region	Cumberland - Hawkesbury/Nepean

3. Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion, (HN635)

Number of ecosystem credits created	6
IBRA sub-region	Cumberland - Hawkesbury/Nepean

4. Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion, (HN635)

Number of ecosystem credits created	2
IBRA sub-region	Cumberland - Hawkesbury/Nepean

5. Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion, (HN630)

Number of ecosystem credits created	86
IBRA sub-region	Cumberland - Hawkesbury/Nepean

6. Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion, (HN630)

Number of ecosystem credits created	18
IBRA sub-region	Cumberland - Hawkesbury/Nepean

7. Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)

Number of ecosystem credits created	102
IBRA sub-region	Cumberland - Hawkesbury/Nepean

8. Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)

Number of ecosystem credits created	39
IBRA sub-region	Cumberland - Hawkesbury/Nepean

9. Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley, (HN674)

Number of ecosystem credits created	104
IBRA sub-region	Cumberland - Hawkesbury/Nepean

10. Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley, (HN674)

Number of ecosystem credits created	58
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Species credits summary

Additional management actions

Additional management actions are required for:

Vegetation type or threatened species	Management action details
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion	Exclude commercial apiaries
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion	Exclude miscellaneous feral species
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion	Fox control
Coast Banksia scrub on sand in the Elderslie area, Sydney Basin Bioregion	Slashing
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Exclude commercial apiaries
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Exclude miscellaneous feral species
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Fox control
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Slashing
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Exclude commercial apiaries
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Exclude miscellaneous feral species
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Fox control
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Slashing
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Control exotic pest fish species (within dams)
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Control of feral pigs
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Exclude miscellaneous feral species

Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Fox control
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Maintain or re-introduce natural flow regimes
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Exclude commercial apiaries
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Exclude miscellaneous feral species
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Feral and/or over-abundant native herbivore control
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Fox control
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Slashing

APPENDIX H :

Bat Call Identification Report

Impact Ecology
Environmental Management
ABN: 92895504799

BAT CALL ANALYSIS

4 June 2018

Client: Cumberland Ecology: Mikael Peck
Location: Menangle, NSW.
Vegetation type:

- Location 1 (Anabat): deployed from 14 to 18 March 2018 (Woodland Area surrounded by open grasslands, small wetlands present in near vicinity)
- Location 2 (SM2): deployed from 14 to 18 March 2018 (Riparian Woodlands)
- Location 3 (Anabat): deployed from 19 to 22 March 2018 (Woodland area near residential dwellings)
- Location 4 (SM2): deployed from 23 to 26 March 2018 (Scattered woodland surrounded by grasslands)
- Location 5 (Anabat): deployed from 23-26 March 2018 (Adjacent to Nepean River)

Reporting standard

This report is a rapid species identification report. It does not follow the nationally accepted standards for the interpretation and reporting of bat echolocation data (Reardon 2003) as per the Australasian Bat Society on-line at http://www.ausbats.org.au/. Calls were analysed by Heidi Kolkert using Analook V4.1 bat call analysis software.

Species nomenclature

Species names used in this summary follow Churchill (2008), except for Mormopterus (Ozimops) species, which follow Reardon *et al.* (2014).

Call identification

Call identification is based on existing call descriptions and keys presented in Pennay *et al.* (2004) and Reinhold *et al.* (2001) as well as reference calls collected in New South Wales. Species' identification was further refined by considering probability of occurrence based on distributional information presented in Churchill (2008) and Van Dyck & Strahan (2008) and spatial data stored on the OEH Bionet and Atlas of Living Australia. Some calls lacked sufficient detail for attribution to species level (not enough pulses, noisy or weak calls). Where *Scotorepens orion*, Scoteanax rueppellii and *Falsistrellus tasmaniensis* call frequencies overlapped (35-36khz region) they could not be confidently attributed to species.

Table 1: Microbats identified in the study area via echolocation

Scientific name	Common Name	Location 1	Location 2	Location 3	Location 4	Location 5
Austronomus australis	White-striped Freetail Bat	✓				
Chalinolobus gouldii	Gould's Wattled Bat	✓	✓	✓	✓	✓
Chalinolobus morio	Chocolate Wattled Bat	✓	✓	✓	✓	✓
Falsistrellus tasmaniensis #	Eastern False Pipistrelle	✓	✓		✓	
Miniopterus australis	Little Bentwing-bat	✓				
Miniopterus orianae oceanensis #	Eastern Bent-winged Bat	✓			✓	
Mormopterus (ozimops) ridei	Ride's Free-tailed Bat	✓	✓	✓	✓	✓
Mormopterus (ozimops) planiceps	Southern Free-tailed Bat	✓			P	P
Mormopterus (Micronomus) norfolkensis #	Eastern Freetail-bat	✓	✓		✓	✓
Myotis macropus #	Southern Myotis	✓				
Scotorepens orion	Eastern Broad-nosed Bat	✓	✓			
Scoteanax rueppellii #	Greater Broad-nosed Bat	✓	✓			
Vespadelus darlingtoni	Large Forest Bat	✓	✓		✓	
Vespadelus troughtoni #	Eastern Cave Bat	✓				
Vespadelus pumilus	Eastern Forest Bat				✓	
Bat calls not identified to species level						
Nyctophilus gouldi or geoffroyi	Long-eared Bat	✓				✓
V. troughtoni or pumilus		✓	✓		✓	
Scotorepens orion / Scoteanax rueppellii / Falsistrellus tasmaniensis		✓	✓	✓	✓	✓
Total bat files		358	289	28	106	635

✓ Species identified in the study area P Potential record of species

\# species listed under the Biodiversity Conservation Act 2016

* species listed under the Environmental Protection and Biodiversity Act

References:

Atlas of Living Australia (2018). http://spatial.ala.org.au.

Churchill, S. (2008). Australian Bats . Jacana Books, Allen & Unwin; Sydney.

Pennay, M., Law, B. and Reinhold, L. (2004). *Bat Calls of New South Wales*. Department of Environment and Conservation, Hurstville.

Reardon, T. (2003). Standards in bat detector based surveys. Australasian Bat Society Newsletter 20, 41-43.

Reardon T. B., McKenzie N. L., Cooper S. J. B., Appleton B., Carthew S. & Adams M. (2014) *A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats Mormopterus (Chiroptera : Molossidae)*. Australian Journal of Zoology 62, 109-36.

Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). *Key to the bat calls of south-east Queensland and north-east New South Wales. Department of Natural Resources and Mines, Brisbane*.

Van Dyck, S. and Strahan, R. (ed.) (2008). *The Mammals of Australia* (Third Edition); New Holland; Sydney.

APPENDIX I :

Groundwater Assessment by JBS&G (2021)

JBS&G 57799 - 134853
L01 - Menangle Park Development GME January 2021 (Rev A)

5 February 2021

Dahua Group
C/- Benaiah Project Management
Richard Marsden
Via email: richard.marsden@benaiah.com.au

Groundwater Monitoring Event, January 2021, Menangle Park Development, Menangle Park, NSW

Dear Richard,

1. Introduction and Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by Dahau Group (the client) via Benaiah Project Management (Benaiah) to undertake ongoing groundwater and soil moisture monitoring program during the Menangle Park development. The development extends over multiple lots between the Hume Motorway and Racecourse Avenue (the site) and it is understood that the site will be redeveloped for mixed land uses including low density residential, schools, public open space and retail/town centre. The site location is shown in **Figure 1**, **Attachment 2**.

It is understood that the client is seeking to monitor the potential impacts of the Menangle Park development on groundwater levels and quality to assist with assessment of the potential effects on the local ecology, in particular effects to the riparian and conservation zones consisting of groundwater dependant ecosystems (GDEs) located across the development, as identified in the *Assessment of Proposed Impacts on GDEs on Lands owned by Dahua Group* (CE 2019[1]).

Groundwater will be monitored at consistent intervals for the duration of the development to assist with ongoing monitoring of ecosystem health (by others). In addition to specific groundwater data, soil moisture and temperature data from on site soil probes and corresponding rainfall data from the Bureau of Meteorology Station at Menangle Bridge will be included in regular reporting to account for other factors which may impact groundwater levels.

2. Objective

The objective of the groundwater monitoring events (GMEs) is to provide a factual snapshot of groundwater levels and general water quality parameters to assist others with assessment of potential impacts of the development on local ecology.

3. Scope of Works

The following scope of works were undertaken for the January 2021 GME:

- Review of site setting was undertaken to determine the appropriate placement of monitoring wells/moisture probes;
- Installation of ten groundwater monitoring wells;

[1] *Assessment of Proposed Impacts on Groundwater Dependant Ecosystems on Lands Owned by Dahua Group Australia at Menangle Park*, 6 June 2019, Cumberland Ecology, ref: 17072-LET25 (CE 2019)

- Installation of 5 soil moisture probes;
- Initial sampling event of 10 groundwater monitoring wells; and
- Preparation of this letter report outlining the results of the groundwater sampling event.

4. Site Setting

4.1 Topography

Review of the regional topographic data (Six Maps[2]) indicated that the site lies between 80 and 100 m Australian Height Datum (AHD). In general, the southern portion of the site slopes gently downward to the north (towards Howes Creek) and the northern portion of the site slopes down towards to the south (towards Howes Creek).

4.2 Geology

Review of the regional geological map (DMS 1966[3]) indicated the site lies within the following geological settings:

- Quaternary aged quartz and lithic fluvial sand, silt and clay;
- Tertiary aged alluvial;
- Alluvium gravel, swamp deposits and sand dunes; and
- Triassic aged Wianamatta Group Shale and Sandstone.

4.3 Hydrology

Howes Creek dissects the central northern portion of the site. Howes Creek flows to the west, eventually discharging into the Nepean River, located approximately 1.2 km to the west of the site.

4.4 Hydrogeology

Seven groundwater wells were previously installed by JBS&G within a small portion of the site (59 Cummins Road) (JBS&G 2020[4]). The seven wells reported groundwater levels ranging from 3.2 to 5.3 m below ground surface (bgs) and the inferred groundwater flow direction was to the north west, towards Howes Creek.

Registered bore information was reviewed from the Water NSW[5] online resource and is included as **Attachment 4**. A review of registered bore information indicated that there were six registered groundwater bores within 1 km radius of the site.

Relevant information is summarised in **Table 4.1** below.

[2] *Six Maps website, http://maps.six.nsw.gov.au/* accessed 7 January 2021
[3] *Wollongong 1:250 000 Geological Series Sheet SI 56-9 Second Edition.* NSW Department of Mines Sydney, 1966 (DMS 1966)
[4] *Data Gap Investigation, Former Fireworks Factory, 59 Cummins Road, Menangle Park NSW*. February 2020. Ref: 55079/1226636 (Rev 1) (JBS&G 2020)
[5] *Water NSW* website accessed 8 January 2021, http://allwaterdata.water.nsw.gov.au/water.stm

Table 4.1: Registered Groundwater Bore Search Summary

Bore ID	Use	Standing Water Level (m below ground surface (bgs))	Well Depth (m bgs)	Distance from site (m)	Lithology
GW109315	Monitoring bore	0.6	3.0	Within southern portion of site	0- 1 m: silty sand 1 – 3 m: sand
GW110413	Industrial bore	17.0	156.0	Within southern portion of site	0-1.5 m: fill 1.5-30 m: sand and clay layers 30 – 39 m: shale 39 – 156 m: sandstone
GW024354	Unknown	11.1	21.3	Within southern portion of site	0-1.52 m: sand 1.52-19.2 m: clay 19.2 – 21.3 m: shale
GW024351	Unknown	1.2	21.9	Within southern portion of site	0-1.21 m: sand 1.21-9.14 m: silt 9.14-19.5 m: clay 19.5-21.9 m: shale
GW112477	Industrial (Mines)	Not provided	2619.3	500 m west of the site	Not provided
GW101106	Test bore	18.0	280.0	Northern extent of site	0 - 6 m: clay 6 – 80 m: shale 80 - 180 m: sandstone 180 – 267 m: sandstone 267 – 280 m: shale

Based on the reported geology and topography, the expected depth to groundwater is expected to vary across the site from <5 m to greater than 10 m depending on ground elevation.

5. Sampling Analysis & Quality Plan (SAQP)

The current investigation utilised data collected from 9 newly installed groundwater monitoring wells on site, specifically GW01, GW02, GW03, GW04, GW05, GW06, GWA, GWB and GWE.

Monitoring well GWC was installed to the maximum target depth of 12 m and no groundwater was encountered.

5.1 Groundwater Well Installation

Groundwater monitoring wells were installed between 16 December 2020 and 5 January 2021 at the locations shown in **Figure 2, Attachment 2**. Groundwater monitoring wells were installed using the following methodology:

- Groundwater monitoring wells were installed using a drill rig utilising a combination of drilling methods dependent on the encountered lithology, this included solid flight auger, hollow flight auger and air hammer drilling techniques;
- All wells were constructed from Class 18 uPVC (50 mm ID) casing and machine slotted screen with appropriate gravel packs, bentonite seals, well caps and lockable monument covers. Wells were generally constructed to depths of approximately 2 m below the encountered groundwater depth, and installed to a maximum depth of 12 m below ground surface (bgs). Groundwater borelogs and well construction details are provided in **Attachment 5.** It is

noted that monitoring well GWC was installed to a depth of 12 m bgs with no groundwater being encountered;

- Wells were developed after construction using disposable HDPE tubing and foot-valve pump and an electric submersible pump to remove turbidity created by the drilling and construction process. A minimum of 3 well volumes were removed from each well during the development. The monitoring wells were then allowed to stabilise for a minimum period of 3 days prior to sampling; and
- Installed groundwater monitoring wells were surveyed to enable identification of relative height of groundwater and inferred groundwater flow direction. Well survey details are provided as **Attachment 6.**

5.2 Soil Moisture Probe Installation

Five 120 cm 'Drill and Drop' Sentek soil moisture probes were installed between 16 December 2020 and 5 January 2021 at the locations shown on **Figure 3**. Soil moisture probes were installed in accordance with the manufacturer's instructions as summarised below:

- At each location a 1.2 m hole was augured using the manufacturers supplied drill bit;
- The soil moisture probes were then wetted and inserted into the hole so that the base of the probe cap was level with the soil surface; and
- A road box gatic was then placed over the probe cap for protection and installed using concrete.

5.3 Groundwater Sampling Method

Ground water sampling was undertaken using the following methodology:

- Prior to sampling, the wells were purged to remove standing water. Field parameters of pH, electrical conductivity, reduction-oxidation potential and temperature were recorded and a sample was obtained once the parameters stabilised to within approximately 10%;
- Groundwater samples were obtained through the use of micro purge pump, with field parameters monitoring in a flow cell;
- Collected groundwater samples were transferred directly into laboratory supplied sample bottles which were appropriately preserved. Sample bottles were labelled with sample identification details, sealed and then transferred to chilled esky with ice; and
- Samples were analysed for total dissolved solids (TDS) and major anions and cations.

At the completion of sampling at each location, single use sampling equipment were disposed of and re-usable sampling equipment including interface probe were appropriately decontaminated using water / detergent mix (i.e. DECON 90).

5.4 Laboratory Analyses

JBS&G contracted Eurofins MGT (Eurofins) for laboratory. Eurofins are NATA accredited for the required analyses. In addition, all laboratory results were required to meet JBS&G's internal QA/QC requirements. The analytical schedule employed for the investigation to which this report details is provided in **Table 5.1.**

Table 5.1: Analytical Schedule

Area	No. of Sampling Locations	Analyses (exc. QA/QC)
Groundwater investigation	9 Monitoring Wells	TDS – 9 samples Cations/anions – 9 samples

6. Results

The GME was conducted on the 11 January 2021. Laboratory reports and chain of custody documentation are provided in **Attachment 8.**

6.1 Observations

Stabilised groundwater parameters as measured in the field prior to the collection of groundwater samples are presented in **Table 6.1.** The calibration certificate for the water quality meter utilised in the current GME is presented in **Attachment 7**.

During the groundwater gauging event, no groundwater was encountered at monitoring well GWC.

Table 6.1 Groundwater Parameters

Well ID	DO (mg/L)	EC (µs/cm)	pH	Redox (mV)	Temperature (°C)
GW01	2.0	14439	5.89	168	20.1
GW02	3.6	338	5.51	193	20.5
GW03	2.5	1886	5.85	103	19.7
GW04	4.2	1373	6.89	125	19.7
GW05	2.1	3440	4.83	140	19.5
GW06	3.6	1140	5.36	121	20.2
GWA	2.6	5799	5.30	181	19.9
GWB	3.9	168	6.30	133	20.1
GWC	-	-	-	-	-
GWE	2.1	7330	6.00	168	19.4

Based on the water quality parameters above, groundwater was slightly brackish (i.e. EC generally ranged between 1000 and 10 000 µs/cm), slightly acidic and slightly anaerobic.

Pre-purging groundwater depths are provided in **Table 6.2**. The measured depth to groundwater ranged from 0.71 m below top of casing (btoc) at GW06 to 8.35 m btoc at GW01. The relative groundwater elevation in each monitoring well was calculated based on measured depth to groundwater and monitoring well elevation (in m Australia Height Datum [AHD]), and suggests groundwater and suggests groundwater within the southern portion of the site flows north towards Howes Creek while groundwater within the northern portion of the site flows south towards Howes Creek, generally consistent with topography and as shown in **Figure 3, Attachment 2**.

Table 6.2 - Pre - Purging Groundwater Depth

Well ID	Date Gauged	Casing Height (m AHD)	Depth to Water (mAHD)	Groundwater Elevation (mAHD)
GW01	11 January 2021	86.835	8.35	78.49
GW02	11 January 2021	81.011	1.995	79.02
GW03	11 January 2021	84.597	2.68	81.92

Well ID	Date Gauged	Casing Height (m AHD)	Depth to Water (mAHD)	Groundwater Elevation (mAHD)
GW04	11 January 2021	80.31	1.49	78.82
GW05	11 January 2021	91.091	0.92	90.17
GW06	11 January 2021	92.695	0.71	91.99
GWA	11 January 2021	72.47	1.05	71.42
GWB	11 January 2021	99.727	2.295	97.43
GWC	11 January 2021	104.849	-	-
GWE	11 January 2021	78.688	2.03	76.66

6.2 Analytical Results – Groundwater

Laboratory reports and chain of custody documentation is provided in **Attachment 8**. A summary of analytical results is provided in **Table A** in **Attachment 3**.

The maximum, minimum and average concentrations for each analyte are presented below in **Table 6.3**.

Table 6.3 – Summary of Analytical Results – January 2021

Analyte	Maximum Concentration (mg/L)	Minimum Concentration (mg/L)	Average Concentration (mg/L)
Calcium	350 (GW01)	9.3 (GW02)	87
Magnesium	700 (GW01)	5.2 (GWB)	158
Potassium	27 (GW01)	1 (GWA)	8.9
Sodium	2,100 (GW01)	17 (GWB)	601
Sulphate (as S04)	65 (GW03)	3.3 (GW02)	31
Chloride	6,300 (GW01)	22 (GWB)	1528
Hardness as CaCO3	910 (GWA)	<1 (GW01)	306
Total Dissolved Solids	8,200 (GW01)	180 (GW02)	2356

7. Conclusions

The January 2021 GME to which this report details, has provided a factual snapshot of groundwater levels and general water quality parameters in which to assist others with assessment of potential impacts of the development on local ecology.

Further groundwater level and soil moisture data will be retrieved from loggers installed at the site within six months time (July 2021). At this time trends in groundwater (water levels) and soil (moisture and temperature data) will be presented, including details on any significant changes in water quality, water levels and soil moisture conditions with respect to the values presented in this report.

Should you require clarification, please contact the undersigned on 02 8245 0300 or by email aboardman@jbsg.com.au.

Yours sincerely:



Alex Boardman
Senior Environmental Consultant
JBS&G Australia Pty Ltd

Reviewed/Approved by:



Dr Greg Dasey
Principal Hydrogeologist
JBS&G Australia Pty Ltd

Attachments:

1) Limitations
2) Figures
3) Groundwater Analytical Summary Table – Table A
4) Water NSW Registered Bore Information
5) Borelogs
6) Well Survey Data
7) Calibration Certificate
8) Laboratory Report and Chain of Custody Documentation

Attachment 1 – Limitations

This report has been prepared for use by the client who has commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquires.

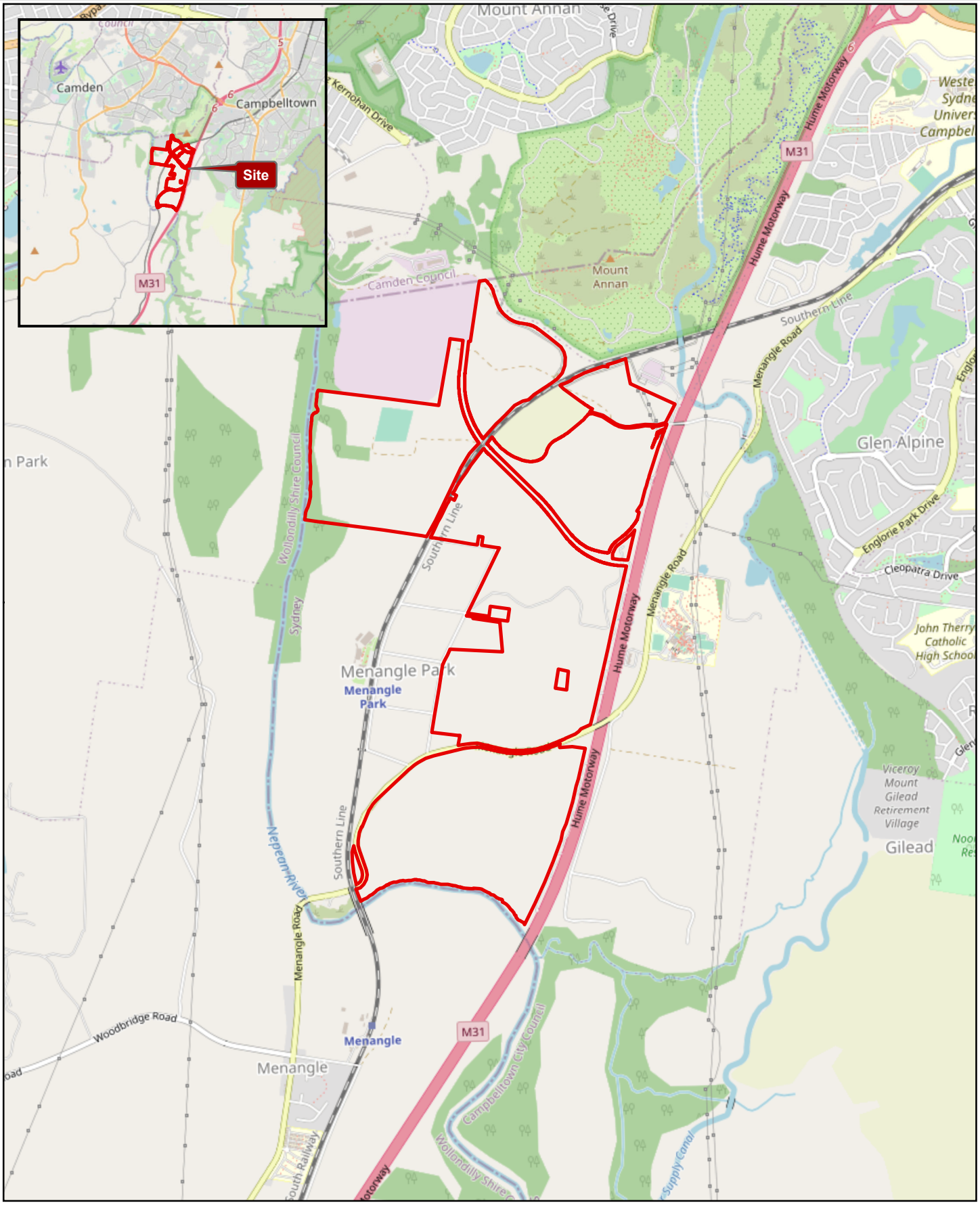
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the report in the context of the additional information.

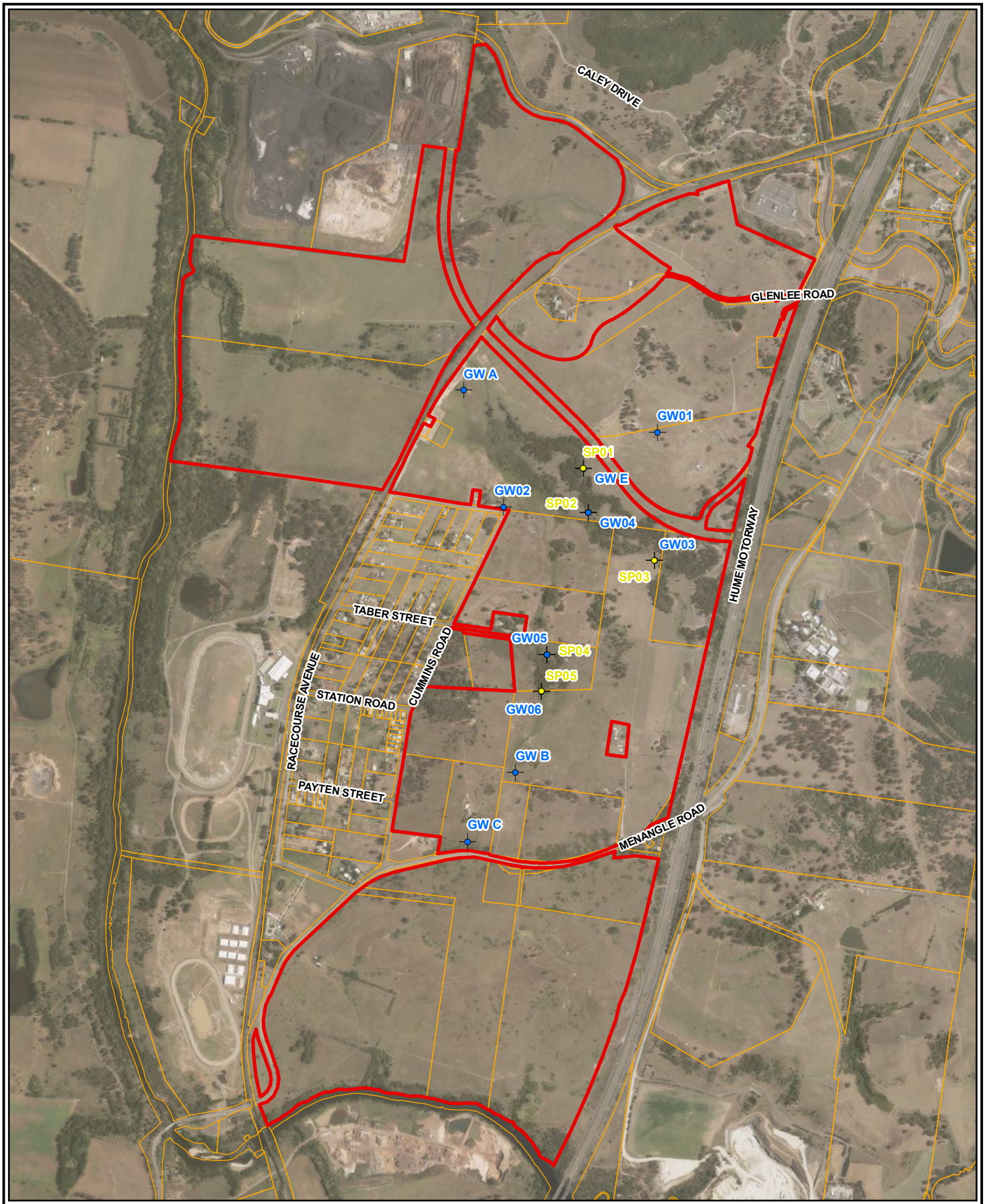
Attachment 2 – Figures



Legend:
Approximate Site Boundary

Scale 1:35,000 (0 430 860 metres)		**Menangle Park, NSW**
Coord. Sys. GDA 1994 MGA Zone 56		**SITE LOCATION**
Job No: 57799		
Client: Dahua Group		**FIGURE 1**
Version: R01 Rev A	Date 21/01/2021	JBS&G
Drawn By: JA	Checked By: AB	

File Name: N:\Projects\Dahua Group\57799 Menangle Park GME\GIS\Maps\R01 Rev A\57799_01_SiteLocation.mxd
Reference: © OpenStreetMap (and) contributors, CC-BY-SA



Legend:

- Approximate Site Boundary
- NSW Cadastre (DFSI, 2020)

Sample Location

- Monitoring Well
- Soil Probe

Scale 1:20,000

0 250 500
metres

Coord. Sys. GDA 1994 MGA Zone 56

Job No: 57799

Client: Dahua Group

Version: R01 Rev A | Date 20/01/2021

Drawn By: JA | Checked By: AB

Menangle Park, NSW

SITE LAYOUT

FIGURE 2

JBS&G

File Name: N:\Projects\Dahua Group\57799 Menangle Park GME\GIS\Maps\R01 Rev A\57799_02_SiteLayout.mxd
Reference: NSW DFSI



Legend:

- Approximate Site Boundary
- NSW Cadastre (DFSI, 2020)

Type

- Inferred Groundwater Direction
- Standing Water Level (m AHD)

Sample Location

- Monitoring Well
- 0.0 Standing Water Level

Scale 1:20,000 (0 250 500 metres)		**Menangle Park, NSW**
Coord. Sys. GDA 1994 MGA Zone 56		**GROUNDWATER CONTOURS**
Job No: 57799		
Client: Dahua Group		**FIGURE 3**
Version: R01 Rev A	Date 21/01/2021	JBS&G
Drawn By: JA	Checked By: AB	

File Name: N:\Projects\Dahua Group\57799 Menangle Park GME\GIS\Maps\R01 Rev A\57799_03_GWContours.mxd
Reference: NSW DFSI

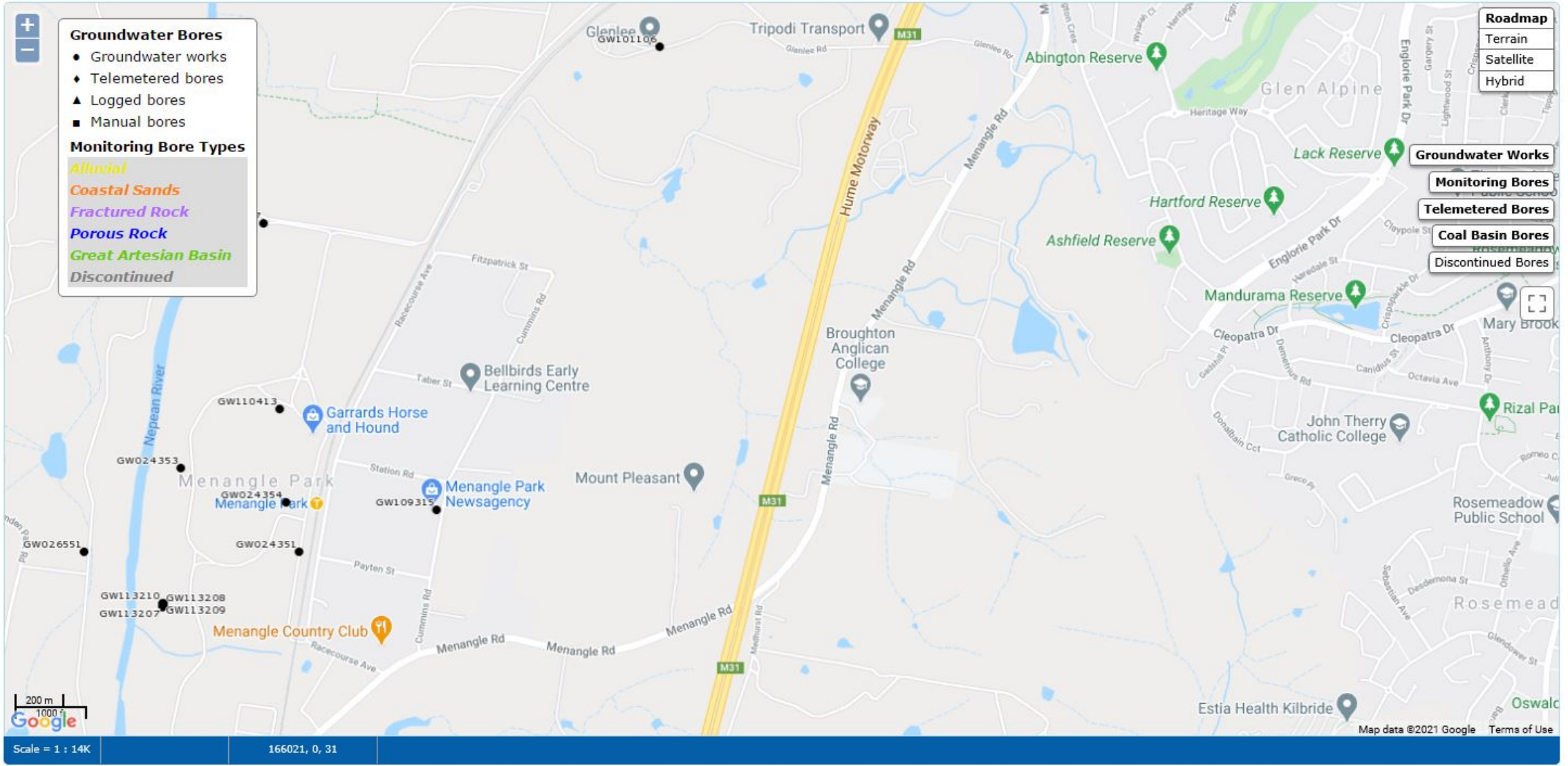
Attachment 3 – Groundwater Analytical Summary Table – Table A

Table A: Groundwater Analytical Summary Table - January 2021
Project Number: 57799
Project Name: Groundwater Monitoring - Menangle Park Development

			Heavy Metal				Inorganic			
			Calcium	Magnesium	Potassium	Sodium	Sulphate (as S04)	Chloride	Hardness as CaCO3	Total Dissolved Solids
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.5	0.5	0.5	0.5	2	1	1	5
Field_ID	**Lab_Report_Number**	**Monitoring_Round**								
GW01	766881	1/01/2021	350	700	27	2100	34	6300	<1	8200
GW02	766881	1/01/2021	9.3	6	4.9	51	3.3	100	48	180
GW03	766881	1/01/2021	43	29	5.2	390	65	440	230	1100
GW04	766881	1/01/2021	48	53	13	220	49	290	340	630
GW05	766881	1/01/2021	79	98	6.3	460	10	1300	600	1600
GW06	766881	1/01/2021	20	29	2	150	9.8	400	170	680
GWA	766881	1/01/2021	63	180	1	920	6.8	2300	910	3800
GWB	766881	1/01/2021	17	5.2	6	17	9.2	22	64	210
GWE	766881	1/01/2021	150	320	15	1100	93	2600	390	4800

Attachment 4 – Water NSW Registered Bore Information

Map



Scale = 1 : 14K | 166021, 0, 31

WaterNSW
Work Summary

GW109315

Licence: 10BL602560 **Licence Status:** ACTIVE

Authorised Purpose(s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method: Auger
Owner Type: Private

Commenced Date: **Final Depth:** 3.00 m
Completion Date: 09/09/2008 **Drilled Depth:** 3.00 m

Contractor Name: ENVIROWEST CONSULTING
Driller: Gregory Peter Madafiglio
Assistant Driller:

Property: ABBAS 67 CUMMINS RD MENANGLE PARK 2563 NSW **Standing Water Level (m):** 0.600
GWMA: - **Salinity Description:** Good
GW Zone: - **Yield (L/s):** 1.000

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBERLAND	MENANGLE	4//23709
Licensed:	CUMBERLAND	MENANGLE	Whole Lot 4//23709

Region: 10 - Sydney South Coast **CMA Map:**
River Basin: - Unknown **Grid Zone:** **Scale:**
Area/District:

Elevation: 0.00 m (A.H.D.) **Northing:** 6224028.000 **Latitude:** 34°06'14.3"S
Elevation Source: Unknown **Easting:** 292422.000 **Longitude:** 150°44'58.9"E

GS Map: - **MGA Zone:** 56 **Coordinate Source:** Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	3.00	80			Auger
1		Annulus	Crushed Aggregate	0.00	0.00				Graded
1	1	Casing	P.V.C.	0.00	3.00	61	53		Seated on Bottom, Screwed

1	1	Opening	Slots - Horizontal	1.50	3.00	61		0	Slotted In Hole, PVC, SL: 1.5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
1.00	3.00	2.00	Unknown	0.60		1.00			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	SILTY SAND	Silty Sandstone	
1.00	3.00	2.00	SAND	Sand	

***** End of GW109315 *****

Warning To Clients: This raw data has been supplied to the WaterNSW by drillers, licensees and other sources. WaterNSW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

WaterNSW
Work Summary

GW110413

Licence: 10WA109581 **Licence Status:** CURRENT

Authorised Purpose(s): INDUSTRIAL
Intended Purpose(s): INDUSTRIAL

Work Type: Bore
Work Status:
Construct.Method: Rotary Air
Owner Type: Private

Commenced Date:
Completion Date: 22/08/2009
Final Depth: 152.00 m
Drilled Depth: 156.00 m

Contractor Name: Britt's Water Solutions
Driller: Darren James Britt
Assistant Driller:

Property: MENANGLE PARK PACEWAY Racecourse Ave MENANGLE PARK 2563 NSW
GWMA: -
GW Zone: -
Standing Water Level (m): 17.000
Salinity Description:
Yield (L/s): 3.000

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBERLAND	MENANGLE	10 1022204
Licensed:	CUMBERLAND	MENANGLE	Whole Lot 10//1022204

Region: 10 - Sydney South Coast
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6224389.000
Easting: 291837.000
Latitude: 34°06'02.2"S
Longitude: 150°44'36.4"E

GS Map: -
MGA Zone: 56
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	42.00	200			Rotary Air
1		Hole	Hole	42.00	96.00	165			Rotary Air
1		Hole	Hole	96.00	152.00	140			Rotary Air

1	1	Casing	Pvc Class 9	-0.30	48.00	140			Seated, Glued

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
45.00	46.00	1.00	Unknown	17.00		1.40			700.00
62.00	62.20	0.20	Unknown			1.30			
141.00	141.20	0.20	Unknown			0.90			
146.00	146.10	0.10	Unknown			3.00			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.50	1.50	FILL	Fill	
1.50	10.50	9.00	SANDY CLAY	Sandy Clay	
10.50	16.00	5.50	SAND	Sand	
16.00	18.00	2.00	CLAY	Clay	
18.00	22.00	4.00	SAND	Sand	
22.00	24.00	2.00	CLAY	Clay	
24.00	30.00	6.00	SAND	Sand	
30.00	39.00	9.00	SHALE	Shale	
39.00	156.00	117.00	SANDSTONE	Sandstone	

Remarks

24/06/2010: Previous Lic No:10BL603031

***** End of GW110413 *****

Warning To Clients: This raw data has been supplied to the WaterNSW by drillers, licensees and other sources. WaterNSW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

WaterNSW
Work Summary

GW024354

Licence:		**Licence Status:**	
		Authorised Purpose(s):	
		Intended Purpose(s):	NOT KNOWN
Work Type:	Bore		
Work Status:	Test Hole		
Construct.Method:	Cable Tool		
Owner Type:	Private		
Commenced Date:		**Final Depth:**	21.30 m
Completion Date:	01/05/1966	**Drilled Depth:**	21.30 m
Contractor Name:	(None)		
Driller:			
Assistant Driller:			
Property:		**Standing Water Level (m):**	
GWMA:		**Salinity Description:**	
GW Zone:		**Yield (L/s):**	

Site Details

Site Chosen By:

		County	**Parish**	**Cadastre**
	Form A:			
	Licensed:	CUMBERLAND	MENANGLE	10//DP1022204

Region:	10 - Sydney South Coast	**CMA Map:**	9029-4N		
River Basin:	212 - HAWKESBURY RIVER	**Grid Zone:**		**Scale:**	
Area/District:					
Elevation:	0.00 m (A.H.D.)	**Northing:**	6224047.000	**Latitude:**	34°06'13.3"S
Elevation Source:	(Unknown)	**Easting:**	291866.000	**Longitude:**	150°44'37.2"E
GS Map:	-	**MGA Zone:**	56	**Coordinate Source:**	GD.,ACC.MAP

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
11.10	11.50	0.40	Unconsolidated						
12.80	19.20	6.40	Unconsolidated						

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.52	1.52	Sand Light Brown	Sand	
1.52	7.01	5.49	Clay Yellow Sandy	Clay	
7.01	8.83	1.82	Clay Pinkish	Clay	
8.83	9.44	0.61	Clay Yellow Sandy	Clay	
9.44	11.12	1.68	Clay Orange Sandy	Clay	
11.12	11.58	0.46	Clay Orange Sandy Water Supply	Clay	
11.58	12.80	1.22	Clay Orange Sandy	Clay	
12.80	19.20	6.40	Clay Orange Sandy Water Supply	Clay	
19.20	21.33	2.13	Shale Some Soft Some Firm	Shale	
11.12	11.58	0.46	Gravel Small	Gravel	
12.80	19.20	6.40	Gravel Small	Gravel	

Remarks

19/02/1975: BAILED DRY AFTER 5 MIN TEST

***** End of GW024354 *****

Warning To Clients: This raw data has been supplied to the WaterNSW by drillers, licensees and other sources. WaterNSW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

WaterNSW
Work Summary

GW024351

Licence: | **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): NOT KNOWN

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date: | **Final Depth:** 21.90 m
Completion Date: 01/05/1966 | **Drilled Depth:** 21.90 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: | **Standing Water Level (m):**
GWMA: | **Salinity Description:**
GW Zone: | **Yield (L/s):**

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:			
Licensed:	CUMBERLAND	MENANGLE	15

Region: 10 - Sydney South Coast | **CMA Map:** 9029-4N
River Basin: 212 - HAWKESBURY RIVER | **Grid Zone:** | **Scale:**
Area/District:

Elevation: 0.00 m (A.H.D.) | **Northing:** 6223863.000 | **Latitude:** 34°06'19.3"S
Elevation Source: (Unknown) | **Easting:** 291921.000 | **Longitude:** 150°44'39.2"E

GS Map: - | **MGA Zone:** 56 | **Coordinate Source:** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing		0.00	21.30	152			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
1.20	9.10	7.90	Unconsolidated						
14.90	19.40	4.50	Unconsolidated	6.00		0.19			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.21	1.21	Sand	Sand	
1.21	9.14	7.93	Silt Orange Sandy	Silt	
9.14	14.93	5.79	Clay Red Grey	Clay	
14.93	19.50	4.57	Clay Red Grey Water Supply	Clay	
19.50	21.94	2.44	Shale	Shale	
14.93	19.50	4.57	Gravel Small	Gravel	

Remarks

19/02/1975: WATER FOR TROTTING TRACK

***** End of GW024351 *****

Warning To Clients: This raw data has been supplied to the WaterNSW by drillers, licensees and other sources. WaterNSW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

WaterNSW
Work Summary

GW112477

Licence: **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): INDUSTRIAL

Work Type: Bore
Work Status: Equipped
Construct.Method:
Owner Type: Mines

Commenced Date: **Final Depth:** 2619.30 m
Completion Date: 18/12/2007 **Drilled Depth:** 2619.30 m

Contractor Name: McDermott Drilling
Driller: Unkown Unknown
Assistant Driller:

Property: **Standing Water Level (m):**
GWMA: **Salinity Description:**
GW Zone: **Yield (L/s):**

Site Details

Site Chosen By:

		County	Parish	Cadastre
Form A:				
Licensed:		CUMBERLAND	MENANGLE	10//1022204

Region: 10 - Sydney South Coast **CMA Map:**
River Basin: - Unknown **Grid Zone:** **Scale:**
Area/District:

Elevation: 0.00 m (A.H.D.) **Northing:** 6225067.000 **Latitude:** 34°05'40.2"S
Elevation Source: Unknown **Easting:** 291760.000 **Longitude:** 150°44'34.0"E

GS Map: - **MGA Zone:** 56 **Coordinate Source:** Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	2619.30	177			(Unknown)
1	1	Casing	Steel	0.00	0.00	177			

Remarks

15/07/2013: Type of casing:Steel
Diameter: 177.8mm
22/07/2014: Nat Carling, 22-July-2014; Added construction components, owner type, work name, status & drill depth.

***** End of GW112477 *****

Warning To Clients: This raw data has been supplied to the WaterNSW by drillers, licensees and other sources. WaterNSW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

WaterNSW
Work Summary

GW101106

Licence: | **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): TEST BORE

Work Type: Bore
Work Status: Test Hole
Construct.Method: Rotary Air
Owner Type: Private

Commenced Date:
Completion Date: 07/03/1997

Final Depth: 280.00 m
Drilled Depth: 280.00 m

Contractor Name: SOUTHERN TABLELANDS DRILLING
Driller: Roger Charles Ritchie
Assistant Driller:

Property:
GWMA:
GW Zone:

Standing Water Level (m): 17.000
Salinity Description:
Yield (L/s): 1.310

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:			
Licensed:	CUMBERLAND	MENANGLE	2//713646

Region: 10 - Sydney South Coast
River Basin: - Unknown
Area/District:

CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6225747.000
Easting: 293207.000

Latitude: 34°05'19.1"S
Longitude: 150°45'31.0"E

GS Map: -
MGA Zone: 56
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	96.00	200			Rotary Air
1		Hole	Hole	96.00	280.00	160			Rotary Air

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
18.00	19.00	1.00	Unknown	14.00		0.26	19.00		4000.00
80.00	84.00	4.00	Unknown	14.00		0.30	84.00		4000.00
160.00	163.00	3.00	Unknown	17.00		0.75	163.00		4000.00

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Red Clay	Clay	
1.00	6.00	5.00	Brown clay	Clay	
6.00	80.00	74.00	Grey shale	Shale	
80.00	102.00	22.00	Grey sandstone	Sandstone	
102.00	145.00	43.00	White sandstone	Sandstone	
145.00	151.00	6.00	Sandstone/shale bands	Sandstone	
151.00	160.00	9.00	Sandstone	Sandstone	
160.00	180.00	20.00	Shale	Shale	
180.00	267.00	87.00	Sandstone	Sandstone	
267.00	280.00	13.00	Illawarra Shale	Shale	

Remarks

16/01/2013: Nat Carling, 16-Jan-2013; Added rock type codes to driller's log & added missing information (based on existing data).

***** End of GW101106 *****

Warning To Clients: This raw data has been supplied to the WaterNSW by drillers, licensees and other sources. WaterNSW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

Attachment 5 – Borelogs

GROUNDWATER WELL GW01

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 293,439.23
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 17-Dec-20 - 18-Dec-20	**NORTHING** 6,225,230.21
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Air Hammer	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 12 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** LR
COMPLETION Monument	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 5 - 12 m bgl

COMMENTS

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
SFA			1		Fill	Silty sand, brown, moist, heterogeneous, loose, inclusions of roots	SM			
			2		Shale	Shale, grey, stiff	D			
			3							
			4							
AH			5							
			6							
			7							
			8							
			9							
			10							
	▽		11		CL-ML	Silty clay, brown, moist, soft, heterogeneous	SM			
			12		Shale	Shale, grey, stiff	D			
						Termination Depth at: 12.0 m.				
			13							

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GROUNDWATER WELL GW02

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 292,829.18
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 16-Dec-20	**NORTHING** 6,224,936.67
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Hollow Flight Auger	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 6 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** LR

COMPLETION Monument | **CASING** Class 18 PVC - 50mm | **SCREEN INTERVAL** 1 - 6 m bgl

COMMENTS

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
HFA	▽		0.5		SW	Sand, grey, very loose, rounded	W			
			1							
			1.5							
			2		SM	Silty sand, yellow, wet, loose, rounded	W			
			2.5							
			3		SM	Silty sand, yellow, saturated, loose rounded	W			
			3.5							
			4							
			4.5							
			5							
			5.5							
			6		CL	Clay, brown, saturated, high plasticity, homogeneous, firm	W			
						Termination Depth at: 6.0 m.				
			6.5							
			7							

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GROUNDWATER WELL GW03

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 293,427.79
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 17-Dec-20	**NORTHING** 6,224,724.75
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Solid Flight Auger	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 6 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** AB
COMPLETION Monument	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 1.5 - 6 m bgl

COMMENTS

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
SFA			0		CL-ML	Topsoil, silty clay, brown, soft, medium plasticity, damp, homogeneous	SM			
			0.5		SM	Silty sand, brown/grey, soft, damp, medium plasticity, well sorted, homogeneous	SM			
	▽		1.5		CL-SC	Sandy clay, light brown, yellow, firm, low to medium plasticity, homogeneous, wet	W			
			3.5		CL-SC	Sandy clay, light brown/yellow, firm/stiff, low plasticity, moist/wet, homogeneous	W			
			6			Termination Depth at: 6.0 m.				

GROUNDWATER WELL GW04

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 293,146.13
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 17-Dec-20	**NORTHING** 6,224,922.63
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Hollow Flight Auger	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 6 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** AB
COMPLETION Monument	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 1.5 - 6 m bgl
COMMENTS		

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
HFA	▽		0.5		SW	Sand, light brown/grey, homogeneous, wet, loose, well sorted	W			
			1							
			1.5		CL-SC	Sandy clay, light brown with grey mottles, damp, soft, high plasticity	W			
			2							
			2.5							
			3							
			3.5		CL-SC	Sandy clay, light brown with grey mottles, firm/stiff, medium plasticity, saturated	W			
			4							
			4.5		CL-SC	Sandy clay, light brown with grey mottles, firm/stiff, medium plasticity, becoming wetter	W			
			5							
			5.5							
			6			Termination Depth at: 6.0 m.				
			6.5							
			7							

GROUNDWATER WELL GW05

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 292,996.18
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 16-Dec-20	**NORTHING** 6,224,353.89
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Hollow Flight Auger	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 6 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** LR
COMPLETION Monument	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 1 - 6 m bgl
COMMENTS		

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
HFA	▽		0.5		SW	Sand, grey/brown, homogeneous, wet, loose, rounded	W			
			1		SM	Silty sand, grey, homogeneous, wet, loose, rounded	W			
			1.5							
			2		SM	Silty sand, grey, homogeneous, saturated, loose, rounded	W			
			2.5							
			3		SM	Silty sand, yellow, homogeneous, saturated, loose rounded	W			
			3.5							
			4							
			4.5							
			5							
			5.5							
			6			Termination Depth at: 6.0 m.				
			6.5							
			7							

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GROUNDWATER WELL GW06

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 292,979.61
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 16-Dec-20	**NORTHING** 6,224,209.66
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Hollow Flight Auger	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 6 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** LR

COMPLETION Monument	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 1 - 6 m bgl

COMMENTS

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
HFA	▽		0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7		SW	Sand, grey/brown, homogeneous, wet, loose, rounded	W			
					SM	Silty sand, grey, homogeneous, wet, loose, rounded	W			
					SM	Silty sand, yellow, homogeneous, saturated, loose rounded	W			
						Termination Depth at: 6.0 m.				

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GROUNDWATER WELL GWA

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 292,681.45
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 17-Dec-20	**NORTHING** 6,225,395.57
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Hollow Flight Auger	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 6 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** AB

COMPLETION Monument | **CASING** Class 18 PVC - 50mm | **SCREEN INTERVAL** 1.5 - 6 m bgl

COMMENTS

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
HFA	▽		0		SM	Topsoil, silty sand, dark brown, damp, medium plasticity, homogeneous	SM			
			0.5		SC	Clayey sand, light brown and grey, firm/stiff, medium plasticity, moist	SM			
			1							
			1.5		SC	Clayey sand, yellow, firm/stiff, medium plasticity, wet	W			
			2							
			2.5							
			3		SC	Clayey sand, light brown/grey, yellow, becoming saturated, well sorted, homogeneous, becoming firm	W			
			3.5							
			4							
			4.5							
			5		SC	Clayey sand, light brown/grey/yellow, saturated, well sorted, homogeneous, firm/stiff	W			
			5.5							
			6			Termination Depth at: 6.0 m.				
			6.5							
			7							

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GROUNDWATER WELL GWB

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 292,873.51
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 05-Jan-21	**NORTHING** 6,223,893.87
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Solid Flight Auger	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 6 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** LR

COMPLETION Monument | **CASING** Class 18 PVC - 50mm | **SCREEN INTERVAL** 1 - 6 m bgl

COMMENTS

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
SFA			0.5		SM	Silty sand, orange/red, dry/moist, heterogeneous, soft	SM			
			1		SM	Silty sand, yellow, dry/moist, heterogeneous, soft	SM			
	▽		2.5		SM	Silty sand, yellow, saturated, heterogeneous, soft	W			
	▽		6			Termination Depth at: 6.0 m.				

