Bayswater Water and Other Associated Operational Works Project

Appendix C – Biodiversity Development Assessment Report

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Biodiversity Development Assessment Report

AGL Macquarie Pty Ltd

Bayswater Power Station Water and Other Associated Operational Works Project

New England Highway, Muswellbrook, NSW 2333

21 May 2020

Biodiversity Development Assessment Report

Bayswater Power Station Water and Other Associated Operational Works Project

New England Highway, Muswellbrook, NSW 2333

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Prepared for:

AGL MACQUARIE PTY LTD
C/- JACOBS GROUP (AUSTRALIA) PTY LTD

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EXECUTIVE SUMMARY

*Kleinfelder were engaged by Jacobs Group on behalf of AGL Macquarie Pty Ltd (**AGLM**) to undertake a Biodiversity Development Assessment Report (**BDAR**) for Bayswater Power Station Water and Other Associated Operational Works (**Bayswater WOAOW**) Project (**the Project**), located at New England Highway, Muswellbrook, NSW. The Development Site for the Project is 561.21 ha; of which 270.85 ha consists of native vegetation.*

*This report has been prepared in accordance with the Biodiversity Assessment Method (**BAM**) to assess the biodiversity impact and offsetting obligation of the Project under the under the Biodiversity Conservation Act 2016 (**BC Act**).*

*Native vegetation surveys conducted within the Study Area (**Section 3**) identified three Plant Community Types (**PCTs**); 206.82 ha of PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter is present in six vegetation zones, 61.64 ha of PCT 1692: Bull Oak grassy woodland of the central Hunter Valley is present in three vegetation zones, and 2.40 ha PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley was present in one vegetation zone. Additionally, areas of non-native vegetation (67.12 ha), dams (1.47 ha) and excluded areas (221.77 ha; existing Ash Dam footprint and other existing pieces of infrastructure) occur within the Development Site. Three vegetation zones within the Development Site were identified as constituting Threatened Ecological Communities under the BC Act and/or the* Environment Protection and Biodiversity Conservation Act 1999 *(**EPBC Act**) (**Section 3.2.2**). There is a total of 14.97 ha of the* Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions *Endangered Ecological Community listed under the BC Act, and a total of 13.62 ha of the* Central Hunter Valley eucalypt forest and woodland *Critically Endangered Ecological Community listed under the EPBC Act.*

*Paddock trees within the Development Site were also assessed as part of the Project, with 23 Class 2 and 19 Class 3 trees being identified and mapped. All trees were assigned to PCT 1691 as the closest equivalent PCT (**Section 3.2.5**).*

*Targeted threatened species surveys identified one threatened population listed as Endangered under the BC Act, and seven threatened species listed as Vulnerable under the BC Act (**Section 4**) within the Study Area:*

- Acacia pendula *Endangered Population in the Hunter Catchment listed under the BC Act: one planted Acacia pendula individual was identified within the Study Area, outside the Development Site. There will not be any direct impacts on this species or its habitat, as such, no further assessment of impacts was conducted.*
- *Large Bent-winged Bat was identified via Anabat detection. This species is a dual Species and Ecosystem Credit Species. The breeding habitat constraint for this species is not present on or*

within 100 m of the Development Site, as such the species was determined to not be a candidate species and no further assessment of impacts was conducted.

- *Little Lorikeet, Hooded Robin, Grey-crowned Babbler and Speckled Warbler were all visually identified within or flying over the Study Area.*
- *Southern Myotis (species credit species) was identified via Anabat detection adjacent to the Ash Dam within the Development Site.*
- *Squirrel Glider (species credit species) was identified via remote camera within Borrow Pit 4 within the Development Site.*
- *Striped Legless Lizard (species credit species) was identified under an old fallen fence post within Borrow Pit 4 with the Development Site*

Due to sub-optimal conditions for the flowering season of Diuris tricolor *(species credit species listed under the BC Act) and* Prasophyllum petilum *(species credit species listed under the BC Act and synonymous with* Prasophyllum sp. Wybong *listed under the EPBC Act), and the lack of flowering of these two species at local reference populations, an expert report was undertaken to determine the habitat suitability of the Study Area for these species (**Expert Report**) (**Section 4.2.2.1 and Appendix 8**). The Expert Report determined that approximately 160 hectares of habitat will be potentially impacted by the proposed development. As such, both species are assumed to be present within the Development Site. An assessment of the Projects impacts on* Prasophyllum *sp. Wybong have been conducted in accordance with the EPBC Act. This assessment concluded that due to the lack of information regarding the occurrence of the species within the Development Site, potential impacts are unknown.*

*The Project including both the Development Site and mode of construction/operation, has been designed in consideration of the principals of avoid and minimise (**Section 5.1**). A number of alternatives, including the do-nothing option, were considered prior to the current design. Direct impacts, indirect impacts and impacts on prescribed matters have been avoided and minimised where possible in the final design of the Project. A range of mitigation and management measures have been incorporated into the Project to reduce impacts on biodiversity during construction and operation (**Section 5.3**).*

No Serious and Irreversible Impacts were identified within the Development Site.

*The residual impacts of the Project which require offsetting include (**Section 6.2**):*

- *Impacts on 206.82 ha of PCT 1691, generating a credit obligation of 3,904 ecosystem credits.*
- *Impacts on 61.64 ha of PCT 1691, generating a credit obligation of 1,275 ecosystem credits*
- *Impacts on 2.40 ha of PCT 1731, generating a credit obligation of 31 ecosystem credits.*
- *Impacts on 42 Paddock Trees associated with PCT 1691 requires a total of 31 ecosystem credits.*
- *Impacts on 166 ha of* Diuris tricolor *habitat, generating a credit obligation of 2,158 species credits.*

- *Impacts on 166 ha of* Prasophyllum petilum *habitat, generating a credit obligation of 2,877species credits.*
- *Impacts on 59.05 ha of Squirrel Glider habitat, generating a credit obligation of 1,433 species credits.*
- *Impacts on 8.11 ha of Southern Myotis habitat, generating a credit obligation of 233 species credits.*
- *Impacts on 120.68 ha of Striped Legless Lizard habitat, generating a credit obligation of 2,169 species credits.*

*The retirement of biodiversity credits will occur in a staged manner as clearing for each portion of the Project will not occur immediately. Additionally, all areas of the Borrow Pits may not be cleared. A separate clearing staging plan will be prepared prior to the commencement of works. This plan will set out the biodiversity credit obligation for each stage of clearing and will be approved by DPIE prior to commencement. The biodiversity credit obligation for species that have been assumed present (*Diuris tricolor *and* Prasophyllum petilum*) will be reassessed following completion of targeted surveys for these species during the optimum period of detection.*

Other relevant biodiversity legislation was also considered as part of the assessment.

A delegate of the Commonwealth Minister for the Environment determined that the project is a controlled action under the EPBC Act. The EPBC Act controlling provisions for the proposed action are listed threatened species and communities. The project will be assessed under the Bilateral Agreement (Amending Agreement No.1, 2020) between the Commonwealth and NSW Governments. Accordingly, the BDAR has been amended in accordance with supplementary requirements. It was concluded that for the majority of the EPBC listed threatened species, ecological communities and migratory species identified within the Development Site or identified as having suitable habitat within the disturbance footprint, the Project is unlikely to have a significant impact. The Striped Legless Lizard and Prasophyllum sp. Wybong have been identified as species for which impacts are uncertain. Prasophyllum *Wybong has been assumed to be present within the development site based on an expert report, which determined that approximately 166 ha of habitat would potentially be impacted by the proposed action; however, this is recognised as a conservative estimate of habitat extent by the expert who also states that the habitat is unlikely to support a population of the species.*

Within the Development Site, two areas were identified as constituting potential Koala habitat as defined under State Environmental Planning Policy (Koala Habitat Protection) 2019 *(**Koala SEPP**). No evidence of Koala activity was identified during surveys, and the habitat was determined not to represent core Koala habitat..*

Five species listed under the Biosecurity Act 2015 (NSW) *were also identified within the Study Area. These species will need to be controlled as part of the Project to ensure their biosecurity risk is managed.*

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1. INTRODUCTION

1.1 SCOPE

Kleinfelder Australia Pty Ltd was engaged by Jacobs Group on behalf of AGL Macquarie Pty Ltd (**AGLM**) to undertake a Biodiversity Development Assessment Report (**BDAR**) for the Bayswater Power Station Water and Other Associated Operational Works (**Bayswater WOAOW**) Project (**the Project**), located at New England Highway, Muswellbrook, NSW (**Figure 1**). This assessment has been undertaken in accordance with the NSW Biodiversity Assessment Method (**BAM**) (OEH, 2017) under the *Biodiversity Conservation Act 2016 (NSW) (**BC Act**)* to support an Environmental Impact Statement (**EIS**) for the Project.

The following terms are used throughout this report to describe particular geographical areas:

- Development Site: the area to be directly impacted by the proposed Project (**Figure 3 A** - **Figure 3 D**).
- Study Area: the Development Site plus a buffer area ranging from 25 to 50 m wide to account for possible indirect impacts (**Figure 2**).
- Locality: land within a 10 km radius of the Study Area.

1.2 LOCAL CONTEXT

The Study Area is within both the Muswellbrook Shire Council (**MSC**) and the Singleton Council (**SC**) Local Government Areas (**LGAs**). The Study Area is zoned SP2 Infrastructure and RU1 Primary Production.

The Study Area is approximately 731.72 ha and consists of existing infrastructure associated with the Bayswater Power Station (**Bayswater**) as well as areas of remnant native vegetation, areas of plantations and rehabilitation, mixed native and exotic grasslands, exotic grasslands, wetlands and dams.

The Study Area is made up of the Development Site plus a variable buffer area ranging from 25 – 50m wide to account for possible indirect impacts.

The land surrounding the Study Area contains existing infrastructure associated with both the Bayswater and Liddell Power Stations and a mixture of remnant native vegetation to the west and, cleared grasslands to the east. The existing infrastructure associated with the Bayswater and Liddell Power Stations in the vicinity of the Study Area includes the Plashett Freshwater Dam and Lake Liddell. Further to the east and north-west, there are a number of existing open cut mining operations **Figure 3 A** - **Figure 3 D**.

1.3 PROPOSED DEVELOPMENT

The total Development Site footprint of the Project (including the required construction footprint) is 561.21 ha. The existing Ash Dam footprint and other existing pieces of infrastructure have been excluded from the Development Site footprint as these areas contain approved infrastructure, which will be retained as part of the Project.

The Development Site has been divided into eight works areas based upon their location within the larger Bayswater site (**Figure 1**) being:

- Coal Handling Plant (CHP) and Wastewater infrastructure upgrades **Figure 3 A**.
- Salt Cake Landfill (**Figure 3 A**).
- Borrow Pits 1 & 2, Ash Dam augmentation, Ash harvesting and Water management works (**Figure 3 C**).
- HP Pipe Clearing (North) and LSP Sludge Line (**Figure 3 C**).
- HP Pipe Clearing (South) (**Figure 3 A**).
- Borrow Pit 3 (**Figure 3 B**).
- Borrow Pit 4 (**Figure 3 B**).
- Ravensworth Ash Line Replacement (**Figure 3 D**).

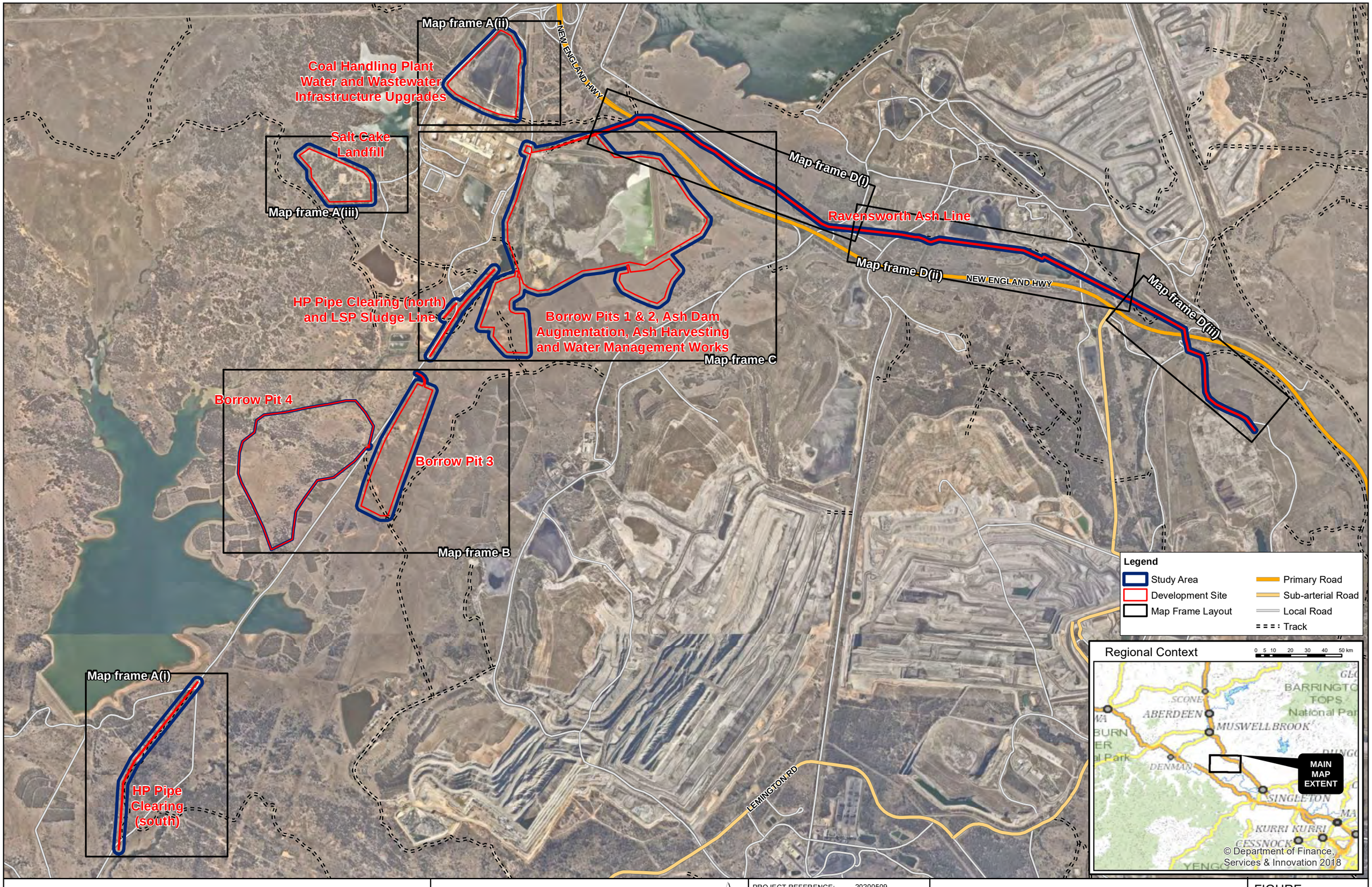
A summary of the key components of the Project are provided in **Table 1**.