GROUNDWATER WELL GWC

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 292,690
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 05-Jan-21	**NORTHING** 6,223,622.07
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Air Hammer	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 12 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** LR
COMPLETION Monument	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 5 - 12 m bgl
COMMENTS		

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
AH			1		Fill	Silty sand, yellow/orange, soft, heterogeneous, dry	D			
					Shale	Shale, grey, hard, dry	D			
			2							
			3							
			4		SM	Silty sand, yellow/grey, heterogeneous, soft, dry	D			
			5							
			6		Shale	Shale, grey, hard, dry	D			
			7		SM	Silty sand, yellow/grey, heterogeneous, soft, dry	D			
			8							
			9							
			10							
			11		Shale	Shale, grey, hard, dry	D			
	▽		12			Termination Depth at: 12.0 m.				
			13							

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GROUNDWATER WELL GWE

PROJECT NUMBER 57799	**DRILLING COMPANY** Terratest	**EASTING** 293,145.42
PROJECT NAME Dahua_MenanglePark_NSW	**DRILLING DATE** 17-Dec-20	**NORTHING** 6,225,084.59
CLIENT Dahua	**DRILL RIG** Geoprobe	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Solid Flight Auger	**COORD SYS** N/A
ADDRESS Fitzpatrick Road Menangle Park	**TOTAL DEPTH** 10.5 m bgl	**COORD SOURCE** GPS
	DIAMETER 125	**LOGGED BY** AB
COMPLETION Monument	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 3.5 - 10.5 m bgl

COMMENTS

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
SFA			0.5		SM	Silty sand, light brown, dry, homogeneous, loose	D			
			1		CL-SC	Sandy clay, light brown/yellow with grey mottles, stiff, low plasticity, damp	W			
			1.5							
			2							
			2.5							
			3							
			3.5		CL-SC	Sandy clay, damp/moist, light brown/yellow with grey mottles, firm/stiff, low plasticity, homogeneous	W			
			4							
			4.5							
			5							
			5.5							
			6							
			6.5							
			7							
			7.5							
			8							
			8.5							
			9							
			9.5							
	▽		10		Shale	Shale, grey, becoming hard	D			
			10.5			Termination Depth at: 10.5 m.				
			11							
			11.5							

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Attachment 6 – Well Survey Data

3110	292689.8	6223620	104.849	GWC	GW	0	0
3113	292878.2	6223892	99.727	GWB	GW	0	0
3114	293001.2	6224355	91.091	GW05	GW	0	0
3116	293000.9	6224353	90.581	SP04	SP	0	0
3118	292979.8	6224210	92.435	SP05	SP	0	0
3121	292979.2	6224209	92.695	GW06	GW	0	0
3122	293424	6224725	84.022	SP03	SP	0	0
3126	293424.8	6224726	84.597	GW03	GW	0	0
3127	293163.8	6224912	79.575	SP02	SP	0	0
3128	293165.2	6224912	80.31	GW04	GW	0	0
3131	293435.8	6225228	86.835	GW01	GW	0	0
3133	293145.6	6225085	78.688	GWE	GW	0	0
3134	293144.7	6225086	77.949	SP01	SP	0	0
3135	292675.8	6225392	72.47	GWA	GW	0	0
3139	292830.4	6224933	81.011	GW02	GW	0	0

Levels are on AHD.
Coordinates are on GDA94.
Origin of Coordinates is PM46441.
E=292 780.132
N=6224 913.329
RL=81.856
Date of Search - 26/09/2017
Serach by SCIMS

Attachment 7 – Calibration Certificate

airmet
Work with Confidence

Calibration Certificate

AirMet Scientific P/L
Level 3, 18-26 Dickson Avenue
Artarmon
NSW 2064, Australia
Tel: 02 8425 8300
Fax: 02 8425 8399

This document certifies that the instrument detailed has been calibrated to the parameters

Certificate Print Date: 11-Nov-2020
Calibration Date: 10-Nov-2020
Next Calibration Due: 9-May-2021

Call ID / Order No: 246403
Job No / Pack No: S2464030001

Customer: JBS&G Australia Pty Ltd-ID 202507 **Serial No:** 17C103048
Description: YSI Professional Plus hand held unit only. Includ

Calibration Summary

Frequency: 180 Days **Temp:** 22°C **As Found:** Out of Tolerance **Result:** Pass
Humidity: 45% **Certificate:** S2464030001

Desc	As Found		As Left (Cal Status)	
	Actual	Result	Actual	Result
PH4 pH	5.9	Fail	4.0	Pass
PH7 pH	10.1	Fail	7.0	Pass
EC µS/cm	2756.0	Pass	2761.0	Pass
DO @Zero %	1.5	Fail	0.0	Pass
DO @Air %	96.8	Fail	100.1	Pass
ORP @23.1°C mV	236.1	Pass	237.4	Pass
Temp °C	22.5	Pass	22.6	Pass
Barometer mmbars	1024.1	Pass	1025.1	Pass

Standard Used			
Equip ID	Description	Valid Until	Cert
SYPH7	pH7 (pH = 7.00 +/- 0.02 @ 25 deg)		
SYFRESHAIR	Ambient Air	29-08-2028	
SYPH4	pH4 (pH = 4.01 +/- 0.02 @ 25 deg)		
SYZobell A	Zobel A: 1/50 mole K3Fe(CN) 6 in 0.1molar KCl	30-06-2021	
01561015	Testo 720 Thermometer	28-02-2021	T_01561015_28022020
SYCOND	Conductivity (2760 µS/cm @ 25 deg)		
SYDO	DO Powder (Sodium Suplphite Solution)	30-03-2022	
SYZobell B	Zobel B: 1/50 mole K4Fe(CN) 6 in 0.1molar KCl	30-06-2021	

Completed By: Jason Cheng **Signed:**

Air-Met Scientific

Service Report

airmet
Work with Confidence
ABN: 73 006 849 949

INVOICE ADDRESS	DELIVERY ADDRESS
JBS&G Australia Pty Ltd Level 1 50 Margaret Street Sydney NSW 2000	JBS&G Australia Pty Ltd Suite 1A 280-286 Keira Street Wollongong NSW 2500 Australia Attention: Leo Rothacker Email: lrothacker@jbsg.com.au

Customer Code	Call Reference	Customer Order No	Work Order	Print Date: 11-Nov-20
202507	246403	10000		Service Date:

Serial Number 17C103048
YSI Professional Plus hand held unit only. Includes Data Manager software, the ProComm II communications saddle, and USB cable.
Instrument inspected

Fault:
Unit requires calibration.
DO probe is calibration failed,needs replacing the membrane.
pH probe is calibration failed , needs replacing.
2x Batteries are dead, needs replacing

Repair Details:
Replaced DO membrane, pH probe and 2x Batteries.
Barometer checked.
All probe are cleaned and tested ok.
Instrument serviced, cleaned and calibrated.
Instrument in good working condition.

No further service required.

AUD

Job Material Component		Unit	Time / Quantity	Rate	GST	Total Value
301	301 Labour (charged)	Hour	0.25			
605101	YSI pH Sensor for Pro Plus	EA	1.00			
BATTCD	PC 1400 C Size Procell Alkaline	EA	2.00			
CALWAT5	Standard calibration of a five parameter water quality meter	EA	1.00			

Miscellaneous Charge

Misc Code	Description
30	SRV Freight

Attachment 8 – Laboratory Report and Chain of Custody Documentation

018552

CHAIN OF CUSTODY

JBS&G

PROJECT NO.: 57799
PROJECT NAME: Menangle Park
DATE NEEDED BY: Standard

LABORATORY BATCH NO.:
SAMPLERS: LR
QC LEVEL: NEPM (2013)

PHONE: Sydney: 02 8245 0300 | Perth: 08 9488 0100 | Brisbane: 07 3112 2688

SEND REPORT & INVOICE TO: (1) adminnsw@jbsg.com.au; (2) L.Rothacker.....@jbsg.com.au; (3) .....A.Boardman.....@jbsg.com.au

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	pH	TOL	BHC	BTEX	BTEX	BTEX	CL	SO4	TYPE OF ASBESTOS ANALYSIS: IDENTIFICATION	TYPE OF ASBESTOS ANALYSIS: NEPM/WA	NOTES:
GWA	water	11/1/21		green plastic		x	x	x			x	x			
GW01						x	x	x			x	x			
GWE						x	x	x			x	x			
GW04						x	x	x			x	x			
GW02						x	x	x			x	x			
GW05						x	x	x			x	x			
GW06						x	x	x			x	x			
GWB						x	x	x			x	x			
~~GWC~~						x	x	x			x	x			
GW03						x	x	x			x	x			
~~Rinsate~~				3x vials, green plastic		x	x	x			x	x			
~~TB/TS~~				4x vials				x							
DUP01				green plastic		x	x	x			x	x			
SPLIT01				green plastic		x	x	x			x	x			~~for work~~ Envirolab

RELINQUISHED BY:	METHOD OF SHIPMENT:	RECEIVED BY:	FOR RECEIVING LAB USE ONLY:
NAME: LR DATE: 11/1/21	CONSIGNMENT NOTE NO.	NAME: Hannah M DATE: 12th	COOLER SEAL – (Yes) ..... No ..... Intact ..... Broken .....
OF: JBS&G	TRANSPORT CO.	OF: January 2021	COOLER TEMP 14.7 deg C 10:30am
NAME: DATE:	CONSIGNMENT NOTE NO.	NAME: DATE:	COOLER SEAL – Yes..... No ..... Intact ..... Broken .....
OF:	TRANSPORT CO	OF:	COOLER TEMP ..... deg C

Container & Preservative Codes: P = Plastic; J = Soil Jar; B = Glass Bottle; N = Nitric Acid Prsvd.; C = Sodium Hydroxide Prsvd; VC = Hydrochloric Acid Prsvd Vial; VS = Sulfuric Acid Prsvd Vial; S = Sulfuric Acid Prsvd; Z = Zinc Prsvd; E = EDTA Prsvd; ST = Sterile Bottle; O = Other

IMSO FormsO13 – Chain of Custody - Generic

Repost Number.

eurofins | Environment Testing

ABN: 50 005 085 521 www.eurofins.com.au EnviroSales@eurofins.com

Australia

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Newcastle
4/52 Industrial Drive
Mayfield East NSW 2304
PO Box 60 Wickham 2293
Phone : +61 2 4968 8448

New Zealand

Auckland
35 O'Rorke Road
Penrose, Auckland 1061
Phone : +64 9 526 45 51
IANZ # 1327

Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Sample Receipt Advice

Company name:	JBS & G Australia (NSW) P/L
Contact name:	Leo Rothacker
Project name:	MENANGLE PARK
Project ID:	57799
Turnaround time:	5 Day
Date/Time received	Jan 12, 2021 10:30 AM
Eurofins reference	766881

Sample Information

✓	A detailed list of analytes logged into our LIMS, is included in the attached summary table.
✓	Sample Temperature of a random sample selected from the batch as recorded by Eurofins Sample Receipt : 14.7 degrees Celsius.
✓	All samples have been received as described on the above COC.
✓	COC has been completed correctly.
✓	Attempt to chill was evident.
✓	Appropriately preserved sample containers have been used.
✓	All samples were received in good condition.
✓	Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.
✓	Appropriate sample containers have been used.
✓	Sample containers for volatile analysis received with zero headspace.
X	Split sample sent to requested external lab.
X	Some samples have been subcontracted.
N/A	Custody Seals intact (if used).

Notes

Contact

If you have any questions with respect to these samples, please contact your Analytical Services Manager:

Ursula Long on phone : or by email: UrsulaLong@eurofins.com

Results will be delivered electronically via email to Leo Rothacker - lrothacker@jbsg.com.au.

Global Leader - Results you can trust

JBS & G Australia (NSW) P/L
Level 1, 50 Margaret St
Sydney
NSW 2000

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Leo Rothacker**

Report **766881-W**
Project name MENANGLE PARK
Project ID 57799
Received Date Jan 12, 2021

Client Sample ID			**GWA**	**GW01**	**GWE**	**GW04**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**S21-Ja05730**	**S21-Ja05731**	**S21-Ja05732**	**S21-Ja05733**
Date Sampled			**Jan 11, 2021**	**Jan 11, 2021**	**Jan 11, 2021**	**Jan 11, 2021**
Test/Reference	LOR	Unit				
Chloride	1	mg/L	2300	6300	2600	290
Sulphate (as SO4)	2	mg/L	6.8	34	93	49
Total Dissolved Solids Dried at 180°C ± 2°C	5	mg/L	3800	8200	4800	630
Hardness mg equivalent CaCO3/L	1	mg/L	910	< 1	390	340
Alkali Metals						
Calcium	0.5	mg/L	63	350	150	48
Magnesium	0.5	mg/L	180	700	320	53
Potassium	0.5	mg/L	1.0	27	15	13
Sodium	0.5	mg/L	920	2100	1100	220

Client Sample ID			**GW02**	**GW05**	**GW06**	**GWB**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**S21-Ja05734**	**S21-Ja05735**	**S21-Ja05736**	**S21-Ja05737**
Date Sampled			**Jan 11, 2021**	**Jan 11, 2021**	**Jan 11, 2021**	**Jan 11, 2021**
Test/Reference	LOR	Unit				
Chloride	1	mg/L	100	1300	400	22
Sulphate (as SO4)	2	mg/L	3.3	10	9.8	9.2
Total Dissolved Solids Dried at 180°C ± 2°C	5	mg/L	180	1600	680	210
Hardness mg equivalent CaCO3/L	1	mg/L	48	600	170	64
Alkali Metals						
Calcium	0.5	mg/L	9.3	79	20	17
Magnesium	0.5	mg/L	6.0	98	29	5.2
Potassium	0.5	mg/L	4.9	6.3	2.0	6.0
Sodium	0.5	mg/L	51	460	150	17

Client Sample ID			GW03
Sample Matrix			Water
Eurofins Sample No.			S21-Ja05738
Date Sampled			Jan 11, 2021
Test/Reference	LOR	Unit	
Chloride	1	mg/L	440
Sulphate (as SO4)	2	mg/L	65
Total Dissolved Solids Dried at 180°C ± 2°C	5	mg/L	1100
Hardness mg equivalent CaCO3/L	1	mg/L	230
Alkali Metals			
Calcium	0.5	mg/L	43
Magnesium	0.5	mg/L	29
Potassium	0.5	mg/L	5.2
Sodium	0.5	mg/L	390

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chloride	Sydney	Jan 12, 2021	28 Days
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Sulphate (as SO4)	Sydney	Jan 12, 2021	28 Days
- Method: E045 Anions by Ion Chromatography			
Total Dissolved Solids Dried at 180°C ± 2°C	Sydney	Jan 12, 2021	7 Days
- Method: LTM-INO-4170 Total Dissolved Solids in Water			
Eurofins Suite B11D: Na/K/Ca/Mg and Hardness			
Hardness mg equivalent CaCO3/L	Sydney	Jan 15, 2021	28 Days
- Method: E020.1 Hardness in water			
Alkali Metals	Sydney	Jan 15, 2021	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			

eurofins | Environment Testing

ABN: 50 005 085 521 web: www.eurofins.com.au email: EnviroSales@eurofins.com

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Site # 1254 & 14271

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NATA # 1261 Site # 18217

Brisbane
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NATA # 1261 Site # 20794

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NATA # 1261
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Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Company Name: JBS & G Australia (NSW) P/L
Address: Level 1, 50 Margaret St
Sydney
NSW 2000

Project Name: MENANGLE PARK
Project ID: 57799

Order No.:
Report #: 766881
Phone: 02 8245 0300
Fax:

Received: Jan 12, 2021 10:30 AM
Due: Jan 19, 2021
Priority: 5 Day
Contact Name: Leo Rothacker

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						Chloride	Sulphate (as SO4)	Eurofins Suite B11D: Na/K/Ca/Mg and Hardness	Total Dissolved Solids Dried at 180°C ± 2°C
Melbourne Laboratory - NATA Site # 1254 & 14271									
Sydney Laboratory - NATA Site # 18217						X	X	X	X
Brisbane Laboratory - NATA Site # 20794									
Perth Laboratory - NATA Site # 23736									
Mayfield Laboratory									
External Laboratory									
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**				
1	GWA	Jan 11, 2021		Water	S21-Ja05730	X	X	X	X
2	GW01	Jan 11, 2021		Water	S21-Ja05731	X	X	X	X
3	GWE	Jan 11, 2021		Water	S21-Ja05732	X	X	X	X
4	GW04	Jan 11, 2021		Water	S21-Ja05733	X	X	X	X
5	GW02	Jan 11, 2021		Water	S21-Ja05734	X	X	X	X
6	GW05	Jan 11, 2021		Water	S21-Ja05735	X	X	X	X
7	GW06	Jan 11, 2021		Water	S21-Ja05736	X	X	X	X
8	GWB	Jan 11, 2021		Water	S21-Ja05737	X	X	X	X
9	GW03	Jan 11, 2021		Water	S21-Ja05738	X	X	X	X

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Melbourne Laboratory - NATA Site # 1254 & 14271				
Sydney Laboratory - NATA Site # 18217	X	X	X	X
Brisbane Laboratory - NATA Site # 20794				
Perth Laboratory - NATA Site # 23736				
Mayfield Laboratory				
External Laboratory				
Test Counts	9	9	9	9

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Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram | **mg/L:** milligrams per litre | **ug/L:** micrograms per litre

ppm: Parts per million | **ppb:** Parts per billion | **%:** Percentage

org/100mL: Organisms per 100 millilitres | **NTU:** Nephelometric Turbidity Units | **MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Chloride	mg/L	< 1			1	Pass	
Sulphate (as SO4)	mg/L	< 2			2	Pass	
Total Dissolved Solids Dried at 180°C ± 2°C	mg/L	< 5			5	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Chloride	%	117			70-130	Pass	
Sulphate (as SO4)	%	103			70-130	Pass	
Total Dissolved Solids Dried at 180°C ± 2°C	%	102			70-130	Pass	
LCS - % Recovery							
Alkali Metals							
Calcium	%	98			80-120	Pass	
Magnesium	%	110			80-120	Pass	
Potassium	%	97			80-120	Pass	
Sodium	%	114			80-120	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
				Result 1					
Sulphate (as SO4)	S21-Ja05730	CP	%	108			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	S21-Ja05738	CP	%	88			75-125	Pass	
Magnesium	S21-Ja05738	CP	%	97			75-125	Pass	
Potassium	S21-Ja05738	CP	%	88			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Total Dissolved Solids Dried at 180°C ± 2°C	S21-Ja09664	NCP	mg/L	130	130	3.0	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	S21-Ja07642	NCP	mg/L	100	100	2.0	30%	Pass	
Magnesium	S21-Ja07642	NCP	mg/L	590	610	3.0	30%	Pass	
Potassium	S21-Ja07642	NCP	mg/L	20	21	4.0	30%	Pass	
Sodium	S21-Ja09759	NCP	mg/L	250	250	2.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Chloride	S21-Ja05738	CP	mg/L	440	420	4.0	30%	Pass	
Sulphate (as SO4)	S21-Ja05738	CP	mg/L	65	65	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Ursula Long	Analytical Services Manager
Charl Du Preez	Senior Analyst-Inorganic (NSW)
John Nguyen	Senior Analyst-Metal (NSW)



Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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FIGURES

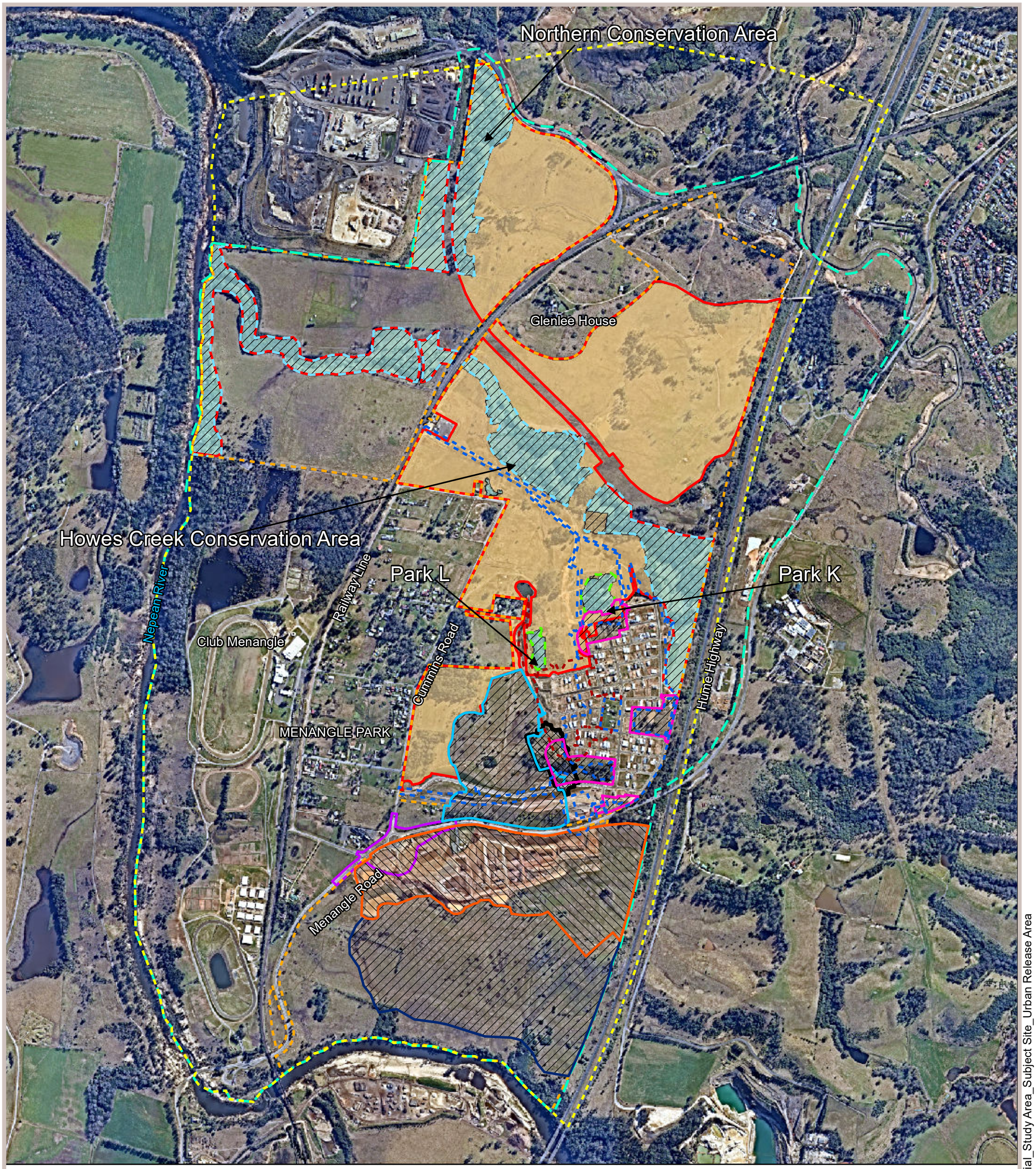
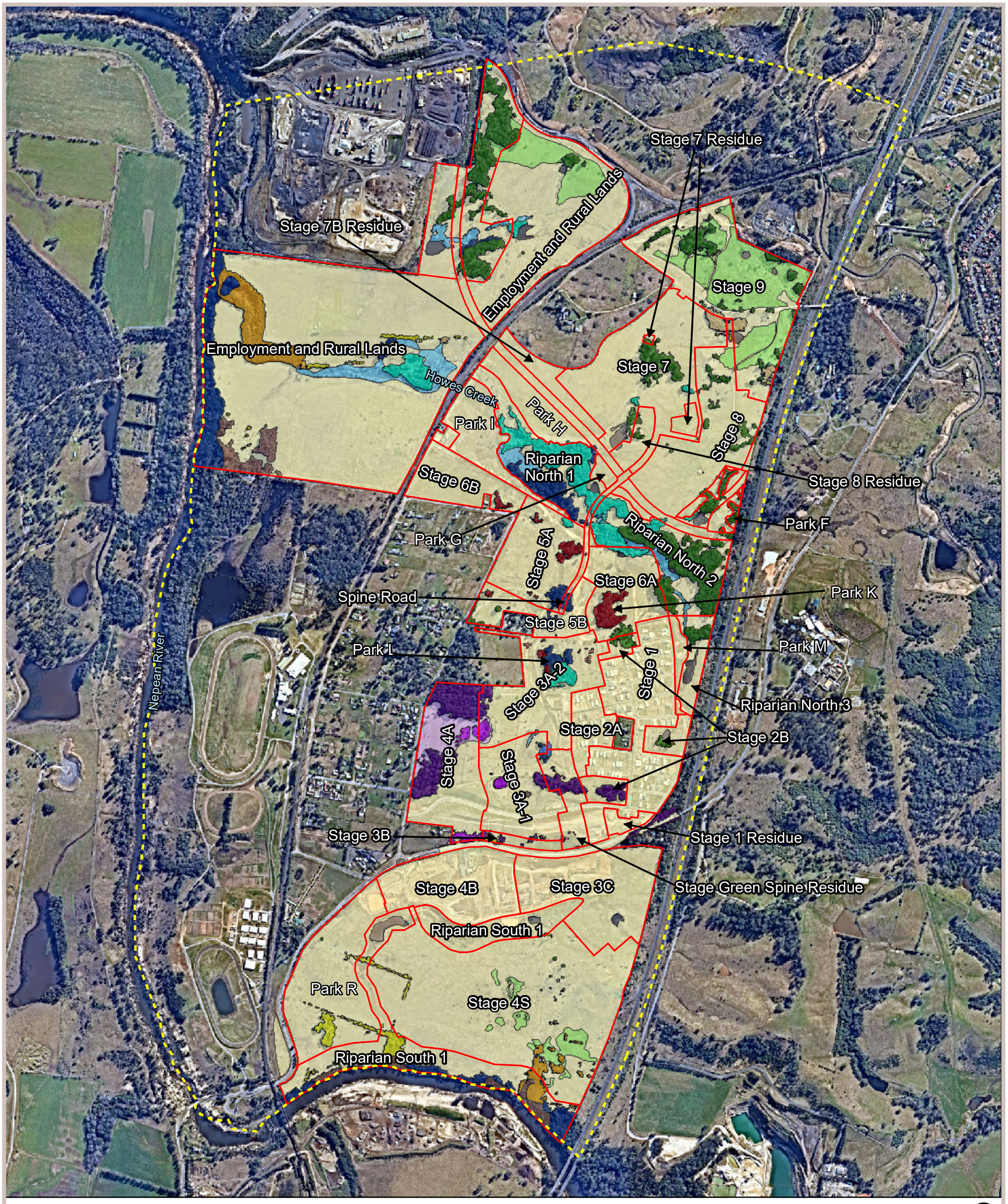


Figure 1. Aerial photograph of the Menangle Park Urban Release Area, subject land, study area and subject site



Legend

- Masterplan Staging Boundaries
- Study Area

Vegetation Community

- Shale Plains Woodland
- Shale Plains Woodland Derived Native Grassland
- Shale Hills Woodland
- Shale Hills Woodland Shrubby Regrowth
- Shale Hills Woodland Derived Native Grassland
- Elderslie Banksia Scrub Forest
- Elderslie Banksia Scrub Forest (Non-TEC)
- River Flat Eucalypt Forest
- River-flat Eucalypt Forest Derived Native Grassland
- River Oak Riparian Woodland
- Swamp Oak Floodplain Forest
- Freshwater Wetlands
- Privet Dominated Exotic Woody Vegetation
- African Olive Dominated Exotic Woody Vegetation
- Other Exotic Dominated Woody Vegetation
- Dam
- Exotic Grassland/Cleared Land

Coordinate System: MGA Zone 56 (GDA 94)

Image Source:
Image © NearMap (2022)
Dated 23/08/2022

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I:\...\17072\Figures\RP37\20240529\Figure 2. Menangle Park Master Plan

Figure 2. Menangle Park Master Plan

0 150 300 450 600 m

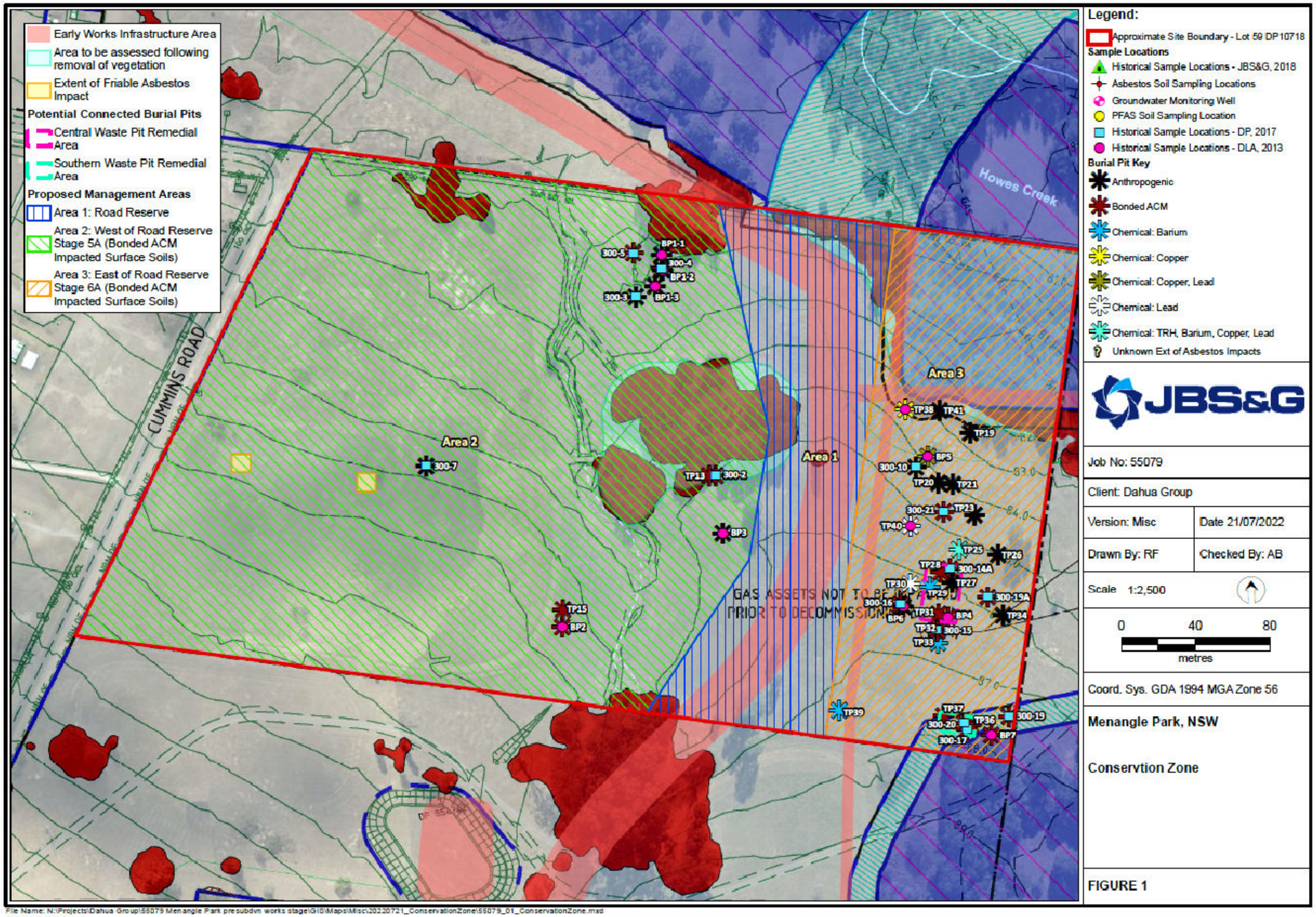


Figure 3. JBS&G contaminated land assessment

Image Source: JBS&G contaminated land assessment (2022)

I:\...\17072\Figures\RP37\20221025\Figure 3. JBS&G contaminated land assessment

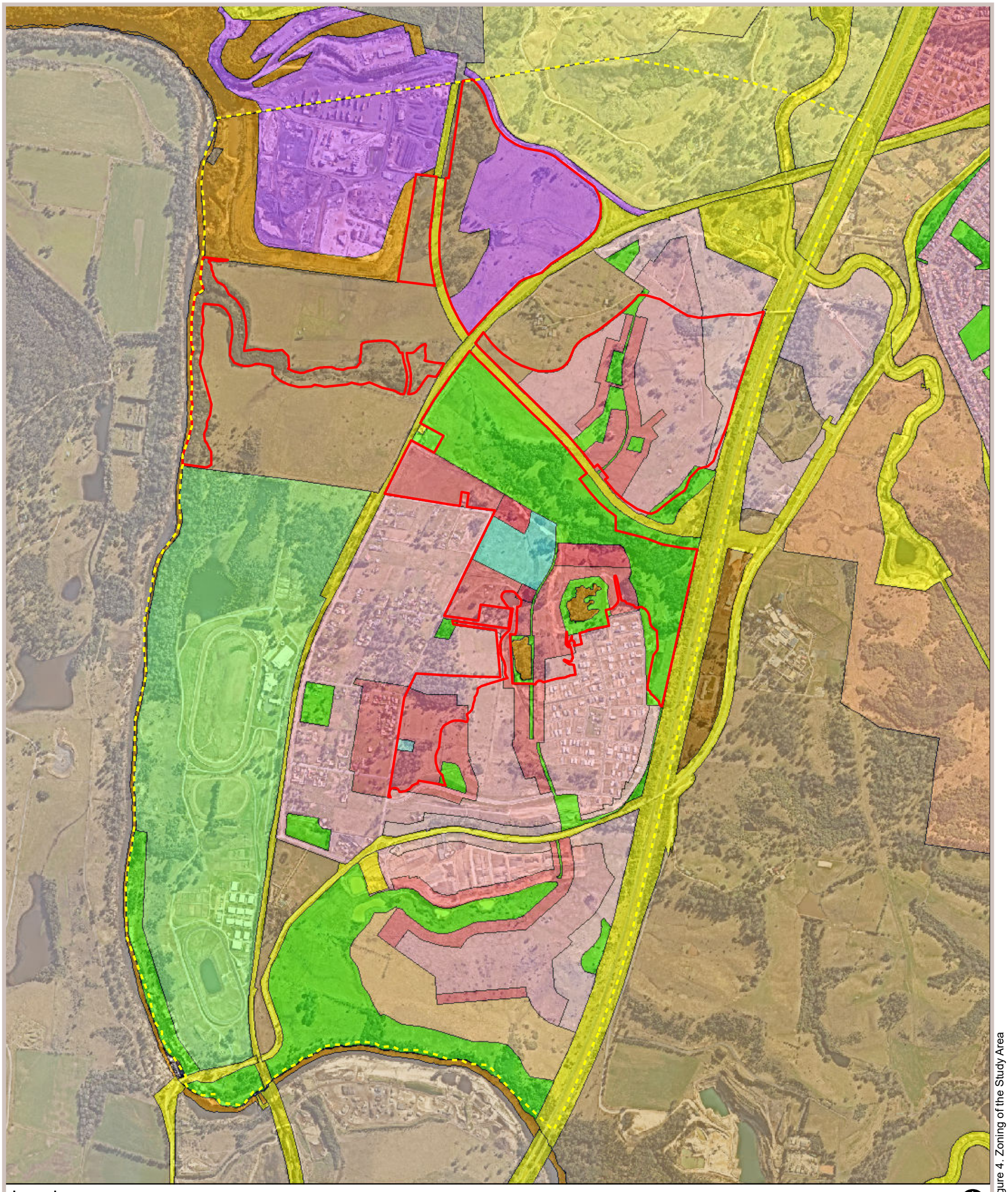


Figure 4. Zoning of the study area

Campbelltown Local Environmental Plan 2015

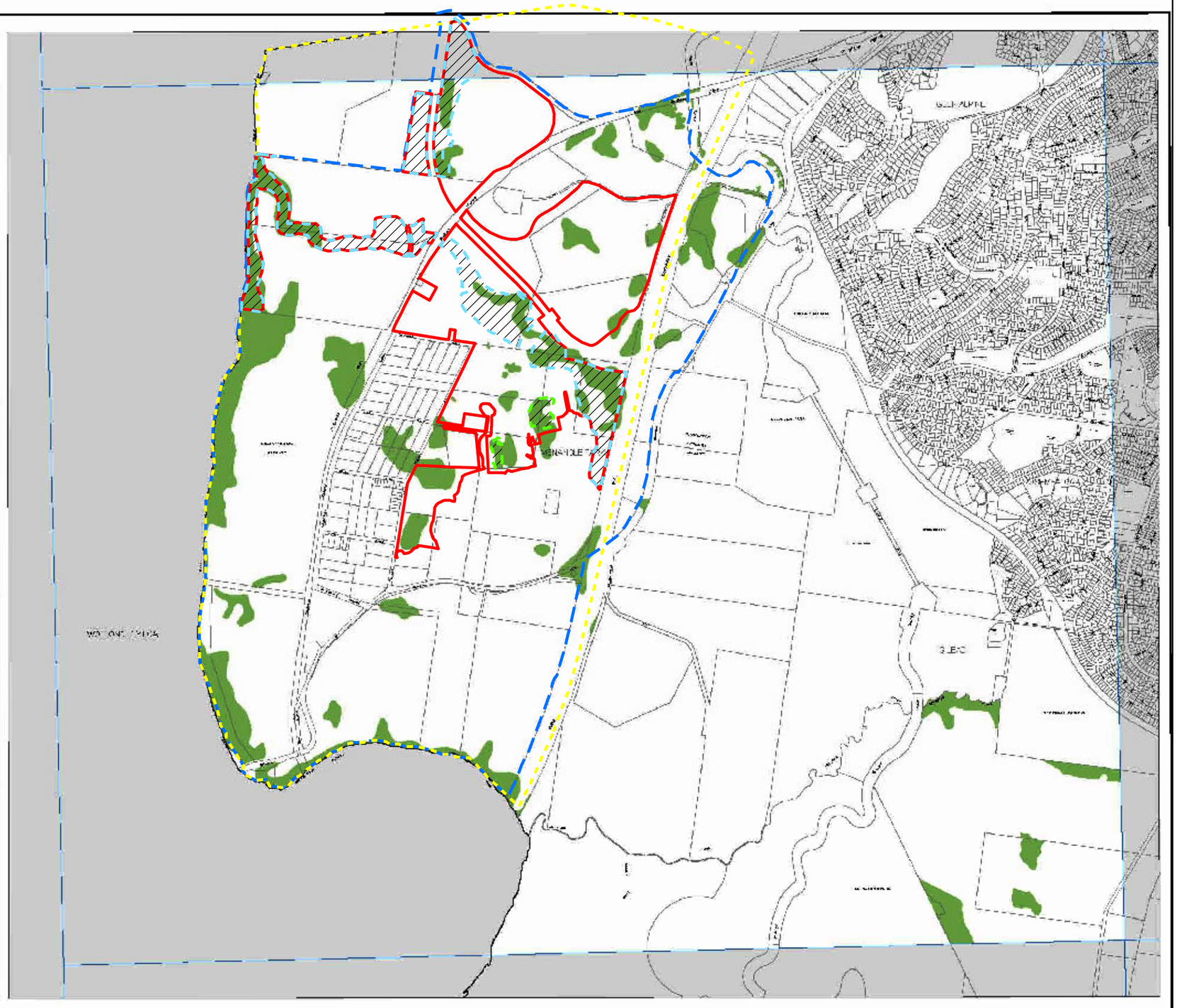
Terrestrial Biodiversity Map - Sheet BIO_003

Terrestrial Biodiversity

Biodiversity - significant vegetation

Cadastre

Cadastre 12/04/2017 © Spatial Services NSW



Legend

- Subject Site
- Study Area
- Howes Creek and Northern Conservation Area
- Parks K and L Conservation Area
- Menangle Park Urban Release Area

Image Source:
Campbelltown LEP 2015

Coordinate System: MGA Zone 56 (GDA 94)

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I:\...\17072\Figures\RP37\20240529\Figure 5. Campbelltown LEP 2015 Biodiversity Mapping

Figure 5. Campbelltown LEP 2015 Biodiversity Mapping

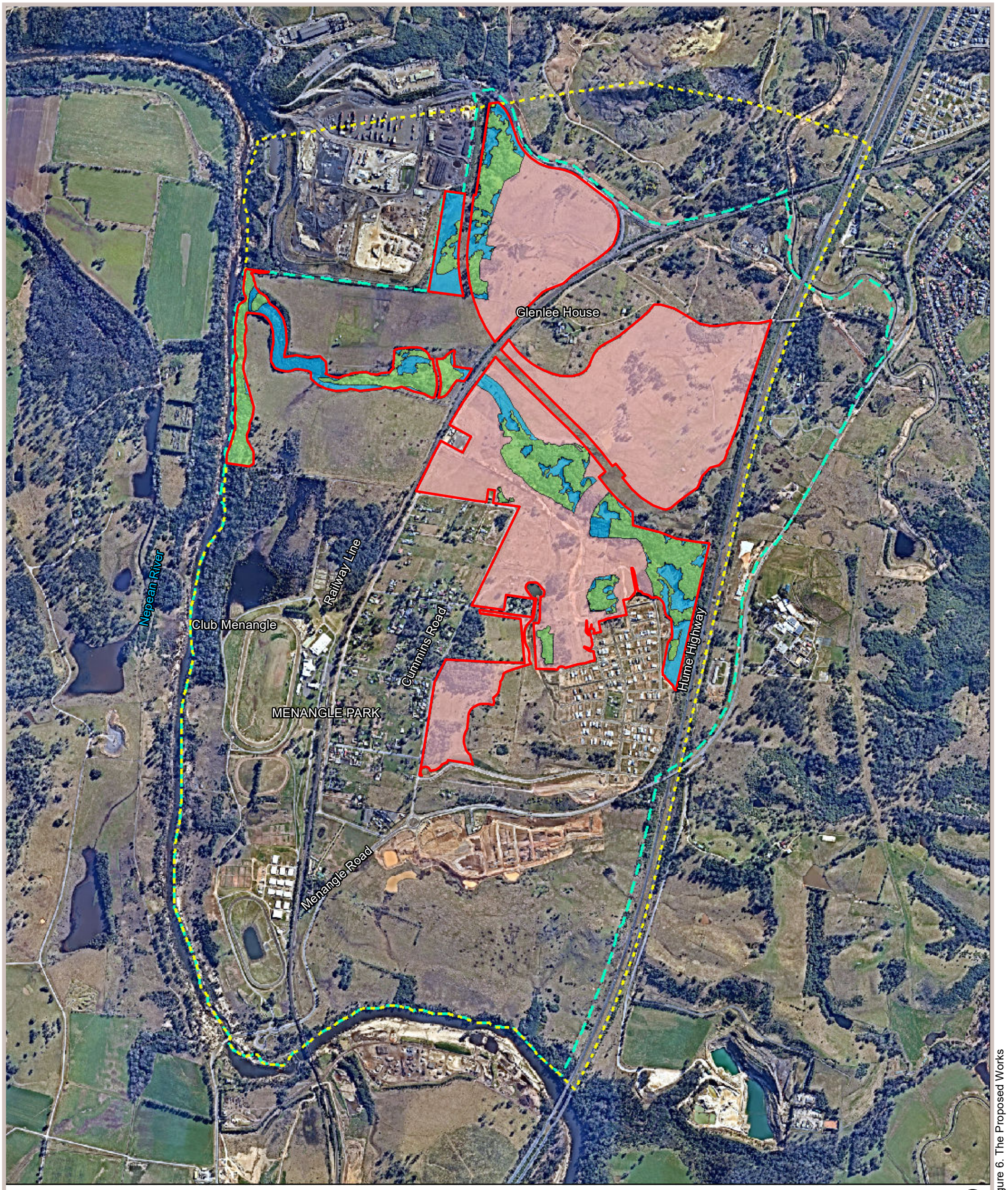


Figure 6. The proposed works

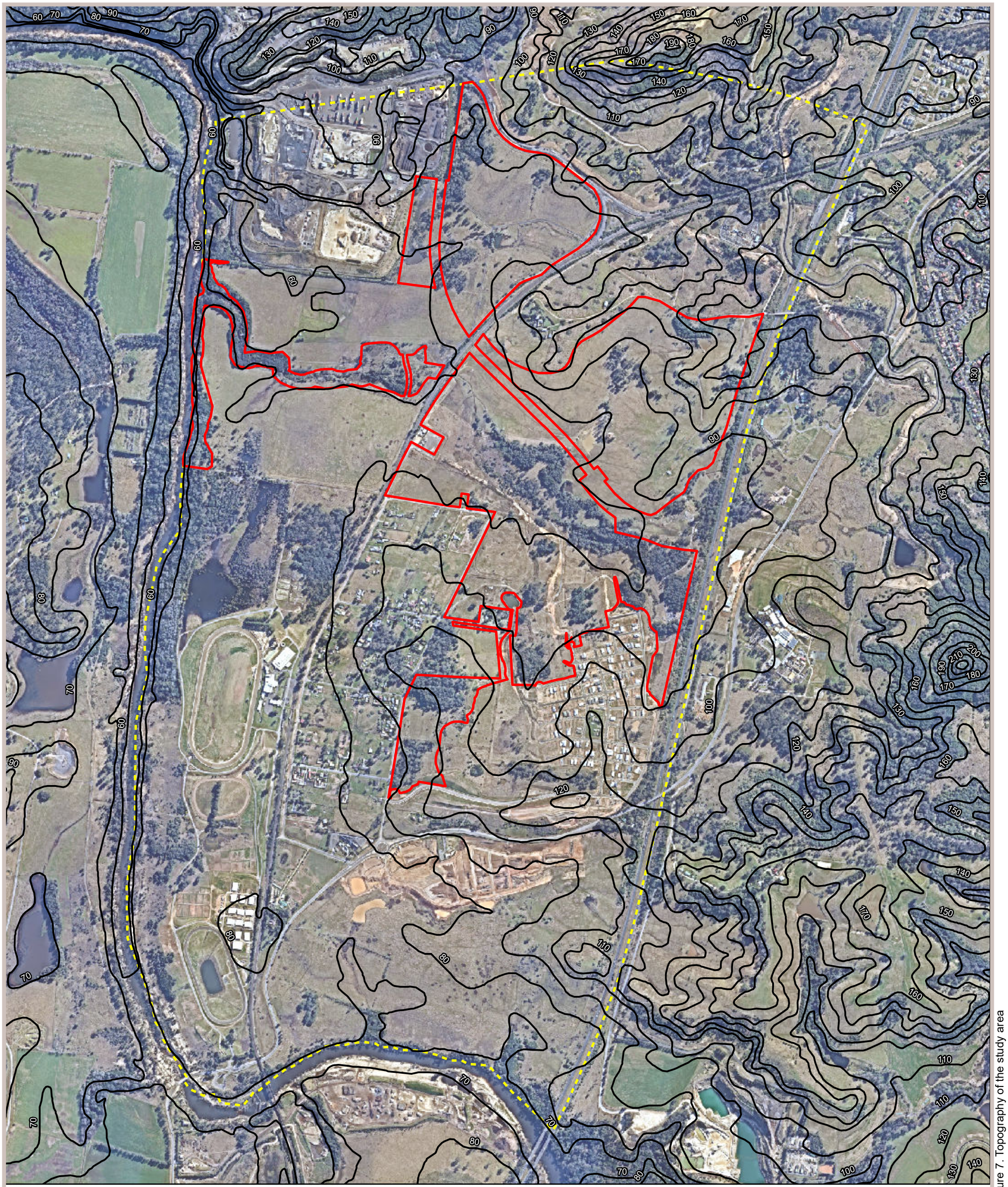


Figure 7. Topography of the study area

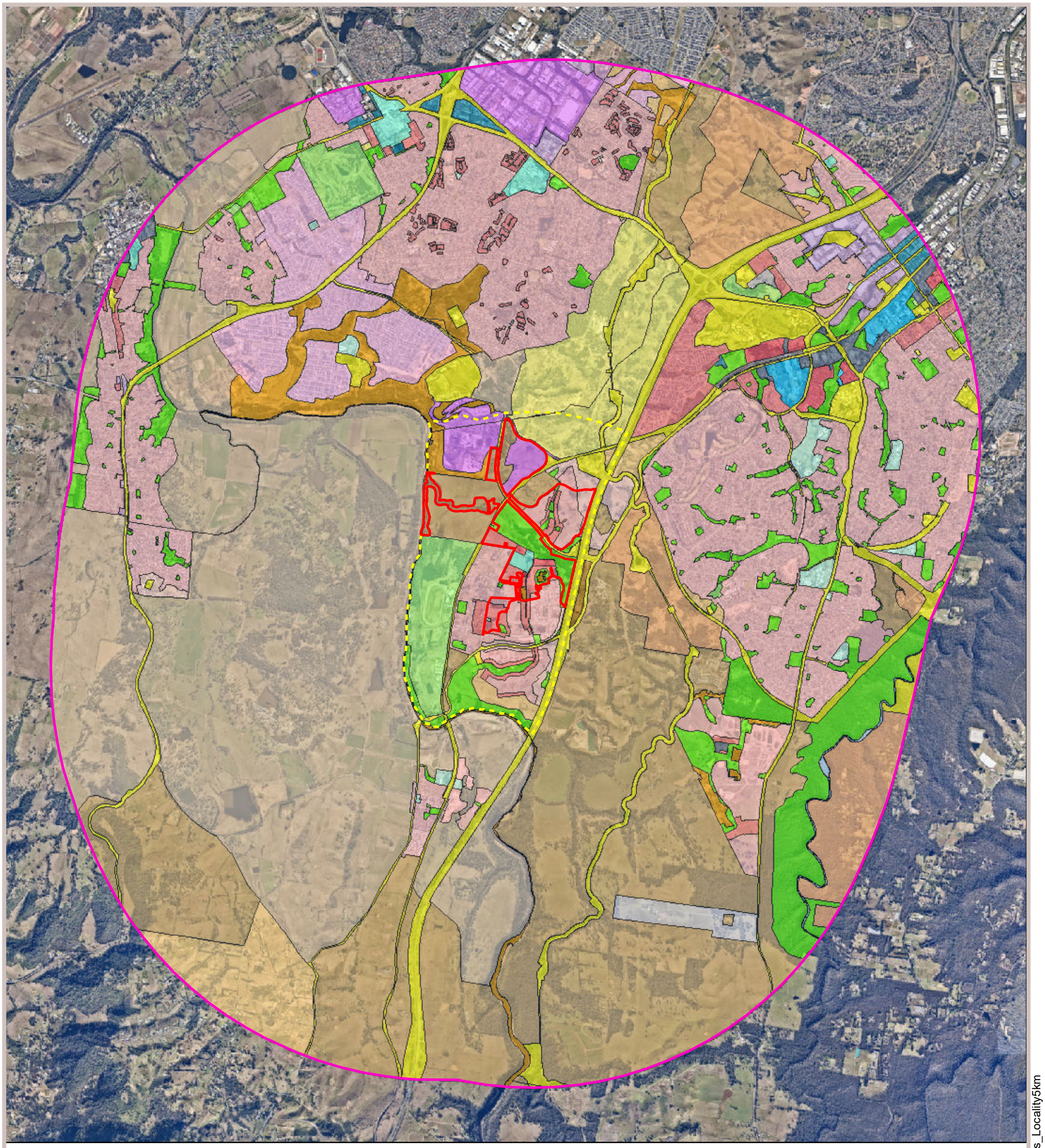


Figure 8. Land uses in the locality

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Subject Site
- Study
- Local

Vegetation Communities (OEH 2013)

- 1 - Shale Sandstone Transition Forest (Low Sandstone
- 2 - Shale Sandstone Transition Forest (High Sandstone Influence)
- 9 - Shale Hills Woodland
- 10 - Shale Plains Woodland
- 11 - Alluvial
- 12 - Riparian Forest
- 14 - Moist Shale Woodland
- 31 - Sandstone Ridgetop Woodland
- 32 - Upper Georges River Sandstone Woodland
- 33 - Western Sandstone Gully Forest
- 35 - Riparian Scrub
- 37 - Elderslie Banksia Scrub Forest

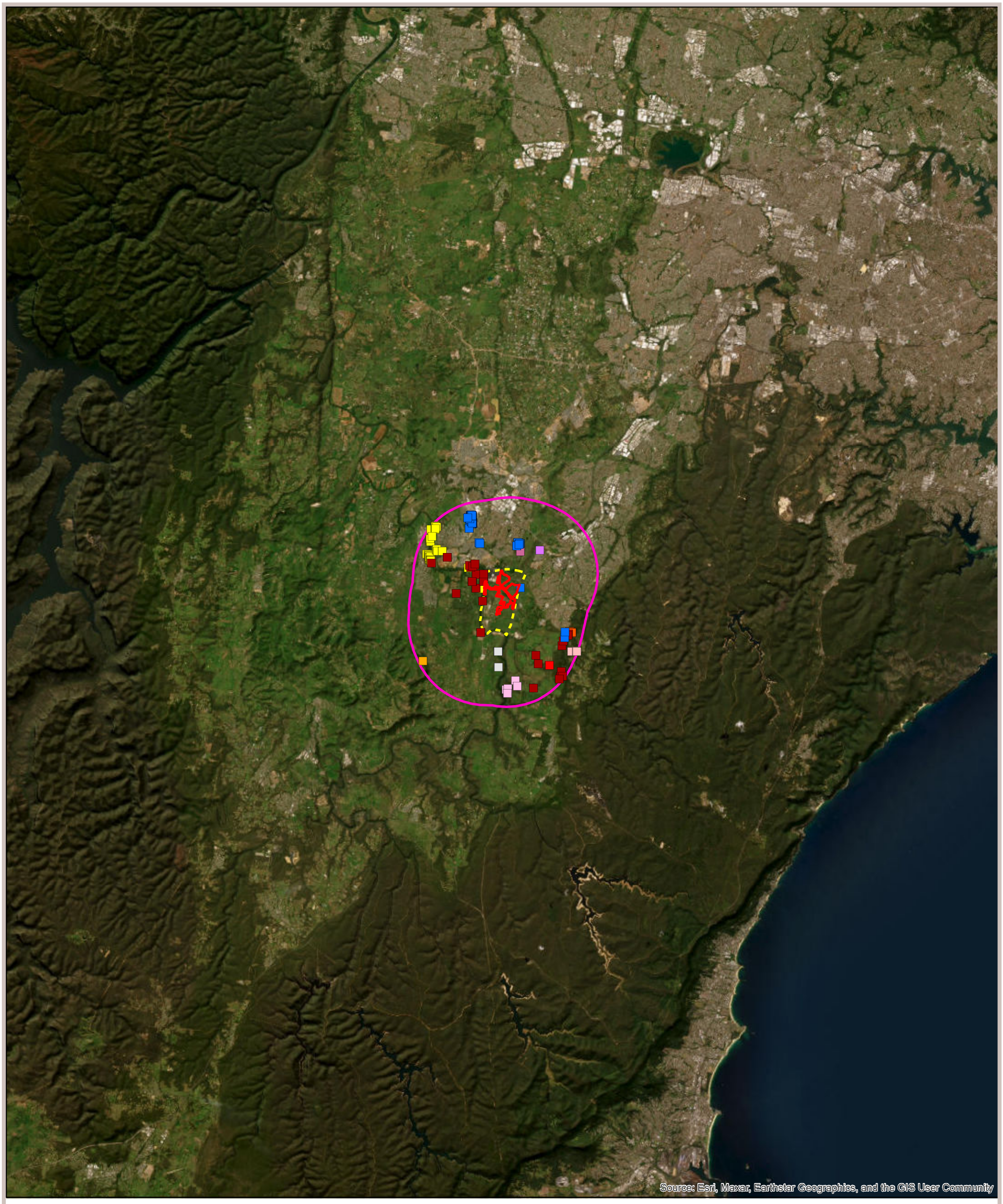
Data Source:
Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207
© State Government of NSW and Department of Planning and Environment 2015