Table 1: Summary of Key Components of the Proposed Action

Component	Description
Ash Dam Augmentation	The augmentation of the existing Bayswater ash dam is required to provide storage for an additional 12.5 million m^3 of coal ash from Bayswater. The augmentation would increase the size of the existing ash dam footprint by approximately 167,000 m^2. The existing ash dam is located to the east of the Bayswater Power Station, on land disturbed by existing operations at Bayswater. The Ash Dam Augmentation consists of: • Construction of a new approximately 11.5 m high standalone levee embankment on the western perimeter of the ash dam. • Raising the existing northern saddle dam embankment of the ash dam by approximately 3.5 metres. • Construction of a concrete parapet wall along the main embankment crest to increase flood attenuation within the dam. • Construction of two new southern saddle dams to prevent ash from spilling out of low points in a ridgeline to the south which forms the current southern Ash Dam edge • Extensions to the ash dispersion and water supply and management systems in the Ash Dam. • Construction of ash dam divider walls within the ash dam to allow ash discharge to be undertaken in alternating cells and the deployment of dust suppression (ie water sprays) where necessary during dust events in accordance with existing dust management processes. • Upgrade to ancillary infrastructure associated with ash transport and disposal including pumps, pipelines and power supply infrastructure. • Water management improvement works associated with the main and saddle dam walls, including diversion of clean runoff around the site and installation of new, and upgraded, seepage capture and return infrastructure. • Relocation/replacement of existing pipelines at the ash dam where necessary to facilitate ongoing operation and reflect current standards. Construction of the Ash Dam Augmentation will require around 1,000,000 m^3 of suitable earthen fill material for the construction of the embankments. The materials required for the Ash Dam Augmentation would be sourced onsite from the proposed borrow pit described below.
Increased Coal Ash Harvesting	Coal ash is produced as part of the coal combustion process undertaken during the generation of electricity at Bayswater. Combustion within the boiler furnaces at the Bayswater produces 2 types of ash. Heavier course ash particles fall to the bottom of the boiler and are referred to as 'bottom ash'. Lighter fine ash particles remain suspended in the combustion flue gas and are referred to as 'fly ash'. In addition, cenospheres are also formed during the combustion process. Cenospheres are light weight hollow ceramic microspheres that typically form part of the fly ash produced. At present, up to 170,000 tonnes per annum of coal ash (including fly ash, bottom ash and cenospheres) from Bayswater are extracted for beneficial re-used by third parties for a range of purposes including as a component in the manufacture of building products such as concrete, as a road and pipe base material and for use in a range of other applications. The Project would increase the approved scale of coal ash recycling activities at Bayswater to enable increased beneficial reuse. AGL Macquarie currently anticipates that the average volume of coal ash harvested for beneficial reuse would be around 600,000 tonnes per annum based on current demand. This would increase to up to 1,000,000 tonnes per annum of coal ash during periods of peak demand. This increased scale of ash recycling would reduce the volume of coal ash requiring deposition on site and enable further beneficial reuse of the coal ash. In order to facilitate the increased scale of ash recycling, the Project includes updated mobile plant and equipment including an additional silo and weighbridges within the existing ash

Component	Description
	recycling areas to enable the increased extraction of coal ash for beneficial reuse. Additional internal access tracks would also be required within the assessed disturbance footprint. In order to facilitate increased coal ash harvesting activities, utilities would be provided including potable water, sewerage and electrical (via either a new generator or mains connection).
Ravensworth Ash Pipeline Replacement	The existing 2 parallel 9.3 km pipelines which transport fly ash, in slurry form, from the Ravensworth Fly Ash Plant at Bayswater to Ravensworth Void No. 3 for disposal have reached the end of their operational life and require replacement. The 2 new pipelines would be located parallel to the existing pipelines The majority of the new pipelines would be installed above ground. However, the pipelines will be trenched or under bored below ground where the pipelines crossroads and infrastructure, and Pikes Creek, including at the New England Highway, Liddell Station Road and existing infrastructure corridors. Where the pipelines cross Bayswater Creek and Chilcotts Creek, they would be raised above ground. The new pipelines would connect to the existing, recently extended, ash pipelines which run from Ravensworth Void 3 to Void 5. Vegetation clearing would be required to facilitate the above works. For the purposes of assessment for this Referral, it is conservatively assumed that all vegetation within a 50 m wide pipeline corridor would be removed as part of the disturbance footprint, however opportunities to reduce clearing widths would be considered and implemented where practicable during detailed design and construction. The pipeline would be installed adjacent to the existing ash pipelines and in previously disturbed areas where possible. Access to the new pipeline alignment would be provided via the existing Ravensworth Road and Pikes Gully Road or via internal access roads from Bayswater. The existing fly ash pumping and ancillary infrastructure would be utilised and the new pipeline would be connected to this infrastructure.
Salt Cake Landfill Facility	The existing Bayswater water treatment plant removes naturally occurring salts and solids from the cooling water before the water is used in the power station. The brine stream from the water treatment plant is either disposed of in the brine concentrator decant basin or discharged =from Lake Liddell to the Hunter River via a licenced discharge point under the environment protection licence held for Bayswater in accordance with the Hunter River Salinity Trading Scheme. Upgrades to the water treatment plant have been separately approved, including a salt caking plant (Project approval 06_0047, as modified) as an alternative salt management solution. The existing approval has a deferred commencement condition which requires the establishment of a salt cake disposal solution prior to the operation of the salt caking plant. To address this deferred commencement condition, the Project includes the construction and operation of a new salt cake landfill facility on site to store the salt cake produced from the approved caking plant. The salt cake landfill facility would include 10 purpose built cells which would be constructed progressively. The facility would be designed to accommodate up to 50,000 tonnes of salt cake per year, with approximately 600,000 tonnes of salt cake being deposited over the operational life. The construction and operation of the salt cake landfill would be in accordance with *NSW EPA Environmental Guidelines for solid waste landfills (Second Edition, 2016)* and would include appropriate leachate barrier systems and capping to prevent contamination of the surface and groundwater during operation. Clay materials for the construction of the cells and capping would be sourced from the proposed borrow pits described below. Vegetation clearing would be required to facilitate the above works. For the purposes of assessment for this Referral, the Study Area has conservatively included the area of direct impact on which works are proposed (referred to as the Development Site) as well as a broader study area which includes a buffer area, ranging from 25 – 50 m wide to account for possible indirect impacts. However, during construction, vegetation beyond the Development

Component	Description
	Site area would not be cleared, and opportunities to reduce the extent of clearing within the buffer area would be considered and implemented where practicable during detailed design and construction.
Borrow Pits	Four borrow pit sites are proposed to provide virgin excavated material for use in construction of the Project, including the Ash Dam Augmentation and the Salt Cake Landfill Facility as well as for other existing activities at Bayswater, including for the ultimate capping of the ash dam. The final design of the borrow pits will be self-draining to prevent surface water ponding following extraction of the clay resource and rehabilitation. During operation, surface water ponding within the borrow pits would be appropriately managed in accordance with *Managing Urban Stormwater: Soils and construction - Volume 1* (the Blue Book) (Landcom 2004). The water would be retained in onsite storages with suitable retention times and treatment provided before being discharged or re-used in operations. Drainage catchments would remain generally consistent with the existing situation. The final design of the water management structures at the borrow pits would ensure that discharge meets the water quality objectives of the receiving water body. Excavation within the borrow pits would not intercept the groundwater table, and no dewatering works would be required except following rainfall events. Each borrow pit would require a level of vegetation clearance. The disturbance footprint used to calculate the areas of vegetation requiring clearance has been conservatively estimated and includes the proposed direct impact area. In addition, the study area includes an additional 50 m buffer for indirect impacts. Opportunities to reduce the extent of clearing within the disturbance footprint would be considered and implemented where practicable during detailed design and construction, and with consideration of the findings of the Biodiversity development assessment report (**BDAR**) being prepared for the Project.
CHP Water Management Upgrades	The existing water management infrastructure at the Bayswater Coal Handling Plant (**CHP**) is proposed to be upgraded to improve environmental outcomes. The Project includes additional water and wastewater management infrastructure works such as: • Construction of clean water diversions to reduce storm water inflows to the existing CHP sediment basin. • Reuse of water within the coal plant water system where possible for operational purposes which may include water treatment. • Changes to the water management structures, including the enlargement/reconfiguration of the CHP sediment basin to allow for a larger volume of water to be stored with increased detention time and improved settlement of coal fines to better treat the water. Construction activities would include minor civil works and plant modifications related to the water management improvements works. Activities would be limited to the existing operational areas of the CHP and would not require any additional clearing.
Ancillary Works	Ancillary infrastructure works in support of the above and other works including repositioning of underground pipelines to above ground, replacement or upgrading of ageing pipelines and vegetation clearing associated with maintaining existing infrastructure, including along pipeline corridors. Routine clearing of vegetation and the construction of new access tracks along the alignments of the existing 0.25 km pipeline from the Lime Softening Plant to the Lime Sludge Lagoons and the 3.5 km High Pressure Pipeline which provides fresh water to Bayswater and Liddell Power Stations. would be undertaken to provide ongoing access for maintenance and management. For the purpose of this assessment it has been conservatively assumed that the disturbance footprint for these activities would occur within a 50 m wide easement along each pipeline. In reality, it is anticipated that the extent of clearing for the access tracks would be limited to between 10 and 15 m wide.



0 0.25 0.5 1 1.5 2 km

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DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Bayswater WAOAW Project Work Areas

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
1

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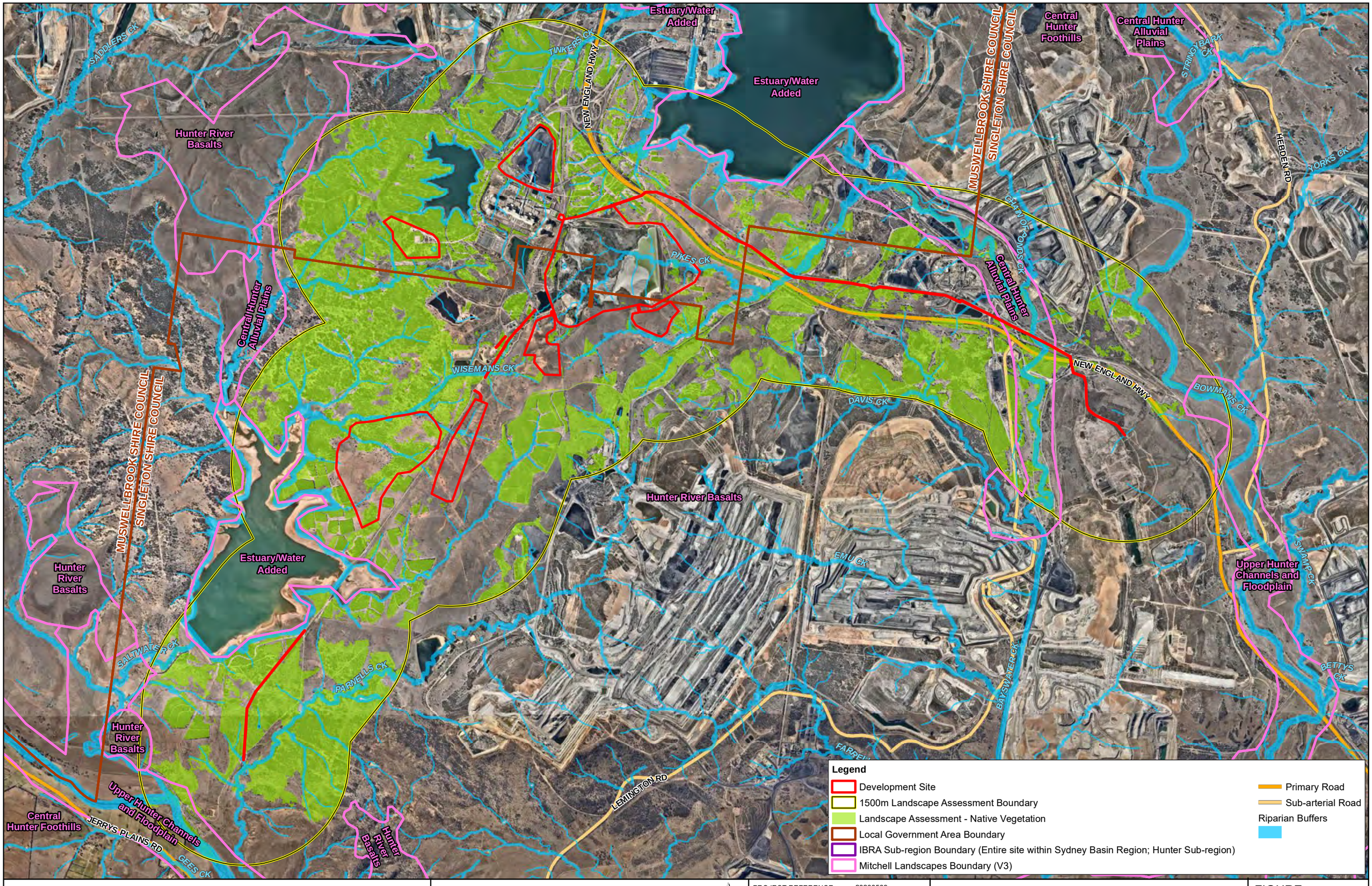

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Development Site Location Map

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FIGURE: 2

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Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Estuary/Water Added
Central Hunter Foothills
Lot 110 DP 625973
Lot 1 DP 616024
Lot 107 DP 547864
Lot 1 DP 1112847
Lot 2 DP 1095515
TIMKERS CK
Lot 29 DP 247944
Lot 3 DP 247943
Lot 5 DP 966589
Lot 6 DP 247943
Lot 3 DP 192253
Lot 1 DP 369326
Lot 1 DP 1153700
PARNELLS

Legend

- Study Area
- Development Site
- IBRA Sub-region Boundary (Entire site within Sydney Basin Region; Hunter Sub-region)
- Mitchell Landscapes Boundary (V3)
- Lot Boundaries
- Local Road
- Track
- Watercourse (Labelled with stream order)
- Riparian Buffers