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0 1 2 km

I:\...\17072\Figures\RP37\20240529\Figure 9. Vegetation communities in the locality

Figure 9. Vegetation communities in the locality



Legend

Subject Site

Study Area

Local Area

Threatened Flora

- Cynanchum elegans
- Eucalyptus benthamii
- Grevillea parviflora subsp. parviflora
- Hibbertia puberula
- Isotoma fluviatilis subsp. fluviatilis
- Marsdenia viridiflora subsp. viridiflora
- Pimelea spicata
- Pomaderris brunnea
- Prostanthera marifolia
- Pterostylis saxicola
- Pultenaea pedunculata

Coordinate System: MGA Zone 56 (GDA 94)

Data Source:
BioNet Atlas of NSW Wildlife
© NSW Office of Environment and Heritage
dated 22/02/2022

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I:\...\17072\Figures\RP37\20240529\Figure 10. Threatened Flora_Locality5km

Figure 10. Threatened flora species recorded within the local area

0 2 4 6 8 km

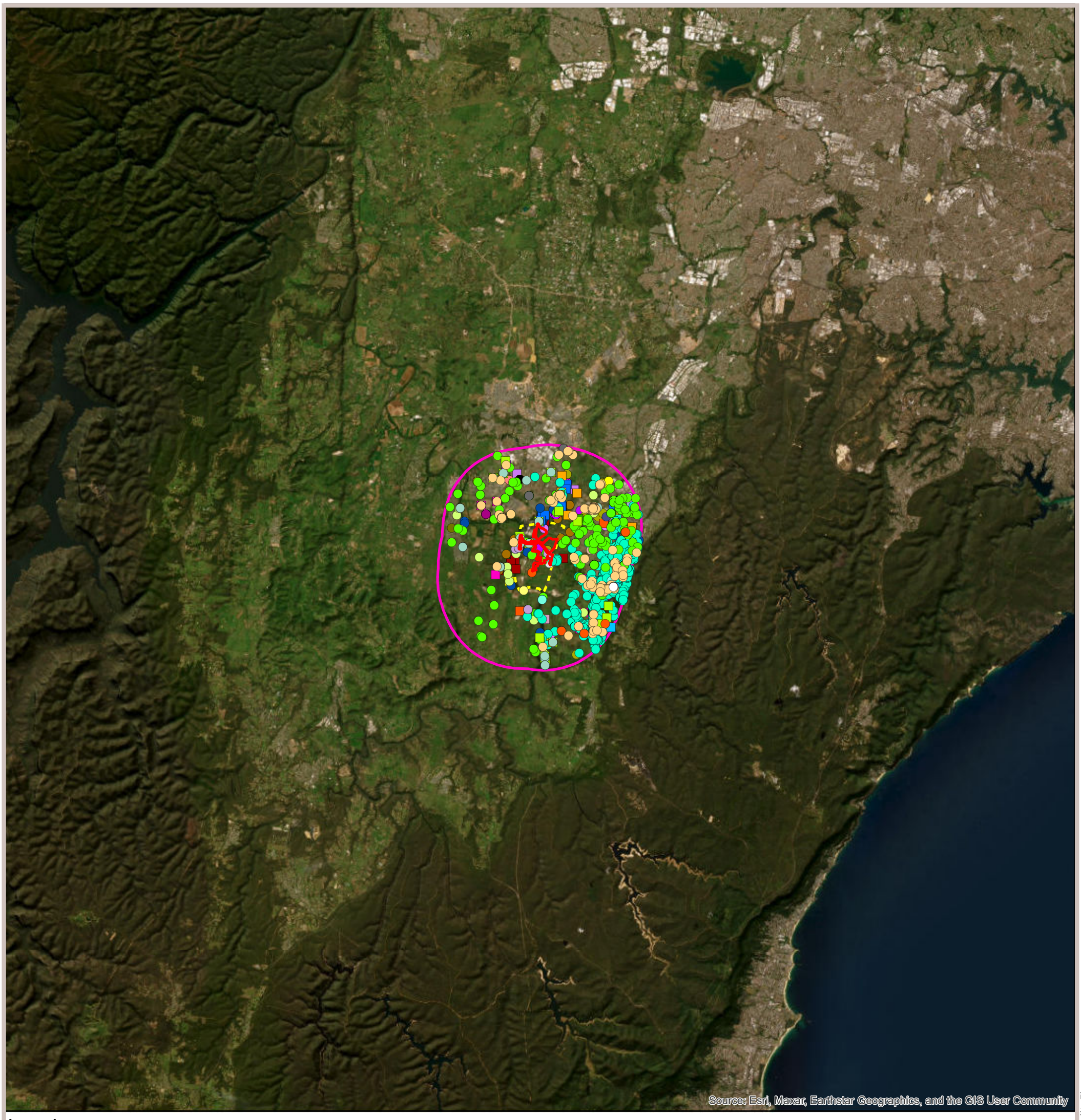
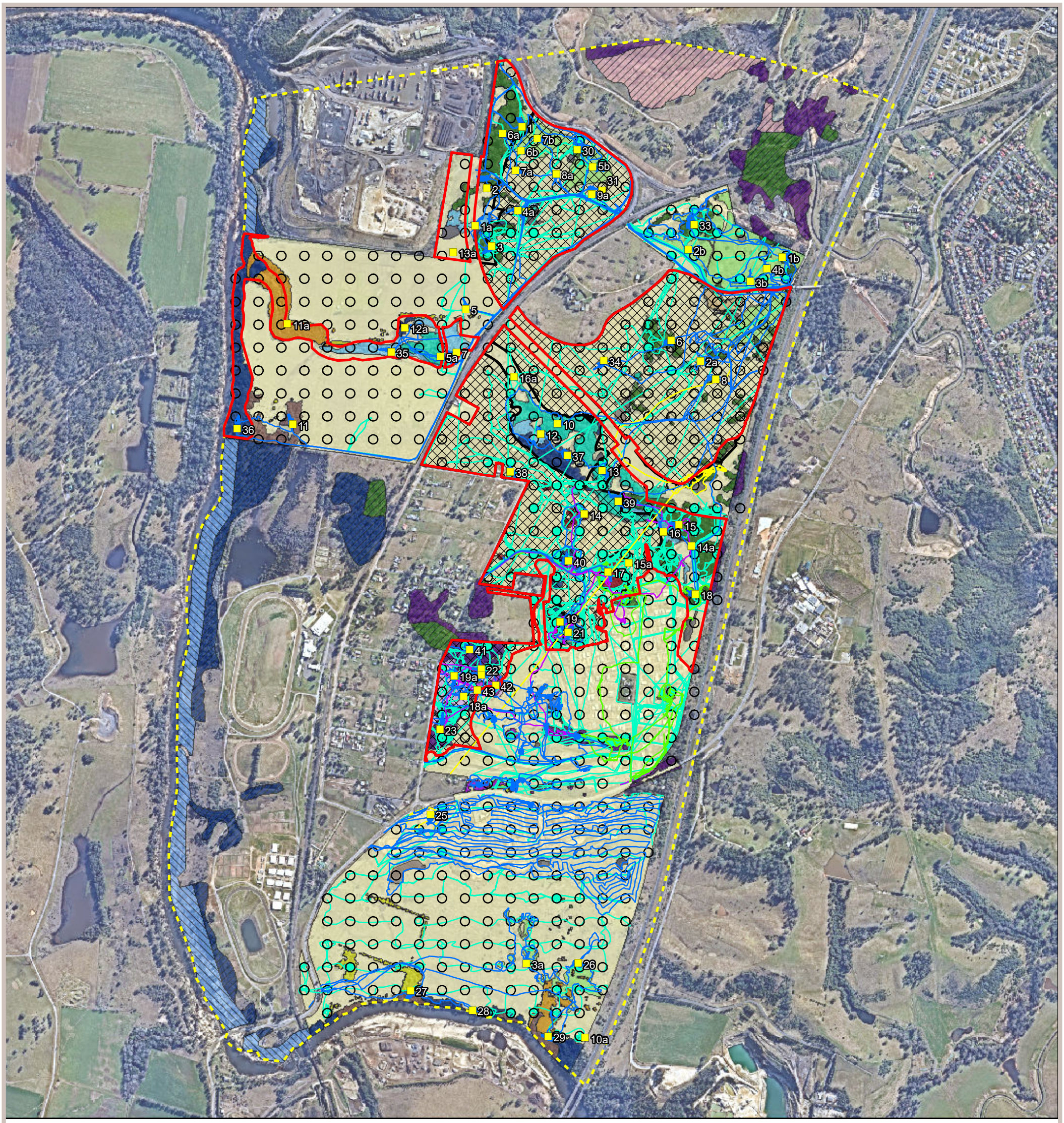


Figure 11. Threatened fauna species recorded within the local area



Legend

- Subject Site
- Impact
- Study
- Targeted Threatened Flora Survey Locations
- Flora Plot Location
- Random Meander Surveys -
- Random Meander Surveys -
- Random Meander Surveys -
- Random Meander Surveys -
- Targeted Threatened Flora Surveys -2021

Vegetation Community

- Shale Plains Woodland
- Shale Plains Woodland Derived Native Grassland
- Shale Hills Woodland
- Shale Hills Woodland Shrubby Regrowth
- Shale Hills Woodland Derived Native Grassland
- Elderslie Banksia Scrub Forest
- Elderslie Banksia Scrub Forest (Non-TEC)
- River Flat Eucalypt Forest
- River-flat Eucalypt Forest Derived Native Grassland
- River Oak Riparian Woodland
- Swamp Oak Floodplain Forest
- Freshwater Wetlands
- Privet Dominated Exotic Woody Vegetation
- African Olive Dominated Exotic Woody Vegetation
- Other Exotic Dominated Woody Vegetation
- Dam
- Exotic Grassland/Cleared Land

Vegetation Communities (OEH 2013)

- 1 - Shale Sandstone Transition Forest (Low Sandstone Influence)
- 9 - Shale Hills Woodland
- 10 - Shale Plains Woodland
- 11 - Alluvial
- 12 - Riparian Forest
- 14 - Moist Shale Woodland

Coordinate System: MGA Zone 56 (GDA 94)

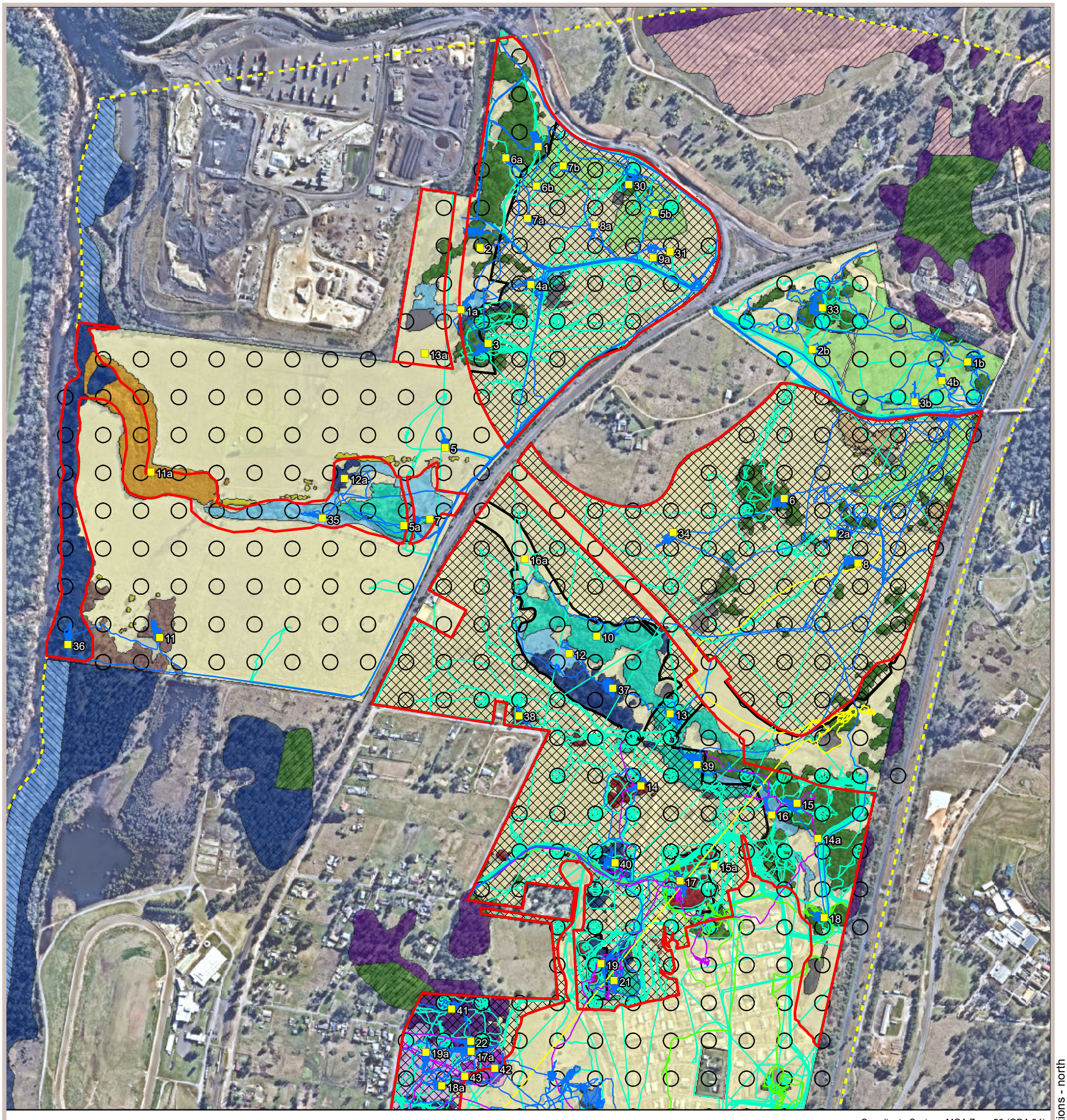
Image Source:
Image © NearMap 2022
Dated 23/08/2022
Data Source:
Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207
© State Government of NSW and Department of Planning and Environment 2015

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I:\...\17072\Figures\RP37\20240529\Figure 12. Flora Survey Locations

Figure 12. Flora Survey Locations

0 150 300 450 600 m



Legend

- Subject Site
- Impact
- Study
- Targeted Threatened Flora Survey Locations
- Flora Plot Location
- Random Meander Surveys -
- Random Meander Surveys -
- Random Meander Surveys -
- Random Meander Surveys -
- Targeted Threatened Flora Surveys -2021

Vegetation Community

- Shale Plains Woodland
- Shale Plains Woodland Derived Native Grassland
- Shale Hills Woodland
- Shale Hills Woodland Shrubby Regrowth
- Shale Hills Woodland Derived Native Grassland
- Elderslie Banksia Scrub Forest
- Elderslie Banksia Scrub Forest (Non-TEC)
- River Flat Eucalypt Forest
- River-flat Eucalypt Forest Derived Native Grassland
- River Oak Riparian
- Swamp Oak Floodplain Forest
- Freshwater Wetlands
- Privet Dominated Exotic Woody Vegetation
- African Olive Dominated Exotic Woody Vegetation
- Other Exotic Dominated Woody Vegetation
- Dam
- Exotic Grassland/Cleared

Vegetation Communities (OEH 2013)

- 9 - Shale Hills Woodland
- 10 - Shale Plains Woodland
- 11 - Alluvial
- 12 - Riparian Forest
- 14 - Moist Shale Woodland

Coordinate System: MGA Zone 56 (GDA 94)

Image Source:
Image © NearMap (2022)
Dated 23/08/2022

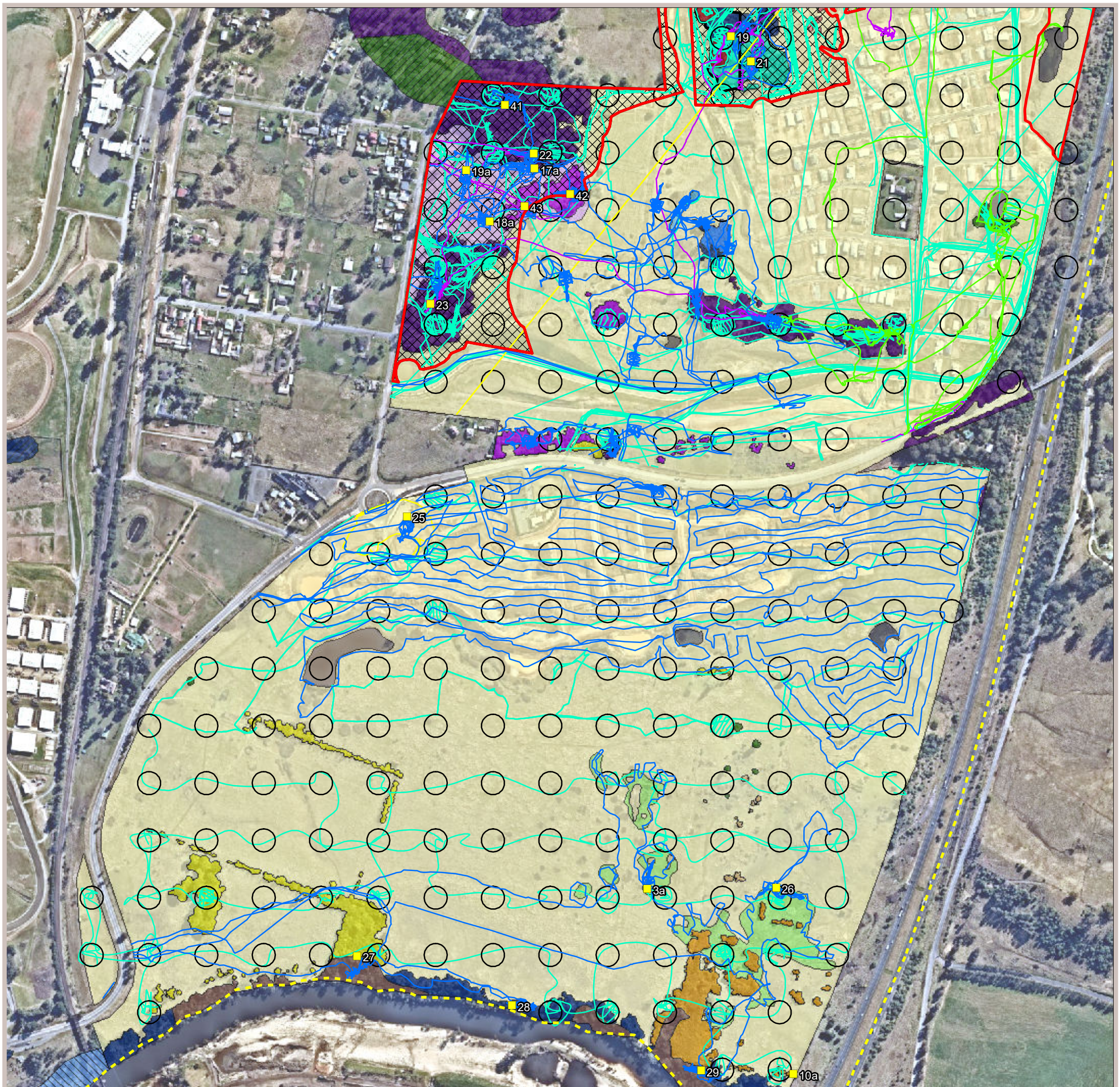
Data Source:
Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207
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I:\...\17072\Figures\RP37\20240529\Figure 12a. Flora survey locations - north

Figure 12a. Flora survey locations - north

0 100 200 300 400 m



Legend

- Subject Site
- Impact
- Study
- Targeted Threatened Flora Survey Locations
- Flora Plot Location
- Random Meander Surveys - 2021
- Random Meander Surveys - 2016
- Random Meander Surveys - 2017
- Random Meander Surveys - 2018
- Targeted Threatened Flora Surveys -2021

Vegetation Community

- Shale Plains Woodland
- Shale Plains Woodland Derived Native Grassland
- Shale Hills Woodland
- Shale Hills Woodland Shrubby Regrowth
- Shale Hills Woodland Derived Native Grassland
- Elderslie Banksia Scrub Forest
- Elderslie Banksia Scrub Forest (Non-TEC)
- River Flat Eucalypt Forest
- River-flat Eucalypt Forest Derived Native Grassland
- River Oak Riparian Woodland
- Swamp Oak Floodplain Forest
- Freshwater Wetlands
- Privet Dominated Exotic Woody Vegetation
- African Olive Dominated Exotic Woody Vegetation
- Other Exotic Dominated Woody Vegetation
- Dam
- Exotic Grassland/Cleared Land

Vegetation Communities (OEH 2013)

- 9 - Shale Hills Woodland
- 10 - Shale Plains Woodland
- 11 - Alluvial
- 12 - Riparian Forest

Coordinate System: MGA Zone 56 (GDA 94)

Image Source:
Image © NearMap (2022)
Dated 23/08/2022

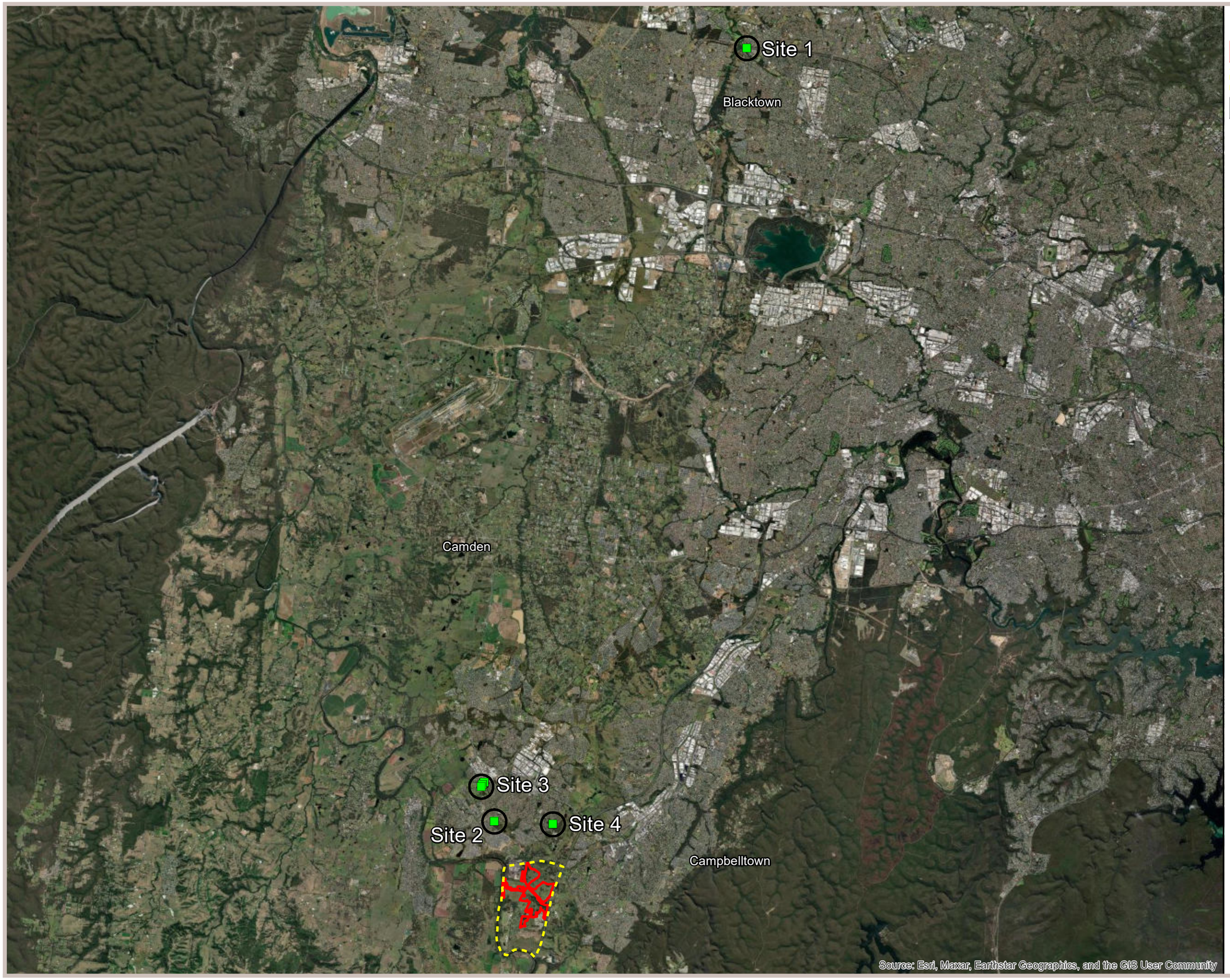
Data Source:
Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207
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I:\...\17072\Figures\RP37\20240529\Figure 12b. Flora survey locations - south

Figure 12b. Flora survey locations - south

0 50 100 150 200 m



Legend

- Subject Site
- Study Area
- Pimelea spicata Reference Sites

Threatened Species Location

- Pimelea spicata

Data Source:
SMEC Australia PTY LTD (2022)
NSW Government Spatial Services
SIX Maps 'Clip and Ship' (2018)
City of Campbelltown

Coordinate System: MGA Zone 56 (GDA 94)

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0 1,750 3,500 5,250 7,000 m

I:\...\17072\Figures\RP37\20240529\Figure 13. Pimelea spicata reference sites

Figure 13. Pimelea spicata reference sites surveyed

Legend

Subject Site

Impact Area

Study Area

Fauna Survey (2017-2018)

- Cumberland Plain Land Snail Survey
- Echolocation Call Detection
- Echolocation Call Detection, Diurnal Bird Census
- Echolocation Call Detection, Diurnal Bird Census, Spotlighting and Call Playback
- Diurnal Bird Census
- Diurnal Bird Census, Spotlighting and Call Playback
- Spotlighting and Call Playback

Fauna Survey (2021)

- Koala Detection Dog Survey
- Spotlighting and Call Playback/Cumberland Plain Land Snail Nocturnal Survey
- Diurnal Bird Census
- GGBF Call Playback
- GGBF Diurnal Survey/Habitat Assessment
- Harp Trapping
- Infra-red Camera
- Koala Detection Dog Survey
- Koala and BSC Call Playback
- Roost Watch
- SAT Survey/CPLS Diurnal Survey (centre tree)

Coordinate System: MGA Zone 56 (GDA 94)

Image Source:
Image © NearMap (2022)
Dated 23/08/2022

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I:\...\17072\Figures\RP37\20240529\Figure 14. Fauna survey locations

Figure 14. Fauna survey locations

0 150 300 450 600 m

Legend

Subject Site

Study

Vegetation Community

- Shale Plains Woodland
- Shale Plains Woodland Derived Native Grassland
- Shale Hills Woodland
- Shale Hills Woodland Shrubby Regrowth
- Shale Hills Woodland Derived Native Grassland
- Elderslie Banksia Scrub Forest
- Elderslie Banksia Scrub Forest (Non-TEC)
- River Flat Eucalypt Forest
- River-flat Eucalypt Forest Derived Native Grassland
- River Oak Riparian Woodland
- Swamp Oak Floodplain Forest
- Freshwater Wetlands
- Privet Dominated Exotic Woody Vegetation
- African Olive Dominated Exotic Woody Vegetation
- Other Exotic Dominated Woody Vegetation
- Dam
- Exotic Grassland/Cleared Land

Vegetation Communities (OEH 2013)

- 9 - Shale Hills Woodland
- 10 - Shale Plains Woodland
- 11 - Alluvial
- 12 - Riparian Forest
- 14 - Moist Shale Woodland

Coordinate System: MGA Zone 56 (GDA 94)

Image Source:
Image © NearMap (2022)
Dated 23/08/2022

Data Source:
Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207
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I:\...\17072\Figures\RP37\20240529\Figure 15. Vegetation communities in the study area

Figure 15. Vegetation communities in the study area

0 150 300 450 600 m

Legend

Study

Subject Site

Vegetation Community

Elderslie Banksia Scrub

Elderslie Banksia Scrub Forest (Non-TEC)

River Flat Eucalypt Forest

River-flat Eucalypt Forest Derived Native Grassland

River Oak Riparian

Swamp Oak Floodplain

Freshwater Wetlands

Coordinate System: MGA Zone 56 (GDA 94)

Image Source:
Image © NearMap (2022)
Dated 23/08/2022

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0 100 200 300 400 m

I:\...\17072\Figures\RP37\20240529\Figure 16. Potential GDEs_Subject Site

Figure 16. Potential GDEs of the subject site

Image Source: Image © NearMap (2022) Dated 23/08/2022 Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Subject Site
- Study
- Howes Creek and Northern Conservation Area
- Parks K and L Conservation

Habitat Feature

- Forest/Woodland
- Freshwater Wetland
- Dam
- Stick Nest
- Hollow Bearing Tree

Threatened Fauna

- Brown Treecreeper (Vulnerable under TSC Act)
- Dusky Woodswallow (Vulnerable under TSC Act)
- Large Bent-winged Bat (Vulnerable under TSC Act)
- Eastern Cave Bat (Vulnerable under TSC Act)
- Eastern False Pipistrelle (Vulnerable under TSC Act)
- Eastern Coastal Free-tailed Bat (Vulnerable under TSC Act)
- Greater Broad-nosed Bat (Vulnerable under TSC Act)
- Grey-headed Flying-fox (Vulnerable under TSC Act and EPBC Act)
- Little Bent-winged Bat (Vulnerable under TSC Act)
- Little Eagle (Vulnerable under TSC Act)
- Rufous Fantail (Migratory under EPBC Act)
- Southern Myotis (Vulnerable under TSC Act)
- Varied Sittella (Vulnerable under TSC Act)

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I:\...\17072\Figures\RP37\20240529\Figure 17. Habitat Features_Threatened Fauna_Study Area

Figure 17. Location of habitat features and threatened fauna recorded within the study area

0 150 300 450 600 m

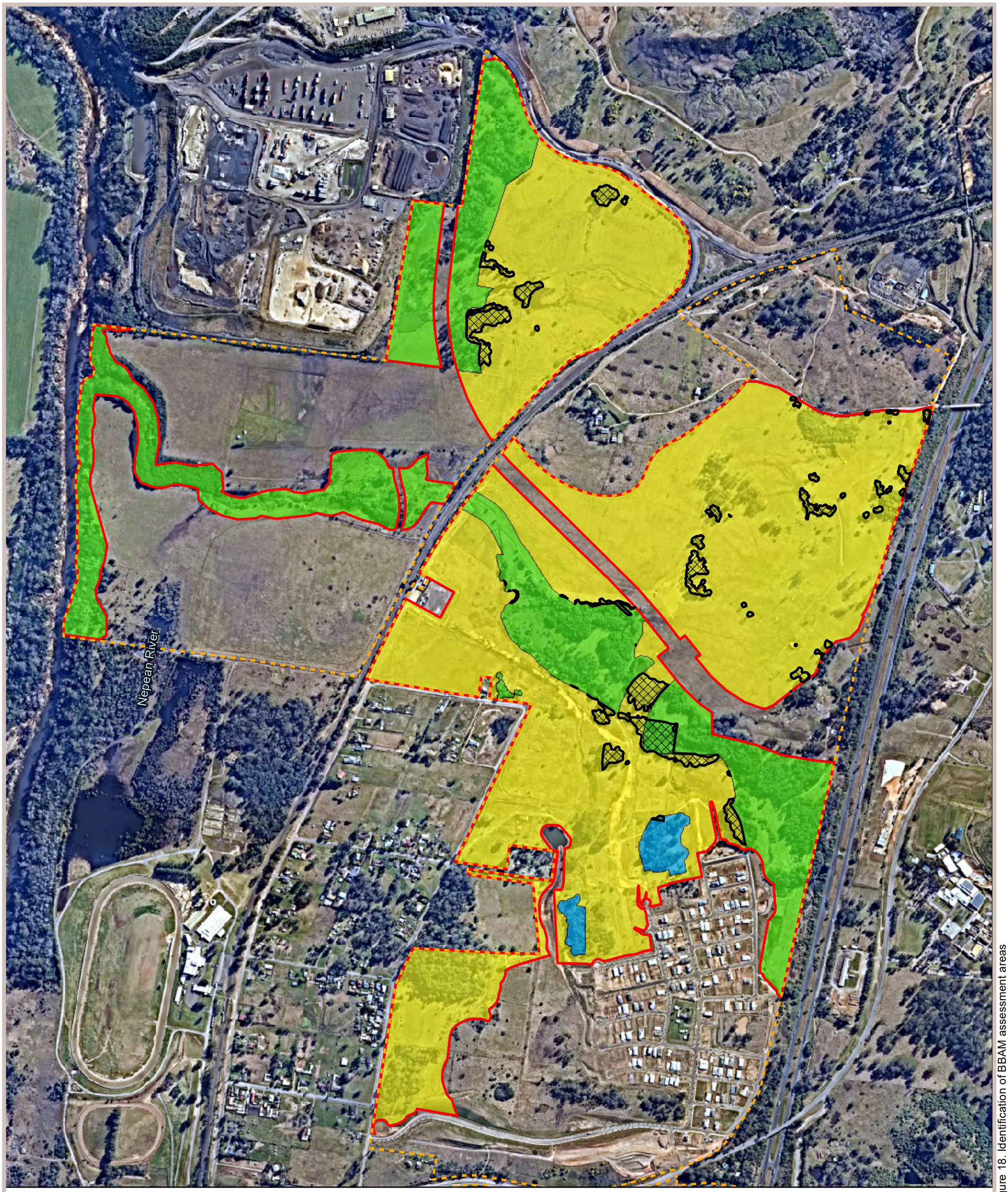


Figure 18. Identification of BBAM assessment areas

Legend

Impact

Assessment Circles

Inner (200 ha)

Outer (2,000 ha)

Species Polygon

Southern Myotis

Native Vegetation

Vegetation Community

Shale Plains Woodland

Shale Plains Woodland Derived Native Grassland

Shale Hills Woodland

Shale Hills Woodland Shrubby Regrowth

Shale Hills Woodland Derived Native Grassland

Elderslie Banksia Scrub Forest

Elderslie Banksia Scrub Forest (Non-TEC)

River Flat Eucalypt Forest

River-flat Eucalypt Forest Derived Native Grassland

River Oak Riparian Woodland

Swamp Oak Floodplain Forest

Freshwater Wetlands

Privet Dominated Exotic Woody Vegetation

African Olive Dominated Exotic Woody Vegetation

Other Exotic Dominated Woody Vegetation

Dam

Exotic Grassland/Cleared Land

Coordinate System: MGA Zone 56 (GDA 94)

Image Source:
Image © NearMap (2022)
Dated 23/08/2022

Data Source:
OEH (2013). Remnant Vegetation of the western Cumberland subregion, 2013 Update. Office of Environment and Heritage, NSW

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I:\...\17072\Figures\RP37\20240529\Figure 19. BBAM impact assessment

Figure 19. BBAM impact assessment

0 100 200 300 400 m

Legend

- Subject Site
- Subject Land
- BBAM Offset Area - Howes Creek and Northern Conservation Area
- Parks K and L Conservation

Assessment Circles Offset

- Inner (200 ha)
- Outer (2,000 ha)

Existing Vegetation

- Elderslie Banksia Scrub Forest
- Freshwater Wetlands
- River Flat Eucalypt Forest
- River Oak Riparian Woodland
- Shale Plains Woodland
- Shale Plains Woodland Derived Native Grassland
- Swamp Oak Floodplain Forest

Proposed Revegetation

- Elderslie Banksia Scrub Forest
- Freshwater Wetlands
- River Flat Eucalypt Forest
- Shale Plains Woodland
- Swamp Oak Floodplain Forest

Coordinate System: MGA Zone 56 (GDA 94)

Image Source:
Image © Nearmap (2022)
Dated: 23/08/2022

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0 100 200 300 400 m

I:\...\17072\Figures\RP37\20240529\Figure 20. BBAM Offset Assessment

Figure 20. BBAM Offset Assessment

SIS to be inserted as a pdf.

APPENDIX C :

Supplementary Flora Surveys of Patch C15, C19 and C 32

GPS # 20

Date: 27/2/2025	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM	Plot ID: P C15	Start:	01	292838	224502	
Photos: 3830-3833	Orientation (°): 90	End:	02	292885	224498	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher	
1	Grevillea roberta	15	1					
2	Melaleuca linariifolia	5	1					
3	Cupressus lusitanica	10	1					
4	Ligostrum lucidum	10	3					
5	Quercus robur	10	1					
6	Brachychiton populneus	3	1					
7	Angophora subvelutina	2	1					
8	Brachychiton acerifolius	7	1					
9	Ailanthus altissima	40	200					
10	(Ailanthus altissima SC)	10	2			SC		*
11	(Ailanthus altissima S)	30	198			S		
12	Ehrharta erecta	30	1500					
13	Eragrostis curvula	10	500					
14	Cestrum parqui	2	80					
15	Microlaena stipoides v. stipoides	10	500					
16	Solanum sisymbriifolium	0.4	10					
17	Heliotropium amplexicaule	0.2	20					
18	Celtis occidentalis	1	1					
19	Commelina cyanea	0.6	30					
20	Axonopus fissifolius	1	50					
21	Melia azedarach	0.1	2					
22	Asparagus asparagoides	0.1	5					
23	Oplismenus aemulus	1	50					
24	Cynodon dactylon	5	250					
25	Dysphania pumilio	0.1	10					
26	Hypochaeris radicata	0.1	5					
27	Einadia nutans ssp. nutans	0.2	20					
28	Brunoniella australis	0.1	1					
29	Tetragonia tetragonioides	0.1	5					
30	Einadia trigonos	0.6	30					
31	Solanum nigrum	0.1	5					
32	Verbena rigida	0.1	2					
33	Gamochaeta pensylvanica	0.1	10					
34	Oxalis corniculata	0.2	20					
35	Stellaria media	0.1	10					
36	Sida rhombifolia	0.1	5					
37	Modiola caroliniana	0.1	10					
38	Senecio madagascariensis	0.1	2					
39	Setaria parviflora	0.2	10					
40	Oxalis purpurea	0.1	1					

Only for BBAM

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

* Only use marked repeats for BBAM composition, exclude from BAM

GPS # 28

Date: 27/02/2025	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM, __	Plot ID: P C19	Start:	03	293689	225059	
Photos: 3845-3848	Orientation (°): 180	End:	04	293671	225017	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: 1 of 2

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher
1	Eucalyptus tereticornis	35	11				
2	Olea europaea ssp. cuspidata	20	15				
3	Bothriochloa macra	5	250				
4	Sporobolus creber	3	150				
5	Aristida ramosa	1	50				
6	Brunoniella australis	0.1	10				
7	Paspalum dilatatum	1	50				
8	Sida rhombifolia	0.4	20				
9	Cenchrus clandestinus	10	500				
10	Cyperus gracilis	0.4	40				
11	Eragrostis leptostachya	1	50				
12	Grona varians	0.4	40				
13	Cynodon dactylon	20	1000				
14	Apium graveolens	0.1	10				
15	Atriplex prostrata	0.6	60				
16	Plantago lanceolata	0.4	40				
17	Microlaena stipoides v. stipoides	5	250				
18	Alternanthera nana	0.2	20				
19	Sida corrugata	0.1	10				
20	Dichondra repens	0.4	40				
21	Senecio madagascariensis	0.2	20				
22	Paronychia brasiliana	0.2	20				
23	Glycine tabacina	0.2	10				
24	Cirsium vulgare	0.2	5				
25	Rytidosperma racemosum	3	150				
26	Setaria parviflora	2	100				
27	Einadia nutans ssp. nutans	0.2	10				
28	Lagenophora stipitata	0.1	10				
29	Carex inversa	0.2	20				
30	Euchiton sphaericus	0.1	5				
31	Scaevola albida v. pallida	0.1	2				
32	Richardia stellaris	0.1	5				
33	Eucalyptus moluccana	15	4				
34	Eucalyptus moluccana C	14	2			C	*
35	Eucalyptus moluccana S	0.1	2			S	
36	Eucalyptus tereticornis C	32	4			C	*
37	Eucalyptus tereticornis S	0.2	6			S	
38	Bidens pilosa	0.1	5				
39	Asparagus asparagoides	0.2	10				
40	Phytolacca octandra	0.1	5				

Only for BBAM

Only for BBAM

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

* Only use marked repeats for BBAM composition, exclude from BAM

Date: __/__/_____	Project #: _____	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: ___,___,___	Plot ID: P C19 (cont)	Start:	_____	_____	_____	
Photos: _____-_____	Orientation (°): ____	End:	_____	_____	_____	
Dimensions: □20x20, □10x40	PCT:					Sheet: 2 of 2

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher	
1	Triglochin striata	0.6	60					
2	Alisma plantago-aquatica	0.1	5					
3	Samolus valerandi	0.1	10					
4	Lycium ferocissimum	0.6	5					
5	Asparagus officinalis	0.1	5					
6	Nasturtium officinale	0.2	20					
7	Typha orientalis	0.1	2					
8	Eleocharis sphacelata	0.2	10					
9	Paspalum distichum	0.4	20					
10	Bursaria spinosa	0.4	5					
11	~~Einadia~~ nutans ssp. linifolia	0.1	5					
12								
13	Eucalyptus tereticornis SC	2	1			SC		*
14	Eragrostis cervela	1	100					
15	Verbena brasiliensis	0.1	5					
16	Ehrharta erecta	0.4	20					
17								
18								
19								
20								
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28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

Only for BBAM

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count)**: 1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

* Only use marked repeats for BBAM composition, exclude from BAM

GPS #20

Date: 27/2/2025	Project #: 17072	Location	Waypoint	Easting	Northing	cumberland ecology
Personnel: RM,__,__	Plot ID: P C32	Start:	05	293921	225523	
Photos: 3858-3864	Orientation (°): 20	End:	06	293930	225573	
Dimensions: ☑20x20, ☐10x40	PCT:					Sheet: 1 of 1

	Species	Cover	Abundance	N, E, HTE	GF Group	Stratum	Voucher	
1	Eucalyptus Moluccana	30	3					
2	Olea europaea ssp. cuspidata	70	100					
3	Asparagus asparagoides	0.4	20					
4	Ligustrum sinense	0.2	10					
5	Ehrharta erecta	2	100					
6	Dichondra repens	0.4	40					
7	Cyperus gracilis	2	200					
8	Olea europaea ssp. cuspidata	60	40			SC		*
9	Olea europaea ssp. cuspidata	10	60			S		
10	Microlaena stipoides v. stipoides	0.4	20					
11	Sida rhombifolia	0.4	20					
12	Chloris truncata	0.2	10					
13	Setaria parviflora	0.6	30					
14	Lycium ferocissimum	0.6	10					
15	Oxalis perennans	0.2	20					
16	Solanum prinophyllum	0.6	20					
17	Sida corrugata	0.1	5					
18	Brachychiton populneus	0.2	1					
19	Ligustrum lucidum	0.1	5					
20	Eragrostis cervela	2	100					
21	Cynodon dactylon	1	50					
22	Solanum radicans	0.2	10					
23	Phytolacca octandra	0.1	5					
24	Conyza sumatrensis	0.1	5					
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

BBAM only

Cover (%): **0.1, 0.2, 0.3**...etc. up to **1, 2, 3**...etc. up to **10, 15, 20, 25**...etc. up to **100**	**GF Group: TG**=Tree, **SG**=Shrub, **GG**=Grass, **FG**=Forb, **EG**=Fern, **OG**=Other
Abundance (Count): **1, 2, 3**... up to **10, 20, 30**...up to **100, 200**... up to **1,000**...etc.	**Stratum: C** = Canopy, **SC** = Sub-canopy, **S** = Shrub, **G** = Ground

Cover Note: *0.1% = approx 63 cm² or circle with 71cm diameter, 0.5% = approx 1.4m², 1% = approx 2m², 5% = approx 4.5m², 25% = approx 10m²*

* Only use marked repeats for BBAM composition, exclude from BAM

APPENDIX D :
EBSF Monitoring Report

17 August 2021

Jacob Newton
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NSW Australia
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Menangle Park EBSF Quarterly Monitoring Report – July 2021

Dear Jacob,

The purpose of this letter is to present the findings of the July 2021 monitoring of the retained threatened ecological community Elderslie Banksia Scrub Forest (EBSF) located adjacent to the approved Stage 2A development at Menangle Park (292/2018/DA-SW) (the 'project').

The methodology and results of the initial baseline data collection in January 2021 as well as the first two monitoring sessions in April and July 2021 are provided in **Appendix A** of this letter.

The results indicate that the project has not negatively impacted on the retained EBSF being monitored and no recommendations are made at this point in time.

Yours sincerely,

Mikael Peck
Senior Project Manager/ Ecologist
Mikael.peck@cumberlandecology.com.au

APPENDIX A :
EBSF Monitoring Results

A.1. Background

Cumberland Ecology was commissioned by Dahua Group (the 'proponent') to prepare an Elderslie Banksia Scrub Forest Monitoring Plan (EBSFMP) (ref. 17072RP19) for lands within Menangle Park, NSW (hereafter referred to as the 'EBSFMP Area'). The EBSFMP Area comprises areas of retained Elderslie Banksia Scrub Forest (EBSF) located adjacent to the approved Stage 2A development at Menangle Park (292/2018/DA-SW) (the 'project').

The requirement for a monitoring plan for EBSF was included in the Conditions of Consent issued by Campbelltown City Council (Council) for the approved Development Application (DA) for the project (Condition 10). An EBSFMP was subsequently prepared by Cumberland Ecology and approved by Council.

The EBSFMP requires quadrat surveys of flora and photo monitoring, as well as recording general observations on a quarterly basis for the duration of the project (i.e. until construction is completed). The full details of the monitoring required are provided within the EBSFMP. Initial baseline data was collected in the EBSFMP in late January 2021, and two subsequent monitoring surveys were conducted in April and July 2021.

A.2. Purpose

The purpose of this letter is to present and compare the findings of the July 2021 monitoring session with those of the April 2021 monitoring session and with the baseline data collected in late January 2021 in the EBSFMP Area. The purpose of the monitoring is to determine if the project is having a negative impact on areas of retained EBSF in the EBSFMP Area. It is anticipated that this letter will be provided to Council as evidence that the monitoring identified in the EBSFMP has been carried out in order to meet Condition 10 of the conditions of consent.

A.3. Methodology

Monitoring was conducted in the EBSFMP Area and in a control site to the north-east in accordance with the EBSFMP. This included the three following components which are detailed below:

- Flora quadrats;
- Photographs; and
- General observations.

A.3.1. Flora Quadrats

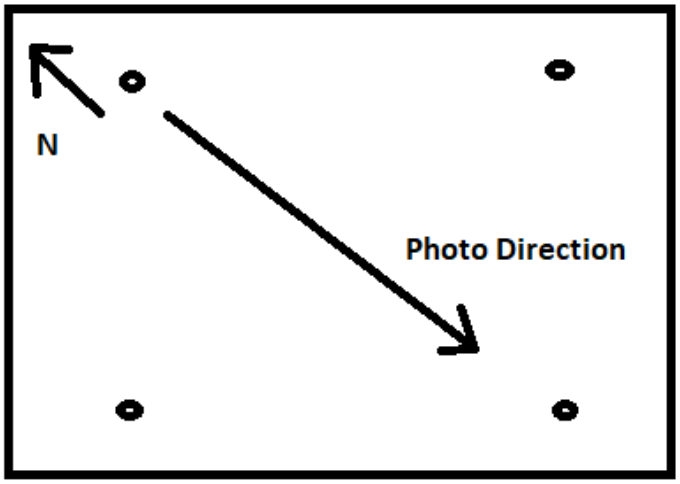
In late January 2021, flora quadrats were established in the EBSFMP Area in both patches of EBSF in Park L (i.e. park directly adjacent to the project) and in the control site to the northeast in order to document the biodiversity present and monitor any changes over time (see **Figure 1** for monitoring locations). A total of three quadrats were established, one in each of the patches of EBSF in Park L and one in the control site to the northeast in Park K. In each patch of EBSF monitored (three total), one (1) 10 m x 10 m flora quadrat was established and all flora were recorded and their cover abundance noted. Baseline data collection was conducted in January 2021, and the first and second monitoring sessions were conducted in April and July 2021, respectively. Within each monitoring flora quadrat the following was recorded:

- All native and exotic species present; and
- Percentage coverage of each species recorded; and
- Percentage coverage of exotic and native species.

A.3.2. Photograph Monitoring

During the baseline data collection (January 2021), and first and second monitoring sessions (April and July 2021), photograph monitoring was undertaken within each of the three (3) 10 m x 10 m flora quadrats established in the EBSFMP Area, as described above. This includes one photograph monitoring site in each of the two patches of EBSF within Park L and one in the control site in Park K. Within each quadrat, the northern corner was designated as the photograph monitoring point and photographs were taken from this point facing diagonally across the quadrat towards the south (see **Diagram 1**). A star picket was installed at the photograph monitoring point during the baseline data collection (January 2021) to ensure consistency between photographs for the purpose of making comparisons.

Diagram 1 Photograph direction



The photographs taken within each quadrat during each monitoring event were compared in order to identify any evidence of change in condition over time.

A.3.3. General Observations

During the baseline data collection (January 2021), and first and second monitoring sessions in April and July 2021, general observations were made regarding the general health of the EBSF and implementation of impact mitigation measures, including such details as the following:

- Evidence of failures in sediment control measures;
- Evidence of damaged vegetation or unauthorised access into area; and

- Notes and photographs regarding the condition of vegetation on the perimeter of extant areas of EBSF as these are the most likely to be impacted by the project.

A.4. Results

The results of the baseline data collection (January 2021), and first (April 2021) and second (July 2021) monitoring sessions are presented below.

A.4.1. Flora Quadrats

Table 1 below includes a summary of the results of the data collected within each of the three flora quadrats established over the three monitoring periods. **Appendix B** includes the details of all flora quadrat data collected. As indicated in **Table 1**, no observable significant changes to the vegetation within the monitoring locations have occurred across the two monitoring periods. Slight increases and decreases to native and exotic species richness have occurred, but these differences are considered to be minor and are likely a result of seasonal environmental conditions and not the project.

Table 1 Summary of floristic data collected across monitoring sessions

	Plot 1 (Park L)			Plot 2 (Park L)			Plot 3 (Park K - Control Site)		
	21 Jan. 2021	23 April 2021	26 July 2021	21 Jan. 2021	23 April 2021	26 July 2021	21 Jan. 2021	23 April 2021	26 July 2021
Total # of Species	19	20	17	19	16	20	26	24	21
Total # Natives	8	9	9	10	9	10	9	9	7
Total # Exotics	11	11	8	9	7	10	17	15	14
Total # High Threat Weeds	4	4	3	3	4	4	5	5	4

A.4.2. Photograph Monitoring

Table 2 below includes the photographs taken at each photo monitoring point within each of the three flora quadrats established over the three monitoring periods. No significant changes in vegetation are evident between photographs with only minor visual differences resulting from shadowing due to different light conditions.

Table 2 Photograph monitoring across monitoring sessions

		
Plot 1 – January 2021	**Plot 1 – April 2021**	**Plot 1 – July 2021**
		
Plot 2 – January 2021	**Plot 2 – April 2021**	**Plot 2 – July 2021**
		
Plot 3 – January 2021	**Plot 3 – April 2021**	**Plot 3 – July 2021**

A.4.3. General Observations

No significant changes to the vegetation being monitored was observed across the monitoring sessions. There was no evidence of sedimentation from the project into retained areas or evidence of unauthorised access into the areas.

Regrowth *Banksia integrifolia* (Coast Banksia) was observed for the first time in areas outside of mapped areas of EBSF within Park L. Areas of regrowth individuals were recorded to the south of Plot 1 (~10 individuals) and to the west of Plot 2 (~15 individuals). The individuals are within a few metres of the dripline of existing canopy individuals. **Photographs 1** and **2** below show examples of the regrowth individuals recorded.