0 50 100 200 300 400 500 Metres

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Development Site Map A

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FIGURE:
3A

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Map Frame B
Borrow Pits 3 and 4

Lot 105 DP 752468
Lot 76 DP 752468
Lot 10 DP 700514
Lot 93 DP 752468
Lot 13 DP 752468
Lot 17 DP 752468
Lot 30 DP 752468
WISEMANS CK
Lot 75 DP 752468
Lot 85 DP 752468
Lot 88 DP 752468
Lot 19 DP 752468
Lot 89 DP 752468
Lot 86 DP 752468
Borrow Pit 3
Lot 64 DP 752468
Borrow Pit 4
Lot 101 DP 752468
Lot 62 DP 752468
Lot 79 DP 752468
Lot 63 DP 752468
Lot 1 DP 616025
Lot 112 DP 1059007
THE MITCHELL LINE
Lot 80 DP 752468
Lot 92 DP 752468

Legend

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0 50 100 200 300 400 500 Metres

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Development Site Map B

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FIGURE:
3B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

TINKERS CK
NEW ENGLAND HWY
PIKES CK
WISEMANS CK

Ash Dam Augmentation, Ash Harvesting and Water Management Works
HP Pipe Clearing (north)
LSP Sludge Line
Borrow Pit 1
Borrow Pit 2

Legend

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- Primary Road
- Local Road
- Track
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- Riparian Buffers

0 50 100 200 300 400 500 Metres

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Development Site Map C

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Bayswater Water and Other Associated Operational Works (WAOAW) Project

FIGURE:
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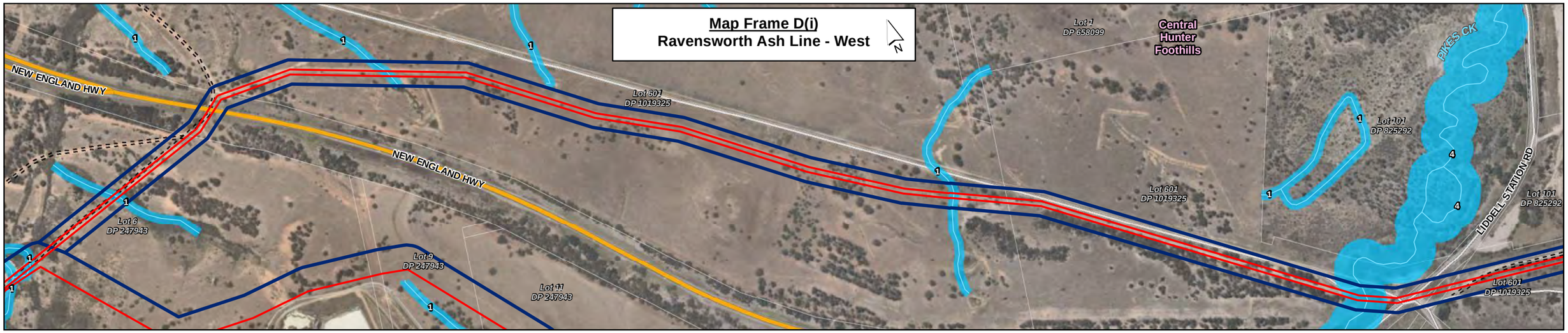

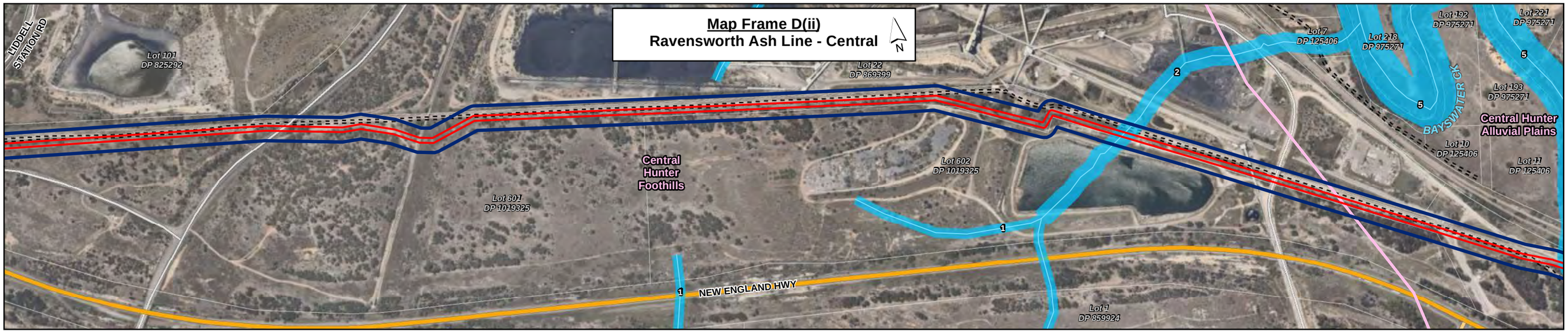

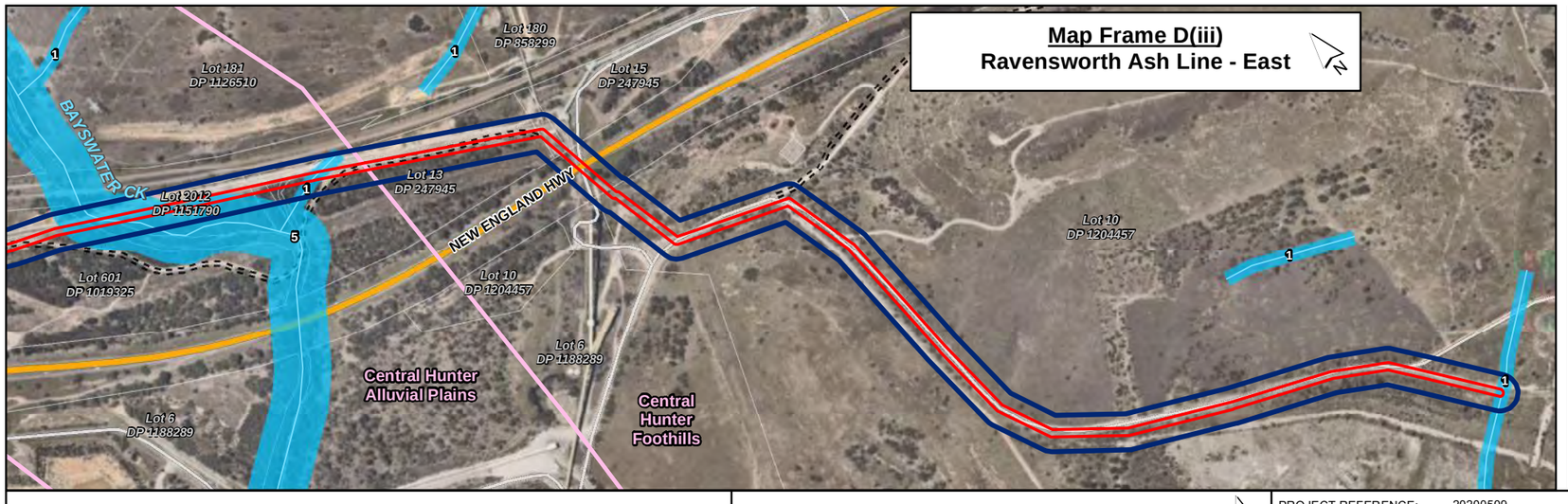

Legend

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Riparian Buffers

0 50 100 200 300 400 500 Metres

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Nearmap - 2019

Development Site Map D

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FIGURE:

3D

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1.4 INFORMATION SOURCES

Knowledge from existing literature pertaining to the Development Site and broader locality was used to inform the BDAR The following information sources were utilised:

- The NSW OEH BioNet Vegetation Classification (https://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx).
- The NSW OEH BioNet Atlas of NSW (http://www.bionet.nsw.gov.au/).
- The NSW OEH Threatened Biodiversity Data Collection (part of BioNet)
- The Department of the Environment and Energy (**DoEE**) Protected Matters Search Tool (**PMST**) for Matters of National Environmental Significance (**MNES**) (http://www.environment.gov.au/epbc/pmst/).
- Relevant published literature (see **Section 8**).

1.5 LEGISLATIVE CONTEXT

This assessment was undertaken in accordance with and/or in consideration of the following Acts and Policies:

- Commonwealth:
  - *Environment Protection and Biodiversity Conservation Act 1999* (**EPBC Act**).
  - *Environment Protection and Biodiversity Conservation Regulations 2000* (**EPBC Regulations**)
- New South Wales:
  - *Biodiversity Assessment Method* (**BAM**) (OEH, 2017a).
  - *Biodiversity Conservation Act 2016* (NSW) (**BC Act**).
  - *Biodiversity Conservation Regulation 2017* (NSW) (**BC Regulation**).
  - *Biosecurity Act 2015* (NSW).
  - *Draft State Environmental Planning Policy (Environment).*
  - *Environmental Planning and Assessment Act 1979* (**EP&A Act**).
  - *Local Land Services Act 2013* (NSW) (**LLS Act**).
  - *State Environmental Planning Policy (Koala Habitat Protection) 2019* (**Koala SEPP**)
  - *State Environmental Planning Policy (Coastal Management) 2018* (**SEPP Coastal Management**).
  - *State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017.*
  - *Water Management Act 2000* (NSW) (**WM Act**).
- Local:

- *Muswellbrook Development Control Plan 2009* (**MDCP 2009**).
- *Muswellbrook Local Environmental Plan 2009* (**MLEP 2009**).
- *Singleton Community - Environmental Sustainability Strategy and Action Plan 2016* (**SCESSAP 2016**).
- *Singleton Development Control Plan 2014* (**SDCP 2014**).
- *Singleton Local Environmental Plan 2013* (**SLEP 2013**).

1.5.1 *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act)

Under the EPBC Act, actions which are likely to have a significant impact on matters of national environmental significance (**MNES**) are required to be referred for a determination as to whether they are a controlled action which requires approval under the EPBC Act. An action includes a project, development, undertaking, activity, or series of activities. The EPBC Act identifies nine MNES:

1. World Heritage properties.
2. National heritage places.
3. Wetlands of international importance (Ramsar Convention).
4. Listed threatened species and communities.
5. Migratory species listed under international agreements.
6. Great Barrier Reef Marine Park.
7. Commonwealth marine areas.
8. Nuclear actions.
9. Water resources in respect to CSG and large coal mines.

While this BDAR is primarily prepared under the BC Act, on 20 April 2020, a delegate of the Commonwealth Minister for the Environment determined that the project is a controlled action under the EPBC Act. The EPBC Act controlling provisions for the proposed action are listed threatened species and communities (sections 18 and 18A).

The project will be assessed under the Bilateral Agreement (Amending Agreement No.1, 2020) between the Commonwealth and NSW Governments. Accordingly, the BDAR has been amended in accordance with supplementary requirements to address the following:

- An assessment of all impacts that the action is likely to have on each matter protected by a provision of Part 3 of the EPBC Act.
- Enough information about the proposal and its relevant impacts to allow the Federal Minister to make an informed decision on whether or not to approve the project.

- Information addressing the matters outlined in Schedule 4 of the EPBC Regulations.

A summary of how the supplementary assessment requirements, including those listed above, is presented in **Section 7.1**.

1.5.2 *Biodiversity Conservation Act 2016* (NSW)

Biodiversity Assessment Pathway

The Secretary's Environmental Assessment Requirements (**SEARs**) for the Project (State Significant Development (**SDD**) 9697) require the biodiversity assessment to provide an assessment of the likely biodiversity impact of the development in accordance with Section 7.9 of the BC Act and the BAM. Section 7.9 of the BC Act requires that all SSD applications are to be accompanied by a BDAR, unless the Planning Agency Head and the Environment Agency Head determine that the proposed development is not likely to have any significant impact on biodiversity values. No such determination has been made for the Project and, accordingly, a BDAR is required for the Project.

Biodiversity Assessment Method

The Project has been assessed in accordance with the BAM (OEH, 2017). The Biodiversity Accredited Assessor System (**BAAS**) Case number for the Project is 00018204. Three BAM Calculator cases have been created under the Parent Case for the Project, two for native vegetation zones, due to one PCT being both a Threatened Ecological Community (TEC) and non-TEC within the Development Site, and one for Paddock Trees:

- 00018204/BAAS17039/20/00018207.
- 00018204/BAAS17039/20/00018902.
- 00018204/BAAS17039/20/00018875.

1.5.3 SEPP (Koala Habitat Protection) 2019

The Koala SEPP aims to encourage the conservation and management of areas of natural vegetation that provide habitat for Koalas to support a permanent free-living population over their present range and reverse the current trend of Koala population decline.

Where a Koala Plan of Management (**KPoM**) applies to the land, Clause 8 of the Koala SEPP applies to the development. The proposed development must be consistent with the approved KPoM that applies to the land. Where a KPoM does not apply to the land, and the land is

identified on the Koala Development Application Map, and has an area of at least 1 ha, the provisions of Clause 9 of the Koala SEPP applies to the development. As such, the determining authority must take into account the requirements of the Guideline, or information prepared by a suitably qualified and experienced person in accordance with the guideline demonstrating that the land is not Highly Suitable Koala Habitat, or Core Koala Habitat.

Where no KPoM applies to the land, and it is not mapped on the Koala Development Application Map, Clause 10 of the Koala SEPP applies to the development. The determining authority is not prevented from granting consent to the development if they are satisfied that the land is not identified on the Koala Development Application Map, does not have an approved KPoM applying to it, and is not Core Koala Habitat.

See **Section 7.2** for a summary of the Koala habitat assessment.

1.5.4 *Biosecurity Act 2015* (NSW)

Under the *Biosecurity Act 2015* (NSW) dealings with plants are subject to a general biosecurity duty "*to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.*" Under the act a biosecurity impact "*is an adverse effect on the economy, environment, or the community that arises, or has the potential to arise, from a biosecurity matter."* This legislation is addressed in **Section 7.3**.

2. LANDSCAPE CONTEXT

2.1 LANDSCAPE FEATURES

The landscape features and site context detailed in Section 4 of the BAM (OEH, 2017a) are described in **Table 2**. These landscape features are also shown on **Figure 3 A** - **Figure 3 D**.

Table 2: Landscape features of the Development Site.