Photograph 1 Banksia integrifolia regrowth south of Plot 1



Photograph 2 Banksia integrifolia regrowth west of Plot 2



A.5. Conclusion

Based on a comparison of the results of the three monitoring sessions undertaken to date (i.e. baseline data collection in January 2021, and first and second monitoring session in April and July 2021, respectively), there are no observable significant changes to areas of EBSF within Parks K or L. Minor changes to vegetation composition were recorded; however these minor variations are not considered to be a result of the project, but rather environmental conditions, primarily seasonality of the surveys. The monitoring photographs show that the vegetation condition appears relatively unchanged and all mitigation measures implemented as part of the project's approval (e.g. exclusion fencing, sediment controls) appear to be well maintained and working as no unauthorised access is evident or sedimentation/runoff from the adjoining development. Further to this, the presence of regrowth *Banksia integrifolia* within areas not previously recorded also indicates that the mitigation measures implemented are working to protect retained vegetation.

APPENDIX B :
Flora Quadrat Data

Table 3 Flora quadrat data collected across monitoring sessions

				Quadrat ID	Plot 1 (Park L)						Plot 2 (Park L)						Plot 3 (Park K)					
				Date	21/01/2021		23/04/2021		27/07/2021		21/01/2021		23/04/2021		27/07/2021		21/01/2021		23/04/2021		27/07/2021	
Scientific Name	**Common Name**		**Exotic**	**HTW**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**
Angophora subvelutina	Broad-leaved Apple																30.0	2	60.0	2	80.0	2
Banksia integrifolia	Coast Banksia				25.0	15	30.0	14	40.0	10	35.0	20	40.0	50	50.0	40						
Brachychiton populneus	Kurrajong												0.1	1	0.1	1						
Cayratia clematidea	Native Grape														0.1	5	0.1	20	0.1	1	0.1	3
Commelina cyanea	Native Wandering Jew				0.2	30	10.0	300	5.0	100	0.2	30	0.5	50	0.2	30						
Cynodon dactylon	Common Couch														0.5	100	5.0	1,000	5.0	100	0.1	50
Cyperus gracilis	Slender Flat-sedge				0.1	1	0.1	10	0.5	70			0.1	10								
Cyperus imbecillis							2.0	10	0.2	30	30.0	150	0.1	10	1.0	20						
Dichondra repens	Kidney Weed										0.5	10							0.2	30		
Duboisia myoporoides	Corkwood				5.0	10	25.0	10	25.0	20	15.0	30	10.0	10	15.0	20	10.0	5	15.0	25	5.0	10
Einadia trigonos	Fishweed																5.0	200	0.5	20	0.1	10
Entolasia marginata	Bordered Panic								0.5	40	0.1	100										
Imperata cylindrica	Blady Grass				1.0	50	0.1	15	0.2	20			0.5	30								
Melia azedarach	White Cedar				10.0	10	5.0	5	0.5	10					0.2	5	1.0	10				
Microlaena stipoides	Weeping Grass				20.0	1,000	20.0				25.0	500	50.0	1,000	5.0	500	10.0	1,000	10.0	500		
Poranthera microphylla	Small Poranthera										0.1	1										
Pteridium esculentum	Bracken				15.0	200	20.0	120	15.0	240	15.0	60	35.0	150	25.0	180	15.0	120	30.0	100	20.0	60
Solanum prinophyllum	Forest Nightshade										0.1	1					0.1	10	0.1	10	0.1	10
Acetosella vulgaris	Sheep Sorrel	*	YES														0.1	50				
Araujia sericiflora	Moth Vine	*															0.1	10	0.5	20	0.1	5
Asparagus asparagoides	Bridal Creeper	*	YES		0.1	10	15.0	1,000	0.3	50	0.1	5	35.0	250	30.0	250	0.5	20	20.0	100	25.0	100
Bidens pilosa	Cobbler's Pegs	*	YES																0.5	20		
Bidens subalternans	Greater Beggar's Ticks	*															0.1	1	0.1	10		
Cirsium vulgare	Spear Thistle	*															0.1	1			0.1	2
Conyza bonariensis	Flaxleaf Fleabane	*			5.0	100	5.0	120	0.1	20	0.2	10	0.5	50	0.2	20	0.2	100	0.1	20	0.1	20

			Quadrat ID	Plot 1 (Park L)						Plot 2 (Park L)						Plot 3 (Park K)					
			Date	21/01/2021		23/04/2021		27/07/2021		21/01/2021		23/04/2021		27/07/2021		21/01/2021		23/04/2021		27/07/2021	
Scientific Name	**Common Name**	**Exotic**	**HTW**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**
Conyza sumatrensis	Tall fleabane	*				0.2	20														
Crassocephalum crepidioides	Thickhead	*														0.1	10				
Ehrharta erecta	Panic Veldtgrass	*	YES	0.2	250	0.5	250	60.0	2,000	10.0	300	30.0	1,000	15.0	2,000	2.0	200	25.0	800	45.0	1,200
Eragrostis curvula	African Lovegrass	*	YES	0.5	50	5.0	45	0.2	5			0.1	1			0.1	40	10.0	20	5.0	10
Heliotropium amplexicaule	Blue Heliotrope	*	YES	0.2	20							10.0	500	0.1	20	5.0	100	15.0	100	0.2	50
Hypochoeris radicata	Catsear	*		0.1	5																
Lactuca serriola	Prickly Lettuce	*		0.1	5																
Lantana camara	Lantana	*														0.2	2				
Lycium ferocissimum	African Boxthorn	*				0.5	1	0.1	5							0.1	1	0.1	1	0.2	5
Ochna serrulata	Mickey Mouse Plant	*	YES			20.0	1,500			0.2	5			0.2	10						
Olea europaea subsp. *cuspidata*	African Olive	*								0.5	10	5.0	10	5.0	10						
Oxalis corniculata	Creeping Oxalis	*														0.1	20	0.1	10		
Phoenix canariensis	Canary Island Date Palm	*								0.1	1			0.1	1						
Phytolacca octandra	Inkweed	*														0.1	1	0.1	5	0.1	5
Rumex acetosella	Sheep Sorrel	*				0.2	50													0.1	5
Senecio madagascariensis	Fireweed	*		0.1	10	0.1	5	0.1	10					0.1	10			0.1	5	0.1	5
Setaria parviflora		*								0.1	100					1.0	800	0.2	100	0.1	5
Sida rhombifolia	Paddy's Lucerne	*		0.2	20	3.0	30	0.8	200	15.0	100	10.0	300	10.0	1,000	0.2	30	2.0	50	0.3	100
Solanum nigrum	Black-berry Nightshade	*		0.1	5	1.0	5	0.1	5	0.1	1					0.1	5	0.1	10	0.2	20
Verbascum virgatum	Twiggy Mullein	*		0.1	5									0.1	5						
	Total # Species			**19**		**20**		**17**		**19**		**16**		**20**		**26**		**24**		**21**	
	Total # Natives			**8**		**9**		**9**		**10**		**9**		**10**		**9**		**9**		**7**	
	Total # Exotics			**11**		**11**		**8**		**9**		**7**		**10**		**17**		**15**		**14**	
	Total # HTW			**4**		**4**		**3**		**3**		**4**		**4**		**5**		**5**		**4**	

HTW=high threat weed, C=cover, A=abundance

FIGURES

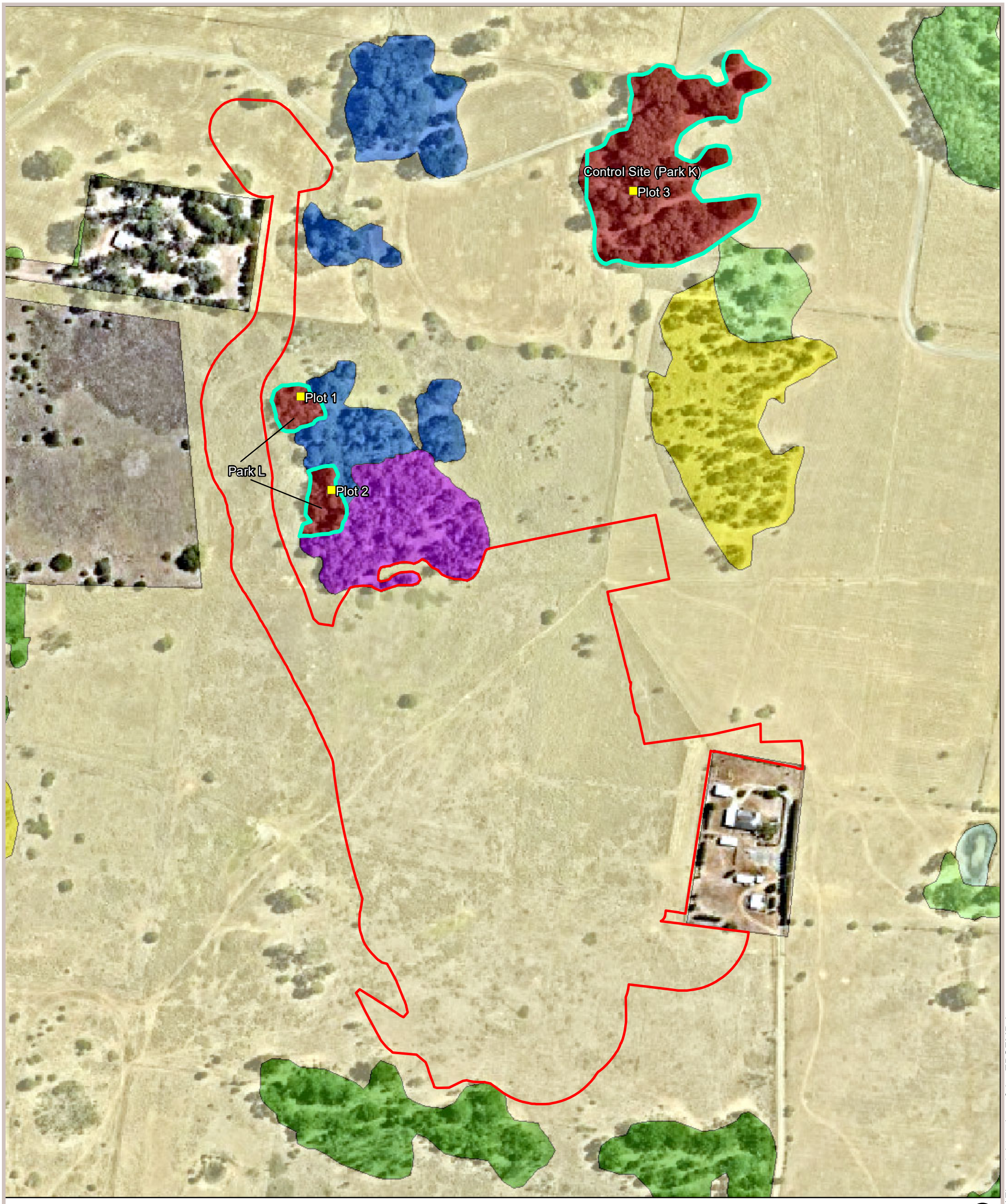


Figure 1. Location of the EBSFMP Area

APPENDIX E :

Menangle Park Site Wide Bulk Earthworks Development Consent Conditions

NOTICE OF DETERMINATION OF A DEVELOPMENT APPLICATION

Application number	3574/2019/DA-CW
Applicant	Urbis Level 8, 123 Pitt St, SYDNEY NSW 2000
Description of development	Bulk earthworks to regrade the site for future development, vegetation clearance, demolition of existing structures within the site, and environmental conservation measures across the Menangle Park Urban Release Area.
Property	Lot 1265 DP1269274 (Lot 1265 Menangle Road, Menangle Park), Lot 1000 DP1219023, Lot 12 DP251335, Lot 15 DP251335, Lot 17 DP251335, Lot 4 DP628052, Lot 2008 DP1234643 (Lot 9 Menangle Road, Menangle Park), Lot 2 DP554242, Lot 59 DP10718, Lot 41 DP1285744 (Lot 41 Menangle Rd, Menangle Park), Lot 44 DP1299204 (Pt Lot 44 Menangle Road, Menangle Park), Lot 1259 DP1269274 (Lot 1259 Menangle Road, Menangle Park), Lot D DP19853, Lot 2009 DP1234643, Lot 2010 DP1234643 (Lot D Menangle Road, Menangle Park), Lot 32 DP1105615 (Lot 32 Menangle Road, Menangle Park).
Determination	Approved Consent Authority • Campbelltown Local Planning Panel
Date of determination	23 October 2024
Date from which the consent operates	23 October 2024
Date on which the consent lapses	23 October 2029
Approval bodies that have given general terms of approval	• Subsidence Advisory NSW • Heritage NSW • Water NSW • The Department of Climate Change, Energy, the Environment and Water – Biodiversity, Conservation and Science

Under section 4.18(1) of the EP&A Act, notice is given that the above development application has been determined by the granting of consent using the power in section 4.16(1)(a) of the EP&A Act, subject to the conditions specified in this notice.

Reasons for approval
Council has made its decision after considering:

- the application's consistency with planning objectives and controls
- the views of the community where submissions were made and
- the impacts that the approved development may have on the environment

Right of appeal / request a review of the determination
If you are dissatisfied with this determination:

Request a review
You may request a review of the consent authority's decision under section 8.3(1) of the EP&A Act. The application must be made to the consent authority within 6 months from the date that you received the original determination notice provided that an appeal under section 8.7 of the EP&A Act has not been disposed of by the Court.

Rights to appeal
You have a right under section 8.7 of the EP&A Act to appeal to the Court within 6 months after the date on which the determination appealed against is notified or registered on the NSW planning portal.

The Dictionary at the end of this consent defines words and expressions for the purposes of this determination.



Kristy Griffiths
Coordinator Development Assessment

For further information, please contact Aaron Essenhigh - 02 4645 4000

Terms and Reasons for Conditions
Under section 88(1)(c) of the EP&A Regulation, the consent authority must provide the terms of all conditions and reasons for imposing the conditions other than the conditions prescribed under section 4.17(11) of the EP&A Act. The terms of the conditions and reasons are set out below.

GENERAL CONDITIONS

1. Approved development

The development shall be carried out in accordance with the approved plans and documents listed in the table below, and all associated documentation supporting this consent, except as modified in red by Council and/or any conditions within.

Plan Detail	Prepared by	Date
Locality Plan (ref: 300178115.31.DA001, rev. 08)	SMEC	--
Sheet Schedule & Notes (ref: 300178115.31.DA002, rev. 08)	SMEC	30/05/2024
Demolition & Tree Removal Plan Sheet 1 (ref: 300178115.31.DA011, rev. 08)	SMEC	30/05/2024
Demolition & Tree Removal Plan Sheet 3 (ref: 300178115.31.DA013, rev. 08)	SMEC	30/05/2024
Demolition & Tree Removal Plan Sheet 4 (ref: 300178115.31.DA014, rev. 08)	SMEC	30/05/2024
Demolition & Tree Removal Plan Sheet 5 (ref: 300178115.31.DA015, rev. 04)	SMEC	30/05/2024
General Arrangement Plan (ref: 300178115.31.DA031, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 6 (ref: 300178115.31.DA106, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 7 (ref: 300178115.31.DA107, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 8 (ref: 300178115.31.DA108, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 9 (ref: 300178115.31.DA109, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 10 (ref: 300178115.31.DA110, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 11 (ref: 300178115.31.DA111, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 12 (ref: 300178115.31.DA112, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 13 (ref: 300178115.31.DA113. rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 14 (ref: 300178115.31.DA114, rev. 08)	SMEC	30/05/2024
Site Works Plan Sheet 15 (ref: 300178115.31.DA115, rev. 08)	SMEC	30/05/2024
Section Plan (ref: 300178115.31.DA241, rev. 08)	SMEC	30/05/2024
Sections A, B, C & D (ref: 300178115.31.DA251, rev. 08)	SMEC	30/05/2024
Section E (ref: 300178115.31.DA.252, rev. 08)	SMEC	30/05/2024
Section F (ref: 300178115.31.DA253, rev. 08)	SMEC	30/05/2024
Section G Sheet 1 (ref: 300178115.31.DA254, rev. 08)	SMEC	30/05/2024
Section G Sheet 2 (ref: 300178115.31.DA255, rev. 08)	SMEC	30/05/2024

	Section H Sheet 1 (ref: 300178115.31.DA256, rev. 08)	SMEC	30/05/2024
	Section H Sheet 2 (ref: 300178115.31.DA257, rev. 08)	SMEC	30/05/2024
	Section H Sheet 3 (ref: 300178115.31.DA258, rev. 08)	SMEC	30/05/2024
	Section I (ref: 300178115.31.DA259, rev. 08)	SMEC	30/05/2024
	Section J (ref: 300178115.31.DA260, rev. 08)	SMEC	30/05/2024
	Soil & Water / Catchment Management Plan Sheet 1 (ref: 300178115.31.DA851, rev. 08)	SMEC	30/05/2024
	Soil & Water / Catchment Management Plan Sheet 3 (ref: 300178115.31.DA853, rev. 08)	SMEC	30/05/2024
	Soil & Water / Catchment Management Plan Sheet 4 (ref: 300178115.31.DA854, rev. 08)	SMEC	30/05/2024
	Soil & Water / Catchment Management Calculation (ref: 300178115.31.DA855, rev. 08)	SMEC	30/05/2024
	Soil & Water Management Details Sheet 1 (ref: 300178115.31.DA861, rev.08)	SMEC	30/05/2024
	Soil & Water Management Details Sheet 2 (ref: 300178115.31.DA862, rev. 08)	SMEC	30/05/2024

Associated Documentation

Species Impact Statement	Cumberland Ecology	30/07/2024
Vegetation Management Plan 1	Cumberland Ecology	31/07/2024
Vegetation Management Plan 2	Cumberland Ecology	31/07/2024
General Terms of Approval (ref: IDAS-2022-10481)	Water NSW	09/12/2022
General Terms of Approval (ref: DOC22/562953-19)	Heritage NSW	02/09/2022
General Terms of Approval (ref: TSUB22-00239)	Subsidence Advisory NSW	27/07/2022
Unexpected Finds Protocol	JBS&G	24/06/2024
Engineering Design Report	SMEC	30/07/2024
Letter of Offer	Dahua	23/09/2024

Condition reason: To ensure all parties are aware of the approved plans and supporting documentation that applies to the development.

2. **Staging**

The development may be undertaken on a standalone basis or such that the works are commensurate with future subdivision stages.

Condition reason: To allow flexibility in the delivery of the development.

3. **Subdivision Works Certificate**

Prior to any stage of the development involving works that require a subdivision works certificate:

- the applicant shall appoint a Principal Certifier;
- the applicant shall obtain a subdivision works certificate for the particular works; and
- when Council is not the Principal Certifier, the appointed Principal Certifier shall notify Council of their appointment no less than two days prior to the commencement of any works.

	Condition reason: To comply with legislation.
4.	**Heritage NSW Conditions** The development shall be carried out in accordance with the General Terms of Approval (DOC22/562953-19) dated 2 September 2022. *Condition reason: To ensure compliance with the relevant General Terms of Approval.*
5.	**Subsidence Advisory NSW Conditions** The development shall be carried out in accordance with the General Terms of Approval (TSUB22-00239) dated 27 July 2022. *Condition reason: To ensure compliance with the relevant General Terms of Approval.*
6.	**Water NSW Conditions** The development shall be carried out in accordance with the General Terms of Approval (IDAS-2022-10481) dated 9 December 2022. *Condition reason: To ensure compliance with the relevant General Terms of Approval.*
7.	**Department of Climate Change, Energy, the Environment and Water Conditions** The development shall be carried out in accordance with the concurrence conditions (DOC24/687576) issued by Biodiversity, Conservation & Science – Department of Climate Change, Energy, the Environment and Water (DCCEEW): 1. The clause(s) in the Voluntary Planning Agreement that require the in-perpetuity management of conservation areas under a Vegetation Management Plan, cannot be revoked without the agreement of the DCCEEW. 2. Any temporary stormwater outlets constructed for each successive stage of the development are not to be directed towards the conservation areas. 3. Prior to commencement of any on-ground works, propagation material is to be collected from remnant Elderslie Banksia Scrub Forest to be cleared, and used for rehabilitation and regeneration purposes, on the advice of the Australian Botanic Gardens, Mt Annan. *Condition reason: To ensure compliance with the relevant concurrence conditions.*
8.	**Australian Rail Track Corporation (ARTC) Conditions** a. A 1.8m palisade fence (or similar) is to be erected to prevent access along the rail corridor adjoining the development site(s). The construction of corridor fencing and/or noise walls along the rail corridor boundary is considered an activity within the rail corridor and the requirements of working within the rail corridor apply. b. The flow of stormwater toward the rail corridor must not be increased by the proposed development. c. Should excavation exceeding 2m be proposed within 25m of the track, the development will require additional review and further details provided to ARTC. d. Cut and fill activities adjacent to the rail corridor boundary will require a Third Party Works application to be made. e. The applicant is to consult with ARTC if works involve the use of cranes that have the potential to affect the rail corridor, or involve any access onto ARTC's land or air space. For these works, a Third Party Access application needs to be submitted to ARTC. *Condition reason: To minimise the impact of the development on the adjoining rail corridor.*

9.	**Endeavour Energy Conditions** a. Although not held under easement, overhead power lines are regarded as protected works under Section 53 'Protection of certain electricity works' of the *Electricity Supply Act 1995* (NSW) and may be managed as if an easement is in place. b. Any works within the notional easement (4.5m to bother sides of the centreline of the overhead power lines) must be approved by Endeavour Energy's Easements Officers via Head Office enquiries on business days from 9am - 4:30pm on telephone: 133 718 or (02) 9853 6666 or alternatively contact can be made by email Easements@endeavourenergy.com.au. *Condition reason: To ensure the development does not have an adverse impact on electricity infrastructure.*
10.	**Transport for NSW Conditions** a. The developer is to submit design drawings and documents relating to the excavation of the site and support structures, to TfNSW for assessment, in accordance with Technical Direction GTD2012/001. All documentation to be submitted at least six (6) weeks prior to commencement of construction and the developer to incur full cost of the assessment by TfNSW. Documents to be submitted via development.sydney@transport.nsw.gov.au. Should excavation occur below the level of the base of adjoining roadway footings, the person acting on the consent should ensure at least seven (7) days' notice for the intention to excavate below the base of the footings be provided to roadway owner(s). Notice to include complete details of the work. b. The subject property abuts a Declared Freeway (Hume Highway) and access is denied across this boundary. c. Any new building or structures, together with any improvements integral to the future use of the site, are to be erected clear of the land required for road (unlimited in height or depth), and the Hume Motorway and Menangle Road boundaries. d. Detailed design plans and hydraulic calculations of any changes to the stormwater drainage system are to be submitted to TfNSW for approval, prior to commencement of any works. Details should be forwarded to development.sydney@rms.nsw.gov.au. A plan checking fee will be payable and a performance bond may be required before TfNSW approval is issued. e. All demolition and construction vehicles are to be contained wholly within the site and vehicles must enter the site before stopping. A construction zone will not be permitted on the Hume Highway or Menangle Road. f. A Road Occupancy Licence should be obtained from Transport Management Centre for any works that may impact on traffic flows on Menangle Road during excavation/construction activities. g. All excavation/construction vehicles are to be contained wholly within the site and vehicles must enter the site before stopping. h. The swept path of the longest vehicle entering and exiting the subject site, as well as manoeuvrability through the site, shall be in accordance with AUSTROADS. *Condition reason: To ensure the development does not have an adverse impact on State roads.*
11.	**Engineering Design Works**

	The design of all engineering works shall be carried out in accordance with the requirements detailed in Council's Specification for Construction of Subdivisional Road and Drainage Works (as amended), Engineering Design for Development Guide (as amended) and the applicable Development Control Plan. *Condition reason: To comply with Council requirements for engineering works.*
12.	**Weed Management** Weed dispersion must be minimised and weed infestations must be managed at all stages of the development. Any priority or environmentally invasive weed infestations that occur during or after works must be fully suppressed and destroyed by appropriate means. New infestations of priority weeds listed for Greater Sydney must be reported to Council. Pursuant to the Biosecurity Act 2015 and the Biosecurity Regulation 2017, the applicant must at all times ensure that machinery, vehicles and other equipment entering or leaving the site are clean and free of priority weed material to prevent the spread of weeds to and from the development site. Weed control activities are to be undertaken in accordance with the Greater Sydney Regional Strategic Weed Management Plan 2023 – 2027; and as set out in section 7.2.1.1 (viii) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024 and Vegetation Management Plans 1 and 2 by Cumberland Ecology dated 31 July 2024. *Condition reason: To ensure weeds are controlled and managed appropriately.*
13.	**Hydrology Management** Hydrology management of the site is required due to the groundwater dependent ecosystems being conserved on site; the monitoring of groundwater is to be ongoing as per section 7.2.1.1(v) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. An annual report on groundwater monitoring is to be provided to Council's Manager Development Assessment (or equivalent), with regards to groundwater monitoring (charge and discharge) and any effects on the groundwater dependent ecosystems conserved on site. The report is to include an analysis of: • pH, Total Nitrogen, Total Phosphate, Biological Oxygen Demand, EC, Calcium, Magnesium, Potassium, Sodium, Sulphate (as so_4), Hardness (as $CaCO_3$) and Chloride. • The above analytes are to be set out in a table in the report as below, and the exceedance(s) is to be compared to the current ANZECC guidelines. | | Analyte | | | | | | | | | | | | Exceedance | | Groundwater borehole No. | pH | Total N | Total P | BOD | EC | Ca | Mg | K | Na | SO_4 | $CaCo_3$ | Cl | | | | | | | | | | | | | | | | | *Condition reason: To ensure suitable groundwater monitoring is undertaken.*
14.	**Existing Easements** Changes to existing easements and their physical infrastructure shall not occur without the written approval of the authority benefitting from such.

	Condition reason: To ensure approval is obtained for any change to existing easements.
15.	**Shoring and adequacy of adjoining property** If the development referred to in this development consent involves an excavation that extends below the level of the base of the footings of a building on adjoining land, the person having the benefit of the development consent must at the person's own expense: 1. Protect and support the adjoining premises from possible damage from the excavation, and 2. Where necessary, underpin the adjoining premises to prevent any such damage. This condition does not apply if the person having the benefit of the development consent owns the adjoining land or the owner of the adjoining land has given consent in writing to that condition not applying. *Condition reason: Prescribed condition under Section 74 of the Environmental Planning and Assessment Regulation 2021.*

BEFORE ISSUE OF A CONSTRUCTION CERTIFICATE

16.	**Geotechnical Report** Prior to the issue of a subdivision works certificate, where proposed excavation and/or filling exceed 300mm in depth or where the subject site is identified as being filled land, a geotechnical report prepared by a NATA registered laboratory shall be prepared to the satisfaction of the Principal Certifier which indicates that the land will not be subject to subsidence, slip, slope failure or erosion.
17.	**Soil and Water Management Plan** Prior to the issue of a subdivision works certificate, a detailed soil and water management plan shall be prepared to the satisfaction of the Principal Certifier. *Condition reason: To ensure no sediments or substances other than rainwater enters the stormwater system and waterways.*
18.	**Construction Traffic Management Plans** Prior to the issue of a subdivision works certificate, a Construction Traffic Management Plan (CTMP) encompassing relevant stages of the development shall be prepared to the satisfaction of the Principal Certifier. Copies of the approved CTMP's shall be kept on site for the duration of the works in accordance with SafeWork NSW requirements and copies shall also be forwarded to Council for its records. *Condition reason: To ensure construction vehicles are managed appropriately.*
19.	**Work on Public Land** Prior to the issue of a subdivision works certificate, the applicant shall obtain written approval from Council for any proposed work on public land. Inspection of this work shall be undertaken by Council at the applicant's expense and a compliance certificate, approving the works, shall be obtained from Council, prior to the Principal Certifier issuing awarding practical completion. *Condition reason: To ensure the relevant approvals are obtained for works on public land.*

20.	**Telecommunications Infrastructure** If the development is likely to disturb or impact upon telecommunications infrastructure, written confirmation from the service provider that they have agreed to the proposed works must be submitted to the Principal Certifier prior to the issue of a subdivision works certificate. The arrangements and costs associated with any adjustment to telecommunications infrastructure shall be borne in full by the applicant/developer. *Condition reason: To ensure that the development does not impact any telecommunications infrastructure and that appropriate arrangements have been made for the approved development.*
21.	**Deposited Plan and 88B Instrument - Rights and Interests** Prior to the issue of a subdivision works certificate, the applicant must obtain written consent from the benefited lot(s), roads(s), bodies or Prescribed Authorities regarding any easements, profit à prendre, restriction or positive covenants registered on the land with respect to the approved development. *Condition reason: To ensure consent is obtained from all affected parties.*
22.	**Sydney Water** If relevant, prior to the issue of a subdivision works certificate, the approved plans must be submitted to Sydney Water via the Sydney Water Tap In service, to determine whether the development will affect any Sydney Water wastewater and water mains, stormwater drains and/or easements, and if any requirements need to be met. *Condition reason: To ensure the development does not adversely affect Sydney Water infrastructure and that appropriate arrangements have been made to connect to Sydney Water services, where required.*

BEFORE BUILDING WORK COMMENCES

23.	**Voluntary Planning Agreement – Council** In accordance with the Letter of Offer dated 23 September 2024 made by the developer to prepare a Planning Agreement in connection with this development application, a Planning Agreement pursuant to Section 7.4 of the *Environmental Planning and Assessment Act 1979* shall be prepared by the applicant and submitted to Council for public exhibition prior to the commencement of any works. The Planning Agreement shall articulate a commitment by the developer to complete all Development and Infrastructure Works, Dedications of Land and the provision of all necessary monetary contributions required in relation to development of the land. *Condition reason: To ensure a Planning Agreement is executed between Council and the Applicant.*
24.	**Biodiversity Offsetting Requirement** Prior to the carrying out of any works that could directly or indirectly impact the biodiversity values requiring offset, the applicant must retire biodiversity credits as specified in Tables 1 and 2 below, relative to each development stage. The credit obligation for each stage must correlate with the biodiversity impact of each stage, to

ensure the appropriate credits are retired prior to the impact occurring.

Table 1 - Ecosystem Credits

Plant Community	BBAM-Number (PCT BAM equivalent)	IBRA region	Credits Required
Shale Plains Woodland	HN528 (849, 3320)	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	152
Shale Hills Woodland	HN529 (850, 3319)	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	302
Elderslie Banksia Scrub Forest*	HN635* (774)	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. Or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	15

** Note: A reasonable equivalence assessment for a credit obligation issued under the repealed Threatened Species Conservation Act 1995 (NSW), is required for BBAM vegetation communities and their PCT equivalents, including HN635 (PCT 774), as this PCT does not exist as an Ecosystem Credit.*

Table 2 - Species Credits

Species	Offset Requirements (Like for Like) Spp	IBRA	Credits Required
Myotis macropus Southern Myotis	Myotis macropus Southern Myotis	Any in NSW	136

Evidence of ecosystem and species credit retirement (i.e., a credit retirement certificate or equivalent) from the Biodiversity Conservation Trust must be provided to Campbelltown City Council's Manager Development Assessment (or equivalent) prior to the carrying out of any development that could directly or indirectly impact the biodiversity values requiring offset.

Condition reason: To comply with legislation.

25. **Vegetation Management Plans**

a. A Vegetation Management Plan for the Stage 6 Conservation area (VMP 3) is to be prepared and submitted to Council for written approval by Council's Manger Development Assessment (or equivalent) prior to the commencement of any on ground works.
b. The VMP's numbered 1, 2 and 3 are to include the Nest Box Plan within the documents.
c. VMP's 2 and 3 are to include the seed collection and propagation plan for the Elderslie Banksia Scrub Forest (EBSF) within the documents, and include species associated with EBSF, including *Duboisia myoripoides – Corkwood,* as a species within the revegetation zones for these VMP's.
d. The BAM plots to be undertaken for the length of time that is stated within the VMP's are to be within the EBSF restoration and revegetation / rehabilitation

	areas. These BAM plots will designate if the Vegetation Integrity Score (VIS) is increasing over time with the VMP implementation and set up a baseline dataset for EBSF within the Campbelltown LGA. *Condition reason: To ensure the vegetation management plans associated with this development consent are suitably prepared.*
26.	**Vehicular Access** Prior to the commencement of any stage of the development, suitable vehicle/plant access points shall be shown on a plan and approved in writing by the Principal Certifier. A sign is to be erected at the access point(s), such that workers may clearly identify the access point(s) for a particular stage of the development. *Condition reason: To ensure access points are provided and clearly identified.*
27.	**Public Property** Prior to the commencement of any works, the applicant shall advise Council of any existing damage to property controlled by Council which adjoins the site including kerbs, gutters, footpaths, walkways, reserves and the like. Failure to identify existing damage may result in all damage detected after completion of the development being repaired at the applicant's expense. *Condition reason: To ensure the condition of public infrastructure is recorded before the commencement of any works.*
28.	**Erection of Construction Sign** Prior to the commencement of any works, a sign/s must be erected in a prominent position on the site: a. Showing the name of the principal contractor (if any) for any building work and a telephone number on which that person may be contacted outside working hours. b. Stating that unauthorised entry to the work site is prohibited. c. Pollution warning sign promoting the protection of waterways (issued by Council with the development consent). d. Stating the approved construction hours in which all works can occur. e. Showing the name, address and telephone number of the appointed Principal Certifier for the work. Any such sign/s is to be maintained while the approved work is being carried out, but must be removed when the work has been completed. *Condition reason: Prescribed condition under Section 70 of the Environmental Planning and Assessment Regulation 2021.*
29.	**Toilet on Construction Site** Prior to the commencement of any works, toilet facilities are to be provided at or in the vicinity of the work site at the rate of one toilet for every 20 persons or part thereof. Each toilet provided must be a standard flushing toilet and be connected to: a. A public sewer, or b. If connection to a public sewer is not practicable, to an accredited sewage management facility approved by Council, or c. If connection to a public sewer or an accredited sewage management facility is

	not practicable, to some other management facility approved by Council. *Condition reason: To ensure that appropriate toilets are provided for construction workers.*
30.	**Trade Waste** Prior to the commencement of any works, a trade waste facility shall be provided on-site to store all waste pending disposal. The facility shall be screened, regularly cleaned and accessible to collection vehicles. *Condition reason: To ensure all waste is moved off-site for disposal.*
31.	**Fence** Prior to the commencement of any works, a fence must be erected around the development site in accordance with Work Cover requirements. The work site must be kept lit between sunset and sunrise if it is likely to be hazardous to persons in the public place. If required, a separate application under Section 68 of the Local Government Act 1993 shall be submitted to and approved by Council prior to the erection of any fence on public land. *Condition reason: To protect workers, the public and the environment.*
32.	**Pre-clearance Surveys** a. Prior to the commencement of any works, pre-clearance surveys are to be conducted in all areas of vegetation to be cleared and undertaken within two weeks of clearing of vegetation. Habitat features appropriate for relocation are to be marked during the pre-clearance survey. b. Fauna pre-clearance surveys are to be undertaken by a suitably qualified ecologist in accordance with Section 7.2.1.1 (iv) (a) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. c. Upon completion of pre-clearance surveys, a report outlining the pre-clearance surveys carried out, including survey effort, results and outcomes will be completed and submitted to Council. d. If threatened species are roosting in any habitat to be removed, a detailed threatened species relocation plan is to be developed and submitted to Council's Manger Development Assessment (or equivalent) for approval prior to the commencement of any on ground works. e. If any habitat features (trees, logs or parts thereof) are identified to be appropriate for relocation to the proposed conservation areas in the Menangle Park Urban Release Area, the felling/removal procedures and storage is to be specified to personnel undertaking vegetation removal. f. If any breeding threatened species are detected during the pre-clearance surveys, then clearance will be postponed until breeding is complete and hollows are vacant. *Condition reason: To ensure pre-clearance surveys are undertaken in accordance with the approved Species Impact Statement.*
33.	**Hollow Offset Replacement** Prior to the commencement of any works, a Hollow Offset Replacement Strategy and associated monitoring / maintenance program must be prepared and submitted to Council's Manager Development Assessment (or equivalent) for approval in accordance

	with Section 11.2.2 of the Campbelltown (Sustainable City) DCP 2015. The nest box replacement ratio is to be 2:1. Should the applicant not be able to accommodate these within their own landholdings, they are to liaise with Council's Manager Development Assessment (or equivalent) about alternative locations. *Condition reason: To comply with Council's requirements and ensure works are undertaken in accordance with the approved Species Impact Statement.*
34.	**Threatened Species Relocation Plan** A Threatened Species Relocation Plan is to be prepared that includes the methodology to be employed to capture and relocate threatened species recorded from the subject land during pre-clearance surveys and/or clearance supervision, as set out in section 7.2.1.1 (iv) (a) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. *Condition reason: To ensure works are undertaken in accordance with the approved Species Impact Statement.*
35.	**Construction Environmental Management Plan** Prior to the commencement of any works a Construction Environmental Management Plan (CEMP) shall be prepared to the satisfaction of the Principal Certifier. The CEMP must detail the environment management and control measures which will be implemented in association with the proposed construction activities to ensure the works are managed in a manner to reduce adverse impacts on the environment. At a minimum the CEMP must address: • Measures to delineate clearing areas and protect native vegetation that is to be retained, as set out in Section 7.2.1 of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. • Preclearance survey requirements as outlined in Section 7.2.1.1 (iv) (a) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. • Measures to prevent the spread of priority and environmental weeds as set out in section 7.2.1.1 (viii) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. • Measures to prevent the transport and spread of Phytophthora cinnamoni and other plant pathogens (for example myrtle rust) into areas of conservation value within the Menangle Park Urban release Area. • Required Sediment and Erosion Control Measures/stockpile management as per Managing Urban Stormwater: Soils and Construction (Landcom, 2004) – The Blue Book and as set out in Section 7.2.1.1 (ix) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. • Noise control measures. • Air quality / dust control measures. • Hazardous material management protocols (i.e., fuel etc.) addressing storage, use, refuelling etc. • Incident and emergency response protocols. • Competence, training and awareness procedures (i.e., environmental inductions, toolbox talks, training and awareness) • Roles and responsibilities for implementing, monitoring and reviewing CEMP requirements. • An overview of relevant environmental management documentation. • Waste Management procedures as per the submitted Waste Management Plan. • Inspection, monitoring and auditing requirements for all environmental controls and adaptive management to ensure environmental mitigation measures remain effective.

	Condition reason: To reduce the impacts of the development on the natural environment.
36.	**Dam Dewatering Plan** A Dam Dewatering Plan is to be prepared that includes the methodology to be employed to dewater the dam, capture and relocate aquatic species, and relevant licences as set out in section 7.2.1.1 (vi) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. This plan shall be prepared to the satisfaction of the Principal Certifier prior to the commencement of any on ground works. *Condition reason: To ensure works are undertaken in accordance with the approved Species Impact Statement.*
37.	**Inductions/ Toolbox Talks** The civil contractor is to ensure that during the site induction process and site toolbox talks, all site workers and visitors are aware of the no-access areas within the site, as per section 7.2.1.1 (i) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024. *Condition reason: To ensure the development is undertaken in accordance with the approved Species Impact Statement.*
38.	**Tree Protection Measures** The Conservation Areas – Parks K and L, Howes Creek and Northern Conservation Area and the Stage 6B EBSF Conservation Area, are required to be protected by fencing prior to the commencement of any works, as set out in section 7.2.1.2 of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024, including: - i) Sediment fencing ii) Protective fencing and signage iii) Monitoring of vegetation condition Site Inductions are to include communication on tree protection measures, and a siting of where the delineation of conservation areas and associated fencing is located. Fences are to be installed around specified tree protection zones and conservation areas prior to any works being undertaken. All tree work is to be supervised by a suitably qualified and insured Arborist; as set out in sections 7.2.1 (ii) and 7.2.1.2 of the Species Impact Statement by Cumberland Ecology dated 30 July 2024. A Conservation Area Fencing Plan is to be prepared and approved in writing by Council's Manger Development Assessment (or equivalent) prior to the commencement of any on ground works. *Condition reason: To ensure the protection of retained vegetation.*
39.	**Delineation of Clearing Limits** Clearing limits are to be marked either by high visibility tape on trees or metal/wooden pickets, fencing or an equivalent boundary marker. Disturbance, including stockpiling, is

	restricted to the clearing limits; as set out in section 7.2.1.1 (ii) of the Species Impact Statement by Cumberland Ecology dated 30 July 2024. *Condition reason: To ensure clearing limits are suitably delineated.*
40.	**Native Seed Collection (Elderslie Banksia Scrub Forest)** A native plant seed collection and propagation plan is to be prepared; This plan must be approved in writing by Council's Manger Development Assessment (or equivalent) prior to the commencement of any on ground works. The collection of native seed for the future rehabilitation/regeneration purposes within Parks K and L and the Stage 6B Conservation Area (and the associated Vegetation Management Plans) is to be undertaken with procedural advice from the Mount Annan Botanic Gardens plant bank personnel. The collection of seed is to be undertaken prior to the commencement of any on ground works. The native plant seed collection and propagation plan is to include (but not limited to) the: - • Methodology to be employed, for seed collection and propagation • Seed storage • Permits and licences required • Propagation techniques • Where the propagation area is sited • Personnel involved for the collection and propagation of native species collected from the Elderslie Banksia Scrub Forest areas to be removed. Reference to the Vegetation Management Plans for the areas to be conserved (Parks K and L and Stage 6B Conservation Area) is to be made in the seed collection and propagation plan. *Condition reason: To assist in rehabilitation/regeneration of Elderslie Banksia Scrub Forest.*

BEFORE ISSUE OF AN OCCUPATION CERTIFICATE

41.	**Construction Work Hours** Unless otherwise approved in writing by Council's Manager Development Assessment (or equivalent), all work on site shall only occur between the following hours: Monday to Friday 7.00am to 6.00pm Saturday 8.00am to 5.00pm Sunday and public holidays No Work. *Condition reason: To protect the amenity of the surrounding area.*
42.	**Access Denied** No direct vehicular access to or from the Hume Motorway is permitted during construction works. *Condition reason: To prevent unauthorised access to and from the Hume Motorway.*

43.	**Erosion and Sediment Control** Erosion and sediment control measures shall be provided and maintained throughout the construction period in accordance with the applicable requirements of Landcom's Managing Urban Stormwater: Soils and Construction, Volume 1 (the Blue Book), the approved plans, Council specifications, Section 7.2.1.1 (ix) of the Species Impact Statement (SIS) by Cumberland Ecology dated 30 July 2024, and to the satisfaction of the principal certifier. The erosion and sediment control devices shall remain in place until the site has been stabilised and fully revegetated. Note: Council may impose significant financial penalties for any non-compliance with this requirement without any further notification or warning. *Condition reason: To ensure sediment laden runoff and site debris do not impact local stormwater and waterways.*
44.	**Dust Nuisance** Measures shall be implemented to minimise wind erosion and dust nuisance in accordance with the requirements of the Landcom's Managing Urban Stormwater: Soils and Construction, Volume 1(the Blue Book). Construction areas shall be treated/regularly watered to the satisfaction of the principal certifier. Note: Council may impose significant financial penalties for any non-compliance with this requirement without any further notification or warning. *Condition reason: To minimise the impacts of the development construction on the environment.*
45.	**Mud/Soil** Mud and soil from vehicular movements to and from the site must not be deposited on public roads. *Condition reason: To minimise the impacts of the development construction on public roads.*
46.	**Excess Material** All excess material is to be removed from site. The spreading of excess material or stockpiling on site will not be permitted without prior written consent from Council. *Condition reason: To ensure compliance with this development consent.*
47.	**Earth Works / Filling Works** All earthworks, including stripping, filling, and compaction shall be: a. Undertaken in accordance with Council's Specification for Construction of Subdivisional Roads and Drainage Works (as amended), Engineering Design for Development (as amended) guide, Australian Standard AS 3798 Guidelines on Earthworks for Commercial and Residential Development (as amended) and the approved construction drawings; b. Supervised, monitored, inspected, tested and reported in accordance with Australian Standard AS 3798 Appendix B 2(a) Level 1 and Appendix C by a NATA registered laboratory appointed by the applicant. Two collated copies of the report and fill plan shall be forwarded to Council; and c. Certified by the laboratory upon completion as complying, so far as it has been

	able to determine, with Council's specification and Australian Standard AS 3798. *Condition reason: To ensure earthworks are carried out in accordance with the relevant Australian Standards and Council's DCP.*
48.	**Clearing Supervision and Protocols** To minimise impacts to native fauna species, clearing is to be undertaken under the supervision of a suitably qualified ecologist, in a two staged process, as set out in section 7.2.1.1(iv)(b) of the Species Impact Statement by Cumberland Ecology dated 30 July 2024. a. All fallen trees to be inspected by the attending ecologist for hollows not detected previously. b. Any fauna residing in the felled hollows to be captured and housed safely, to be released in the conservation areas. c. All personnel involved in the clearing works to be inducted about the possibility of fauna being present. d. Any animals disturbed or dislodged during clearance but not injured should be assisted to move into the adjacent bushland or other specified locations; and e. If any animals are injured during vegetation clearance, appropriate steps must be taken to humanely treat the animal under the advice of the attending ecologist, and WIRES or local VET to be contacted at the discretion of attending ecologist. f. Salvaged material suitable for use in proposed conservation areas, must be stockpiled in an appropriate place with appropriate signage, to ensure it can be reused at a later date. g. A report outlining how salvaged material has been/will be reused must be prepared and submitted to Council's Manager Development Assessment (or equivalent) prior to the principal certifying authority issuing a Final Compliance Certificate. h. The removal of hollow-bearing trees is not be undertaken during the months of June, July and August. *Condition reason: To minimise impacts to native fauna species.*
49.	**Remediation** Following the removal of vegetation in Lot 59 in Deposited Plan 10718, remediation works are to be undertaken in accordance with a relevant development consent issued by Campbelltown City Council. No earthworks are to be undertaken at this site until after remediation works have been completed. *Condition reason: To ensure contaminated land is remediated in accordance with a development consent prior to the undertaking of approved earthworks.*
50.	**Revegetation** Revegetation in accordance with the requirements of Landcom's Managing Urban Stormwater: Soils and Construction, Volume 1 (the Blue Book) shall be applied to all disturbed areas within seven days after the completion of earthworks unless further works are occurring simultaneously as part of a separate development consent. If further site works are not being undertaken in accordance with a relevant development consent, and revegetation is to be applied in accordance with the Blue Book, it shall be fully established prior to the Principal Certifier awarding the relevant practical completion certificate. *Condition reason: To ensure disturbed areas are appropriately revegetated.*

51.	**Public Safety** Any works undertaken in a public place are to be always maintained in a safe condition in accordance with Australian Standard AS 1742.3. Council may at any time and without prior notification make safe any such works that are unsafe and recover all reasonable costs incurred, from the applicant. *Condition reason: To ensure compliance with the Australian Standard.*
52.	**Compliance with Relevant Authority's Specifications** All design and construction work shall be in accordance with: a. Council's Specification for Construction of Subdivisional Road and Drainage Works (as amended); b. Council's Engineering Design for Development (as amended) guide; c. Council's applicable Development Control Plan; d. Landcom's Managing Urban Stormwater: Soils and Construction, Volume 1 (the Blue Book); e. TfNSW Traffic Control at Work Sites Technical Manual; f. Australian Standard AS 2890 various (Parking Facilities); g. Australian Standard AS 1742 various (Manual of uniform traffic control devices); and h. Other relevant Australian Standards, Austroads and/or State Government publications. *Condition reason: To ensure compliance with the relevant specifications and Australian Standards.*
53.	**Associated works** The applicant shall undertake any works external to the development, that are made necessary by the development, including additional drainage works or any other civil works directed by Council, to make a smooth junction with existing work. *Condition reason: To ensure there is a smooth junction with existing development.*

PRIOR TO AWARDING PRACTICAL COMPLETION OF WORKS / ISSUE OF A PRACTICAL COMPLETION CERTIFICIATE

54.	**Works as Executed Plans** Prior to Council or the Principal Certifier awarding the relevant practical completion certificate, the applicant shall submit to Council an electronic copy of fully marked up and certified work as executed plans in accordance with the requirements detailed in Council's Specification for Construction of Subdivisional Road and Drainage Works (as amended) and Engineering Design for Development (as amended) guide. The applicant shall also submit a copy of the Works as Executed information to Council in an electronic format in accordance with the following requirements: *Survey Information* • Finished ground and building floor levels together with building outlines. • Spot levels every five (5) metres within the site area. • Where there is a change in finished ground levels that are greater than 0.3.m between adjacent points within the above mentioned 5m grid, intermediate levels

	will be required. • A minimum of fifteen (15) site levels. • If the floor level is uniform throughout, a single level is sufficient. • Details of all stormwater infrastructure including pipe sizes and types as well as surface and invert levels of all existing and/or new pits/pipes associated with the development. • All existing and/or new footpaths, kerb and guttering and road pavements to the centre line/s of the adjoining street/s. • The surface levels of all other infrastructure. *Format* • MGA 94(Map Grid of Australia 1994) Zone 56 - Coordinate System • All level information to Australian Height Datum (AHD) *AutoCAD Option* • The "etransmit" (or similar) option in AutoCAD with the transmittal set-up to include as a minimum: Package Type • Zip File Format • AutoCAD 2004 Drawing Format or later Transmittal Options • Include fonts • Include textures from materials • Include files from data links Include photometric web files • Bind external references • The drawing is not to be password protected. ' *MapInfo Option* • Council will also accept either MapInfo Native format (i.e. .tab file) or MapInfo mid/mif. All surveyed points will also be required to be submitted in a point format (x,y,z) in either an Excel table or a comma separated text file format. *Condition reason: To ensure there is a record of the works as executed.*
55.	**Restoration of Public Roads** Prior to Council or the Principal Certifier awarding the relevant practical completion certificate, any restoration of the public road pavement required as a result of the development, shall be carried out by Council and all costs shall be paid by the applicant. *Condition reason: To ensure any damage to public infrastructure is rectified.*
56.	**Public Utilities** Prior to Council or the Principal Certifier awarding the relevant practical completion certificate, any adjustment to public utilities required as a result of the development, shall be completed to the satisfaction of the relevant authority and at the applicant's expense. *Condition reason: To ensure any changes to public utilities are completed.*

57.	**Voluntary Planning Agreement – Council** Prior to the Council or the Principal Certifier awarding the relevant practical completion certificate (applying to the relevant conservation zone), the Planning Agreement referred to in Condition No.22 of this development consent shall be executed to the satisfaction of the consent authority (Council) and all Development and Infrastructure Works, Dedications of Land and Monetary Contributions listed within the executed agreement are to be finalised, or otherwise guaranteed, to the satisfaction of the consent authority (Council). *Condition reason: To ensure a Planning Agreement is in place for the conservation outcomes of this development.*
58.	**Council Fees and Charges** Prior to the Council or the Principal Certifier awarding the relevant practical completion certificate, the applicant shall obtain written confirmation from Council that all applicable Council fees and charges associated with the development have been paid in full. Written confirmation will be provided to the applicant following Council's final inspection and satisfactory clearance of the public area adjacent the site. *Condition reason: To ensure that there are no outstanding fees, charges or rectification works associated with the approved development.*

General advisory notes
This consent contains the conditions imposed by the consent authority which are to be complied with when carrying out the approved development. However, this consent is not an exhaustive list of all obligations which may relate to the carrying out of the development under the EP&A Act, EP&A Regulation and other legislation. Some of these additional obligations are set out in the *Conditions of development consent: advisory notes*. The consent should be read together with the *Conditions of development consent: advisory notes* to ensure the development is carried out lawfully.

The approved development must be carried out in accordance with the conditions of this consent. It is an offence under the EP&A Act to carry out development that is not in accordance with this consent.

Building work or subdivision work must not be carried out until a construction certificate or subdivision works certificate, respectively, has been issued and a principal certifier has been appointed.

A document referred to in this consent is taken to be a reference to the version of that document which applies at the date the consent is issued, unless otherwise stated in the conditions of this consent.

ADVISORY NOTES

A. Environmental Planning and Assessment Act 1979 Requirements

The Environmental Planning and Assessment Act 1979 requires you to:

a. Obtain a construction certificate prior to the commencement of any works. Enquiries regarding the issue of a construction certificate can be made to Council's Customer Service Centre on 4645 4608.
b. Nominate a Principal Certifier and notify Council of that appointment prior to the commencement of any works.
c. Give Council at least two days notice prior to the commencement of any works.
d. Have mandatory inspections of nominated stages of the construction inspected.
e. Obtain an occupation certificate before occupying any building or commencing the use of the land.

B. Commonwealth Government Approval

Elderslie Banksia Scrub Forest is a critically endangered ecological community protected under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). This development may be considered a controlled action under the Act. It is recommended to refer the project to the Department of Climate Change, Energy, the Environment and Water, to obtain the relevant approvals.

C. Dial before you Dig

Underground assets may exist in the area that is subject to your application. In the interests of health and safety and in order to protect damage to third party assets please contact Dial before you dig at www.1100.com.au or telephone on 1100 before excavating or erecting structures (This is the law in NSW). If alterations are required to the configuration, size, form or design of the development upon contacting the Dial before you dig service, an amendment to the development consent (or a new development application) may be necessary. Individuals owe asset owners a duty of care that must be observed when working in the vicinity of plant or assets. It is the individual's responsibility to anticipate and request the nominal location of plant or assets on the relevant property via contacting the Dial before you dig service in advance of any construction or planning activities.

D. Telecommunications Act 1997 (Commonwealth)

Telstra (and its authorised contractors) are the only companies that are permitted to conduct works on Telstra's network and assets. Any persons interfering with a facility or installation owned by Telstra is committing an offence under the Criminal Code Act 1995 (Cth) and is liable for prosecution.

Furthermore, damage to Telstra's infrastructure may result in interruption to the provision of essential services and significant costs. If you are aware of any works or proposed works which may affect or impact on Telstra's assets in any way, you are required to contact: Telstra's Network Integrity Team on phone number 1800 810 443.

E. Inspections - Civil Works (Generally for Developments)

Where Council is nominated as the principal certifying authority for civil works, the following stages of construction shall be inspected by Council.

a. EROSION AND SEDIMENT CONTROL
    i. Direction/confirmation of required measures.
    ii. After installation and prior to commencement of earthworks.
    iii. As necessary until completion of work.
b. STORMWATER PIPES - Laid, jointed and prior to backfill.
c VEHICLE CROSSINGS AND LAYBACKS - Prior to pouring concrete.
d FINAL INSPECTION - All outstanding work.

Dictionary

The following terms have the following meanings for the purpose of this determination (except where the context clearly indicates otherwise):

Approved plans and documents means the plans and documents endorsed by the consent authority, a copy of which is included in this notice of determination.
AS means Australian Standard published by Standards Australia International Limited and means the current standard which applies at the time the consent is issued.
Building work means any physical activity involved in the erection of a building.
Certifier means a council or a person that is registered to carry out certification work under the *Building and Development Certifiers Act 2018*.
Construction certificate means a certificate to the effect that building work completed in accordance with specified plans and specifications or standards will comply with the requirements of the EP&A Regulation and *Environmental Planning and Assessment (Development Certification and Fire Safety) Regulation 2021*.
Council means Campbelltown City Council.
Court means the Land and Environment Court of NSW.
EPA means the NSW Environment Protection Authority.
EP&A Act means the *Environmental Planning and Assessment Act 1979.*
EP&A Regulation means the *Environmental Planning and Assessment Regulation 2021.*
Independent Planning Commission means Independent Planning Commission of New South Wales constituted by section 2.7 of the EP&A Act.
Local planning panel means Campbelltown local planning panel.
Occupation certificate means a certificate that authorises the occupation and use of a new building or a change of building use for an existing building in accordance with this consent.
Principal certifier means the certifier appointed as the principal certifier for building work or subdivision work under section 6.6(1) or 6.12(1) of the EP&A Act respectively.
Site work means any work that is physically carried out on the land to which the development the subject of this development consent is to be carried out, including but not limited to building work, subdivision work, demolition work, clearing of vegetation or remediation work.
Stormwater drainage system means all works and facilities relating to:

- the collection of stormwater,
- the reuse of stormwater,
- the detention of stormwater,
- the controlled release of stormwater, and
- connections to easements and public stormwater systems.

Strata certificate means a certificate in the approved form issued under Part 4 of the *Strata Schemes Development Act 2015* that authorises the registration of a strata plan, strata plan of subdivision or notice of conversion.
Subdivision certificate means a certificate that authorises the registration of a plan of subdivision under Part 23 of the *Conveyancing Act 1919*.
Subdivision works certificate means a certificate to the effect that subdivision work completed in accordance with specified plans and specifications will comply with the requirements of the EP&A Regulation.
Sydney district or regional planning panel means Sydney Western City Planning Panel (SWCPP).

Department of Climate Change, Energy, the Environment and Water

Your ref: DA 3574/2019/DA-CW
Our ref: DOC24/687576

Mr Aaron Essenhigh
Senior Town Planner
Campbelltown City Council
PO Box 57
CAMPBELLTOWN NSW 2560

By email: aaron.essenhigh@campbelltown.nsw.gov.au

Dear Mr Essenhigh

Re: Request for threatened species concurrence – Bulk Earthworks DA

I refer to your concurrence request dated 29 May 2023 to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) for the proposed bulk earthworks (Development application number DA 3574/2019/DA-CW). I also refer to the most recent update of this request on 16 August 2024, which was accompanied by a number of documents, most notably an updated species impact statement (July 2024), and a response to DCCEEW's request for further information (July 2024).

I have considered your request with the accompanying updated documents and have decided to grant concurrence in accordance with Section 79B(3) of the *Environmental Planning and Assessment Act 1979*, with conditions. These conditions are as follows:

CONCURRENCE CONDITIONS:

1. The clause(s) in the Voluntary Planning Agreement that require the in-perpetuity management of conservation areas under a Vegetation Management Plan, cannot be revoked without the agreement of the DCCEEW.
2. Any temporary stormwater outlets constructed for each successive stage of the development are not to be directed towards the conservation areas.
3. Prior to commencement of any on-ground works, propagation material is to be collected from remnant Elderslie Banksia Scrub Forest to be cleared, and used for rehabilitation and regeneration purposes, on the advice of the Australian Botanic Gardens, Mt Annan.

If you have any questions about this issue, please contact Ms Sarah Burke, Senior Team Leader Compliance & Regulation, Biodiversity Conservation & Science, on 9995 6848 or at sarah.burke@environment.nsw.gov.au .

Yours sincerely

SARAH BURKE
Senior Team Leader, Compliance & Regulation, Greater Sydney
Biodiversity Conservation & Science

As delegate to the Secretary

APPENDIX F :
Economic and Social Impact Statement



ECONOMIC AND SOCIAL IMPACT STATEMENT

Menangle Park

Prepared for
DAHUA GROUP SYDNEY PROJECT 2 PTY LTD
26 May 2025

URBIS

URBIS STAFF RESPONSIBLE FOR THIS REPORT WERE:

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Project Code	P0030011
Report Number	Final



Acknowledgement of Country

Urbis acknowledges the Traditional Custodians of the lands we operate on.

We recognise that First Nations sovereignty was never ceded and respect First Nations peoples continuing connection to these lands, waterways and ecosystems for over 60,000 years.

We pay our respects to First Nations Elders, past and present.

The river is the symbol of the Dreaming and the journey of life. The circles and lines represent people meeting and connections across time and space. When we are working in different places, we can still be connected and work towards the same goal.

Title: Sacred River Dreaming
Artist Hayley Pigram
Darug Nation
Sydney, NSW

All information supplied to Urbis in order to conduct this research has been treated in the strictest confidence. It shall only be used in this context and shall not be made available to third parties without client authorisation. Confidential information has been stored securely and data provided by respondents, as well as their identity, has been treated in the strictest confidence and all assurance given to respondents have been and shall be fulfilled.

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You must read the important disclaimer appearing within the body of this report.

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Appendix A SIA Guideline Methodology
Appendix B EIA Guideline Methodology

EXECUTIVE SUMMARY

Dahua Group Sydney Project 2 Pty Ltd (Dahua Group) engaged Urbis Ltd (Urbis) to prepare an Economic and Social Impact Statement (ESIS) for a 498ha landholding within the Menangle Park Urban Release Area (the Subject Site).

This ESIS will inform a Referral Application under Section 68 of the *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act),* which forms part of a Development Application for the site, aiming to establish a master-planned community in Menangle Park (the Development).

REPORT PURPOSE AND SCOPE

This ESIS aims to provide economic and social inputs into the Referral Application under Section 68 of the EPBC Act. It includes an assessment of the expected long- and short-term economic and social impacts of the Development, including both positive and negative outcomes. This includes the following economic and social matters:

- Consideration of negative impacts (e.g. disruption to existing community infrastructure, environmental features, and/or cultural and traditional activities).
- Consideration of positive impacts (e.g., increased housing, employment, social amenity).
- Consideration of different scales of impact (e.g. local, regional, state).
- Estimated capital value and ongoing economic value, using specific dollar or other numerical values where relevant for the construction phase and the ongoing phase of the development.

An overview of the social impact analysis methodology is provided in Appendix A. The methodology for the economic analysis is included in Appendix B.

THE SUBJECT SITE

The Subject Site is a 498ha landholding within the Menangle Park Urban Release Area (MPURA), which is undergoing construction and will include 5,250 dwellings (including a range of houses, terraces and apartments), a retail and commercial town centre (including community facilities to support the proposed increase to the population), an industrial estate, up to two schools, a revised road and street network, sporting fields and parks, integrated passive recreation area within a riparian corridor network and land for environmental conservation.

THE DEVELOPMENT

Dahua Group's landholding within the MPURA is generally located to the east of Cummins Road. The full utilisation of Dahua Group's landholding is essential to address the strategic need for additional and diverse housing stock in Southwest Sydney.

Dahua Group has a vision to deliver a premium, master-planned community at Menangle Park, featuring over 4,000 new homes, recreational spaces, and local retail uses.

A subsequent Planning Proposal was submitted in November 2018 on behalf of Dahua Group, which was gazetted on 29 April 2022. This Planning Proposal increased dwelling yield across Dahua Group's landholding within the MPURA to accommodate a range of densities, lot sizes and residential typologies.

ECONOMIC IMPACT ANALYSIS FINDINGS

The Economic Impact analysis examines the Construction and Operational phases of the development at Menangle Park Subject Site.

Total expenditure estimates for the proposed development have been provided by Dahua Group and calculated from Rawlinsons (2025). The total estimated capital investment value of the entire development is approximately $3,779 million, representing direct expenditure (Economic Output), inclusive of GST.

The project is estimated to have a nine-year construction period, concluding in 2033. The results were calculated at the local, regional, and state levels. The results at the local level are shown overleaf.

Table 1 Economic impact assessment key results

Construction Phase Local Economic Impacts – Campbelltown LGA			
	Direct	**Indirect**	**Total**
Project Expenditure ($M)	$3,779.2	-	$3,779.2
Avg Employment per year (Peak Jobs)	632 jobs over a year	640 over a year	1,271 over a year
Value-Added ($M)	$9,345.4	$8,773.7	$18,119.1
Operational Phase Economic Impacts per year – Campbelltown LGA			
	Direct	**Indirect**	**Total**
Jobs (FTE)	2,568	904	3,472
Wages/Salaries ($M)	$244.0	$89.9	$333.9
Value-Added ($M)	$410.6	$160.8	$571.4

SOCIAL IMPACT ANALYSIS FINDINGS

The Social Impact analysis examines the potential negative impacts (e.g., disruption to existing community infrastructure, environmental features, and/or cultural and traditional activities) and potential positive impacts (e.g., increased housing, employment, and social amenity) of the development at the Menangle Park Subject Site. It considers the different scales of impact (e.g., local, regional, and state) of the development.

The identified potential positive impacts include:

- Increased access to social infrastructure for current and future residents, workers and visitors
- Increased opportunities for precinct activation and the realisation of state strategic plans
- Increased access to a diversity of housing types
- Increased opportunity to provide a range of housing price options
- Change to the demographic profile of Menangle Park and associated change to community character and cohesion, including increased diversity associated with new residents
- Improved vehicular access and connectivity
- Increased opportunities to celebrate local Aboriginal history and culture through the built environment
- Enhanced social amenity via healthier built environments, which would, in turn, promote healthy lifestyles (via enhanced footpaths and active transport opportunities)
- Increased access to employment opportunities, local development, and upskilling opportunities.

The identified potential negative impacts include:

- Change to local character and potential community concerns due to perceived impacts to environmental values, including the Nepean River.
- Increase pressure on existing public transport and the road network associated with the upcoming residents.
- Increased pressure on existing social infrastructure, which would vary depending on the timely provision of new social infrastructure.
- Potential disruption to sites of Aboriginal significance.
- Perceived urban heat island effect associated with loss of green space.

- Amenity impacts during construction due to increased noise, dust, and potential vibration
- Potential risk of flooding impacting the safety of residents.
- Potential construction and community consultation fatigue.

CONCLUSION

Considering the status of this Development and from a planning and delivery perspective, several of the identified social impacts have been previously identified and addressed. This is reflected in:

- a Local and State Planning Agreement ensuring delivery and funding of social infrastructure, including a network of parks, roads, community spaces, sports fields and ecology retention;
- Design Guidelines that address future vegetation and Urban Heat Island Effect; and,
- Vegetation Management Plans with initial revitalisation of key ecology areas, revegetation and long-term preservation.

The delivery of the Development has progressed with the opening of Spring Farm Parkway and key intersection upgrades. Additional stages of the Development, including further road and intersection upgrades, have received development consent, and a park is currently under construction.

Combined, these mitigation measures have the potential to address potential impacts while enabling social value creation opportunities. For example, besides the jobs and economic growth that will be supported during the construction and operational periods, the Development is also expected to have other social and economic impacts on the local economy and the wider region. The following table summarises the Development's wider social and economic benefits in terms of employment uplift and retail spending generated during the construction and operation of Menangle Park.

Table 2 Other Social and Economic Impacts

Development Component	Social and Economic Impact
Diversification of Housing	The housing opportunities at Menangle Park are extensive, offering potential for apartments, terraces/townhouses, small lot housing, regular detached dwellings, and larger rural/residential allotments. This also provides a variety of price points that will assist in achieving housing affordability. The Greater Sydney Region Plan recognises the crucial role of housing diversity in promoting and enabling housing affordability. Offering low, medium, and high-density housing options caters to various demographic and lifestyle needs while accommodating different household budgets. A diverse housing strategy can foster vibrant, sustainable communities that support local and regional growth.
Increased population	An increased population catchment for Campbelltown will boost economic activity, including output, wages, and incomes, and support the creation of more direct and indirect jobs for the Campbelltown LGA, as demonstrated by the economic modelling. The increased population will positively impact the viability of the proposed local centres and higher-order centres, such as Campbelltown CBD, Macarthur, and Narellan.
Retail	Retail as part of a town centre can significantly boost economic benefits by creating jobs in various sectors, including sales, management, and indirectly through logistics and distribution. Retail attracts consumers, increasing local spending and supporting surrounding businesses. It also enhances the placemaking or appeal of an area, drawing in more visitors and potential residents and further investment. Additionally, it generates tax revenue for governments, which can be reinvested into community services and infrastructure. Using the CommBank iQ spending per person of $14,100 and migration based on the 2021 Census (of 5.5%) in the Campbelltown LGA, it is estimated that based on the expected population in the Menangle Park development that are likely to come to the area from overseas or interstate (578 people) an additional annual retail spend of $8,147,623 could be achieved for NSW through the completion of the Menangle Park Development.

Development Component	Social and Economic Impact
Industrial and Commercial Space	Industrial estates and Commercial Spaces are key drivers of economic growth, creating jobs both directly within the estates and indirectly through supporting industries and services. These land uses attract businesses, fostering innovation and collaboration, which can lead to increased productivity and competitiveness. Additionally, they generate significant tax revenue for governments, which can be reinvested into community infrastructure and services.
Schools	In addition to the jobs and wages/salaries created and assessed in the Economic Impact Assessment schools attract families to the area boosting demand for local services. A well-educated population is important for future earning potential and economic growth, and additional school means fewer students per classroom and more opportunities for students. Furthermore, schools often partner with local businesses for internships and training programs, which fosters a skilled workforce that meets the needs of the local economy.

1. SOCIO-ECONOMIC CONTEXT

1.1. SOCIAL LOCALITY

A social locality helps to identify the scale and nature of the development's likely social impacts, as well as the likely impacted groups.

The development's social locality considers the following scales of impact:

- **Local social locality:** The local social locality encompasses the suburb of Menangle Park, including the Subject Site and its immediate surrounding areas, such as landholdings, property owners, and residents of associated dwellings. For the economic impact assessment, Campbelltown Local Government Area (LGA) is considered as part of the local social locality to provide a holistic picture of the development's local impact on housing and employment needs in the neighbouring suburbs and broader LGA.
- **Regional social locality:** The regional social locality encompasses Greater Sydney, specifically including Campbelltown LGA and the Greater Macarthur Priority Growth Area, where the Subject Site is located. The regional social locality provides insights into the development's contribution to broader impacts being experienced in the regional area, particularly concerning increasing demand for social infrastructure, open space, public transport, and other essential services and facilities as the region's population continues to grow across Greater Sydney.
- **State social locality**: The state social locality encompasses the population of New South Wales (NSW) to provide a broader and comparative social context for the development.

1.2. SOCIAL BASELINE OVERVIEW

1.2.1. Current local context

Menangle Park is currently a rural residential suburb located in the Campbelltown Local Government Area (LGA). Menangle Park is situated approximately 10 km south-west of the Campbelltown Central Business Area (CBA) and 50 km south-west of the Sydney Central Business District (CBD).

Hume Highway is located immediately east of Menangle Park, which connects the Sydney CBD to the south-western CBD. Menangle train station is located immediately west of the Development and is on the Southern Highlands Line (SHL), providing individuals with direct connections to Campbelltown CBD and Sydney CBD. Currently, SHL train services are relatively infrequent, once every 1 – 2 hours. Menangle Park is also serviced by two bus routes, the '889' providing connections from Goulburn to Campbeltown Station all week and '6SH' providing connections from Moss Vale to Campbelltown Station on weekends.

Menangle Park currently comprises rural residential homes, local retail services, entertainment and limited access social infrastructure and open space, including childcare, places of worship, and education facilities. Community places of significance in Menangle Park include Broughton Anglican College, providing education for students from Kindergarten to Year 12, Menangle Country Club and the associated horse racing track, and the Nepean River Reserve.

The Subject Site is located within the Menangle Park Urban Release Area (MPURA), which forms part of the Greater Macarthur Priority Growth Area. The Greater Macarthur Priority Growth Area is a major urban renewal area that is intended to significantly contribute additional housing and employment opportunities for the rapidly growing south-west Sydney population. Menangle Park, along with 11 other precincts in south-west Sydney was earmarked for redevelopment by the NSW Government within the Greater Macarthur 2040 Interim Plan (2018).

Campbelltown City Council's Local Strategic Planning Statement (2020) notes the development potential of Menangle Park as delivering 4,000 potential new homes. The LSPS also notes that it expects for Menangle Park to be one of the first new residential communities to be delivered within the Greater Macarthur Priority Growth Area, given the MPURA was one of the first precincts to be rezoned for residential uses. The MPURA comprises 958ha of land in Menangle Park, 498ha of which is owned or under the control of Dahua Group and the remaining areas are owned or under the control of other landowners.

In summary, the Development is surrounded by:

- Existing and proposed road and rail infrastructure,
- A State Heritage-listed property (Glenlee House, No.00009)
- Adjoins the Nepean River to the south and Howes Creek bisects the northern part of the Subject Site.
- The current township of Menangle Park contains various amenities including Menangle Country Club, Club Menangle Paceway and club facility and Aussie Night Markets.
- Menangle Park Train Station sits in the township of Menangle Park. The station provides services to Campbelltown (where commuters can join various City Lines) and a regional connection to the southern highlands line.
- There is a small existing bus network between Menangle Park and Campbelltown which will require expansion as the suburb makes an urban transition.
- Macarthur Square is a regional shopping centre 4 km north-east of Menangle Park in the heart of Campbelltown. The centre contains David Jones, Coles, Woolworths, Aldi and over 230 specialty stores.
- Campbelltown Mall is a sub-regional shopping centre situated 5 km north-east of the Subject Site. The centre features Kmart, Coles, Woolworths, Aldi and over 90 specialty stores.
- Three additional supermarket centres are 5 km north of the Subject Site. A small supermarket centre is 3.5 km to the north-west in Spring Farm.
- Western Sydney University Campbelltown Campus and TAFE NSW Campbelltown are both 2 km north-east of the Subject Site.
- Broughton Anglican College is a K-12 School siting directly to the east of the Subject Site and Bellbirds Early Learning sits in the original Menangle Park township, to the east of the Subject Site
- Schools feature prominently to the north-east of the Subject Site with a mix of six public and private schools within 5 km. These include St. Helens Public School, Ambarvale High School, Rosemeadow Public School, John Therry Catholic College, Our Lady Help of Christians Catholic Parish Primary School, Mary Brooksbank School and Thomas Acres Public School.
- Campbelltown Hospital and Campbelltown Private Hospital are located 4 km north-east of the Subject Site, providing convenient health services for residents.

1.2.2. Demographic overview

This Section provides an overview of Menangle Park's population characteristics to understand the likely communities and groups that the Development may impact. The Menangle Park suburb (SAL) is used to identify the likely impacted groups within the local social locality, and Campbelltown LGA, Greater Sydney, and NSW are provided for comparison and to understand the regional and state social localities.

Population and age

Drawing on 2021 ABS Census data, the population of Menangle Park was relatively small, with 224 residents, representing 0.13% of the Campbelltown LGA. Over the last decade, Menangle Park's population declined slightly from 241 to 224 residents, representing a 7.1% decrease between 2011 and 2021. However, given the strategic significance of Menangle Park within the Greater Macarthur Priority Growth Area, the population is projected to increase significantly over the next two decades. According to Profile id. Population Forecast, Menangle Park is projected to increase to 12,725 residents in 2046, representing a 193.1% increase between 2021 and 2046.

Menangle Park and NSW had the same median age of 39, a higher proportion compared to 35 in Campbelltown LGA and 37 in Greater Sydney, as a greater proportion of residents were in the parent and homebuilder (35 to 49 years) and older worker and pre-retiree (50 to 59 years) age groups.

Cultural and linguistic diversity

Menangle Park's Aboriginal and Torres Strait Islander population was 1.7% higher than Campbelltown LGA, 3.7% higher than Greater Sydney and 2% higher than NSW. However, Menangle Park had a less culturally and linguistically diverse population, as most residents were born in Australia or England and only spoke

English at home (85.7% and 86.6%, respectively), compared to Campbelltown LGA (59.5% and 57.8%, respectively), Greater Sydney (56.8% and 57.3%, respectively), and NSW (65.4% and 67.6%, respectively). Amongst Campbelltown LGA residents who were born overseas, the most common locations include India, Bangladesh and the Philippines.

Household characteristics

Menangle Park is a low-density rural-residential community that primarily comprises separate houses (94.2%) with a relatively high average number of people per household (2.9), compared to Greater Sydney (2.7) and NSW (2.6), but similar to Campbelltown LGA (2.9). Car ownership rates were also higher in Menangle Park, with the average household owning 2.7 cars in 2021, compared to 1.7 in Greater Sydney and 1.8 in Campbelltown LGA and NSW.

A greater proportion of Menangle Park households were rented compared to Campbelltown LGA and more than a third of renter households were experiencing rental stress, meaning rent payments are greater than 30% of the household income. In contrast, of households who owned their home with a mortgage, none reported having mortgage stress, meaning mortgage payments were greater than 30% of the household income. This represented a lower proportion of households experiencing rental or mortgage stress compared to Campbelltown LGA and NSW.

Health and wellbeing

Menangle Park had a relatively healthy community, with a third of residents identifying themselves as having a long-term health condition (30.8%), a similar proportion to Campbelltown LGA (31.1%) and NSW (30.9%), but higher than Greater Sydney (27.5%). The most commonly identified long-term health conditions in Menangle Park were arthritis, heart disease (including heart attack or angina) and mental health conditions (including depression or anxiety), which aligns with the health needs of an older community that exists in Menangle Park.

Demographic trends in south-west Sydney

Demographic trends are emerging across south-west Sydney as the region's population continues to grow because of new greenfield development areas and increasing densification of existing centres. Insights into demographic trends across south-west Sydney are provided by the Committee for Sydney (Western Sydney Progress and Prospects, 2023) and WSU Centre for Western Sydney (Home Truths: The Real Housing Story in Western Sydney, 2023).

These institutions found that new communities often foster culturally diverse households, support higher proportions of young families with babies and preschoolers and primary school-aged children, and high-density areas generally attract more young adults. It was also found that these communities generally have increasing rates of educational attainment, including university degrees, while also accommodating greater variations in socio-economic disadvantage and advantage. This means there are often lower household incomes and higher levels of mortgage and rental stress. These demographic trends provide insights into the potential characteristics of the future Menangle Park population.

1.2.3. Local and regional priorities

A desktop review indicates that the Development has support from Campbeltown City Council and the local community. A Development Contribution Plan has been adopted for the redevelopment area, and a Voluntary Planning Agreement has been agreed upon outlining a variety of community needs. These community infrastructure needs include open space and recreational areas, land dedication, bioretention facilities, and monetary contributions toward community needs.[1]

The Campbelltown City Council also broadly supports development in the region, with a vision for Menangle Park "*as an impressive southern gateway to the Sydney Metropolitan Region, Menangle Park will become a unique urban community characterised by sustainable design, accessibility and a vibrant town centre. As*

[1] https://www.campbelltown.nsw.gov.au/Build-and-Develop/Planning-Policies-and-Controls/Planning-Agreement-Register/Menangle-Park-Release-Area-Planning-Agreement

part of the broader Macarthur community, Menangle Park's urban form will capitalise on the existing economic resources, existing natural and cultural heritage qualities and the adjacent Nepean River".[2]

1.2.4. Community sentiment

Understanding current and future local and regional community perspectives is critical to optimising a project's positive outcomes. Therefore, reviewing public sentiment towards a project and comparable development projects in the region helps better identify current community concerns, priorities, and expectations.

The Development is situated near the Nepean River and Howes Creek, which are highly valued by the community as places for recreation, relaxation, and enjoying nature. There is general support for developments that aim to promote and enhance opportunities associated with the waterways and initiatives to maintain and improve biodiversity.[3] However, some community concern exists regarding the potential impacts on wildlife, riverbanks, and water quality from developments. Given that developments in Western Sydney are along a floodplain, there are also calls for robust planning to ensure resilience and safety from flooding.[4] Dahua Group has considered the significance of these waterways and developed a Vegetation Management Plan to minimise potential impacts associated with the Development and ensure their long-term conservation and maintenance.

To further support the additional development stages, it is recommended that continued community stakeholder engagement, including with First Nations people and communities, be undertaken.

[2] https://www.campbelltown.nsw.gov.au/files/sharedassets/public/v/1/build-and-develop/documents/amendedmenangleparkcontributionsplan2020.pdf

[3] https://www.penrithcity.nsw.gov.au/images/documents/waste-environment/environment/Our_River_Summary_Community_Engagement_Report.pdf

[4] https://www.infrastructure.nsw.gov.au/media/e5tnapdq/2022_december_hawkesbury-nepean-valley-floods-community-sentiment-survey_sec-newgate.pdf

1.3. ECONOMIC OVERVIEW

Menangle Park is located in the Campbelltown LGA. This LGA has a Gross Regional Product (GRP) of $10,950.457 million. On a per capita basis, this represents $62,036 of GRP per person.

The GRP for Campbelltown LGA (NSW) was calculated by REMPLAN using the Expenditure method.

GRP is the total value of final goods and services produced in the region over a one-year period. As can be seen from the table below, this includes exports and subtracts imports. This calculation does not include intermediate expenditure, as this would lead to double-counting.

GRP can be measured by adding up all forms of final expenditure

- consumption by households
- consumption by governments
- additions or increases to assets (minus disposals)
- exports (minus imports)

Table 3 Gross Regional Product Campbelltown LGA

GRP (Expenditure Method)	$millions
Household Consumption	$10,681.153
Government Consumption	$3,961.501
Private Gross Fixed Capital Expenditure	$3,370.989
Public Gross Fixed Capital Expenditure	$899.555
Gross Regional Expenses Calculation	**$18,913.198**
plus Regional Exports	$6,912.455
minus Domestic Imports	-$11,317.422
minus Overseas Imports	-$3,557.774
Gross Regional Product	**$10,950.457**
Population	176,519
Per Capita GRP	$0.062
Per Worker GRP	$0.202

Source: Remplan, ABS 2021 Census Place of Work Employment (Scaled), ABS 2021 / 2022 National Input Output Tables, ABS June 2024 Gross State Product.

1.3.1. Output

Total Output in the LGA is estimated at $23,602.819 million.

All industry sectors in the City of Campbelltown LGA (NSW) ranked by Output are shown in the table below.

Table 4 Output Campbelltown LGA

Industry Sector	$million	%
Manufacturing	$7,601.405	32.2%
Construction	$3,052.503	12.9%
Rental, Hiring & Real Estate Services	$2,447.433	10.4%
Health Care & Social Assistance	$1,838.118	7.8%
Transport, Postal & Warehousing	$1,628.311	6.9%
Education & Training	$1,106.709	4.7%
Retail Trade	$936.237	4.0%
Public Administration & Safety	$893.608	3.8%
Wholesale Trade	$699.931	3.0%
Professional, Scientific & Technical Services	$682.235	2.9%
Financial & Insurance Services	$619.627	2.6%
Accommodation & Food Services	$388.224	1.6%
Other Services	$379.667	1.6%
Electricity, Gas, Water & Waste Services	$346.798	1.5%
Administrative & Support Services	$308.459	1.3%
Information Media & Telecommunications	$305.598	1.3%
Mining	$145.240	0.6%
Agriculture, Forestry & Fishing	$112.153	0.5%
Arts & Recreation Services	$110.563	0.5%
Total	$23,602.819	100.0%

Source: Remplan, ABS 2021 Census Place of Work Employment (Scaled), ABS 2021 / 2022 National Input Output Tables, ABS June 2024 Gross State Product

Output data represents the gross revenue generated by businesses/organisations in each of the industry sectors in a defined region. Gross revenue is also referred to as total sales or total income.

1.3.2. Employment

Total Employment in the City of Campbelltown LGA is estimated at 54,189 jobs. Employment is a key social outcome of economic development; employment data represent the number of people employed by businesses and organisations in each of the industry sectors in the Campbelltown LGA (NSW) Region.

The industry sector contribution to employment is shown in the following table.

Table 5 Employment Campbelltown LGA

Industry Sector	Jobs	%
Health Care & Social Assistance	9,987	18.4%
Manufacturing	6,703	12.4%
Education & Training	6,265	11.6%
Retail Trade	6,036	11.1%
Construction	5,072	9.4%
Transport, Postal & Warehousing	3,584	6.6%
Accommodation & Food Services	3,325	6.1%
Public Administration & Safety	2,729	5.0%
Other Services	1,983	3.7%
Professional, Scientific & Technical Services	1,892	3.5%
Wholesale Trade	1,777	3.3%
Administrative & Support Services	1,754	3.2%
Rental, Hiring & Real Estate Services	836	1.5%
Financial & Insurance Services	750	1.4%
Arts & Recreation Services	460	0.8%
Information Media & Telecommunications	377	0.7%
Electricity, Gas, Water & Waste Services	357	0.7%
Agriculture, Forestry & Fishing	232	0.4%
Mining	70	0.1%
Total	54,189	100.0%

Source: Remplan, ABS 2021 Census Place of Work Employment (Scaled), ABS 2021 / 2022 National Input Output Tables, ABS June 2024 Gross State Product

1.3.3. Local Sales

Local Sales data represents the value of goods and services produced in the LGA which are sold to local industry sectors as intermediate inputs into production and for further value-adding. The total value of local sales for an industry sector relative to exports provides insights into the degree to which the industry is dependent on local demand versus demand from outside of the region.

The total local sales estimate for the Campbelltown LGA (NSW) is $6,197.139 million. The breakdown by industry sector is shown in the following table.

Table 6 Local Sales Campbelltown LGA

Industry Sector	$M	%
Manufacturing	$1,570.629	25.3%
Construction	$1,110.715	17.9%
Transport, Postal & Warehousing	$706.605	11.4%
Professional, Scientific & Technical Services	$554.299	8.9%
Rental, Hiring & Real Estate Services	$328.908	5.3%
Wholesale Trade	$328.475	5.3%
Financial & Insurance Services	$272.891	4.4%
Administrative & Support Services	$254.484	4.1%
Electricity, Gas, Water & Waste Services	$214.618	3.5%
Retail Trade	$175.577	2.8%
Information Media & Telecommunications	$161.771	2.6%
Public Administration & Safety	$148.065	2.4%
Other Services	$144.015	2.3%
Accommodation & Food Services	$68.624	1.1%
Agriculture, Forestry & Fishing	$55.616	0.9%
Health Care & Social Assistance	$33.332	0.5%
Arts & Recreation Services	$30.441	0.5%
Education & Training	$19.094	0.3%
Mining	$18.980	0.3%
Total	$6,197.139	100.0%

Source: Remplan, ABS 2021 Census Place of Work Employment (Scaled), ABS 2021 / 2022 National Input Output Tables, ABS June 2024 Gross State Product

1.3.4. Value-Added

The total value-added in the area is estimated at $9,845.178 million. Value-Added represents the marginal economic value that is added by each industry sector in a defined region. Value-Added is calculated by subtracting local expenditure and expenditure on regional imports from the output generated by an industry sector. Value-Added by industry sector is the major element in the calculation of Gross Regional Product.

The industry sector contribution to value-added are shown in the following table.

Table 7 Value-Added Campbelltown LGA

Industry Sector	$M	%
Rental, Hiring & Real Estate Services	$1,829.813	18.6%
Manufacturing	$1,275.823	13.0%
Health Care & Social Assistance	$1,274.648	12.9%
Construction	$859.614	8.7%
Education & Training	$799.054	8.1%
Transport, Postal & Warehousing	$725.899	7.4%
Retail Trade	$542.366	5.5%
Public Administration & Safety	$507.610	5.2%
Wholesale Trade	$370.647	3.8%
Financial & Insurance Services	$368.979	3.7%
Professional, Scientific & Technical Services	$346.646	3.5%
Accommodation & Food Services	$186.159	1.9%
Administrative & Support Services	$172.390	1.8%
Other Services	$161.817	1.6%
Information Media & Telecommunications	$121.493	1.2%
Electricity, Gas, Water & Waste Services	$113.740	1.2%
Mining	$98.980	1.0%
Agriculture, Forestry & Fishing	$49.326	0.5%
Arts & Recreation Services	$40.172	0.4%
Total	$9,845.178	100.0%

Source: Remplan, ABS 2021 Census Place of Work Employment (Scaled), ABS 2021 / 2022 National Input Output Tables, ABS June 2024 Gross State Product

1.3.5. Regional development context

The designation of the Greater Macarthur Priority Growth Area, within which the Subject Site is located, is one of many planning interventions implemented by the NSW Government to increase housing delivery across Greater Sydney and broader NSW.

The NSW Government's Housing 2041 Strategy (2021) identifies several directions to drive the supply, diversity, affordability and resilience of homes in NSW by 2041. These directions encourage the strategic location of new residential developments in proximity to public transport nodes, employment opportunities, and high levels of amenity, such as open space and social infrastructure. There is also a focus on supporting the delivery of new and diverse housing tenure options and housing typologies, including size, number of bedrooms, layout, and accessibility requirements, to meet the needs of diverse communities.

In the context of Greater Sydney, a significant level of development is occurring across the region following the directions outlined in the Greater Sydney Region Plan (DPHI, 2018). The Greater Sydney Region Plan states that Greater Sydney could deliver an additional 725,000 dwellings by 2036, creating new communities and urban release areas that support new and existing centres.

The eastern portion of the Subject Site adjoins the Hume Highway. Stage One of the Spring Farm Parkway, which opened in early 2024, delivered a four-lane divided road that provides Menangle Park, including the Subject Site, with direct access to the Hume Highway. It has an interchange over the Hume Highway. Stage Two is now advancing to the subsequent phases of planning and will complete the connection from Stage One to Liz Kernohan Drive, reducing congestion and travel time, improving flood resilience, and enhancing access to established and developing residential and employment precincts in the area, including Spring Farm, Elderslie, Menangle Park, Mount Annan, and Glen Alpine. Importantly for the industrial precinct, it will provide direct access for freight trucks to a Southern Sydney Freight Line terminal.

Outside the Subject Site's northern border is the Glenlee Estate and Homestead. This estate includes a 17.7-hectare site that has been rezoned to accommodate low-scale residential development interfacing with the Subject Site.

2. ECONOMIC IMPACT ASSESSMENT

The Economic Impact analysis examines the Construction and Operational phases of the development at Menangle Park Subject Site.

2.1. ECONOMIC LOCALITY

The locality helps to identify the scale and nature of the Development's likely economic impacts.

The locality considers the following scales of impact:

- **Local economic locality:** The local economic locality is the Campbelltown LGA
- **Regional economic locality:** The regional social locality comprises Greater Sydney which captures the LGA and Greater Macarthur Priority Growth Area in which the Subject Site is located.
- **State economic locality**: The state economic locality is New South Wales (NSW)

2.2. CONSTRUCTION PHASE IMPACTS

This study assessed the potential economic activity supported by the construction of the proposed development. The following impacts of the project were measured.

- ***Direct impacts*** are the initial round of impacts, including economic output, employment and household income.
- ***Indirect impacts*** are inclusive of production-induced (i.e., supply chain) effects and exclude consumption-induced effects. Production-induced effects (Type I) are additional output, employment and household income resulting from re-spending by firms that receive payments from the sale of services to the firms undertaking the project.

The modelling assessed:

- ***Economic activity*** – the total dollar amount impact (or contribution to gross domestic product)
- ***Employment*** – the full-time equivalent per annum employment generated by the project
- ***Wages/Salaries*** – the wages and salaries generated by the project
- ***Value-added*** – the value added to materials and labour expended on the project and
- ***Supply chain impacts*** – the value of further spending in the supply chain.

Table 8 Construction Phase Impact Modelling Steps

Task	Description
Estimate Direct Impacts	Direct costs were received from Dahua Group. They include direct construction costs for the buildings, infrastructure and public domain.
Calculate Indirect Effects	This study used an Economic Impact Assessment (EIA) approach to estimate the impact of the project. At the core of EIAs are Input–Output (IO) tables. IO tables are part of the national accounts by the ABS and provide detailed information about the supply and use of products in the Australian economy, and the structure of and inter–relationships between Australian industries. IO tables are converted, through statistical analysis, into a series of economic multipliers. These multipliers represent the relationship between the direct expenditure associated with a project and economic changes. The EIA assessed the additional effects from further rounds of spending in the supply chain but has not included a consumption effect (Type II), which may result from consumer spending generated in the region.

Construction Phase Impact Results

Direct economic benefits during the construction / development phase of the proposed development are identified in the form of employment and value-added benefits. These direct benefits, in turn, generate flow on (multiplier or indirect) benefits, which also benefit the regional and state economies.

Project Expenditure

Total expenditure estimates for the proposed development have been provided by Dahua Group and calculated from Rawlinsons (2025). The total estimated capital investment value of the entire development is $3,436 million (excluding GST). For the purposes of assessing economic impacts, however, GST must be included. As such, the development is estimated to generate approximately $3,779 million of direct expenditure (Economic Output) including GST for the local, regional and state economic localities. The project has an estimated construction period of nine years, completing in 2033, for the purposes of modelling the construction phase economic benefit.

Construction Phase Local Economic Impact – Campbelltown LGA

Employment Benefits

New jobs will be supported during the development phase through direct expenditure on the proposed development. The direct (mostly on-site construction jobs) calculated by REMPLAN from the project expenditure estimated from the breakdown of land uses provided by Dahua Group and indirect employment benefits according to the REMPLAN analysis are shown below:

- Direct Jobs = 632 jobs over a year
- Indirect Jobs = 640 over a year
- Total Jobs = 1,271 over a year.

Wages and Salaries

The new jobs on site will support Wages/Salary growth throughout the development phase. The direct Wages and Salaries are calculated from largely on-site construction jobs and indirect employment benefits (supply chain wages and salaries) according to the REMPLAN analysis are shown below:

- Direct Wages and Salaries = $578.2 million over a year

- Indirect Wages and Salaries = $557.3 million over a year
- Total Wages and Salaries = $1,135.5 million over a year

Economic Growth Value-Added Benefits

Value-added benefits will be generated from the direct expenditure incurred on the proposed development. Value-Added data represents the marginal economic value that is added by each industry sector in a defined region. Value-Added can be calculated by subtracting local expenditure and expenditure on regional imports from the output generated by an industry sector, or alternatively, by adding the Wages and Salaries paid to local employees, the gross operating surplus and taxes on products and production. Value-Added by industry sector is the major element in the calculation of Gross Regional Product. The direct and indirect value-added benefits are shown below:

- Direct Value-Added = $9,345.4 million
- Indirect Value-Added = $8,773.7 million
- Total Value-Added = $18,119.1 million.

Table 9 Local Construction Economic Impacts

	Direct	Indirect	Total
Project Expenditure ($M)	$3,779.2	-	$3,779.2
Avg Employment Per Annum (Peak Jobs)	632 jobs over a year	640 over a year	1,271 over a year
Value-Added ($M)	$9,345.4	$8,773.7	$18,119.1

Source: Remplan, Urbis

Construction Phase Regional Economic Impact – Greater Sydney

Employment Benefits

New jobs will be supported during the development phase through direct expenditure on the proposed development. The direct (mostly on-site construction jobs) calculated by REMPLAN from the project expenditure estimated from the breakdown of land uses provided by Dahua Group and indirect employment benefits according to the REMPLAN analysis are shown below:

- Direct Jobs = 583 jobs over a year
- Indirect Jobs = 788 over a year
- Total Jobs = 1,371 over a year.

Wages and Salaries

The new jobs on site will support Wages/Salary growth throughout the development phase. The direct Wages and Salaries are calculated from largely on-site construction jobs and indirect employment benefits (supply chain wages and salaries) according to the REMPLAN analysis are shown below:

- Direct Wages and Salaries = $550.7 million over a year
- Indirect Wages and Salaries = $717.1 million over a year
- Total Wages and Salaries = $1,267.8 million over a year

Value-Added Benefits

Value-added benefits will be generated from the direct expenditure incurred on the proposed development. Value-Added data represents the marginal economic value that is added by each industry sector in a defined region. Value-Added can be calculated by subtracting local expenditure and expenditure on regional imports from the output generated by an industry sector, or by adding the Wages & Salaries paid to local employees, the gross operating surplus and taxes on products and production. Value-Added by industry sector is the major element in the calculation of Gross Regional Product. The direct and indirect value-added benefits are shown below:

- Direct Value-Added = $9,001.0 million
- Indirect Value-Added = $11,505.4 million
- Total Value-Added = $20,506.4 million.

Table 10 Regional Construction Key Economic Impacts

	Direct	Indirect	Total
Project Expenditure ($M)	$3779.2	-	$3,779.2
Avg Employment Per Annum (Peak Jobs)	583 jobs over a year	788 over a year	1,371 over a year
Value-Added ($M)	$9,001.0	$11,505.4	$20,506.4

Source: Remplan, Urbis

Construction Phase State Economic Impact - NSW

Employment Benefits

New jobs will be supported during the development phase through direct expenditure on the proposed development. The direct (mostly on-site construction jobs) calculated by REMPLAN from the project expenditure estimated from the breakdown of land uses provided by Dahua Group and indirect employment benefits according to the REMPLAN analysis are shown below:

- Direct Jobs = 617 jobs over a year
- Indirect Jobs = 872 over a year
- Total Jobs = 1,489 over a year.

Wages and Salaries

The new jobs on site will support Wages/Salary growth throughout the development phase. The direct Wages and Salaries are calculated from largely on-site construction jobs and indirect employment benefits (supply chain wages and salaries) according to the REMPLAN analysis are shown below:

- Direct Wages and Salaries = $557.5 million over a year
- Indirect Wages and Salaries = $781.0 million over a year
- Total Wages and Salaries = $1,338.5 million over a year

Value-Added Benefits

Value-added benefits will be generated from the direct expenditure incurred on the proposed development. Value-Added data represents the marginal economic value that is added by each industry sector in a defined region. Value-Added can be calculated by subtracting local expenditure and expenditure on regional imports from the output generated by an industry sector, or by adding the Wages & Salaries paid to local employees,

the gross operating surplus and taxes on products and production. Value-Added by industry sector is the major element in the calculation of Gross Regional Product. The direct and indirect value-added benefits are shown below:

- Direct Value-Added = $9,119.9 million
- Indirect Value-Added = $12,639.3 million
- Total Value-Added = $21,759.2 million.

Table 11 State Construction Key Economic Impacts

	Direct	Indirect	Total
Project Expenditure ($M)	$3,779.2	-	**$3,779.2**
Avg Employment Per Annum (Peak Jobs)	617 jobs over a year	872 over a year	**1,489 over a year**
Value-Added ($M)	$9,119.9	$12,639.3	**$21,759.2**

Source: Remplan, Urbis

2.3. OPERATIONAL PHASE IMPACTS

Impact Modelling Methodology

Operational impacts have been assessed based on the benefits and costs attributable to operational costs and employment generation.

- ***Direct impacts*** are the initial round of economic output, employment and household income generated by an economic activity.
- ***Indirect impacts*** are the sum of production-induced (i.e. supply chain) effects and consumption-induced effects. Production-induced effects (Type I) are additional output, employment and household income resulting from re-spending by firms that receive payments from the sale of services to firms undertaking production.

The modelling assessed:

- ***Economic activity*** – the total dollar amount impact (or contribution to gross domestic product);
- ***Employment*** – the full-time equivalent per annum employment generated by the project (referenced as FTE job years);
- ***Wages/Salaries*** – the wages and salaries generated by the project
- ***Value-added*** – the value added to materials and labour expended on the project; and
- ***Supply chain impacts*** – the value of further spending in the supply chain.

Table 12 Operational Phase Impact Modelling Steps

Task	Description
Estimate Direct Impacts	Economic output of the development has been estimated based on the estimated ongoing jobs supported by each land use. Estimated ongoing jobs is based on applying workspace ratios to the GFA component of each land use. Workspace ratios are based on surveys performed by the City of Sydney, with the most appropriate workspace ratio being applied for each land use.
Calculate Consumption and Supply Chain (Indirect) Impacts	This study used an Economic Impact Assessment (EIA) approach to estimate the impact of the operational phase of the project. At the core of EIAs are Input–Output (IO) tables. IO tables are part of the national accounts by the ABS and provide detailed information about the supply and use of products in the Australian economy, and the structure of and inter–relationships between Australian industries. IO tables are converted, through statistical analysis, into a series of economic multipliers. These multipliers represent the relationship between the direct expenditure associated with a project. The EIA assessed the additional effects from further rounds of spending in the supply chain but has not included a consumption effect (Type II), which may result from consumer spending generated in the region.

Table 13 Employment Calculations

Land Use	Proposed GFA (sq.m) /number	Workspace Ratio	FTE Total Jobs^
Residential	▪ 2,649 houses ▪ 646 Terraces ▪ 400 apartments	2,899.7	140
Commercial Community and Administration	3,000 sq.m	13	231
Retail	25,000 sq.m	42	595
Two Schools	36,000 sq.m	150	240
Industrial/Warehouses	128,189 sq.m	94.1	1,362

Source: Dahua Group, Rawlinsons, City of Sydney and Urbis

Operational Phase Impact Results

When construction of the proposed development is complete, the development will support new jobs in the form of staff required to operate the facilities at the town centre, employment lands and schools as well as the maintenance and service jobs created by the residential development. This direct employment benefit will also have a direct Value-Added benefit and supply chain flow on effects felt through the economy. This component of the study has assessed the operational phase impacts on an annual basis. The following impacts have been modelled for the operational phase of the completed development.

Operational Phase Local Economic Impact – Campbelltown LGA

Employment Benefits

The finished proposed development could require up to 2,568 FTE employees on site. The proposed operations could support 904 additional jobs supplying industries throughout the Campbelltown LGA.

Therefore, total employment generated from the operational phase could be in the order of 3,472 jobs ongoing throughout the operational phase.

- Direct Jobs = 2,568 over a year
- Indirect Jobs = 904 over a year
- Total Jobs = 3,472 over a year

Wages and Salaries

The jobs created on an ongoing basis at the Menangle Park Site will create direct and indirect salaries and wages. These are calculated by REMPLAN as follows:

- Direct Wages/Salaries = $244.0 per year
- Indirect Wages/Salaries = $89.9 per year
- Total Wages/Salaries = $333.9 per year

Value-Added Benefits

The direct ongoing employment of 2,568 FTE jobs at the facility has the potential to support direct GVA of up to $410.6 million in each year of operation.

This direct employment and economic benefit, in turn, can support up to $160.8 million in supply chain GVA across the Region each year. Indirect (Supply chain) GVA reflects increased economic activity in supporting and supplying businesses because of jobs and output from the facility. Therefore, the total economic benefit from the operational phase could be on the order of $571.4 million in GVA in each year of operation.

- Direct Value-Added = $410.6 million per year
- Indirect Value-Added = $160.8 million per year
- Total Value-Added = $ 571.4 million per year.

Table 14 Operational Phase Local Economic Impacts per year

	Direct	Indirect	Total
Jobs (FTE)	2,568	904	3,472
Wages/Salaries ($M)	$244.0	$89.9	$333.9
Value-Added ($M)	$410.6	$160.8	$571.4

Source: Remplan, Urbis

Operational Phase Regional Economic Impact – Greater Sydney

Employment Benefits

The finished proposed development could require up to 2,568 FTE employees on site. The proposed operations could support 1,299 additional jobs supplying industries throughout the Greater Sydney Region. Therefore, total employment generated from the operational phase could be in the order of 3,867 jobs ongoing throughout the operational phase.

- Direct Jobs = 2,568 over a year
- Indirect Jobs = 1,299 over a year
- Total Jobs = 3,867 over a year

Wages and Salaries

The jobs created on an ongoing basis at the Menangle Park Site will create direct and indirect salaries and wages. These are calculated by REMPLAN as follows:

- Direct Wages/Salaries = $257.3 per year
- Indirect Wages/Salaries = $137.4 per year
- Total Wages/Salaries = $394.7 per year

Value-Added Benefits

The direct ongoing employment of 2,568 FTE jobs at the facility has the potential to support direct GVA of up to $426.9 million in each year of operation for the Region.

This direct employment and economic benefit, in turn, can support up to $251.8 million in supply chain GVA across the region each year. Indirect (Supply chain) GVA reflects increased economic activity in supporting and supplying businesses because of jobs and output from the facility. Therefore, the total economic benefit from the operational phase could be on the order of $678.7 million in GVA in each year of operation.

- Direct Value-Added = $426.9 million per year
- Indirect Value-Added = $251.8 million per year
- Total Value-Added = $678.7 million per year.

Table 15 Ongoing Regional Economic Impacts per year

	Direct	Indirect	Total
Jobs (FTE)	2,568	1,299	3,867
Wages/Salaries ($M)	$257.3	$137.4	$394.7
Value-Added ($M)	$426.9	$251.8	$678.7

Source: Remplan, Urbis

Operational Phase State Economic Impact - NSW

Employment Benefits

The finished proposed development could require up to 2,568 FTE employees on site. The proposed operations could support 1,344 additional jobs supplying industries throughout the State. Therefore, total employment generated from the operational phase could be in the order of 3,912 jobs ongoing throughout the operational phase.

- Direct Jobs = 2,568 over a year
- Indirect Jobs = 1,344 over a year
- Total Jobs = 3,912 over a year

Wages and Salaries

The jobs created on an ongoing basis at the Menangle Park Site will create direct and indirect salaries and wages. These are calculated by REMPLAN as follows:

- Direct Wages/Salaries = $254.6 per year
- Indirect Wages/Salaries = $141.3 per year
- Total Wages/Salaries = $395.9 per year

Value-Added Benefits

The direct ongoing employment of 2,568 FTE jobs at the facility has the potential to support direct GVA of up to $420.0 million in each year of operation in NSW.

This direct employment and economic benefit, in turn, can support up to $258.7 million in supply chain GVA across NSW each year. Indirect (Supply chain) GVA reflects increased economic activity in supporting and

supplying businesses because of jobs and output from the facility. Therefore, the total economic benefit from the operational phase could be on the order of $678.7 million in GVA in each year of operation.

- Direct Value-Added = $420.0 million per year
- Indirect Value-Added = $258.7 million per year
- Total Value-Added = $678.7 million per year.

Table 16 Operational Phase Local Economic Impacts per year

	Direct	Indirect	Total
Jobs (FTE)	2,568	1,344	3,912
Wages/Salaries ($M)	$254.6	$141.3	$395.9
Value-Added ($M)	$420.0	$258.7	$678.7

Source: Remplan, Urbis

3. SOCIAL IMPACT ASSESSMENT

The economic and social impact assessment approach used for this ESIS follows the SIA Guideline on evaluating the likely significance of positive and negative impacts across social categories.

This ESIS has identified a range of key social impacts relevant to near neighbours, local community residents, and other key stakeholders regarding the Development. Mitigation and management measures have been recommended against each identified impact. The identified potential impacts must be ground-truthed and reviewed against changes associated with further design development as the Development progresses.

Considering the status of this Development and from a planning and delivery perspective, several of the identified social impacts have been previously identified and addressed. This is reflected in:

- A Local and State Planning Agreement ensuring delivery and funding of social infrastructure, including a network of parks, roads, community spaces, sports fields and ecology retention;
- Design Guidelines that address future vegetation and Urban Heat Island Effect; and,
- Vegetation Management Plans with initial revitalisation of key ecology areas, revegetation and long-term preservation.

The delivery of the Development has progressed with the opening of Spring Farm Parkway and key intersection upgrades. Additional stages of the Development, including further road and intersection upgrades, have received development consent, and a park is currently under construction.

Table 17 Potential positive impacts

Social impact category	Potential Positive Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
Way of life	Increased access to social infrastructure for current and future residents, workers and visitors	The Development will introduce a new population to Menangle Park, which will require access to a range of social infrastructure and services to cater to their diverse needs, including education facilities, health services, and open and recreational spaces. A Social Infrastructure and Open Space Needs Assessment was prepared as part of the Subject Site's Planning Proposal (November 2018) to understand likely future social infrastructure needs and inform the approved Master Plan.	Regional	High	Undertake proactive community engagement, to better understand and verify the needs for community services and activities for both the current and future communities which could be accommodated within the planned social infrastructure.