Landscape Features	Development Site
Interim Biogeographic Regionalisation for Australia (**IBRA**) bioregion	**Sydney Basin.** The Development Site occurs within the northern portion of the Sydney Basin IBRA Region.
IBRA subregion	**Hunter.** The Development Site occurs within the northern portion of the Hunter IBRA sub-region.
LGA	The site straddles the boundary of the Muswellbrook and Singleton Local Government Areas.
Mitchell Landscapes	**Central Hunter Foothills.** This landscape is described as undulating lowlands, rounded to steep hills with rock outcrop on ridges on Permian lithic sandstone, conglomerate, shale and coal, general elevation 40 to 300 m with a few higher peaks, local relief 30 to 120 m. Red-brown to yellow brown harsh texture-contrast soils on slopes, dark coloured clays in valleys and limited accumulations of sand and gravel in streams.
Rivers, streams and estuaries	Chain of Ponds Creek (5th order) intersects the Ravensworth Ash Pipeline Replacement in the east. Pikes Creek (4th order) intersects the Ravensworth Ash Pipeline Replacement in the west and Ash Dam area (3rd order). Wiseman's Creek (3rd order) intersects the northern HP Pipe Clearing area. A number of other unnamed 1st and 2nd order streams intersect various parts of the site. All waterways on site are highly modified where the natural drainage line has been interrupted by constructed dams and/or drainage infrastructure and contain minimal fringing aquatic vegetation.
Wetlands	There are no important wetlands (as defined by the BAM) within or adjacent to the site. The closest important wetland to the Study Area is the Coastal Wetland, Hunter River – Estuarine, listed under SEPP (Coastal Management) which is located over 65 km to the south-east of the Development Site. Local wetlands (being any wetland which is not identified as an important wetland under the BAM) occur within the Study Area. In particular, there are a number of local wetlands (mapped as Wetland/Dams with Wetland Vegetation) in low lying areas of the Study Area. Additionally, the peripheries of the Ash Dam contain Wetland Vegetation.
Connectivity of different areas of habitat	The Study Area is not mapped as occurring within any regional corridors (Scott, 2003). On a local level the Development Site is situated in the vicinity of infrastructure associated with Bayswater, interspersed with land leased for grazing purposes. Land surrounding the Development Site contains a mixture of infrastructure, mining lands, cleared lands, cropping areas and intact vegetation. Existing infrastructure and open cleared areas dominate the Development Site. However, some areas of intact native

Landscape Features	Development Site
	vegetation occur across the site, particularly in the western portions where it connects to patchy vegetation in the broader landscape. Much of the vegetation within the Development Site and surrounds is fragmented by roads, infrastructure (e.g. pipelines), and areas cleared for agriculture and mining.
Areas of geological significance and soil hazard features	There are no areas of geological significance within the Development Site or Study area. There are no significant soil hazard features within the Study Area; no steep slopes occur, no significant drainage features and no mapped Acid Sulphate Soil areas.
Areas of outstanding biodiversity value	There are no areas of outstanding biodiversity value mapped within the Development Site or Study Area.

2.2 SITE CONTEXT

Details of the landscape assessment for the Development Site, according to the BAM (OEH, 2017a) using the site-based assessment methodology and determined by remote sensing and GIS, are provided below.

2.2.1 Native Vegetation Cover

Native vegetation cover was assessed as per Section 4.3.2 of the BAM. Whereby, the native vegetation cover is assessed on the Development Site and within a 1,500 m buffer area surrounding the outside edge of the boundary of the Development Site. This 1,500 m site buffer has an area of 7,980 ha which has a native vegetation cover of 2,897 ha or 36%.

All native woody vegetation within the 1,500 m buffer, including plantation and rehabilitation areas were mapped within the native vegetation cover. The majority of the woody vegetation occurs to the west of the Development Site. Areas of native grasslands were assessed using previous mapping conducted by Kleinfelder (within Bayswater and Liddell), and the Upper Hunter State Vegetation Type Mapping.

2.3 GEOLOGY AND SOILS

The Study Area occurs on three Soil Landscapes mapped by the Soil Landscapes of the Singleton 1:250 000 Sheet (Kovac and Lawrie 1991):

- Liddell Soil Landscape: Covers undulating low hills and undulating hills in the Liddell area. The Geology is the Singleton Coal Measures, with parent rock material including lithic sandstone, shale, mudstone, conglomerate, siltstone and coal seams. The main

soils are yellow Soloths and some yellow Solodic Soils on slopes, Earthy and Siliceous Sands on mid to lower slopes and some red Soloths, red Solodic Soils and Red Podzolic Soils.
    - This soil landscape occurs across the northern portions of the Study Area, and the northern section of the Southern HP Pipe Clearing area.
- Bayswater Soil Landscape: Covers undulating low hills south-west of Muswellbrook. The Geology is the Singleton Coal Measures, with parent rock material including sandstone, shale, mudstone, conglomerate, and coal. The main soils are Solodic Soils on slopes with Alluvial Soils in drainage lines.
    - This soil landscape occurs within Borrow Pits 3 and 4.
- Brays Hill Soil Landscape: Covers undulating low hills to the west of Muswellbrook. The Geology is the Singleton Coal Measures and Tertiary basalt, with parent rock material including calcareous shale and sandstone, and some basalt. The main soils are red Clays on the mid to upper slopes, with black Earths and Grey Clays on the mid to lower slopes.
    - A small area of this soil landscape occurs in the southern portion of the southern HP Pipe Clearing area.

3. NATIVE VEGETATION

3.1 METHODOLOGY

Native vegetation across the Study Area was assessed in accordance with Section 5 of the BAM (OEH, 2017).

3.1.1 Data Review

Vegetation mapping has been previously conducted across the majority of the Study Area by Kleinfelder (2017). This mapping was reviewed and updated based on the vegetation surveys outlined below to refine the vegetation mapping for the current Project and map areas not previously covered.

3.1.2 Vegetation Surveys

Vegetation Mapping and Surveys

Vegetation surveys were conducted across the Study Area from June to November 2019. The boundaries of each of the identified vegetation communities within the Study Area were mapped using a combination of rapid data points (**RDP**) and walking transects, using the polygons produced through aerial photo interpretation (**API**) to assist in targeting survey effort. RDPs involved collecting waypoints over the Study Area using hand-held GPS units and recording dominant species, structure and condition. Walking transects involved verifying polygons which were homogenous in floristic composition and condition, as well as walking vegetation ecotones and using the recorded tracks to define vegetation community boundaries. The RDPs and survey tracks were then overlaid on an aerial photograph and used to delineate and/or clarify vegetation boundaries.

Linework and Attribution

RDPs and plots were classified and tagged with a Plant Community Type (**PCT**) by field surveyors. Polygons produced from the API work adopted the PCT of the sample point that they intersected.

Vegetation Zones

Vegetation zones were identified and delineated within the Study Area in accordance with Section 5.3 of the BAM (OEH, 2017). A vegetation zone is defined in the BAM (OEH, 2017) as a relatively homogenous area that is the same vegetation type and broad condition.

Native woody vegetation zones were defined as groups of four or more trees within 50 m of each other. Scattered trees which do not meet this definition were included in non-woody vegetation zones or exotic vegetation zones.

Native non-woody vegetation zones were defined as those areas which contained ≥50% native ground and/or shrub cover.

Plant Community Type Determination

Each vegetation community identified within the Study Area was assigned to the closest equivalent PCT from those listed in the BioNet Vegetation Classification database. The closest equivalent PCT for each vegetation community was determined through a comparison of the floristic descriptions of PCTs in the database with the plot / transect data collected from the site. In addition to floristic and structural similarity, the landscape position, soil type and other diagnostic features of the vegetation communities on the sites were also compared to the descriptions in the database in order to determine the most suitable PCT. Threatened ecological communities (**TECs**) as defined under the BC Act and EPBC Act were also identified if present.