Social impact category	Potential Positive Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		As such, the Development will increase access to social infrastructure for the community with plans to provide a local and neighbourhood centre, sporting fields and parks, an integrated passive recreation area within a riparian corridor network, community facilities and a new public primary school and catholic high school.			
Way of life	Precinct activation and realisation of state strategic plans	Realising state strategic plans through precinct activation could drive significant social and economic benefits in Menangle Park. The influx of infrastructure, residents and workers into Menangle Park could transform the existing rural residential areas into vibrant, functional spaces that provide safe living environments, enhance local amenities, create job opportunities, and foster a sense of community pride. Alignment with state strategic plans ensures that development is sustainable, inclusive, and responsive to the needs of the current and future NSW population, ultimately contributing to a more dynamic and resilient urban environment. The delivery of social infrastructure, as detailed in the previous impact, will create destinations for activity.	Local	High	Undertake proactive community engagement, to better understand and verify community aspirations for precinct activation and identify opportunities for social infrastructure and local centres to optimise precinct activation (e.g. community events, markets, music or cultural events, outdoor cinema, etc.)
Way of life	Increased access to a diversity of housing types	Increased access to diverse housing types fosters inclusive and thriving communities. The proposed development will have a diversity of lot type units, townhouses and detached lots 250- 750 sqm and large rural lots. The Development will contribute to a more balanced and varied housing market, providing options that accommodate different income levels and lifestyle	State	Medium	There are opportunities to enhance the positive impacts and improve the on-site amenity for future residents by providing a diversity of housing types to support a range of household sizes.

Social impact category	Potential Positive Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		preferences. By catering to a variety of housing type needs, the Menangle Park community can foster social cohesion and enrich community life. Greater access to diverse housing options can also help address the demand for new housing in NSW, thereby alleviating pressure on the housing market.			
Way of life	Opportunity to provide a range of housing price options	While no formalised affordable housing is proposed, the Development would deliver a diversity of housing types with a range of price options. Demographic trends in south-west Sydney suggest that greenfield developments typically support a greater variety of individuals and families with varying socio-economic levels, given the variety of housing types and price points.	Regional	Neutral	There are opportunities to enhance the positive impacts and improve the on-site amenity for future residents by providing a diversity of housing types to support a range of household sizes.
Community	Change to community character and cohesion, including mixing with the upcoming and existing community, increased diversity	The introduction of new residents and workers to an existing community is likely to change the existing community character and cohesion. The Development will need to consider design and operational measures to encourage the formation of new community connections amongst incoming residents, workers and visitors, as well as between new residents and existing residents in Menangle Park. This will support the development of a new community character which is inclusive of the diverse community the Development is likely to introduce to Menangle Park.	Local	Medium	Use public or event spaces to host events like community markets, youth engagement programs or sports and picnic days to promote community identity. Create spaces for shared ownership and stewardship, such as community gardens, to foster community cohesion.
Community	Change to demographic profile of Menangle Park	The Development would introduce a large population that is likely to result in changes to the existing community's demographic profile. This could impact on the community's composition, how it functions	Local	Low	At the detailed design stage of planned social infrastructure, ensure that spaces are designed to cater to the needs of a

Social impact category	Potential Positive Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		day to day and the social infrastructure and services needed to support all demographic groups. Considering the Development and demographic trends in south-west Sydney, these changes are likely to result in a greater diversity of cultural backgrounds, socio-economic levels and household composition. The overall increase in population numbers will also change the community's average age groups. The Development's Voluntary Planning Agreement (VPA) contains various triggers to ensure the timely provision of social infrastructure as the community grows. This also provides opportunities for social infrastructure to be developed in response to emerging demographic trends in the community as residents move in.			diverse community and foster interactions between different demographic groups. This includes the provision of spaces that support multi-generational groups, such a multipurpose community spaces and the co-location of facilities and services.
Access	Increased vehicular access and connectivity	The Development will expand the existing road network within Menangle Park, increasing vehicular access and connectivity across the suburb. Improved road networks will positively impact individuals' connectivity via private vehicles to jobs, education, commercial precincts, and recreation and leisure activities. The Development will also need to consider strategies to reduce the risk of creating a car dependent community. The Master Plan responds to this risk through the planned provision of cycleways, footpaths with tree canopy coverage and a network of local parks to provide areas for rest during potentially long journeys from residential areas to the local centre, school, employment or recreation areas.	Local	Low	Ensure all future residents and workers are provided with a Green Travel Plan to optimise vehicular connectivity and encourage active and public transport utilisation.

Social impact category	Potential Positive Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		A Transport Impact Assessment has been prepared for the Subject Site to ensure the Development's Road network will increase vehicular connectivity, while also encouraging public and active transport usage.			
Culture	Opportunities to celebrate local Aboriginal history and culture through the built environment	Celebrating local Aboriginal history and culture through the built environment can enrich community identity and cohesion. This both honours the traditional custodians of the land and promotes inclusivity, education, and a sense of pride among all community members. The Dharawal people, as the traditional custodians with an ongoing connection to Country, present an opportunity for the Development to acknowledge and celebrate their connection to Country. An Aboriginal Cultural Heritage Assessment Report (ACHAR), Connecting with Country and Designing with Country reports were prepared for the Subject Site to identify opportunities to celebrate the local Aboriginal history and culture through the built environment and landscaping.	Local	Medium	Proactively engage Aboriginal stakeholders as part of the engagement process and perform a walk on Country for the project team to understand the Aboriginal history of the Subject Site and region. In consultation with Aboriginal stakeholders, further explore opportunities for spaces designed to celebrate the local Aboriginal history and culture, such as Aboriginal public art, yarning circles, and an Aboriginal community garden, amongst others.
Health and wellbeing	Healthy built environment to promote healthy lifestyles (footpaths, active transport)	The development of a new master planned community provides an opportunity to deliver a built environment that support healthy lifestyles and active communities. The Development will deliver a healthy built environment through the provision of high-quality footpaths, cycleways, walkable neighbourhoods, linear green spaces, extensive tree canopy coverage, access to open spaces and free to access recreation spaces, including outdoor gyms and dog parks.	Local	Medium	No further recommendations identified.

Social impact category	Potential Positive Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		Opportunities to deliver a healthy built environment have been optimised through the preparation of an Urban Design and Landscape Design Reports, previously prepared for the Subject Site.			
Livelihoods	Local development and upskilling opportunities	The construction of the Development would require a large construction workforce. Dahua Group should consider opportunities to employ local construction companies, prioritising those with a greater social licence to operate, such as those that provide upskilling opportunities to vulnerable or minority groups (e.g., Aboriginal workers, students, or apprentices).	Regional	Medium	At the Construction Certificate stage, prioritise the procurement of local construction companies with a greater social licence to operate.
Livelihoods	Increased access to employment opportunities	The Development includes the provision of employment lands and local centres, which would support the provision of additional employment opportunities in Menangle Park. These employment opportunities are likely to provide a diverse mix of job opportunities that cater to a range of educational attainment levels, professional skill levels, and industries, thereby supporting the employment needs of the incoming population.	Regional	Medium	Support the provision of a diverse range of employment opportunities that are easily accessible for workers in Menangle Park and surrounding suburbs. In consultation with Transport for NSW, explore opportunities for providing additional bus services from Menangle Park train station to key employment areas.

Table 18 Potential negative impacts

Social impact category	Potential Negative Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
Community	Change to demographic profile.	The Development would introduce a large population, likely to result in changes to the existing community's demographic profile. This could impact the community's composition and how it functions on a day-to-day basis. Considering the Development and demographic trends in south-west Sydney, these changes are likely to result in a greater diversity of cultural backgrounds, socio-economic levels and household composition. The overall increase in population numbers will also change the community's average age groups. The Development's VPA contains various triggers to ensure the timely provision of social infrastructure as the community grows. This also provides opportunities for social infrastructure to be developed in response to emerging demographic trends in the community as residents move in.	Local	Low	Consider engaging the community and stakeholders to develop a Community Benefits Strategy that supports local community initiatives. At the detailed design stage of planned social infrastructure, ensure that spaces are designed to cater to the needs of a diverse community and foster interactions between different demographic groups. This includes the provision of spaces that support multi-generational groups, such a multipurpose community spaces and the co-location of facilities and services.
Access	Increase pressure on public transport and the road network	The incoming residential and employee population generated by the Development would likely increase pressure on the existing public transport and road network, particularly during peak travel to work periods (7am-9am and 4pm-7pm). Consideration will need to be given to existing capacity on the SHL to ensure it can accommodate the transport needs of the incoming population. Providing frequent access to public transport from	Regional	Medium	In consultation with Transport for NSW, explore opportunities to increase the frequency of train services on the SHL to meet the residents and worker needs of the incoming population. Ensure a Green Travel Plan, or equivalent, is provided to all incoming

Social impact category	Potential Negative Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		the outset when residents and workers utilise Menangle Park, will ensure positive transport habits are formed from the beginning. Given the restricted access to public transport, it is also likely that individuals may choose to travel by private vehicle when undertaking daily activities instead. This will impact on existing levels of traffic on the Hume Highway, the primary road link to the rest of Greater Sydney. A Transport Impact Assessment was previously undertaken for the Subject Site to understand the likely impacts of the Development on the existing public transport and road network.			residents and workers to inform them of their public and active transport options when they move into the proposed development.
Access	Increased pressure on existing social infrastructure, depending on the timely provision of new social infrastructure	The incoming residents and worker population would require access to social infrastructure and services, such as education, childcare, health, and recreation facilities. This would require the timely provision of the proposed social infrastructure facilities, including the proposed school, childcare centre, local centre and parks. In the circumstance where residents and workers are living and working in the proposed development prior to the delivery of new social infrastructure, there is potential for increased pressure on existing social infrastructure. This would impact existing Menangle Park residents and their capacity to access these facilities as they currently do. This would also impact incoming residents and workers as they may be required to travel outside of the suburb to access the relevant social infrastructure and services to support their	Regional	Medium	Ensure that social infrastructure is delivered in accordance with the development triggers contained within the Development's VPA. This will ensure the timely provision of social infrastructure is aligned with when residents and workers are expected to move into the proposed development.

Social impact category	Potential Negative Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		diverse needs, thereby expanding the scale of impact. The Development's VPA has considered the above risk and contains various development triggers to ensure the timely provision of social infrastructure as the community grows.			
Culture	Potential disruption to sites of Aboriginal significance	The construction of any urban development should consider impacts on Aboriginal objects, the landscape, or the spiritual connection that Aboriginal people have with Country. Potential disruption to sites of significance can lead to a loss of cultural heritage, connection to Country, and identity for Indigenous communities. As the Subject Site is primarily a greenfield development with some existing properties, there is a possibility of uncovering Aboriginal archaeological finds during earthworks. The Dharawal people, have an ongoing connection to this country. An ACHAR Report and Archaeological Assessment Report have been previously prepared for the Subject Site to minimise potential impacts to sites of Aboriginal significance.	Local	Medium	Engage Indigenous communities early in the planning process to identify and protect these sites, including site due diligence via the Aboriginal Heritage Information Management System (AHIMS). Adopt an 'unexpected finds procedure' to reduce the potential for disruption to any unexpected potentially significant items identified on site.
Health and wellbeing	Increased urban heat through a loss of green space	An urban heat island occurs when natural land cover is replaced with dense concentrations of urban structures, such as roads, car parks and buildings, leading to increased temperature. The Development would transition greenfield land to an urban built environment, including hardstand areas, new roads, housing, employment lands, and other urban structures. This would result in a significant loss of existing green	Local	High	As the Development is developed, monitor the average temperature of the Subject Site to ensure a cool and comfortable urban environment is maintained for existing and future residents and workers.

Social impact category	Potential Negative Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		space, likely contribute to local urban heat, and may impact the health and well-being of existing and incoming residents and workers. Dahua Group engaged UNSW to undertake an urban heat island study to minimise the Development's contribution to urban heat. The findings of this Study informed the Development's Design Guidelines, which include design measures to reduce urban heat, such as ensuring all dwellings have light-coloured roofs to reflect heat and planting vegetation.			
Health and wellbeing	Amenity impacts during construction	The construction of the Development would impact local amenity for the immediate surrounding community. Emissions such as noise, vibration, dust, and construction activities involving heavy equipment, may affect individuals and vulnerable groups in the area, including their overall health and safety. For example, individuals with respiratory or mental health conditions that reduce their capacity to manage changes to their environment. A Noise and Vibrations Impact Assessment and Air Quality Impact Assessment were previously prepared for the Subject Site to minimise risk of amenity impacts generated during the proposed construction activities.	Local	Medium	Ensure all recommendations provided in the Noise and Vibrations Impact Assessment and Air Quality Impact Assessment are implemented prior to a construction certificate being issued.
Health and wellbeing	Potential risk of flooding impacting safety of residents	The Development is located on the Western Sydney floodplain. Given this, the Development's incoming resident population may experience concerns related to the potential risk of flooding. Feelings of uncertainty or lack of security	Regional	Low	Preparation of a Flood Emergency Response Plan to reduce the risk of flooding to people on site during a flood event. Ensure this Plan is

Social impact category	Potential Negative Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		relating to an individual's safety can impact on their mental and physical health and wellbeing.			distributed to all future landowners, residents and workers. Implement building practises and strategies to ensure resilience and safety from flooding. Proactively engage with the relevant government agencies and the community to understand the level of actual and perceived risk of flooding.
Surroundings	Change to local character	Changes to a community's local character may impact its social fabric and sense of identity. While new developments and modernisation can bring economic benefits and improved amenities, they can also alter the unique aesthetic and cultural elements that define the area. In line with the combined impacts of changed density, visual landscape, and community composition, the Development is likely to contribute to a change in local character. Long-term residents of Menangle Park and Campbelltown LGA would most acutely feel the change to local character.	Regional	Low	Consider opportunities to preserve a community's distinctive character by incorporating a range of public art that reflects local values into the building design and public realm areas. This will allow existing and incoming residents to form new connections to the Subject Site and, in turn, to the emerging local character. To explore these opportunities, consider preparing a Public Art Strategy and a local artist procurement strategy.
Surroundings	Community sentiments towards the Nepean River and Howes Creek and potential environmental impacts	The communities along the Nepean River and Howes Creek highly value their biodiversity and as a place for recreation and relaxation. The existing community has raised concerns broadly related to proposed	Local	Low	In accordance with the Development's Vegetation Management Plan, ensure works do not negatively impact the river, implement initiatives

Social impact category	Potential Negative Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		developments along these waterways and the potential environmental impacts on wildlife, riverbanks, and water quality from these developments. There is potential for the community to share similar sentiments towards the Development. Dahua Group has considered the significance of these waterways and has developed a Vegetation Management Plan to minimise potential impacts associated with the Development and to ensure their long-term conservation and maintenance.			to maintain and improve biodiversity, and promote and enhance opportunities for activation along the river. Proactively engage with the existing community to understand local priorities and aspirations for the Nepean River and Howes Creek.
Decision-making systems	A perceived lack of communication and communication channels between Dahua Group and the incoming community	The ability to contribute to or influence the decision-making process is a fundamental aspect of the social impact Development could generate. Important decisions about the built environment can adversely affect how people interact and live within communities. Ensuring people are effectively informed about development changes is critical to reducing feelings of uncertainty and fear. Developing avenues for people to provide input and further providing a platform for face-to-face consultation is essential to build trust and support from the community.	Local	Medium	Develop and implement a communication strategy that enables residents to provide feedback throughout the construction period. Continue providing ongoing community communication and engagement throughout all planning, design, construction and operation phases. Demonstrate how community concerns and ideas have been addressed and incorporated into the development plans during the design phase.
Cumulative impacts	Construction fatigue	Cumulative construction impacts can occur with state-wide development plans across Western Sydney. This could include impacts on people's way of life, surroundings, health, and wellbeing, as well as accessibility due to	Regional	Medium	To minimise the potential for cumulative social impacts during construction, implement a communication strategy to keep the public

Social impact category	Potential Negative Impact	Description	Scale (local, regional, state)	Potential impact significance (low, medium, high)	Recommended mitigations and benefit optimisation measures
		increased noise, air quality, vibrations, traffic, and any changes to the pedestrian network. Given the scale of development planned for this area and proximity to the highway, the communities most impacted by cumulative social impacts associated with construction would be current and incoming residents and visitors to the immediate and surrounding social locality. To minimise construction-related impacts and the risk of construction fatigue, a Construction Noise and Vibration Management Plan and Traffic Assessment and Management Plan were previously preprepared for the Subject Site.			informed and ensure all recommendations provided within the Construction Noise and Vibration Management Plan and Traffic Assessment and Management Plan are implemented before a construction certificate is issued. Where possible, coordinate construction activities and reduce disruption to the surrounding community's everyday life, including continuous access to pedestrian pathways and main roads and consultation mechanisms (e.g., complaints handling procedures) as appropriate.
Cumulative impacts	Community consultation fatigue	Community consultation fatigue may result from frequent engagement or several developments occurring over a short period that require stakeholder and community engagement with the same groups and individuals. This can lead to decreased engagement and trust in the process, resulting in lower participation rates, community frustration, and the underrepresentation of marginalised groups.	Regional	Medium	Develop and implement an integrated Engagement and Communication Strategy to ensure the community is well-informed and demonstrates tangible outcomes from community inputs. Monitor community sentiment to address any social risk and maintain social license proactively.

DISCLAIMER

This report is dated 26 May 2025 and incorporates information and events up to that date only and excludes any information arising, or event occurring, after that date which may affect the validity of Urbis Ltd **(Urbis)** opinion in this report. Urbis prepared this report on the instructions, and for the benefit only, of Dahua Group Sydney Project 2 Pty Ltd **(Instructing Party)** for the purpose of ESIS **(Purpose)** and not for any other purpose or use. To the extent permitted by applicable law, Urbis expressly disclaims all liability, whether direct or indirect, to the Instructing Party which relies or purports to rely on this report for any purpose other than the Purpose, and to any other person which relies or purports to rely on this report for any purpose whatsoever (including the Purpose).

In preparing this report, Urbis was required to make judgements which may be affected by unforeseen future events, the likelihood and effects of which are not capable of precise assessment.

All surveys, forecasts, projections and recommendations contained in or associated with this report are made in good faith and on the basis of information supplied to Urbis at the date of this report, and upon which Urbis relied. Achievement of the projections and budgets set out in this report will depend, among other things, on the actions of others over which Urbis has no control.

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This report has been prepared with due care and diligence by Urbis and the statements and opinions given by Urbis in this report are given in good faith and in the reasonable belief that they are correct and not misleading, subject to the limitations above.

APPENDIX A SIA GUIDELINE METHODOLOGY

The methodology for the assessment of social impacts follows guidance provided in the NSW Department of Planning, Housing and Infrastructure's (DPHI) Social Impact Assessment (SIA) Guideline (2023).

The SIA Guideline states that the assessment of social impacts should consider the likely changes to the social elements of value to people outlined in Table 19 below.

Table 19 Social impact category definitions

Social impact category	Definition
Way of life	Including how people live, how they get around, how they work, how they play, and how they interact each day
Community	Including composition, cohesion, character, how the community functions and people's sense of place
Accessibility	Including how people access and use infrastructure, services and facilities, whether provided by a public, private or not-for-profit organisation
Culture	Both Aboriginal and non-Aboriginal, including shared beliefs, customs, values and stories, and connections to Country, land, waterways, places and buildings
Health and wellbeing	Including physical and mental health especially for people vulnerable to social exclusion or substantial change, psychological stress resulting from financial or other pressures, and changes to public health overall
Surroundings	Including ecosystem services such as shade, pollution control, and erosion control, public safety and security, access to and use of the natural and built environment, and aesthetic value and amenity
Livelihoods	Including people's capacity to sustain themselves through employment or business, whether they experience personal breach or disadvantage, and the distributive equity of impacts and benefits
Decision-making systems	Particularly whether people experience procedural fairness, can make informed decisions, can meaningfully influence decisions, and can access complaint, remedy and grievance mechanisms.

Source: SIA Guideline (DPHI 2023, p.19)

Each impact is assessed following the risk assessment methodology applied in the SIA Guideline Technical Supplement, whereby the significance of each potential social impact is assessed by comparing the magnitude of the impact against the likelihood of the impact occurring.

Table 20 Significance matrix

		Magnitude level				
		1	2	3	4	5
Likelihood level		Minimal	Minor	Moderate	Major	Transformational
A	Almost certain	Low	Medium	High	Very high	Very high
B	Likely	Low	Medium	High	High	Very high
C	Possible	Low	Medium	Medium	High	High
D	Unlikely	Low	Low	Medium	Medium	High
E	Very unlikely	Low	Low	Low	Medium	Medium

Source: DPHI, 2023, SIA Guideline: Technical Supplement, p. 13

Table 21 Likelihood levels

Level	Definition
Almost certain	Definite or almost definitely expected (e.g. has happened on similar projects)
Likely	High probability
Possible	Medium probability
Unlikely	Low probability
Very unlikely	Improbable or remote probability

Source: SIA Guideline: Technical Supplement (DPHI 2023, p. 12)

Table 22 Magnitude levels

Magnitude level	Meaning
Transformational	Substantial change experienced in community wellbeing, livelihood, infrastructure, services, health, and/or heritage values; permanent displacement or addition of at least 20% of a community.
Major	Substantial deterioration/improvement to something that people value highly, either lasting for an indefinite time, or affecting many people in a widespread area.
Moderate	Noticeable deterioration/improvement to something that people value highly, either lasting for an extensive time, or affecting a group of people.
Minor	Mild deterioration/improvement, for a reasonably short time, for a small number of people who are generally adaptable and not vulnerable.
Minimal	Little noticeable change experienced by people in the locality.

Source: SIA Guideline: Technical Supplement (DPHI 2023, p. 13)

Table 23 Dimensions of social impact magnitude

Dimension	Explanation
Extent	Who specifically is expected to be affected (directly, indirectly, and/or cumulatively), including any vulnerable people? Which location(s) and people are affected? (e.g., near neighbours, local, regional, future generations).
Duration	When is the social impact expected to occur? Will it be time-limited (e.g., over particular project phases) or permanent?
Intensity or scale	What is the likely scale or degree of change? (e.g., mild, moderate, severe)
Sensitivity or importance	How sensitive/vulnerable (or how adaptable/resilient) are affected people to the impact, or (for positive impacts) how important is it to them? This might depend on the value they attach to the matter; whether it is rare/unique or replaceable; the extent to which it is tied to their identity; and their capacity to cope with or adapt to change.
Level of concern / interest	How concerned/interested are people? Sometimes, concerns may be disproportionate to findings from technical assessments of likelihood, duration and/or intensity.

Source: SIA Guideline: Technical Supplement (DPHI 2023, p. 12)

Mitigation and enhancement measures

Social impacts are assessed before and after the implementation of mitigation measures (for negative social impacts) and enhancement measures (for positive social impacts). These measures can take various forms and may be incorporated into the design, planning, construction, or operational stages of the proposed development.

APPENDIX B EIA GUIDELINE METHODOLOGY

The Economic Impact Assessment (EIA) assesses the potential economic impacts, whether positive or negative, expected to arise from a proposed development. Key components of the analysis include assessing impacts such as net employment benefits, net value-added benefits, and any other identified potential positive or negative impacts.

Analysis presented here uses REMPLAN economic modelling to assess current and potential economic impacts. REMPLAN is an Input-Output model that captures inter-industry relationships within an economy. It can assess the area-specific direct and flow-on implications across industry sectors in terms of employment, wages and salaries, output and value-added, allowing for analysis of impacts at the State level.

Key points regarding the workings or terminology of the model are as follows:

- REMPLAN uses either the value of investment or employment generation as the primary input. For this analysis, the value of total upfront investment has been used as the key input to assess the benefits of the construction phase.
- Outputs from the model include employment generated through the project and economic Gross Value-Added (GVA) at the State level
- Outputs from the model include employment generated through the project at both the local and the state level.
- Employment generated is calculated over the life of the construction phase; or in terms of the on-going operations, total on-going jobs generated.
- Both the direct and indirect employment are modelled:
    - *Direct* refers to the effect felt within the industry as a result of the investment. For example, the construction phase will directly result in the creation of construction jobs.
    - *Indirect* effects are those felt within industries that supply goods to the industries directly affected.
- It should be noted that the results presented in this report are estimates only based on the existing state of economic activity in the area. Due to the static nature of input-output modelling, they have the potential to overstate the actual effects. Nonetheless, the analysis still reflects the fact that employment growth will be positive for the State and the local area.
- Urbis consider that in the absence of the investment package it is unlikely that similar projects would be undertaken within the same period, and, therefore, the investments can be considered additional.
- Urbis assumed a breakdown of costs by industry sector based on industry knowledge.

SOURCES

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Rawlinsons (online), 2025 Digital Rawlinsons Construction Cost Guide, accessed 17 May 2025

REMPLAN (online), Economy, Campbelltown LGA, accessed 21 May 2025

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APPENDIX G :

DCCEEW Comments on Preliminary Documentation Report

Item	RFI Criteria	Sub-category	Present and Location	Department comments [July 2025 – emailed received 16 July]	Open OR Closed	Where addressed in Preliminary Documentation
1.0	**Overview and Formatting**					
1.1	The preliminary documentation must be able to be read as a standalone document and should enable interested stakeholders and the Minister for the Environment and Water (or delegate) to understand the impacts of the proposed action on relevant protected matters.		Present	No further action required.	Closed	
1.2	Relevant policies - Significant Impact Guidelines 1.1 - Other relevant EPBC Act policy statements and guidelines - All relevant guidance documents for determining, avoiding, mitigating and managing likely impacts on listed threatened species and communities - Offsets mitigation hierarchy		Present	No further action required.	Closed	
1.3	Format and Style		Present	No further action required.	Closed	
2.0	**Controlling Provisions - Listed threatened species and ecological communities**					
2.1	Extent within C15, C19 and C32	Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest threated ecological community (CPW TEC)	Present Section 2.2.2.1	No CPW TEC was identified within C15, C19 or C32. No further action required.	Closed	
2.2	CPW TEC against key diagnostic characteristics within the listing advice	CPW TEC	Present Section 3.1.1.1	No further action required.	Closed	
2.3	Identify PCTs and Vegetation Zones that align with the CPW TEC	CPW TEC	Present Section 3.1.1	Although not considered to meet the EPBC Act threshold, areas of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW) in the project area consist of two variants listed under the NSW Biodiversity Conservation Act 2016 (BC Act): Shale Hills Woodland and Shale Plains Woodland. No further action required.	Closed	
2.4	Extent of CPW TEC within C15, C19 and C32	CPW TEC	Present Section 3.1.1.1, Table 2	CPW TEC not identified during the survey of these areas. No further action required.	Closed	
2.5	Total area of CPW TEC (ha)	CPW TEC	Present Section 5.1.2, Figures 10 - Figure 15, Section 4.1.1, Table 4	No further action required.	Closed	
2.6	Map of CPW TEC – within and adjacent to project area	CPW TEC	Present Figure 9	No further action required.	Closed	
2.7	Undertake on-ground surveys for the species and its habitat.	Brown Treecreeper	Present Section 2.2.2.2	The department notes that the surveys were undertaken in 2021, with no updated data provided. No further action required.	Closed	
2.8	Determine the type(s) of habitat available (e.g. foraging, nesting, roosting) based on a habitat assessment against the SPRAT Database and relevant statutory documents.	Brown Treecreeper	Present Section 3.3.1	The department notes that foraging and nesting habitat has been identified within the project area. **Further information required** Provide a specific map that identifies the 17 ha of Brown Treecreeper habitat being impacted by the proposed action.	Open	This is provided in Figure 8. Justification for the removal of patches of habitat for the species is provided in Section 5.1.2.2 and Appendix H.
2.9	Describe the quality of each habitat type.	Brown Treecreeper	Present Section 3.3.1	Described as sub-optimal/highly disturbed. No further action required	Closed	
2.10	Describe and quantify key habitat features (e.g. water availability, hollow-bearing trees).	Brown Treecreeper	Present Section 3.3.1	The department notes that all patches of woodland/forest surveyed in the project area contained at least one remnant tree that contains hollows and therefore provides potential breeding habitat. No further action required.	Closed	
2.11	The total amount of habitat (in ha) within and adjacent to the project area. The amount of each habitat type (in ha) within and adjacent to the project area.	Brown Treecreeper	Present Sections 3.3.1, 4.1.2	No further action required.	Closed	

Item	RFI Criteria	Sub-category	Present and Location	Department comments [July 2025 – emailed received 16 July]	Open OR Closed	Where addressed in Preliminary Documentation
2.12	Describe whether the habitat in the project area is habitat critical to the survival of the species as described in the BT Conservation Advice.	Brown Treecreeper	Present Sections 3.3.1, 4.1.2	The draft PD indicates that it isn't considered critical habitat as it is highly disturbed and fragmented and has limited to no connectivity to larger patches of habitat. The draft PD justifies this conclusion, stating that the species is likely to utilise the suitable habitat to be cleared primarily for foraging purposes only and is considered more likely to utilize habitat within the retained areas for nesting purposes as these areas include larger tracts of vegetation that are less exposed to edge effects, as well as more hollow-bearing trees. It further states that literature for the Brown Treecreeper identifies that the species is unable to maintain viable populations in remnants of native vegetation less than 200 ha and its abundance decreases as remnant size decreases (Barret & Ford, 1994). Additionally, a detailed study of woodland patches on the New England Tablelands indicated that the species was absent from woodland patches less than 6 ha (Barrett 1994). No patches of potential habitat for the species to be removed from the project area are larger than 3 ha. **Department's consideration** As specified in the PD RFI, the department considers that the removal of 17 ha of foraging and nesting/roosting habitat for the Brown Treecreeper will adversely affect habitat critical to the survival of the species. Whilst the department acknowledges the literature in regard to minimum size of areas to maintain a viable population, based on the previous records of the species within the project area, the suitability of 17 ha of vegetation which forms nesting and foraging habitat within the project area, and an absence of recent surveys, the department still considers that the project area contains habitat critical to the survival of the species as described in the Conservation Advice for Climacteris picumnus victoriae (brown treecreeper (south-eastern) (2023).	Closed	
2.13	Provide any other relevant information describing the species' habitat.	Brown Treecreeper	Sections 3.3.1, 4.1.2	No further action required.	Closed	
3.0	**Impact Assessment**					
3.1	Updated assessment on the CPW TEC and Brown Treecreeper		Present Sections 4, 3.3.1	The department notes that the impact assessment remains consistent with the original referral documentation as no new areas of CPW TEC or Brown Treecreeper habitat has been identified. No further action required.	Closed	
3.2	Likely short-term and long-term impacts		Present Sections 4.1.2, 4.2.1, 4.4.5	No further action required.	Closed	
3.3	Quantify the total area of direct and indirect impacts (in ha)		Present Section 4	The department notes that the direct impacts have been quantified in hectares with indirect, whilst considered, have not been quantified. No further action required.	Closed	
3.4	Conservation areas where no buffers have been implemented?		Present Section 5.1.3	The department notes that Vegetation Management Plans have been proposed to manage any potential impacts to the conservation areas. No further action required.	Closed	
3.5	Consideration of the cumulative impacts with the CPCP		Present Section 4.3	No further action required.	Closed	
4.0	**Avoidance, mitigation and management measures**					
4.1	Updated information on specific and enforceable measures proposed to avoid, mitigate and manage each identified impact from the proposed action on CPW TEC and the Brown Treecreeper.		Present Section 5	The department notes the measures provided within the draft PD, which include avoidance (e.g. changes of layout, MNES removal rationale and ecological buffers), mitigation (e.g. CEMP) and compensation (offsets – credits and on-ground areas). **Further information required** Noting the department's consideration that there will be 17 ha of direct impacts to habitat critical to the survival of the Brown Treecreeper, provide any updated proposed measures to further avoid, mitigate and/or manage impacts on the Brown Treecreeper and its habitat. If no updated measures are proposed, please specify this in the draft PD and provide clear references to measures specific to the Brown Treecreeper in the referral documentation.	Open	The PD has been updated with a new commitement that 25% of all nest boxes installed within retained areas will be nest boxes specifically designed for the Brown Treecreeper. The PD has also been updated to specify how the proposed mitigation measures specifically address impacts to the Brown Treecreeper and its habitat. Changes are tracked throughout Chapter 5.

Item	RFI Criteria	Sub-category	Present and Location	Department comments [July 2025 – emailed received 16 July]	Open OR Closed	Where addressed in Preliminary Documentation
4.2	Outlines whether buffers will be implemented.		Present Section 5.1.3	The department acknowledges the implementation of buffer areas to MNES areas that remain for conservation purposes. The draft PD indicates that the minimum buffer area for the Elderslie Banksia Scrub Forest is 50 m, however based on the Conservation Advice for the Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion (page 9), the recommended minimum buffer zone is 30 m from the outer edge of the patch. Although the minimum has not been met completely for Park L (E1) and Park K (E4), the justification within the draft PD is considered sufficient. However, in regard to the patch E7 that is proposed to remain, there is insufficient justification to the lack of a minimum 30 m buffer. **Further information required** Provide justification for why a minimum 30 m buffer cannot be implemented around Elderslie Banksia Scrub Forest conservation area (patch E7) in accordance with the Conservation Advice.	Open	The PD has been updated to prouved justification as to why a minimum 30m buffer cannot be implemented around all areas of EBSF patch E7 located within the Stage 6B conservation area (refer to Section 5.1.3.3 and Figure 19.
4.3	Maps updated with buffer areas		Present Figures 15 to 17	No further action required.	Closed	
4.4	Development Consent conditions attached		Present Section 5.4	No further action required.	Closed	
4.5	CPCP commitments		Present Section 5.5	No further action required.	Closed	
5.0	**Residual significant impacts**					
5.1	Assessment undertaken with consideration of the information requested in this document and the Significant Impact Guidelines 1.1		Present Section 4.2	*CPW TEC* The assessment undertaken with consideration of the draft PD and the Significant impacts Guidelines 1.1 found that although the proposed action will reduce the extent of the CPW TEC, the retention and management of other areas in perpetuity, in addition to the use of biodiversity credits, will ensure that no significant impacts will occur. **Department's consideration** Environmental offsets do not mean that there will be no significant impacts on an MNES. Environmental offsets are compensation for residual significant impacts on MNES after consideration of avoidance, mitigation and management measures as outlined in the EPBC Act Environmental Offsets Policy (2012) (Offsets Policy). *Brown Treecreeper* The draft PD states that as there will be no impacts to an important population or habitat critical to the survival of the Brown Treecreeper, limited records in the area (2 recorded in 2018), patch sizes, retention areas and the sub-optimal habitat, there will be no significant impacts. **Department's consideration** *Brown Treecreeper* As stated above, the department considers that the proposed action will impact on 17 ha of habitat critical to the survival of the Brown Treecreeper. With consideration of the draft PD, and in accordance with the Offsets Policy and the Significant Impact Guidelines 1.1, the department considers that the proposed action will have a residual significant impact on the species. **Further information required** Undertake an updated residual significant impact assessment for the Brown Treecreeper with consideration of the updated avoidance, mitigation and management measures (if required).	Open	The PD includes an updated residual significant impact assessment (refer Section 4.2.2) that considers the avoidance, mitigation and management measures proposed specific to the Brown Treecreeper, including the new commitement to install nest boxes specifically designed for the Brown Treecreeper.
6.0	**Compensation measures (offsets)**					

Item	RFI Criteria	Sub-category	Present and Location	Department comments [July 2025 – emailed received 16 July]	Open OR Closed	Where addressed in Preliminary Documentation
6.1	Offsets are in accordance with the EPBC Act Environmental Offsets Policy 2012		Present Section 5.3.2	The department acknowledges that the NSW Threatened Species Conservation Act 1995 (TSC Act) was repealed and replaced by the NSW Biodiversity Conservation Act 2016 (BC Act) in August 2017; however, the associated Biodiversity Conservation (Savings and Transitional) Regulation 2017 includes a transitional period for the Campbelltown Local Government Area (LGA) which allows for developments to be assessed under the former planning provisions for a period of 18 months, starting 25 August 2017 and ending November 2019. As the DA for project area was submitted to Council within the transitional period, the DA was assessed under the former planning provisions, including the TSC Act. No further action required.	Closed	
6.2	Description of the proposed Offset Strategy that outlines how offsets will be achieved for each protected matter and the expect timeframe of their security.		Present Section 5.3.3	No further action required.	Closed	
6.3	How the offsets compare to the environmental outcomes of the CPCP		Present Section 5.5	No further action required.	Closed	
6.4	A summary of the proposed offsets for the residual significant impacts on relevant listed threatened species and ecological communities.	Endorsed offset frameworks	Present Section 5.3	The draft PD states that the offset commitments for the Brown Treecreeper include the establishment of the conservation areas (Parks K and L, the Stage 6B EBSF Conservation Area, and the Howes Creek and the Northern Conservation Area) for in perpetuity protection of viable, representative occurrences of habitat for this species. Additionally, a further 44 ha of native vegetation will be retained and managed under a VMP and a further 23 ha revegetated. Each of these areas are considered as potential habitat for the Brown Treecreeper and no additional offsets are required. **Department's consideration** The department acknowledges the information in the draft PD. However, based on the department's consideration that the proposed action will have a residual significant impact on the species, detailed offset information is required (similar to other MNES). **Further information required** Brown Treecreeper Provide updated data on the total area (ha) within the proposed development works, BBAM Credit Liability (credits), total area (ha) within the proposed conservation works and NSW Approval BBAM Credit Liability (credits) (similar to Table 7 of the draft PD).	Open	No credit liability for the Brown Treecreeper was included in the NSW approval. The Brown Treecreeper is an Ecosystem Credit Species under the BAM, but was a species credit under the BBAM. A review of the BioBanking public register identifies that no BBAM species credits are available for the species, nor has a species credit for the species ever been retired under the BBAM. With consideration of the above, even if a BBAM species credit liability was required for the Brown Treecreeper, there is no way that the credit obligation could be met as no credits exist. As all the TECs occuring in the project area potentially provide suitable habitat for the Brown Treecreeper, all the offsets established for these TECs will also directly benefit the Brown Treecreeper, which is consistent with the BAM and the projects NSW approval. Further details have been provided in Section 5.3.2 and 5.3.4.
6.5	Identify and describe suitable area/s for the proposed environmental offsets, including location, size and environmental values for relevant listed threatened species and/or ecological communities.	EPBC Act Environmental Offsets	Present Section 5.3.1, Figure 8	The draft PD states that if the requisite BBAM credits are not available, reasonable equivalency will be requested based on BBAM offset liability and payment of the requisite amount will be made for any outstanding offset liability into the Biodiversity Conservation Trust (BCT). Payment into the BCT will occur prior to issuing a Construction Certificate. **Further information required** Demonstrate that BBAM credits for relevant MNES are available in full. If not, clearly outline the: - available BBAM credits for each MNES; - outstanding offset liability for each MNES for payment into the BCT; and - provide a map that highlights the areas of Brown Treecreeper habitat being retained.	Open	This information is presented in Section 5.3.2 A map of Brown Treecreeper habitat is presented in Figure 8.
6.6	Demonstrate how the proposed environmental offsets meet the principles specified in the Offsets Policy and the OAG, including clearly justifying the scores entered into the OAG	EPBC Act Environmental Offsets	Present Section 5.6	No further action required.	Closed	
6.7	Directly contribute to the ongoing viability of the relevant listed threatened species and/or ecological communities to deliver an overall conservation outcome that improves or maintains the viability of the protected matter in the region, as compared to what is likely to have occurred under the status quo (i.e. if neither the proposed action nor the offset had taken place)	EPBC Act Environmental Offsets	Present Section 5.3	No further action required.	Closed	
6.8	Describe the proposed legal securing mechanism for the proposed environmental offsets	EPBC Act Environmental Offsets	Present Section 5.3	No further action required.	Closed	
6.9	Compensate for the residual significant impacts over the duration of the proposed action.	EPBC Act Environmental Offsets	Present Section 5.3	No further action required.	Closed	

Item	RFI Criteria	Sub-category	Present and Location	Department comments [July 2025 – emailed received 16 July]	Open OR Closed	Where addressed in Preliminary Documentation
6.10	Apply the 'S.M.A.R.T' Principle (Specific, Measurable, Achievable, Relevant, Time- Bound).	EPBC Act Environmental Offsets	Present Section 5.3.4	No further action required.	Closed	
7.0	**Principles of ecologically sustainable development (ESD)**					
7.1	The proposed action is consistent with each of the principles of ESD.		Present Section 6	No further action required.	Closed	
8.0	**Economic and social matters**					
8.1	Consideration of: - negative impacts (e.g. disruption to existing community infrastructure, environmental features, and/or cultural and traditional activities). - positive impacts (e.g., increased housing, employment, social amenity). - different scales of impact (e.g. local, regional, state).		Present Section 7, Appendix F	No further action required.	Closed	
8.2	Estimated capital value and ongoing economic value, using specific dollar or other numerical values where relevant.		Present Section 7, Appendix F	No further action required.	Closed	
8.3	Public consultation discussion, including first nations people and communities.		Present Section 7, Appendix F	No further action required.	Closed	
8.4	Discussion of any contributions for the proposed action (e.g. Commonwealth and/or State government funding).		Present Section 7, Appendix F	No further action required.	Closed	

APPENDIX H :

Brown Treecreeper Habitat Removal Rationale

Memorandum

To	Dahua Group	Date	1 August 2025
From	Graeme Fleming, Manager, Engineering, Urban Development, Parramatta	No. of pages	1 of 15
Reference	300178115.87.SitewideBEW_Memo_v2		
Subject	Menangle Park BEW DA – Brown Treecreeper Habitat		

SMEC are engaged by Dahua Group Australia as engineering consultants for the engineering design of the Sitewide Bulk Earthworks design at Menangle Park along with individual subdivision stage designs across the Menangle Park release area.

SMEC have been requested to review the existing ecology across the site associated with the habitat of the Brown Treecreeper. Refer to Figure 1 from Cumberland Ecology (SLR) – Habitat of Brown Treecreeper outlining the areas of vegetation proposed to be retained and removed.

Refer also to Figure 2 – Menangle Park Masterplan outlining the Subdivision Stages across the Release area.

This memo summarises the engineering justifications for proposed tree removals across various subdivision stages of the development. Each stage includes specific areas where trees must be cleared to accommodate critical infrastructure, grading requirements, or site reconfiguration. Associated diagrams or images have been included where available from the current engineering design plans.

Yours sincerely,



Graeme Fleming
Manager, Engineering, Urban Development, Parramatta

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If you have received this Memorandum in error, please contact the sender.

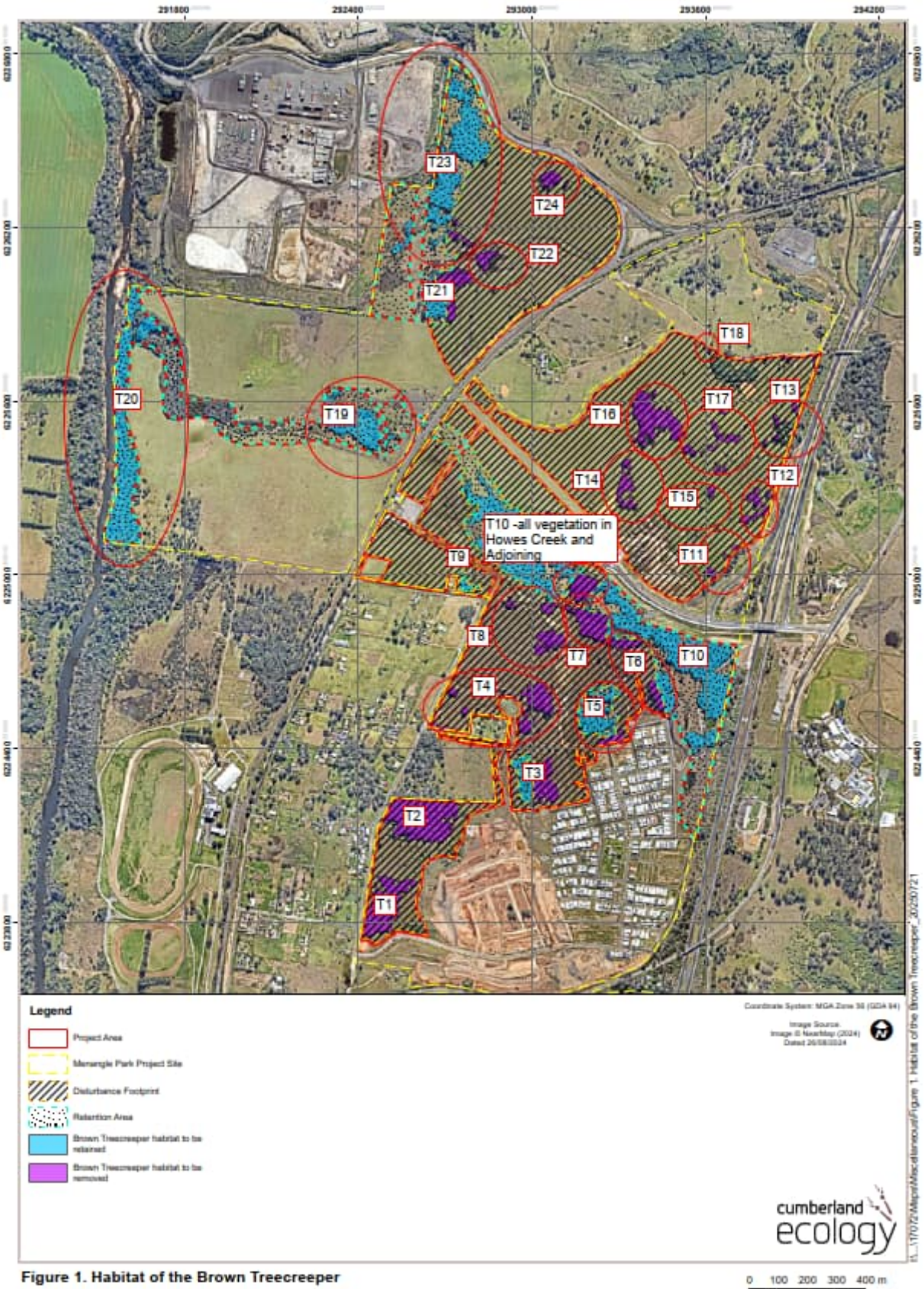


Figure 1. Habitat of the Brown Treecreeper

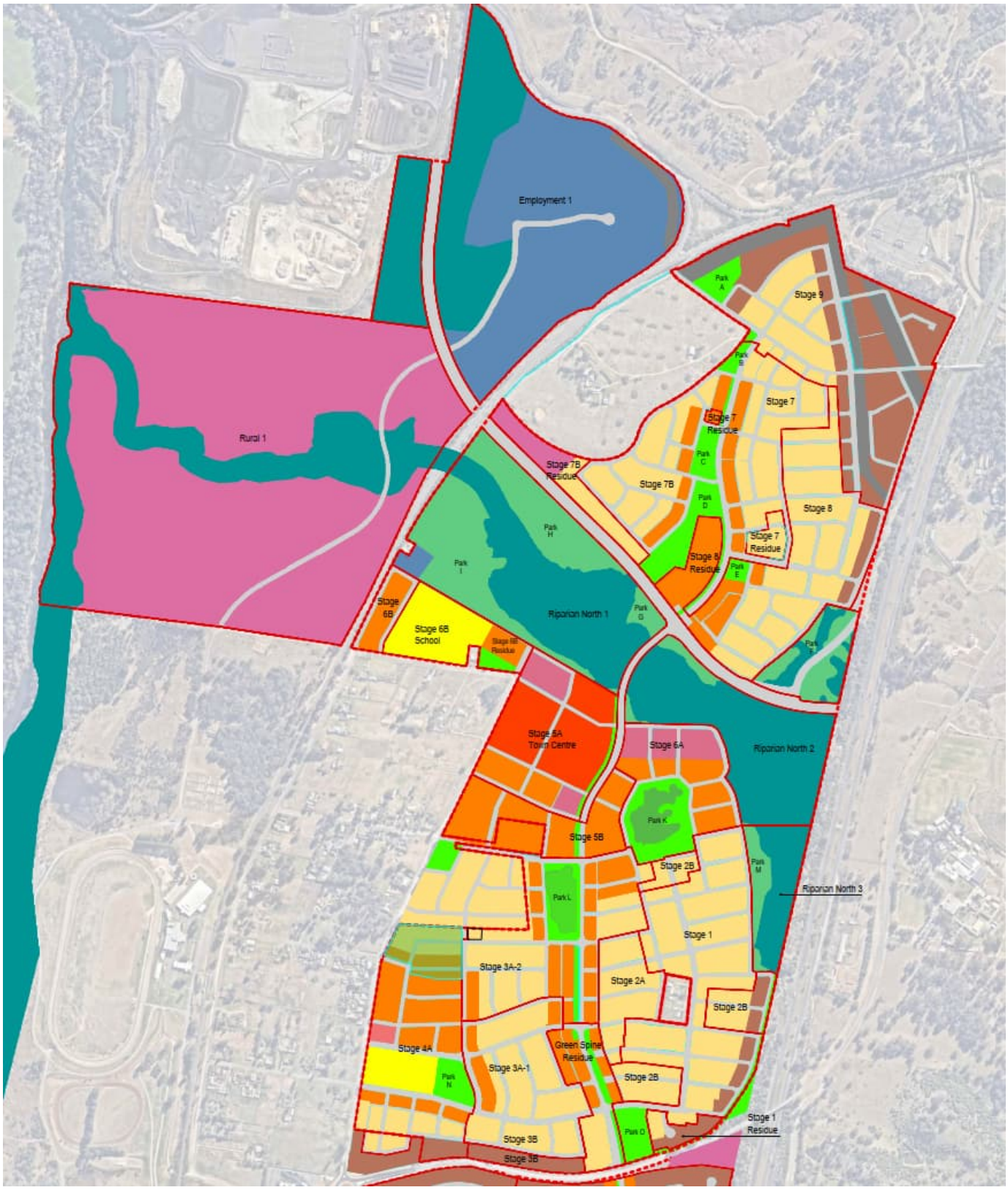
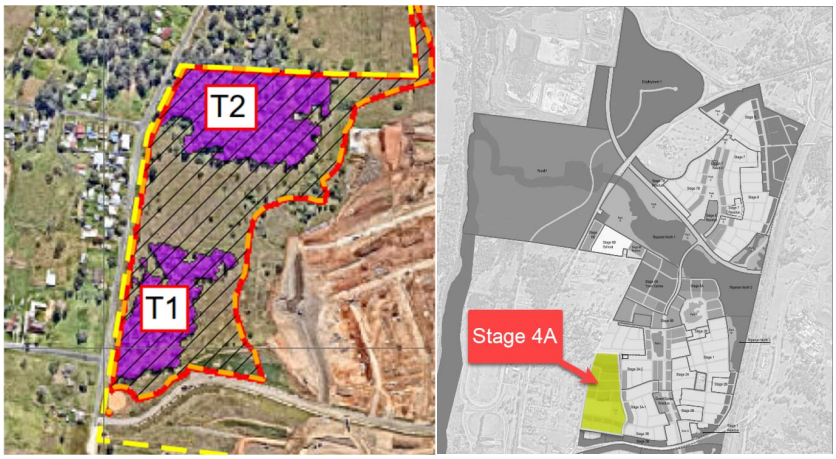


Figure 2- Menangle Park Masterplan

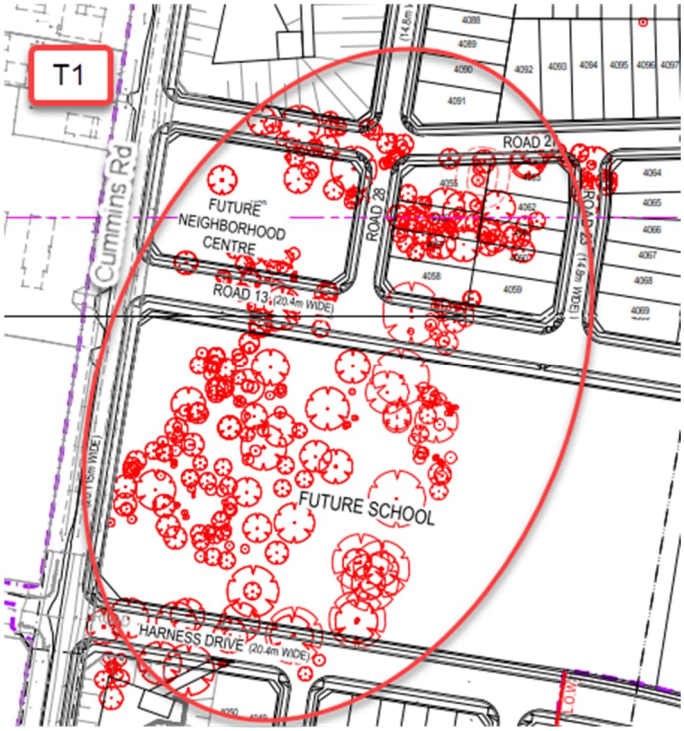
Stage 4A

Current Status – DA approved

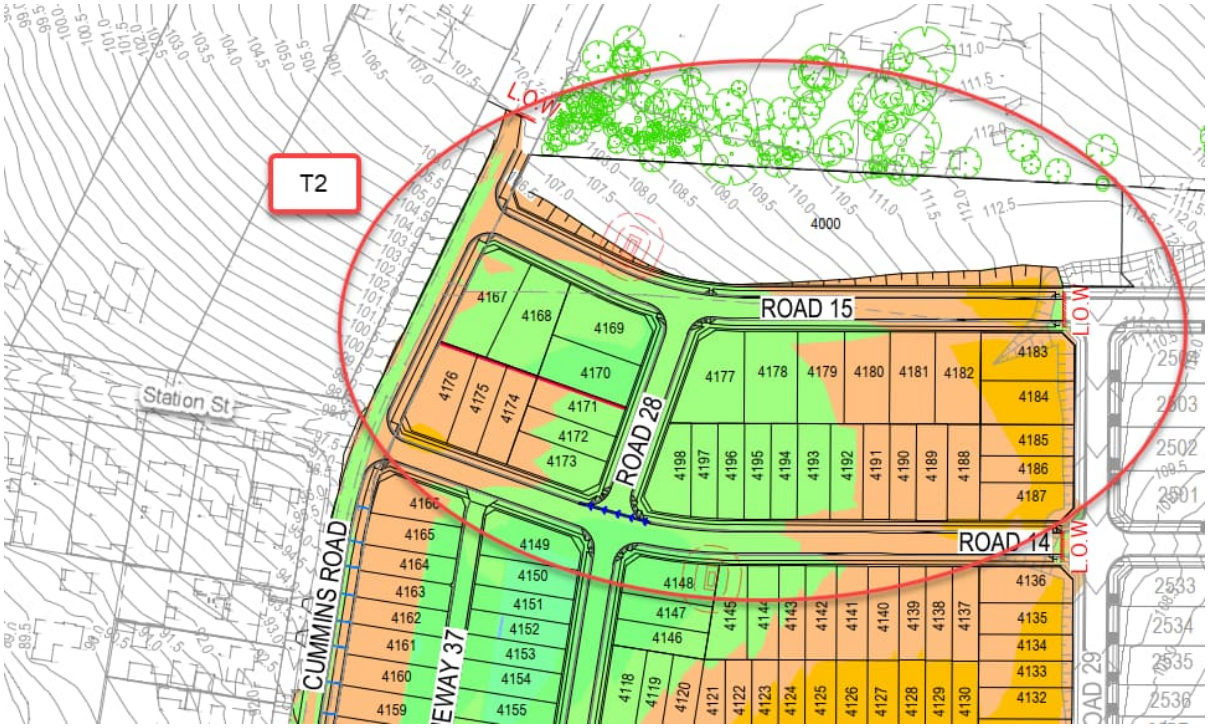


Engineering justification for removal of areas T1 & T2

- DCP/DA approved roads – with Harness Drive and Road 13 being collector roads and main links connecting the school and subdivision to Menangle Park station
- Extensive site regrading is required to meet steep existing grade of Cummins Rd (up to 10%)
- Internal road grades at 7% requires regrading and retaining walls - lots/road in 1-4m cut
- Proposed school site to be cleared and regraded to meet Department of Education requirements
- Trunk services including stormwater and water mains connect from Cummins Road to the subdivision

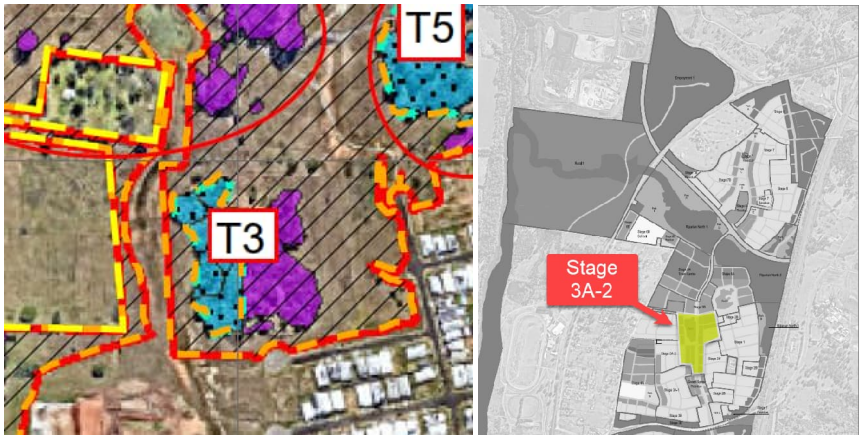



Regrading required for residential lots
T2
ROAD 15 (14.8m WIDE)
ROAD 14 (14.8m WIDE)
ROAD 105 (14.8m WIDE)
ROAD 28 (14.8m WIDE)
ROAD 29 (14.8m WIDE)
ROAD 26 (14.8m WIDE)
CUMMINS ROAD (20.115m WIDE)
LANEWAY 37 (7.0m WIDE)
Station St
L.O.W
ROAD


T2
L.O.W
ROAD 15
ROAD 28
ROAD 14
CUMMINS ROAD
LANEWAY 37
Station St
4000

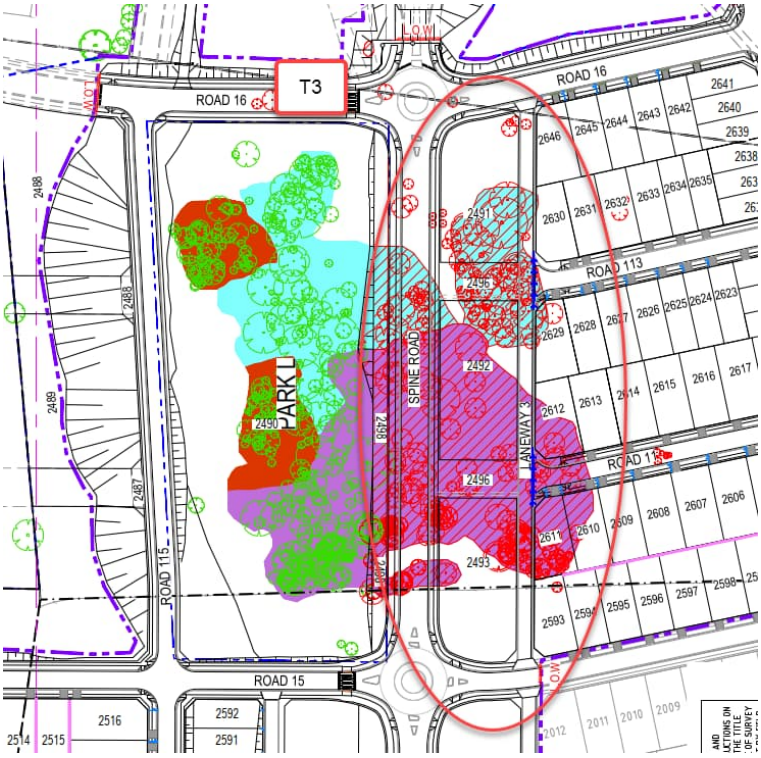
Stage 3A-2

Current Status – DA approved



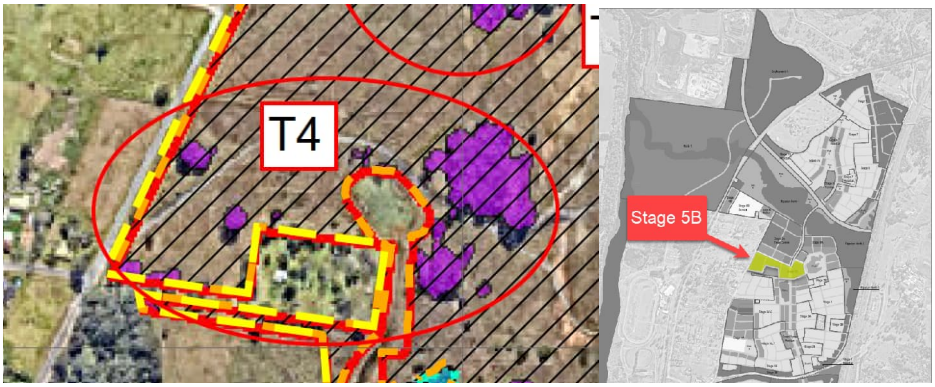
Engineering justification for removal of area T3

- DCP/DA approved roads – including the Collector Spine road which is fixed in location from existing roads to the south and existing Spring Farm Parkway to the north.
- The Spine Rd has been relocated from the original masterplan allow retention of ecology for Park L and Park K.
- The Spine Rd includes the major stormwater infrastructure (2x1500mm pipes) as well as trunk sewer (portion already laid) and water mains
- Regrading of lots east of Spine Rd to ensure Spine Rd as trunk drainage route



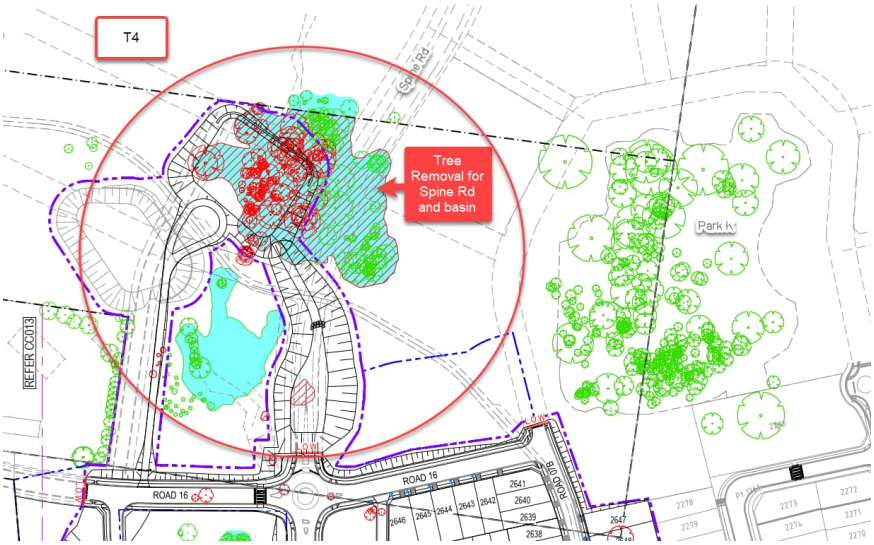
Stage 5B

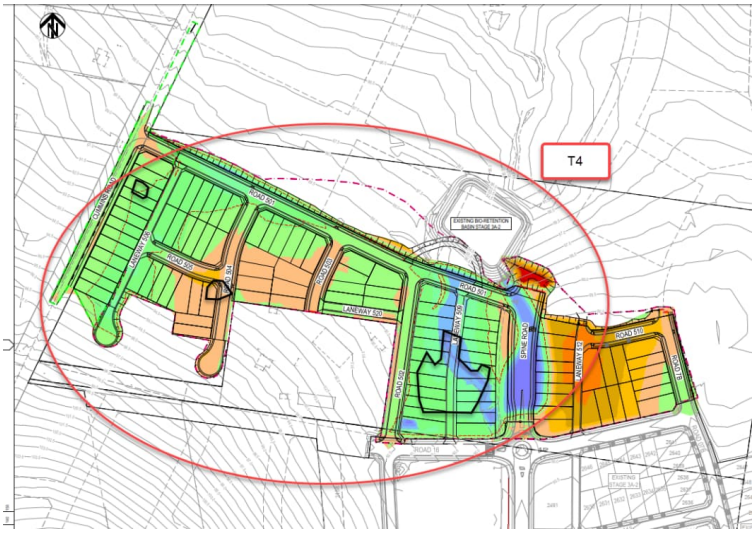
Current Status – DA anticipated approval August 2025



Engineering justification for removal of area T4

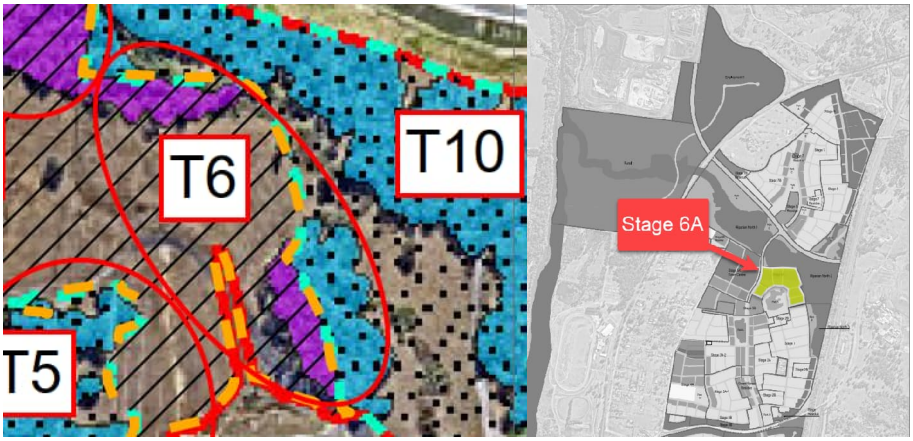
- DCP/DA approved roads
- Trees in area for creation of basin and Spine Rd extension
- Residential lots require regrading (cut and fill) to maintain catchment flows to ultimate discharge points





Stage 6A

Current Status – DA lodgement August 2025



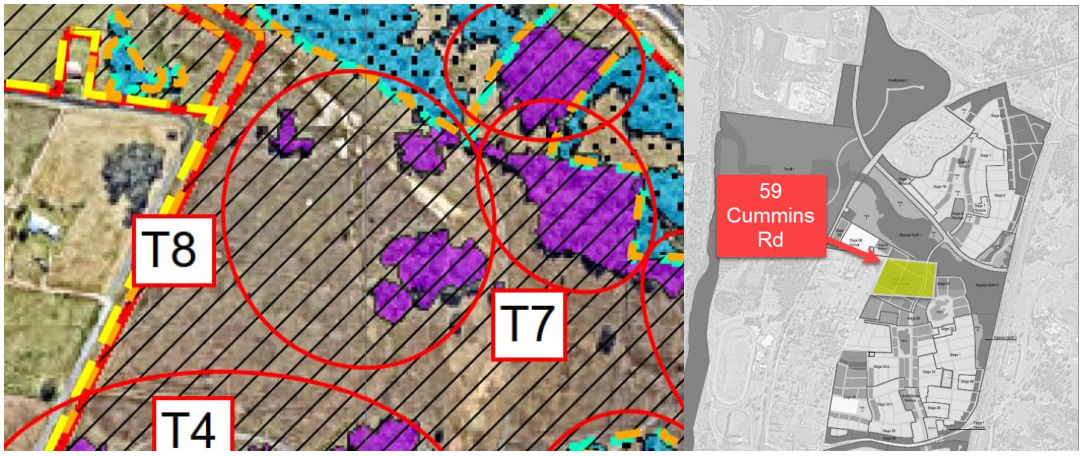
Engineering justification for removal of area T6

- DCP/DA approved roads
- Perimeter roads in fill on edge of riparian corridor to remain above flood levels



Lot 59 Cummins Rd – Contaminated site

Current Status – DA expected August 2025

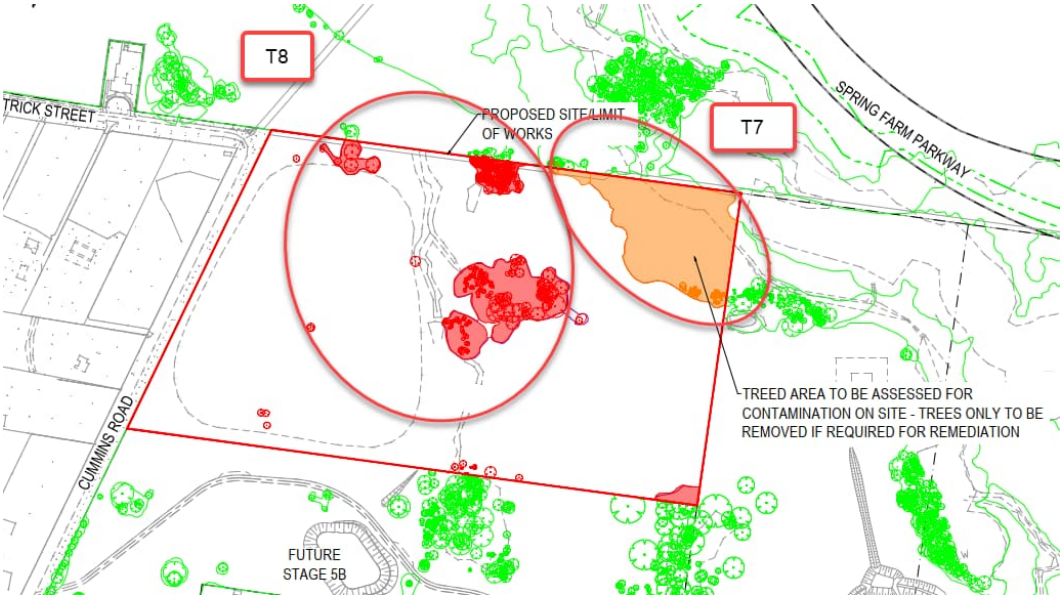


Engineering justification for removal of area T7

- Soil to be tested on site and trees removed if soil contaminated. Trees to remain if no contamination detected
- If contamination is detected, area can be revegetated after remediation

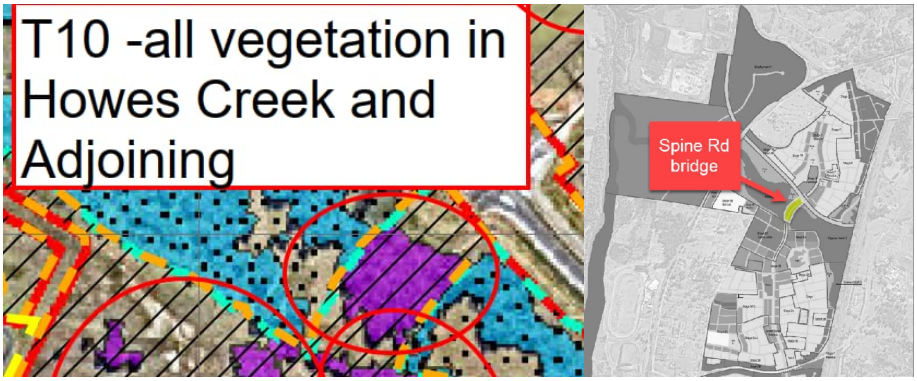
Engineering justification for removal of area T8

- Contaminated soil and burial pits requires remediation via stripping and removal - including trees
- Future Town Centre proposes additional fill in this area



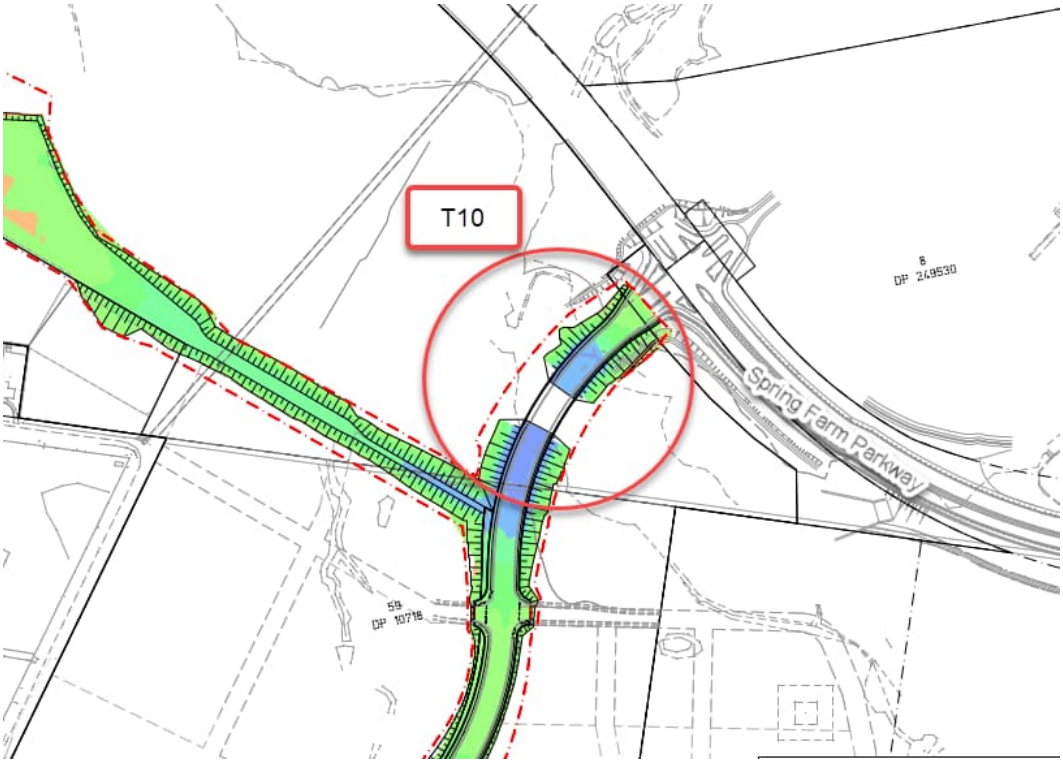
Spine Rd bridge over Howes Creek

Current Status – DA lodged – anticipated approval November 2025



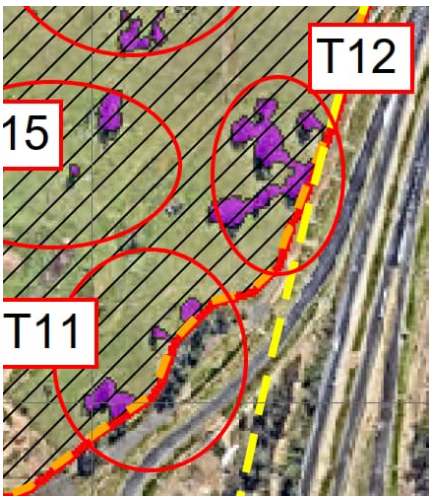
Engineering justification for removal of portion of area T10

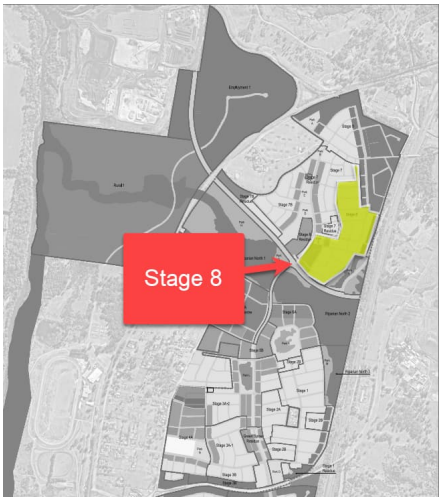
- Clearing for bridge construction and batters over Howes Creek
- The bridge is the connection to the existing Spring Farm Parkway, regional transport connection
- Multiple service conduits will be incorporated into the bridge design to alleviate the need for additional crossings and associated potential additional clearing in Howes Creek



Stage 8

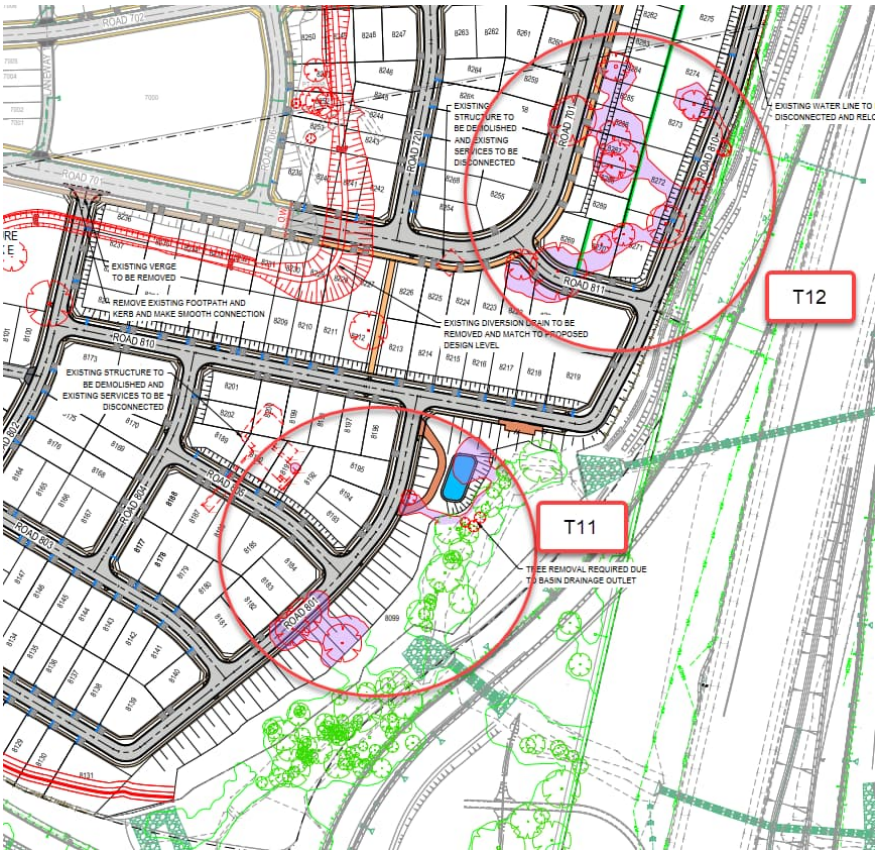
Current Status – DA lodged – anticipated approval August 2025





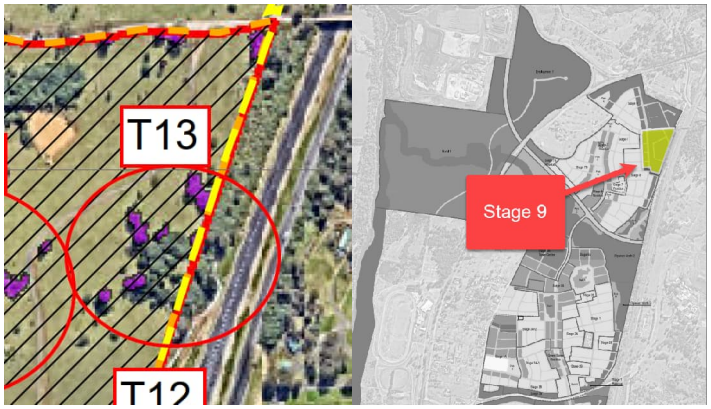
Engineering justification for removal of areas T11 & T12

- DCP/DA approved roads
- Levels dictated by provision of water quality basin and restriction of batter lengths to avoid encroachment to TfNSW land
- Steep existing grades (10%) requires regrading - lots/road in 3-4m cut



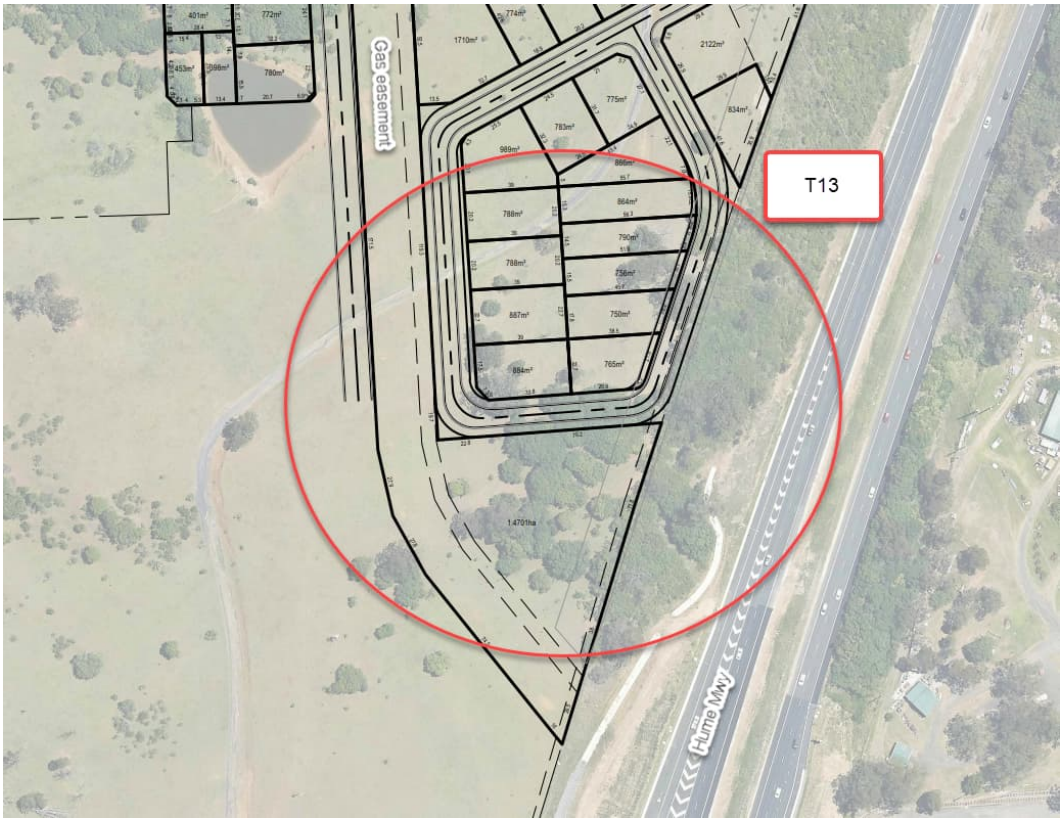
Stage 9

Current Status – DA lodgement September 2025



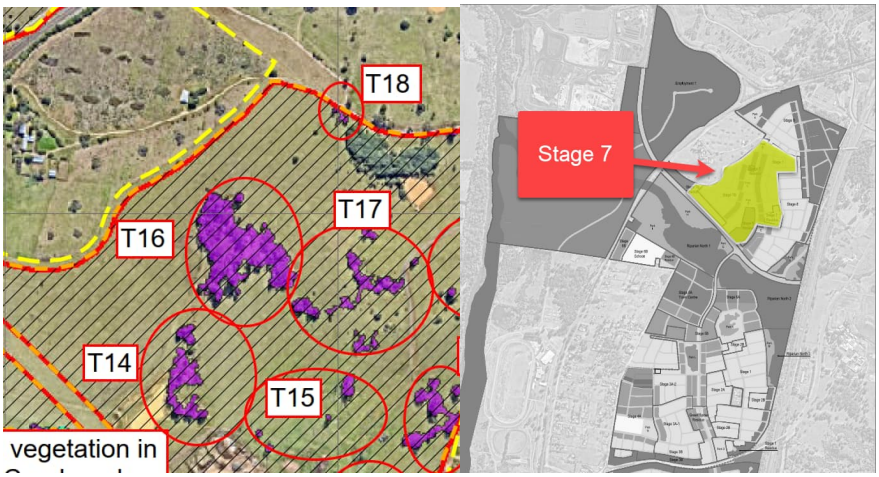
Engineering justification for removal of area T13

- DCP/DA approved roads
- Steep existing grades up to 20% requires regrading - roads/lots up 3-4m fill



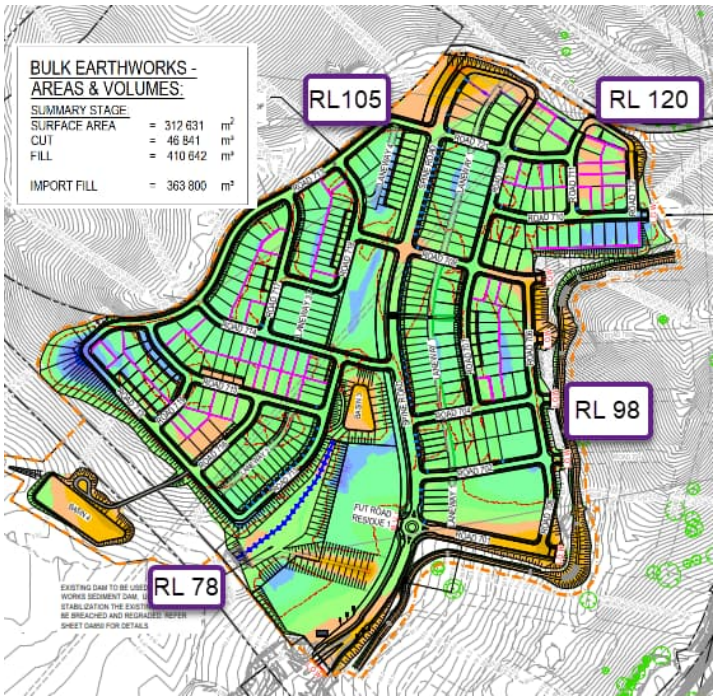
Stage 7

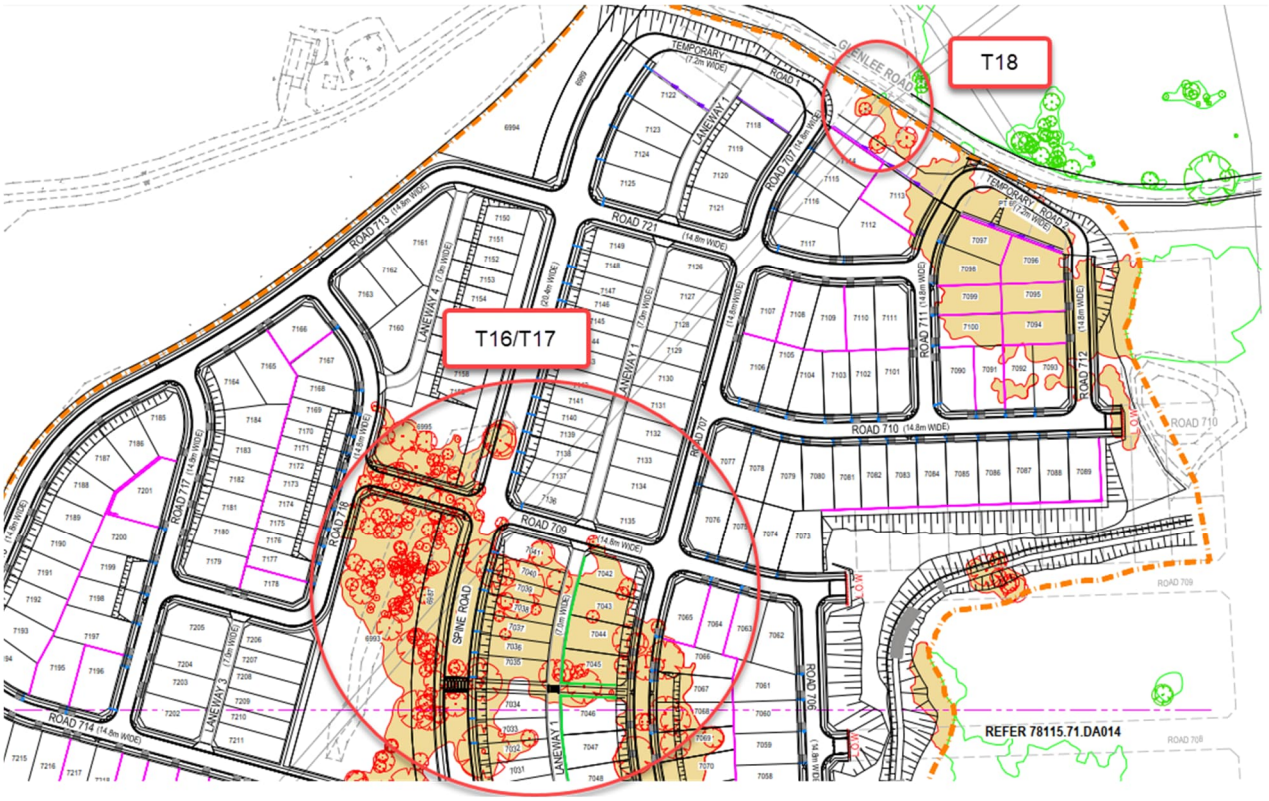
Current Status – DA approved

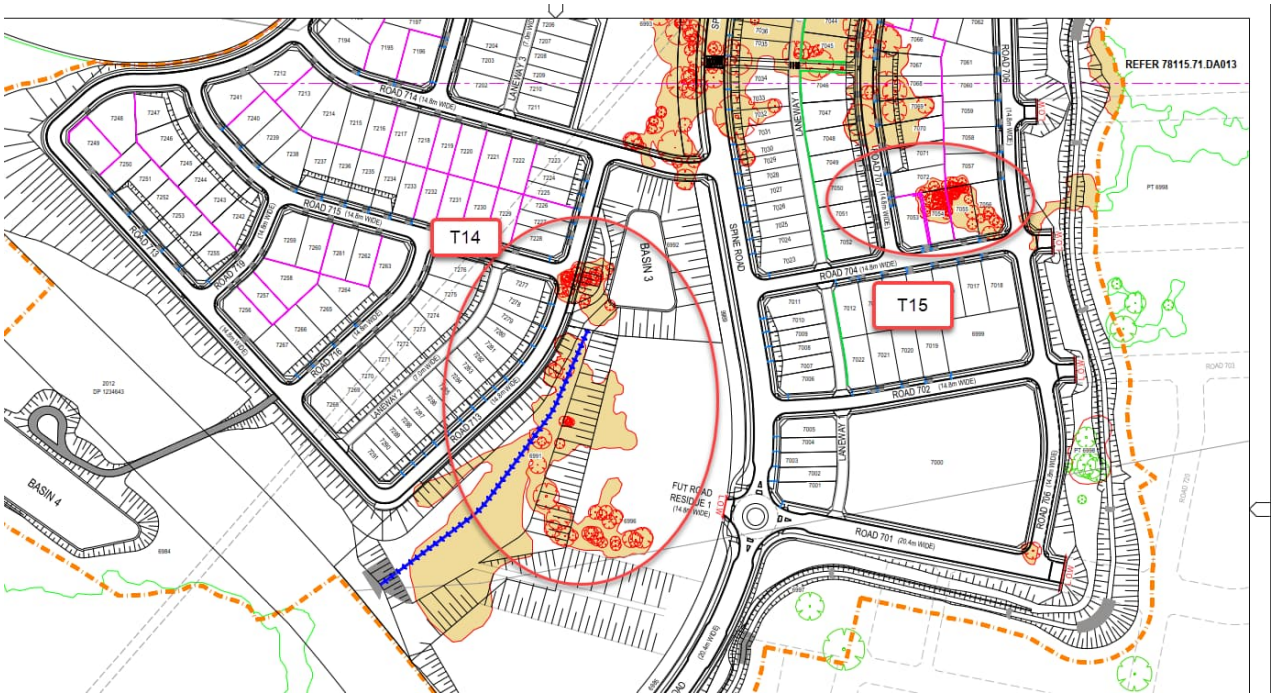


Engineering justification for removal of area T14-T18

- DCP/DA approved roads with alignments governed by steep terrain
- Severe grades across site with constraints to the north (Glenlee Rd), West (Glenlee House), East (APA and Jemena easements) and the south (Spring Farm Parkway).
- Extensive fill required across site with a fall of 42m from Glenlee Road to Spring Farm Parkway.
- Resulting steep road grades along the Spine Road including truck stormwater, sewer and water mains.
- Trees to be removed in existing depression/creekline with filling required
- Steep existing grades requires regrading and retaining walls for residential lots
- Widening of Glenlee from 10m to 20.4 collector road including allowance for electrical transmission line to be laid from Transgrid Regional Substation to Endeavour Zone Substation

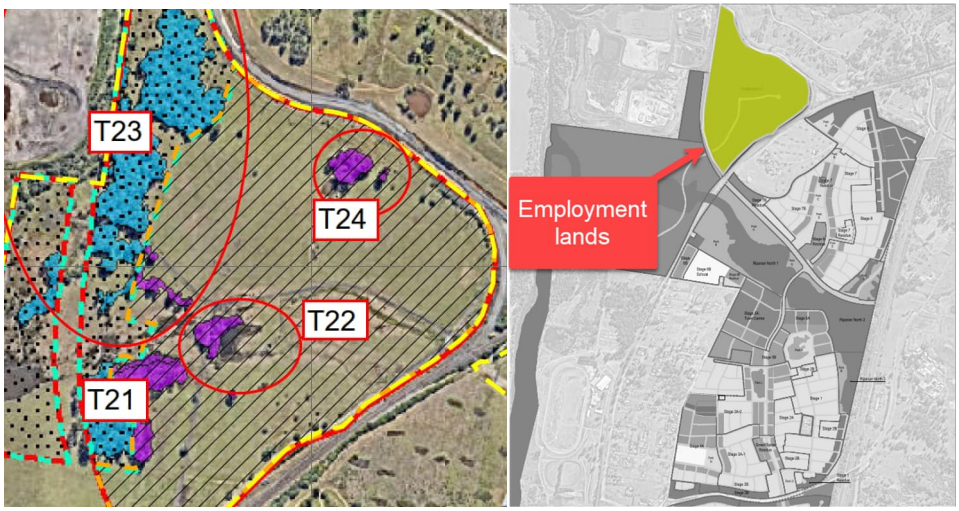



T18
T16/T17
REFER 78115.71.DA014
ROAD 710 (14.8m WIDE)
ROAD 709 (14.8m WIDE)
ROAD 721 (14.8m WIDE)
SPINE ROAD


T14
T15
REFER 78115.71.DA013
BASIN 3
BASIN 4
ROAD 704 (14.8m WIDE)
ROAD 702 (14.8m WIDE)
ROAD 701 (20.4m WIDE)
SPINE ROAD

Employment Lands

Current Status – DA to be lodged following Spring Farm Parkway Stage 2 – +2030.



Engineering justification for removal of areas T21, T22 & T24

- The 30Ha Employment land area is dependant upon the construction of Spring Farm Parkway Stage 2 by TfNSW. Due to the elevation of the Spring Farm Parkway bridge across the railway, the Employment Lands intersection and road will require fill and impact trees (T21 & T22)
- Proposed Employment land lots will be required to be flat. Existing grades at 4% (T24) will require regrading



FIGURES

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Figure 3 Land zoning of the project area

Figure 4 Flora survey locations

Figure 5 Fauna survey locations

Figure 6 MNES vegetation communities within the project area

Figure 7 MNES within the project area

Figure 8 Brown Treecreeper habitat in the project area

Figure 9 Proposed Conservation Areas in the project area

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Figure 12 MNES patch C30

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Figure 14 MNES patch R5

Figure 15 MNES patch C12

Figure 16 Howes Creek Conservation Area Buffers

Figure 17 Park K Conservation Area Buffers

Figure 18 Park L Conservation Area Buffers

Figure 19 Stage 6B Conservation Area Buffers

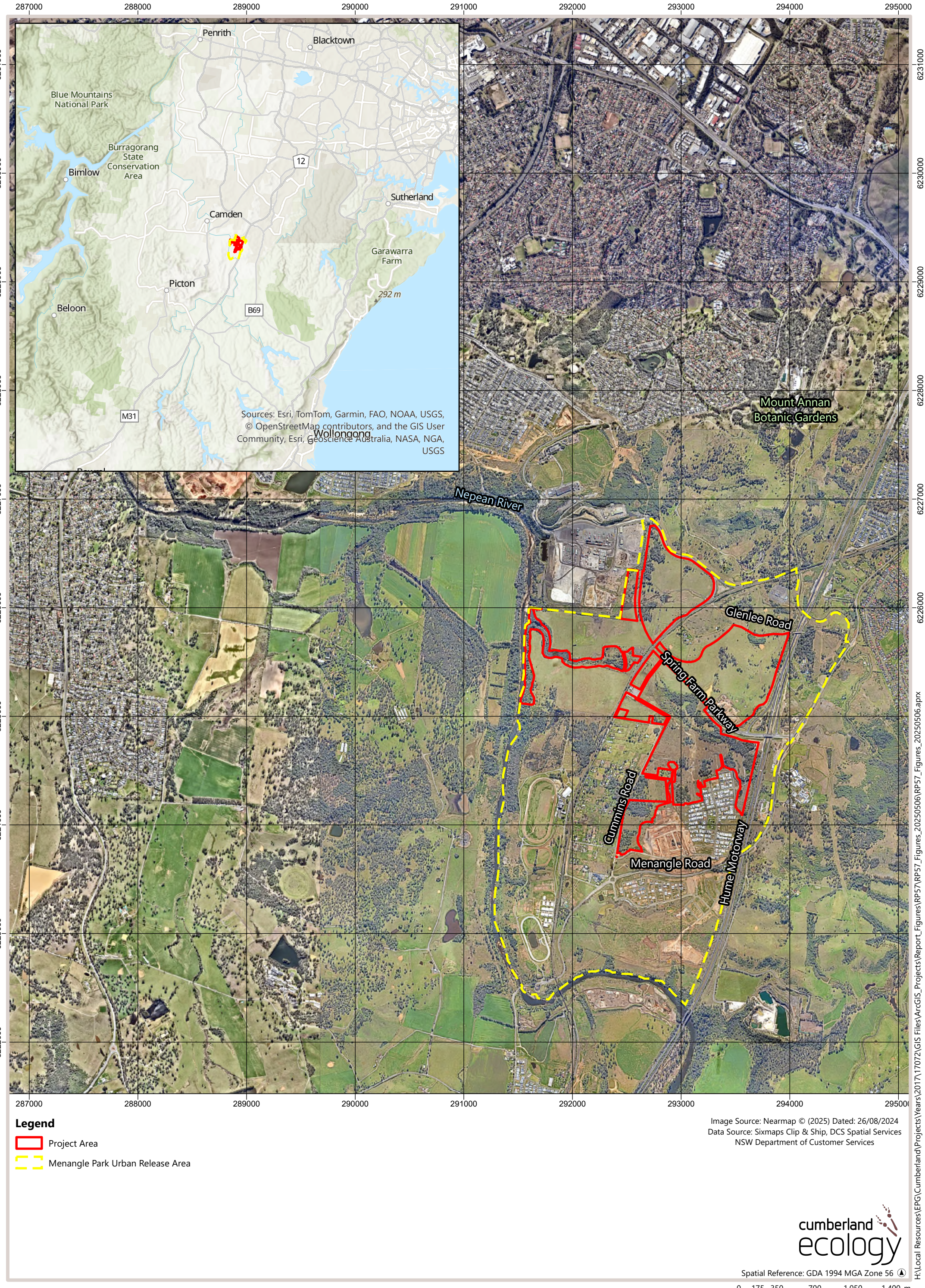
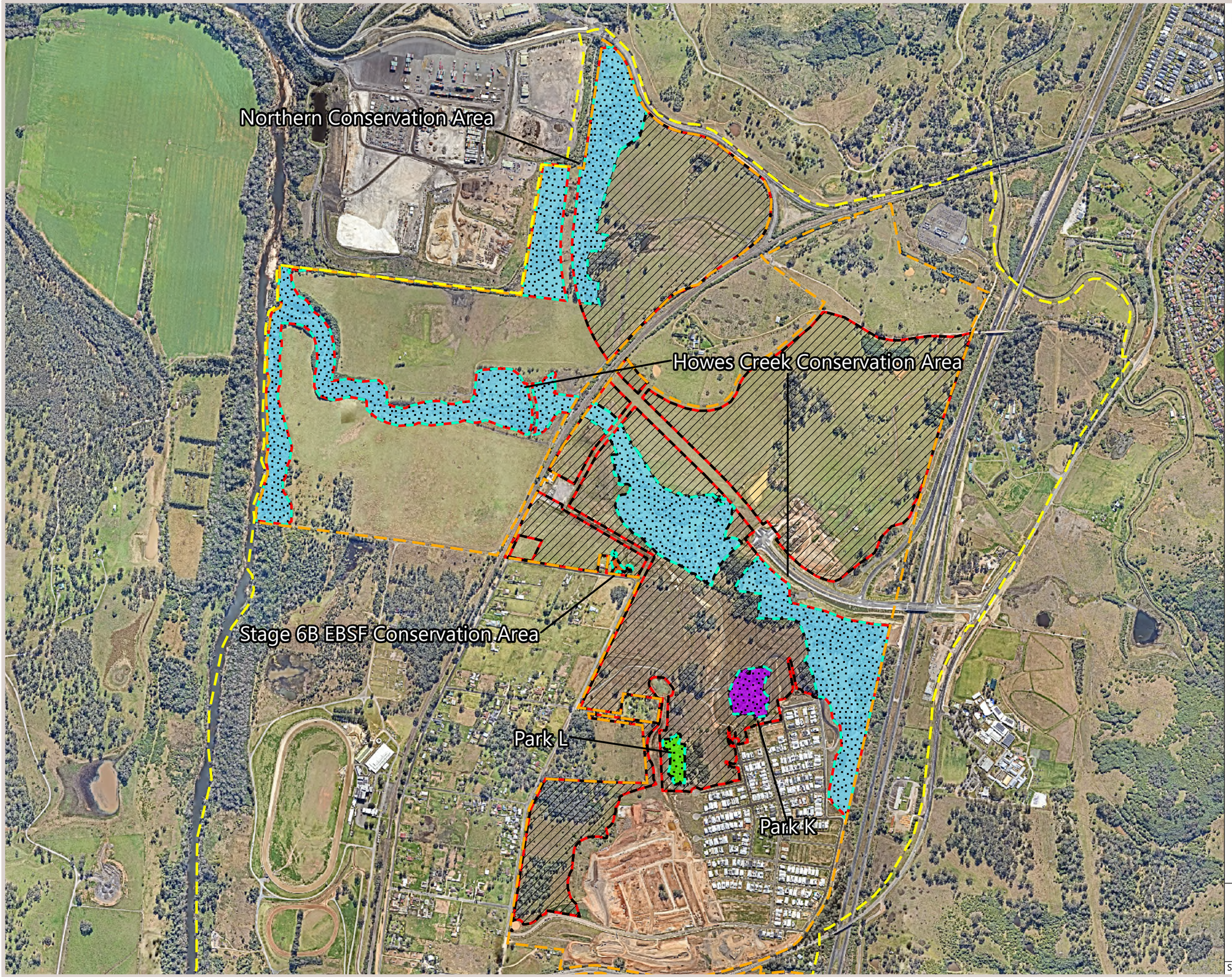


Figure 1. Location Map



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Disturbance Footprint

Conservation Area

- Howes Creek and Northern Conservation Area
- Park K
- Park L
- Stage 6B EBSF Conservation Area

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Data Source: SMEC (2025)
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Spatial Reference: GDA 1994 MGA Zone 56

0 88 175 350 525 700 m

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Figure 2. Layout of the project

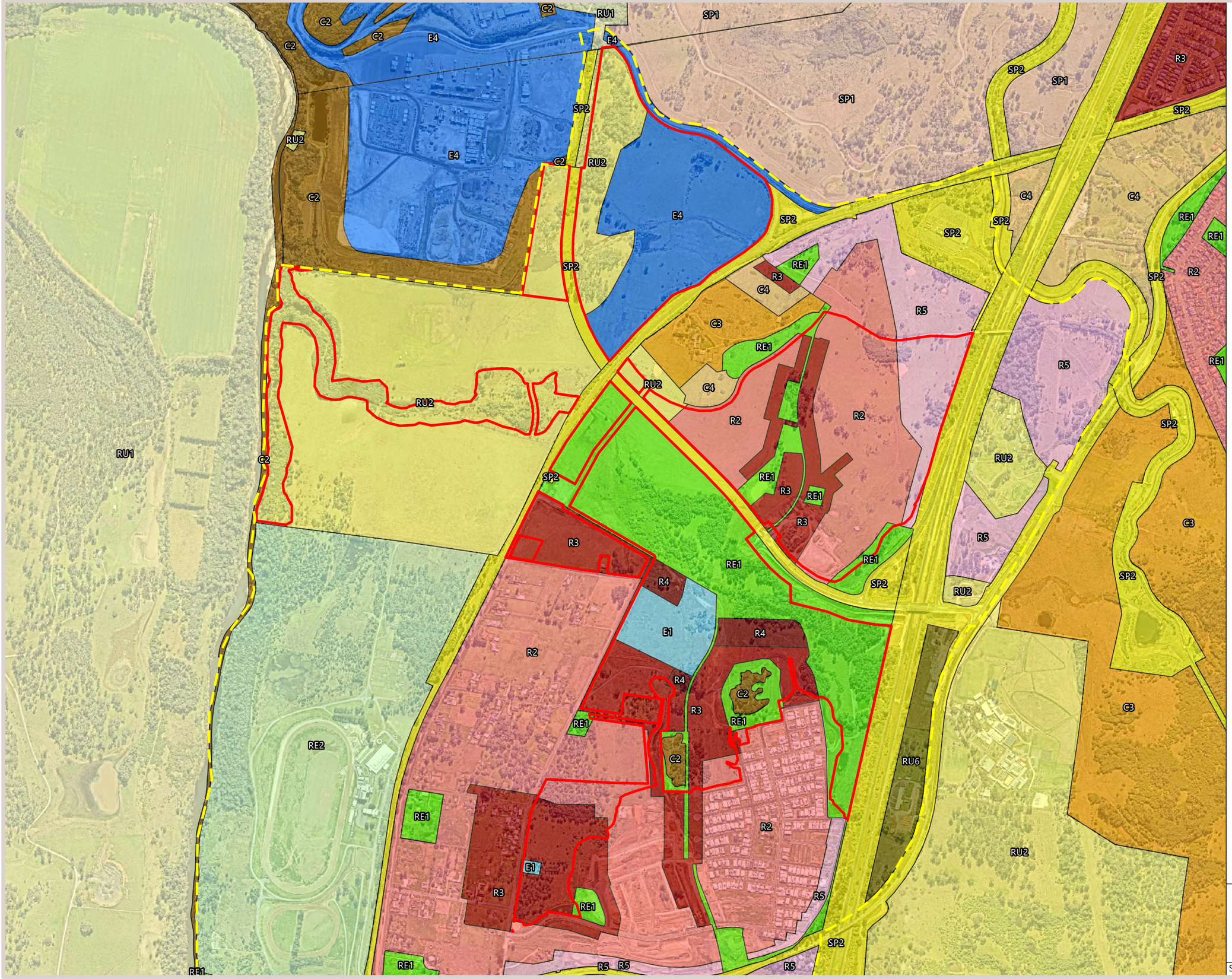


Figure 3. Land zoning of the project area

PC32
PC19
PC15

Legend

- Project Area
- Menangle Park Urban Release Area
- Survey Tracks
- Flora Plot Location (2025)

Matters of National Environmental Significance

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria

Potential Matters of National Environmental Significance

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

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0 88 175 350 525 700 m

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Figure 4. Flora survey locations

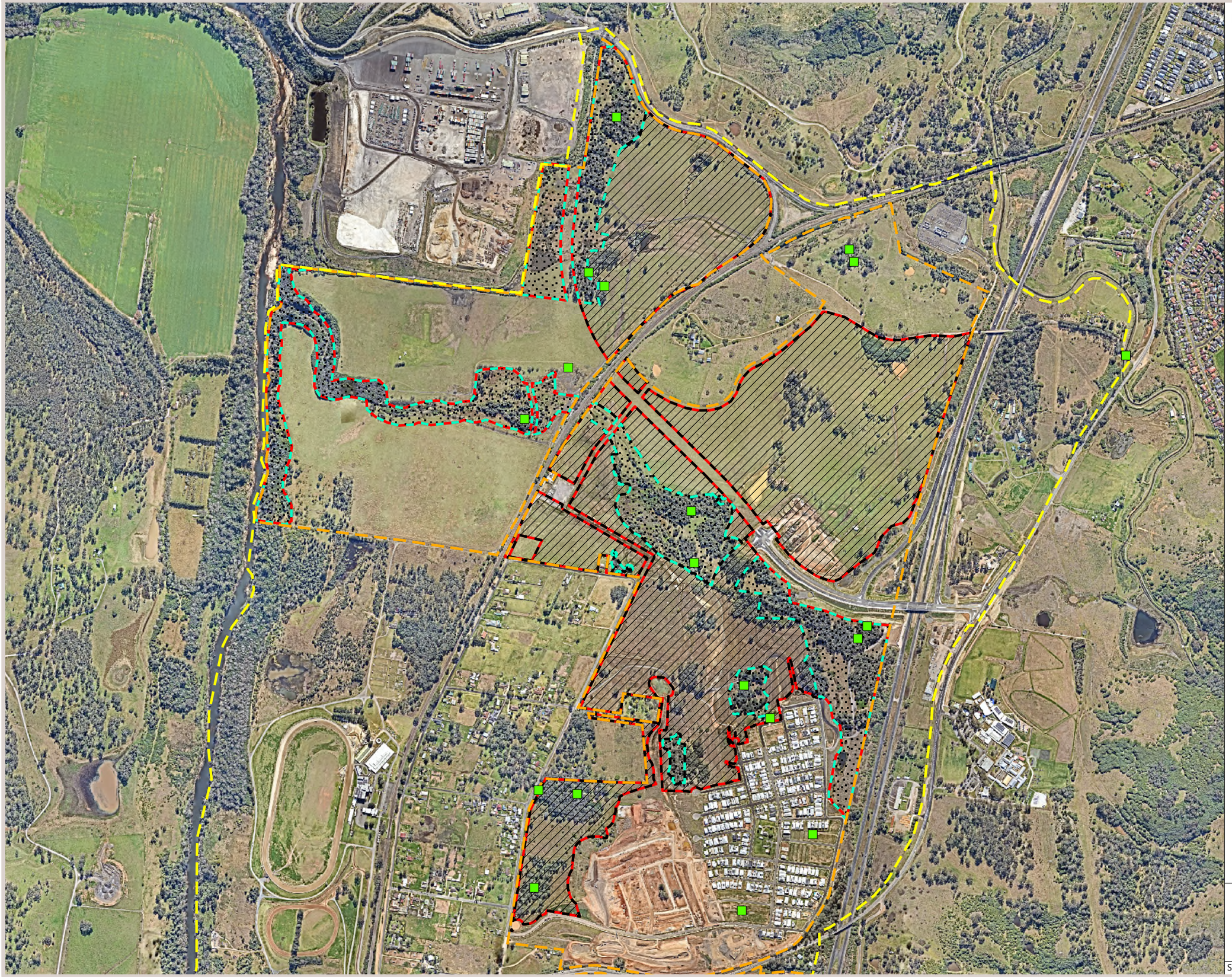
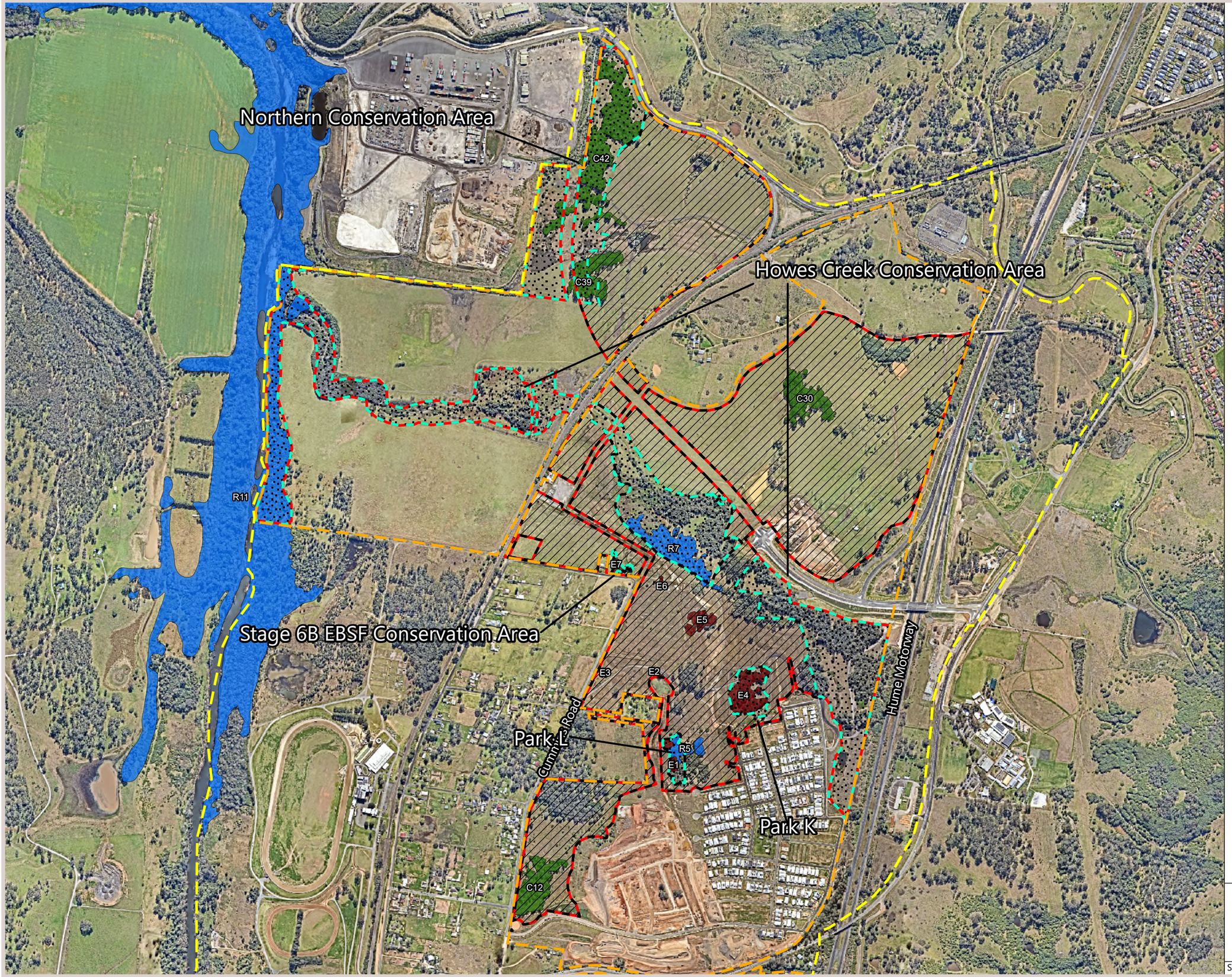


Figure 5. Fauna survey locations



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Disturbance Footprint

Matters of National Environmental Significance

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria

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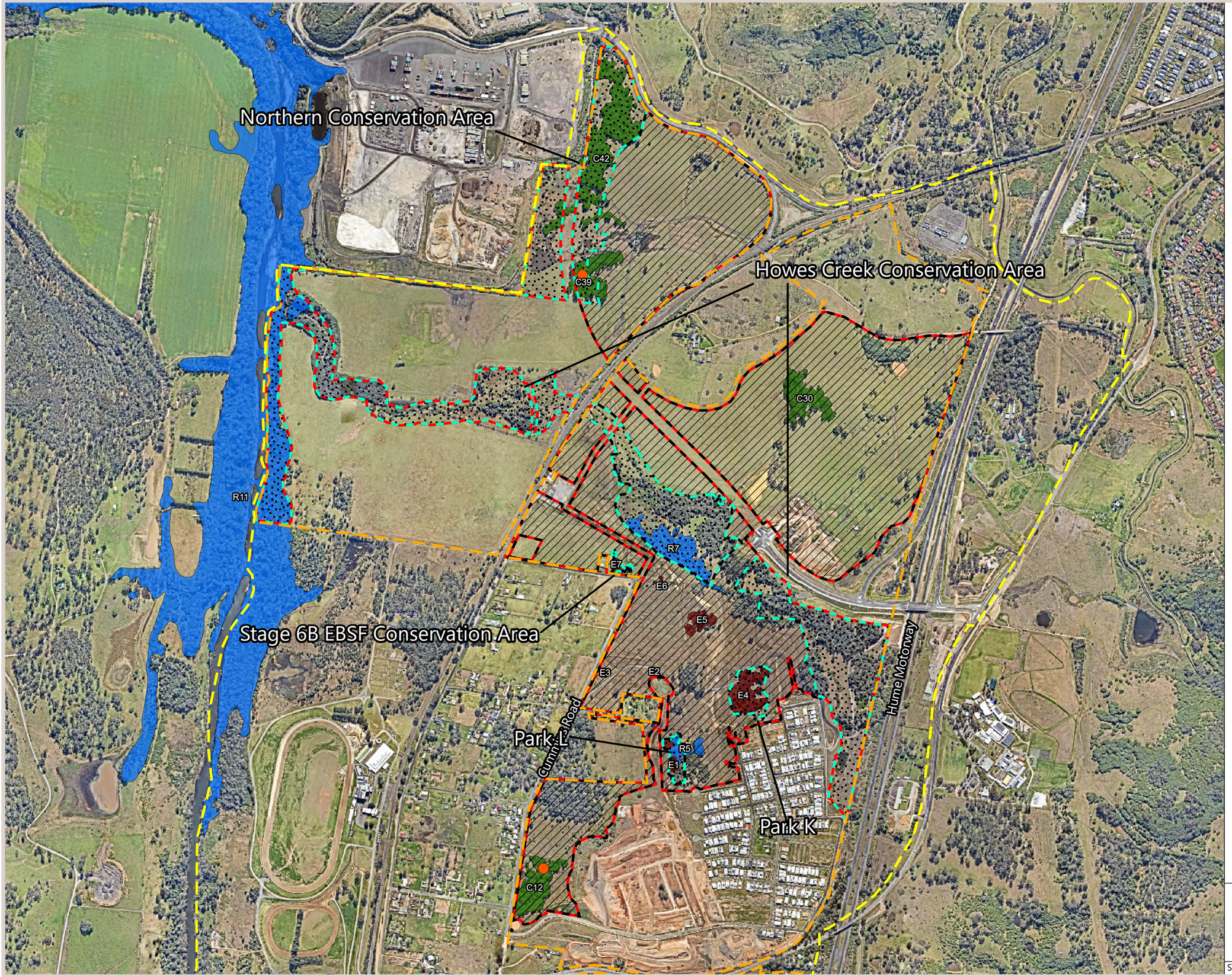
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Spatial Reference: GDA 1994 MGA Zone 56

0 88 175 350 525 700 m

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Figure 6. MNES vegetation communities within the project area



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Disturbance Footprint

Matters of National Environmental Significance

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest
- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria

Threatened Fauna

- Brown Treecreeper

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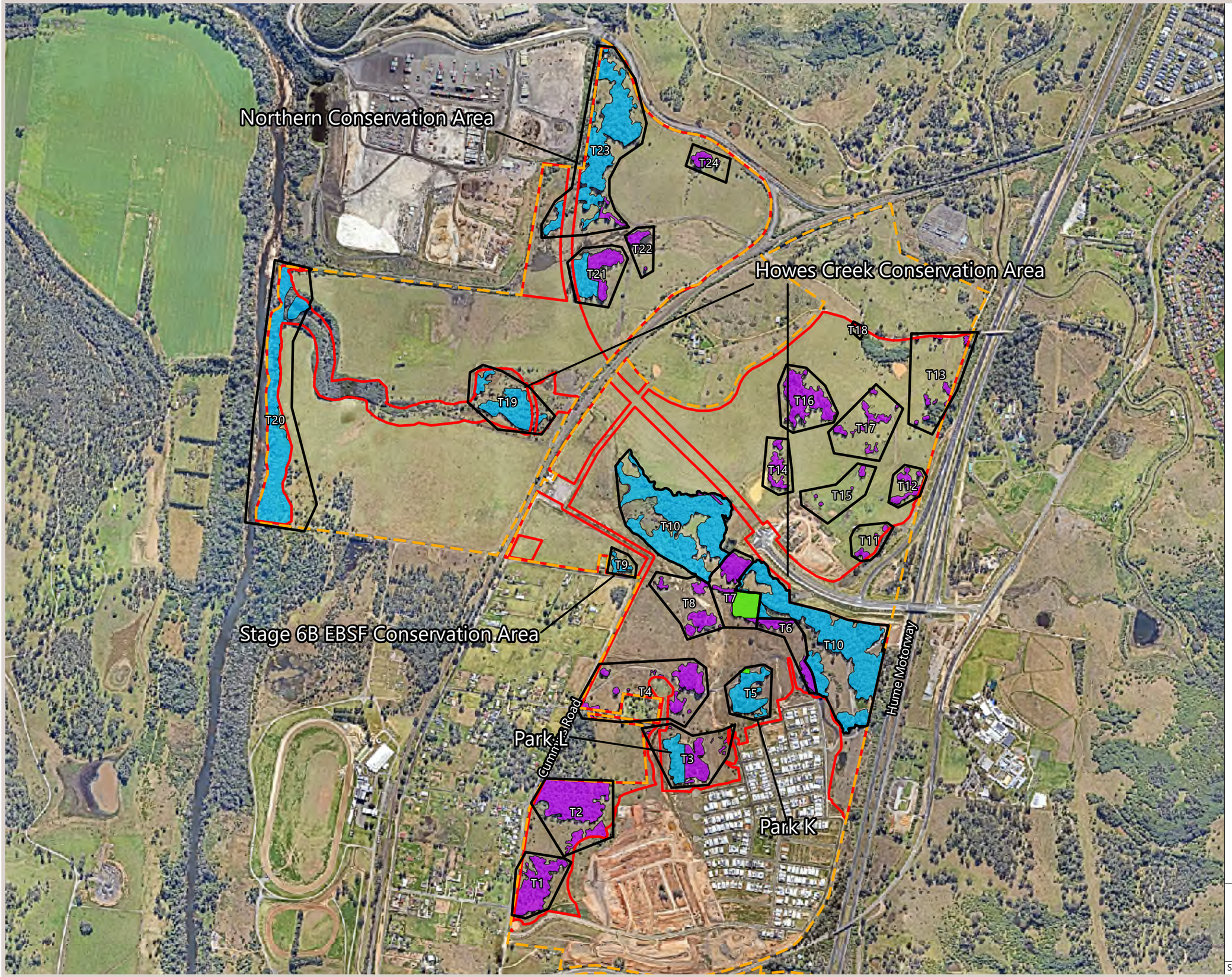
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Spatial Reference: GDA 1994 MGA Zone 56

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Figure 7. MNES within the project area



Legend

- Project Area
- Menangle Park Project Site
- Brown Treecreeper Habitat to be Removed
- Brown Treecreeper Habitat to be Retained
- Brown Treecreeper Habitat Removed/ Replanted
- Habitat Patch Identification Polygons

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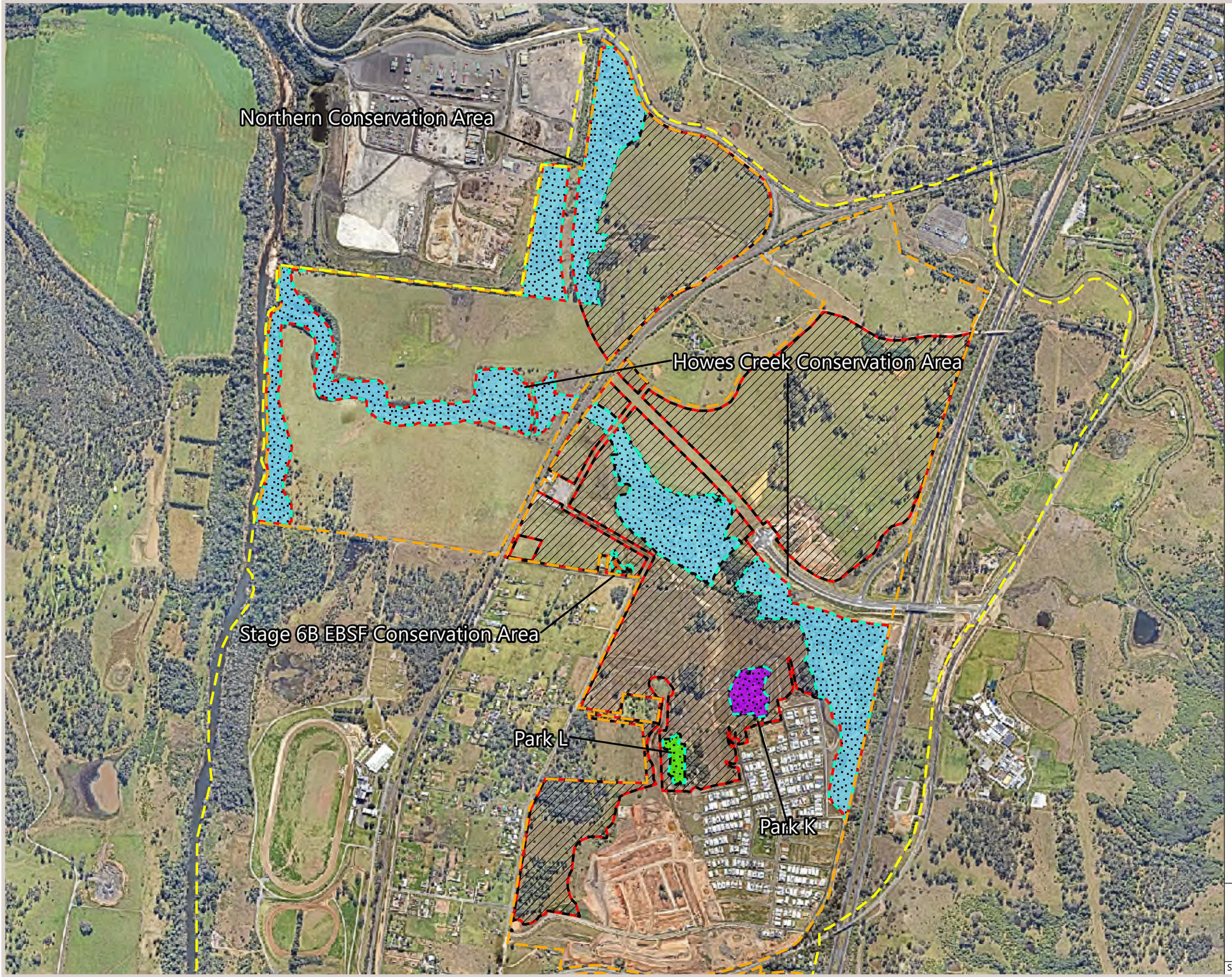
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Spatial Reference: GDA 1994 MGA Zone 56

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Figure 8. Brown Treecreeper habitat in the project area



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Disturbance Footprint

Conservation Area

- Howes Creek and Northern Conservation Area
- Park K
- Park L
- Stage 6B EBSF Conservation Area

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0 88 175 350 525 700 m

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Figure 9. Proposed Conservation Areas in the project area

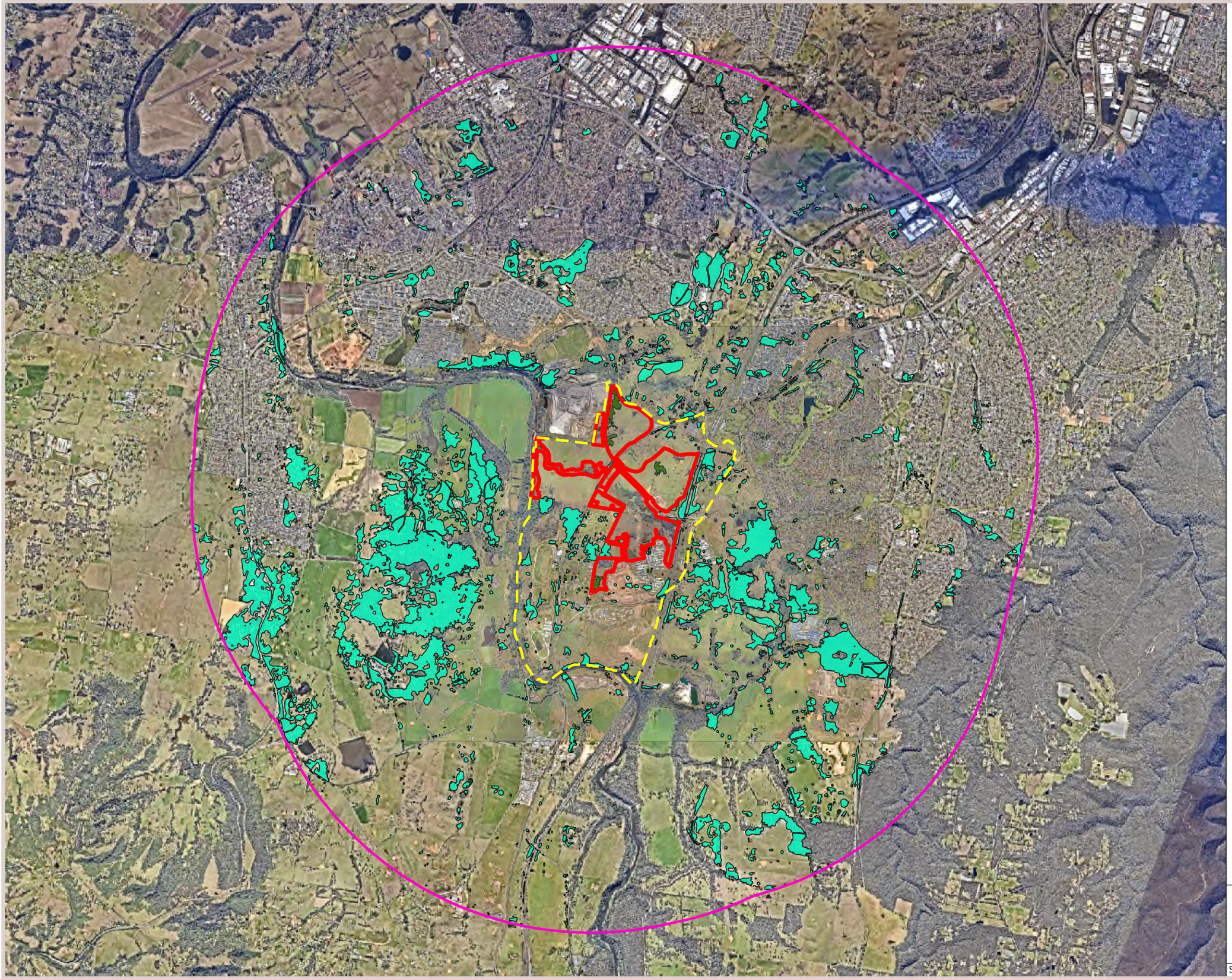


Figure 10. Extent of CPW within 5km of the project area

C42

C39

Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Disturbance Footprint

Matters of National Environmental Significance

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

Land Zoning

- C2: Environmental Conservation
- C3: Environmental Management
- C4: Environmental Living
- E4: General Industrial
- R3: Medium Density Residential
- RU1: Primary Production
- RU2: Rural Landscape
- SP1: Special Activities
- SP2: Infrastructure

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Data Source: SMEC (2025)
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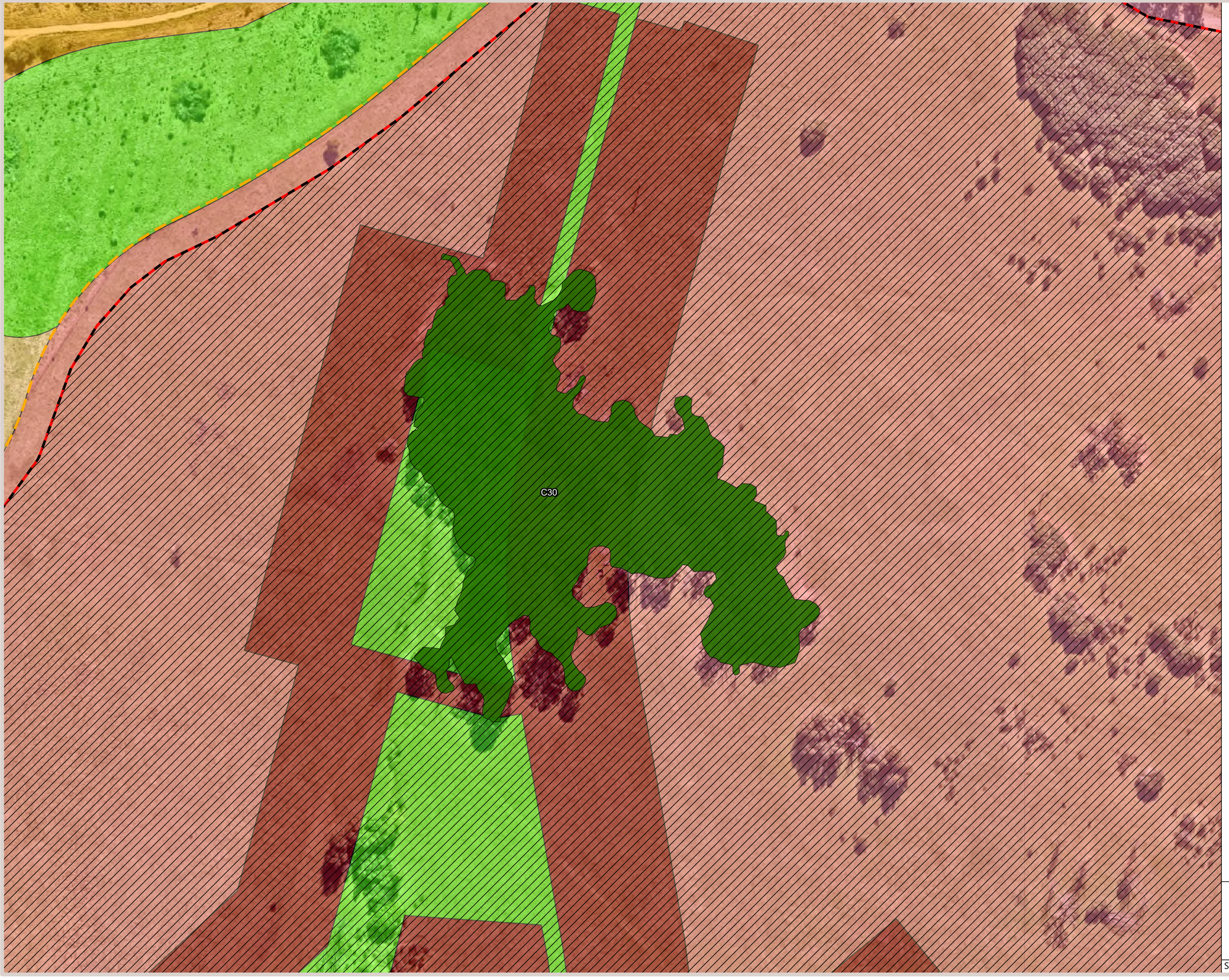
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Spatial Reference: GDA 1994 MGA Zone 56

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Figure 11. MNES patches C42 and C39



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Disturbance Footprint

Matters of National Environmental Significance

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

Land Zoning

- C3: Environmental Management
- C4: Environmental Living
- R2: Low Density Residential
- R3: Medium Density Residential
- RE1: Public Recreation

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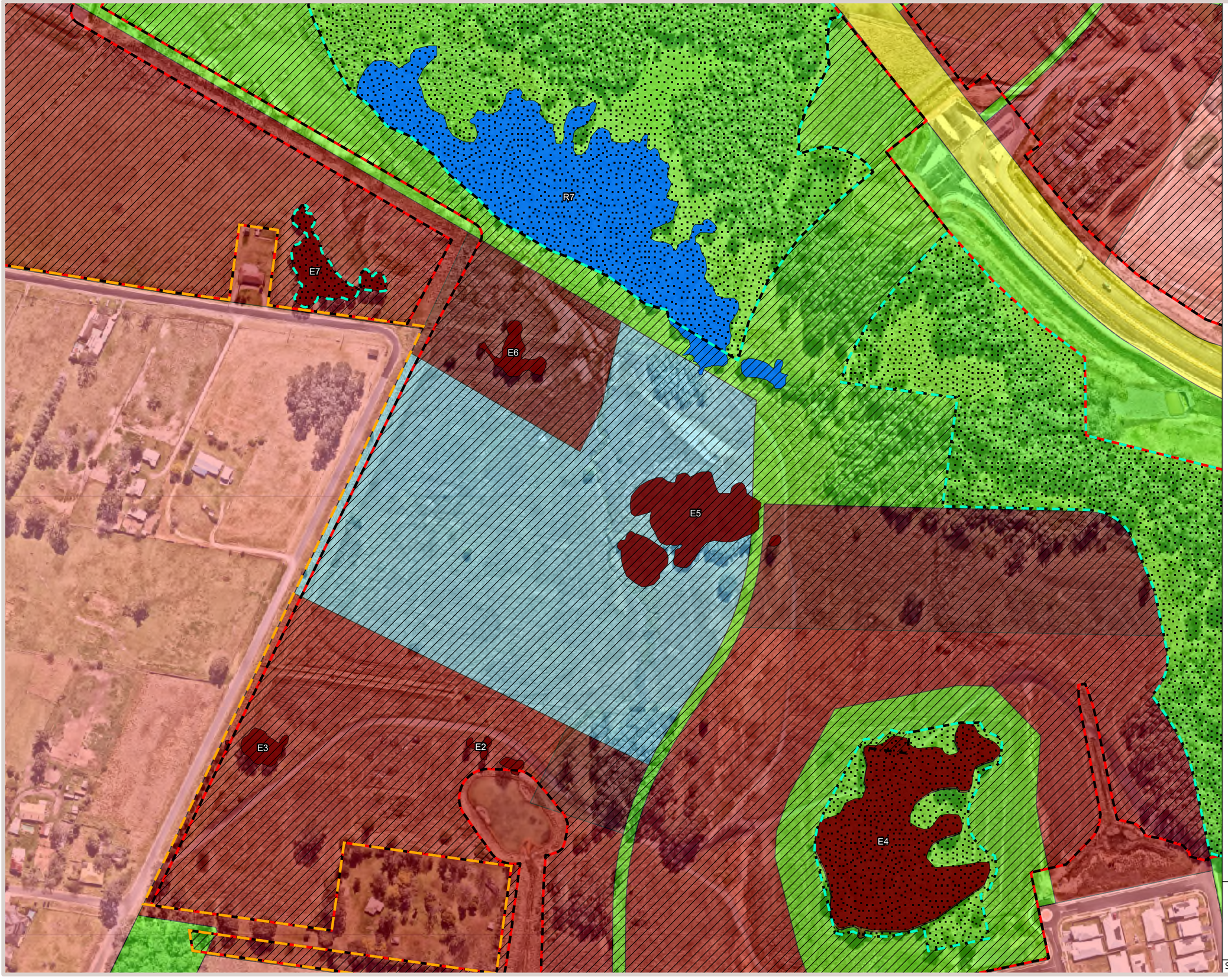
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Spatial Reference: GDA 1994 MGA Zone 56

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Figure 12. MNES patch C30



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Disturbance Footprint

Matters of National Environmental Significance

- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria

Land Zoning

- C2: Environmental Conservation
- E1: Local Centre
- R2: Low Density Residential
- R3: Medium Density Residential
- R4: High Density Residential
- RE1: Public Recreation
- SP2: Infrastructure

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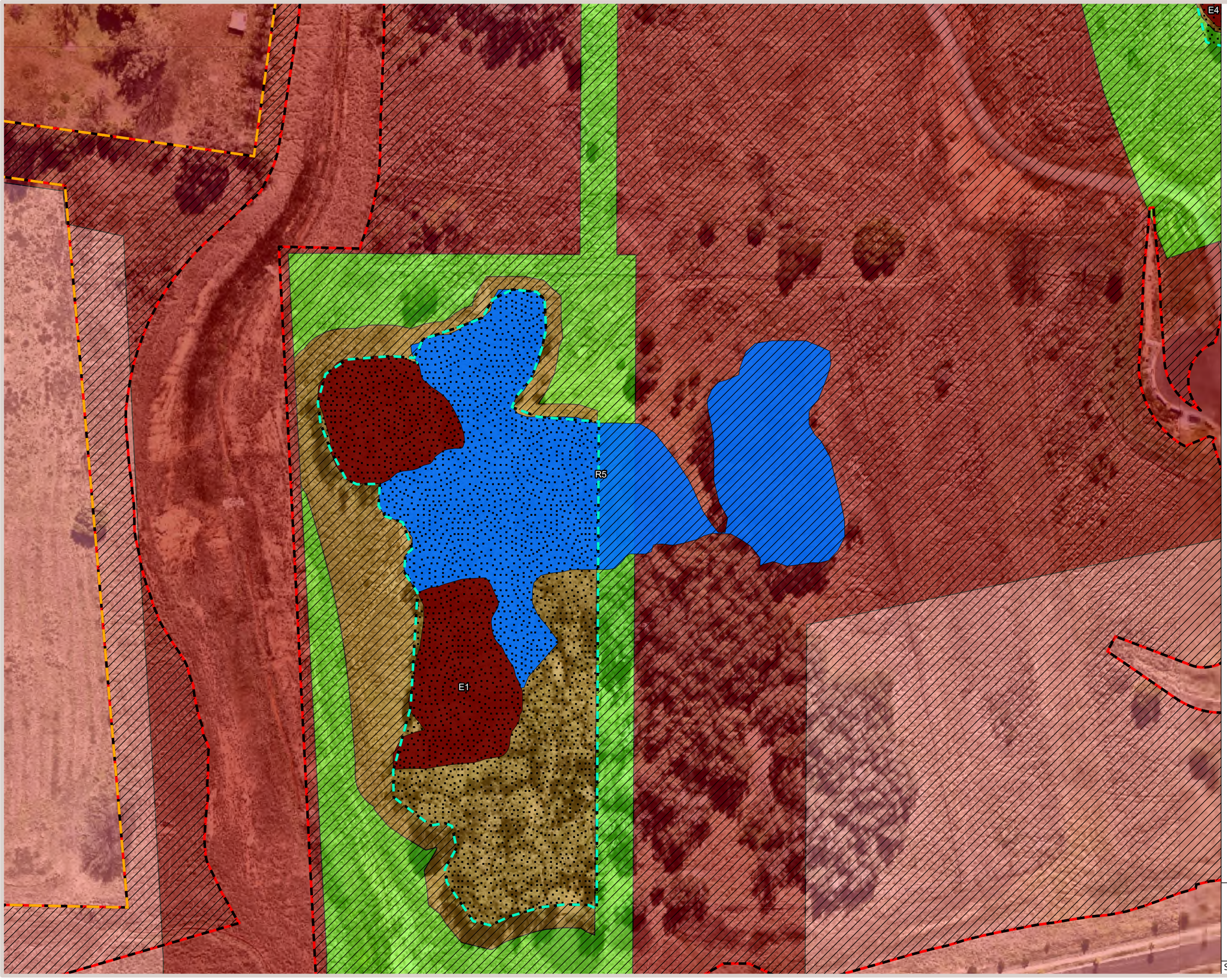
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Spatial Reference: GDA 1994 MGA Zone 56

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Figure 13. MNES patches E2, E3, E4, E5, E6 and R7



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Disturbance Footprint

Matters of National Environmental Significance

- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria

Land Zoning

- C2: Environmental Conservation
- R2: Low Density Residential
- R3: Medium Density Residential
- RE1: Public Recreation

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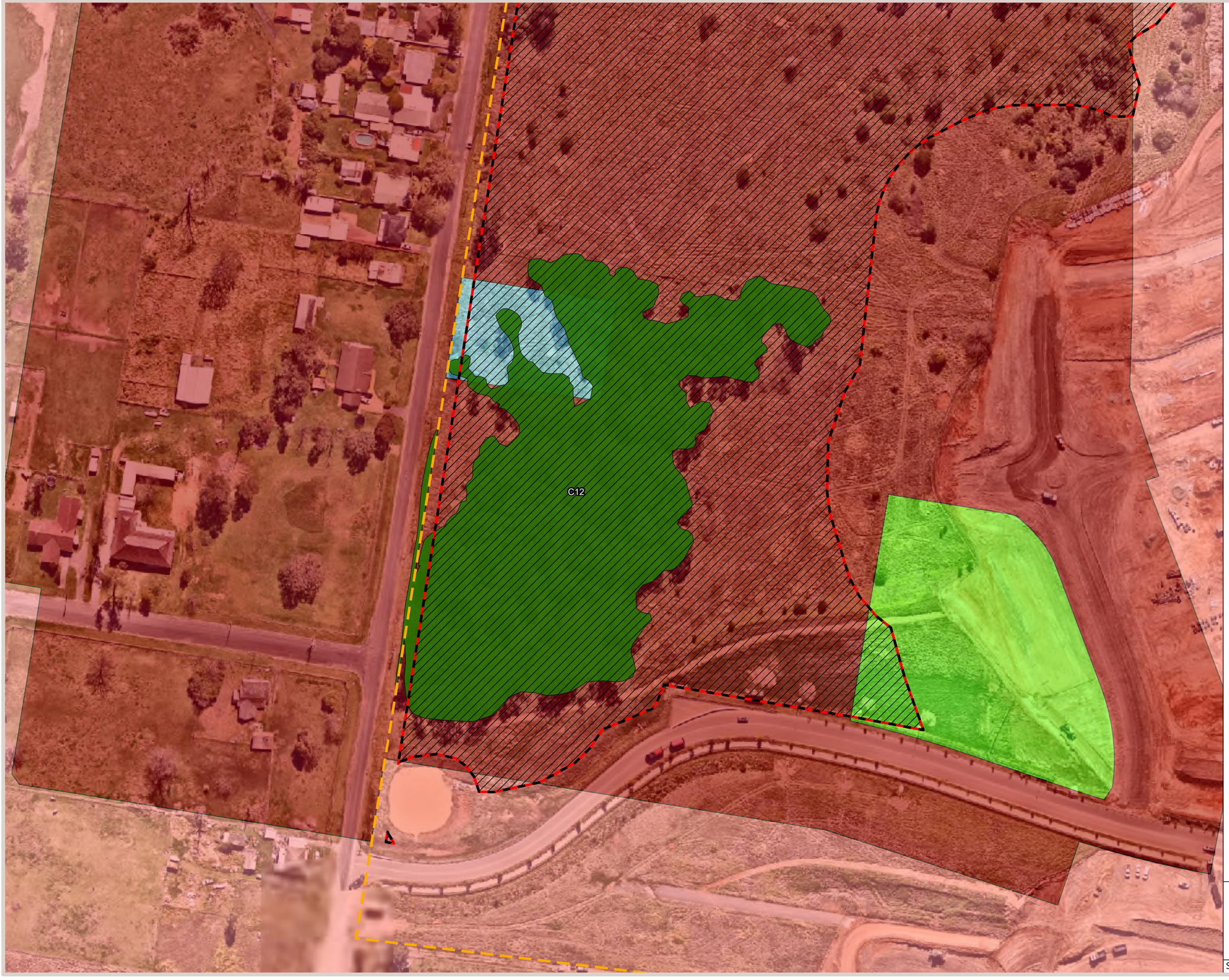
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Spatial Reference: GDA 1994 MGA Zone 56

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Figure 14. MNES patch R5



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Disturbance Footprint

Matters of National Environmental Significance

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

Land Zoning

- E1: Local Centre
- R2: Low Density Residential
- R3: Medium Density Residential
- RE1: Public Recreation

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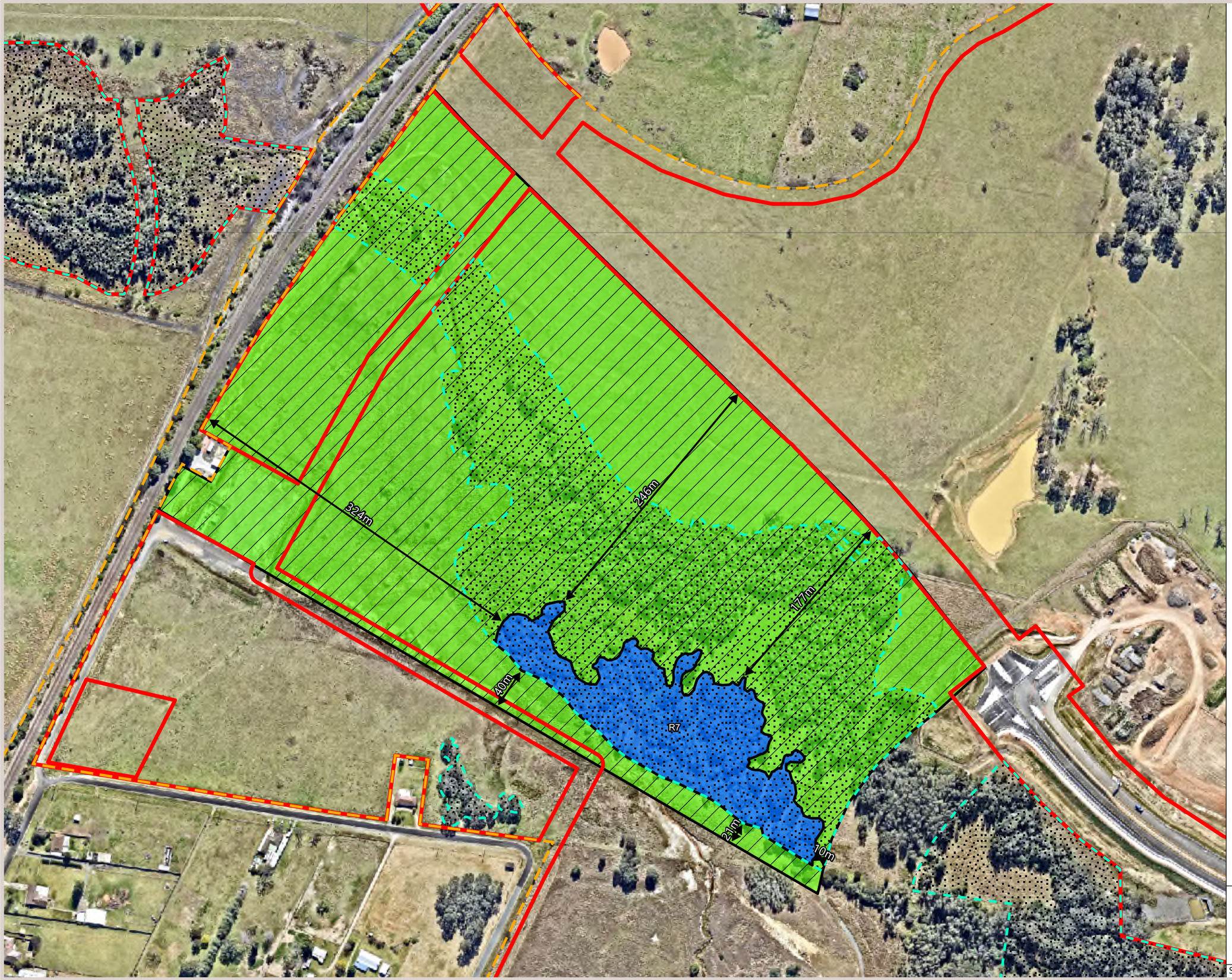
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Spatial Reference: GDA 1994 MGA Zone 56

0 8 15 30 45 60 m

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Figure 15. MNES patch C12



Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Zoning based MNES buffer
- Buffer distance measure

Matters of National Environmental Significance

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

Land Zoning

- RE1: Public Recreation

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Data Source: SMEC (2025)
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Spatial Reference: GDA 1994 MGA Zone 56

0 25 50 100 150 200 m

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Figure 16. Howes Creek Conservation Area Buffers

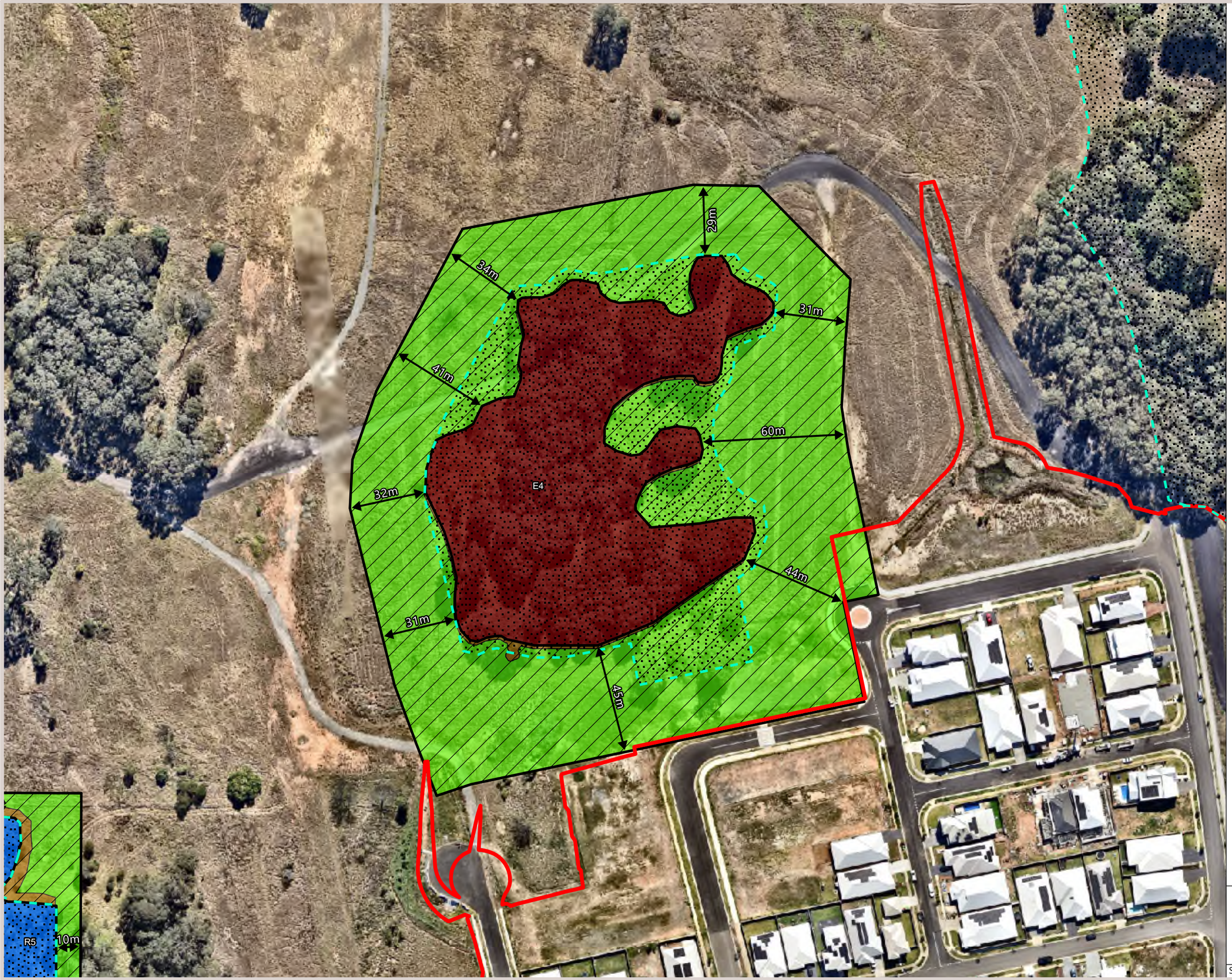


Figure 17. Park K Conservation Area Buffers

Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Zoning based MNES buffer
- Buffer distance measure

Matters of National Environmental Significance

- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria

Land Zoning

- C2: Environmental Conservation
- RE1: Public Recreation

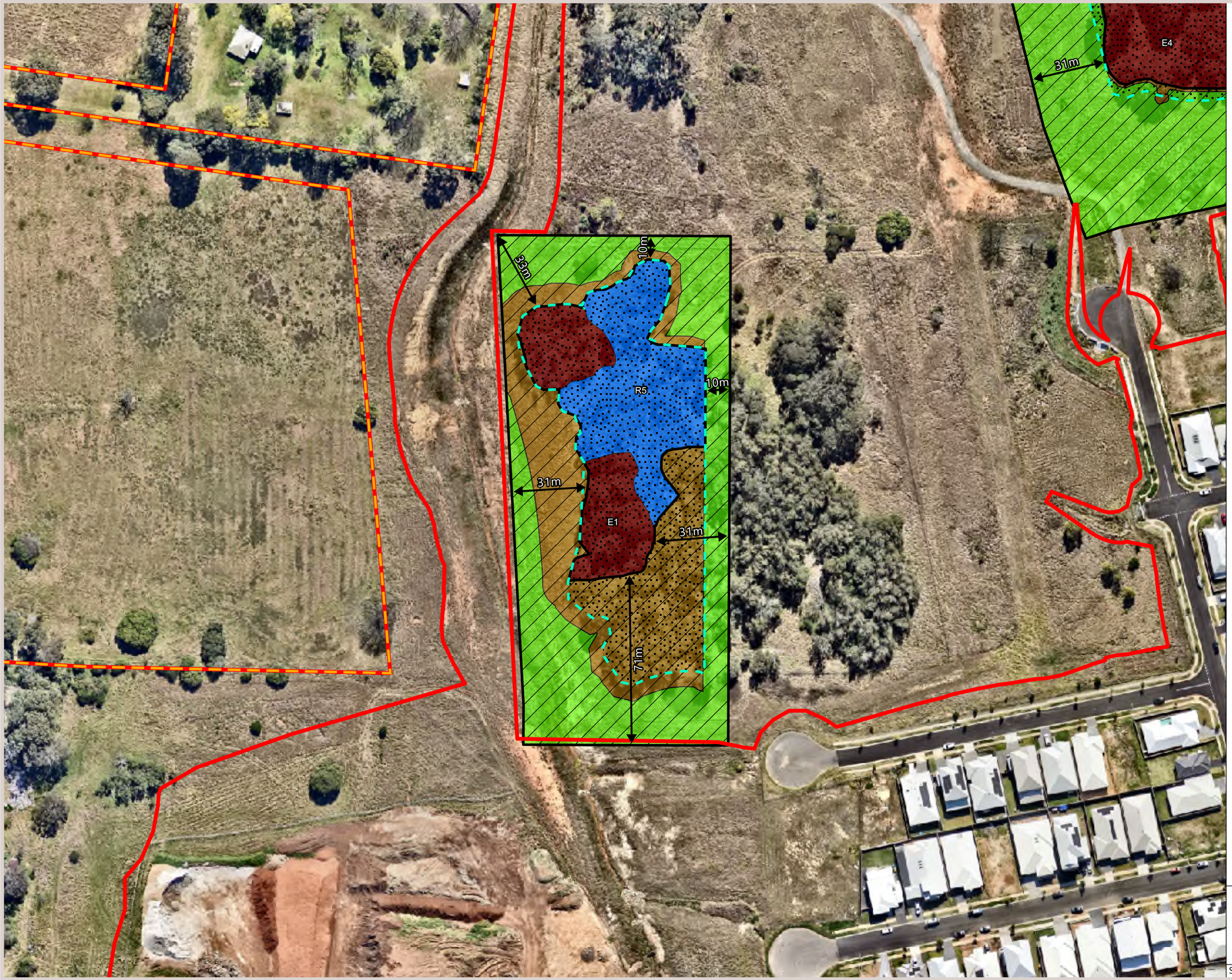
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Spatial Reference: GDA 1994 MGA Zone 56

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Legend

- Project Area
- Menangle Park Urban Release Area
- Menangle Park Project Site
- Retention Area
- Zoning based MNES buffer
- Buffer distance measure

Matters of National Environmental Significance

- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria

Land Zoning

- C2: Environmental Conservation
- RE1: Public Recreation

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Spatial Reference: GDA 1994 MGA Zone 56

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Figure 18. Park L Conservation Area Buffers



Legend

- Project Area
- Menangle Park Project Site
- Menangle Park Urban Release Area
- Disturbance Footprint
- Retention Area
- Future RE1: Public Recreation
- Buffer distance measure

Matters of National Environmental Significance

- Elderslie Banksia Scrub Forest in the Sydney Basin Bioregion (Future C2: Environmental Conservation)

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Data Source: SMEC (2025)
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Spatial Reference: GDA 1994 MGA Zone 56

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Figure 19. Stage 6B Conservation Area Buffers