Central Hunter Eucalypt Forest and Woodland Ecological Community

The EPBC conservation advice for the *Central Hunter Valley eucalypt forest and woodland ecological community,* which is a Critically Endangered Ecological Community (**CEEC**) (listed by the Threatened Species Scientific Committee (**TSSC**) in 2015) states that to be considered a MNES under the EPBC Act, areas of the ecological community must meet the key diagnostic characteristics, and at least the minimum condition thresholds for moderate quality.

Once all native vegetation zones were defined, they were assessed against the key diagnostic characteristics and determined if they had the potential to meet the CEEC criteria. For those vegetation zones which meet the characteristics, an assessment of each patch against the condition criteria was applied. A patch was defined using the EPBC conservation advice (TSSC 2015) definition, which states that a patch is a discrete and mostly continuous area of the

ecological community. Where there is a break in native vegetation cover from the edge of the tree canopy (or regeneration that meets the 20 stems/ha density) of 30 m or more, then that gap indicates separate patches. Floristic plots sampled as part of the BAM survey were used to determine the perennial understorey cover and number of native understorey species present within a patch.

In addition to the EPBC conservation advice for the CEEC (TSSC 2015), supplementary information provided by DoEE regarding the determination of the CEEC within areas of Bull Oak Woodland was used to map vegetation zones which meet the CEEC criteria. The following steps were followed when implementing the conservation advice for the recognition of the CEEC in Bull Oak Woodland:

- To meet the key diagnostic characteristics, there must be at least 3 diagnostic eucalypt species per ha within a patch. This translates to one eucalypt every 57.7 m (if evenly spaced; 60 m spacing can be used for simplicity).
- Therefore, a 30 m side GIS buffer around canopy of any diagnostic eucalypt represents the area where the eucalypt density requirement is met.
- Where these GIS buffer areas around individual trees overlap, they can be considered to be part of the same patch.
- If any patch contains at least one canopy eucalypt and meets the patch size and other condition requirements, it could be considered as the CEEC (note: a single isolated tree would therefore not make a patch, as 30 m wide buffer is less than the minimum 0.5 ha patch size requirement).
- Similarly, when moving from an area of the CEEC into an area of solely Bulloak, a GIS buffer of 30 m wide from the edge of the eucalypts would represent where the eucalypt density requirement is no longer met, and therefore forms the edge of the patch.

In order to apply the above methodology, surveys of mature and juvenile trees within areas of Bull Oak Woodland were conducted in-conjunction with threatened flora surveys for trees and shrubs (**Section 4.2.2.1**). These surveys consisted of parallel transects across areas of suitable habitat (including the Bull Oak Woodland) at 10 – 20 m intervals. Where Eucalypt trees were identified their location was recorded using a handheld GPS device. The above process was then conducted using this data in a GIS system to map the areas of Bull Oak Woodland which meet the CEEC.

Assessing Vegetation Integrity (Site Condition)

Following stratification of the Development Site into vegetation zones, plots/transects were undertaken to collect site condition data for the composition, structure and function attributes listed in **Table 3** in accordance with Section 5.3 of the BAM (OEH, 2017). The location of the plots/transects were selected through stratified random sampling to provide a representative sample of the variation in vegetation composition and condition within each vegetation zone.

Table 3: Composition, Structure and Function components of vegetation integrity

Growth form groups used to assess composition (species richness) and structure (percent foliage cover)	Function attributes
• Tree (TG) • Shrub (SG) • Grass and grass-like (GG) • Forb (FG) • Fern (EG) • Other (OG)	• Number of large trees • Tree regeneration (presence/absence) • Tree stem size class (presence/absence) • Total length of fallen logs • Litter cover • High threat exotic vegetation cover (HTE) • Hollow-bearing trees (HBT)

The number of plots/transects undertaken across the site meets the minimum number of transects required for each vegetation zone area as detailed in Section 5.3.4, Table 4 of the BAM (OEH, 2017). The locations of the plots/transects undertaken on the Development Site are shown on **Figure 4 A** - **Figure 4 D** in the following section.

Floristic Identification and Nomenclature

Floristic identification and nomenclature is based on classification by Royal Botanic Gardens and Domain Trust, Sydney, published on PlantNET (the NSW Plant Information Network System http://plantnet.rbgsyd.nsw.gov.au).

For use in the BAM Calculator, native species were assigned to growth forms as per their classification in BioNet, and High Threat Weeds were classified as per the list published by The Biodiversity Conservation Division (**BCD**, formerly known as the Office of Environment and Heritage or **OEH**).

3.1.3 Paddock Trees

Paddock trees were assessed in accordance with Appendix 1 of the BAM (OEH 2017) on 6 January 2020. Trees assessed as part of the Paddock Tree Assessment were defined as all native trees outside of mapped native vegetation zones and where the groundcover is

dominated by exotic species. Within the Study Area this equated to those areas mapped as Non-native Vegetation: Exotic Grasslands. These areas meet the definition of Paddock Trees as:

a) The native vegetation that comprises the groundcover is:
   i. less than 50% of the cover is of indigenous species of vegetation, and
   ii. not less than 10% of the area is covered with vegetation (whether dead or alive), and
   iii. the assessment is made at the time of year when the proportion of the amount of indigenous vegetation in the area to the amount of non-indigenous vegetation in the area is likely to be at its maximum, and

b) the foliage cover for the tree growth form group is less than 25% of the benchmark for tree cover for the most likely plant community type.

Paddock trees were assigned to the most likely PCT based on the tree species location within the landscape and mapped surrounding PCTs.

3.2 ASSESSMENT RESULTS

3.2.1 Vegetation Zones

Three PCTs, as defined in the BioNet Vegetation Classification database, were identified within the Study Area being:

- PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter. PCT 1691 was divided into five zones based on condition, this included areas of Rehabilitation and Plantations, which were both assigned to PCT 1691 as the closest equivalent (this is discussed further in descriptions below).
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley. PCT 1692 was divided into two zones.
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley. Areas of PCT 1731 constituted one zone.

Additionally, the site contains areas of Non-Native vegetation; exotic grasslands, dams, and cleared land (existing tracks, roads and infrastructure) (**Figure 4 A** - **Figure 4 D**). Cleared land, including areas of existing infrastructure, were mapped as Excluded, as these areas do not require further assessment under the BAM.

Details on the vegetation zones (including vegetation formation and class, condition class and area) defined within the Development Site are outlined in **Table 4**. Full descriptions of each vegetation zone are provided in the following sub-sections. **Figure 4 A** - **Figure 4 D** show the distribution of PCTs and vegetation zones within the Development Site. Plot data sheets and an excel of plot data have been provided as separate documents along with the BDAR.

Table 4: Plant Community Types and other areas within the Development Site

Zone	PCT	Condition Class	Vegetation Formation	Vegetation Class	Area (ha)
1	1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Mod-Good-CEEC	Grassy Woodlands	Coastal Valley Grassy Woodlands	8.09
2		Mod-Good			6.70
3		Regrowth			40.36
4		Grassland			147.77
5		Rehabilitation			3.75
6		Plantation			0.14
				Sub-total of PCT	***206.82***
7	1692: Bull Oak grassy woodland of the central Hunter Valley	Mod-Good	Grassy Woodlands	Coastal Valley Grassy Woodlands	56.11
8		Mod-Good-CEEC			5.53
				Sub-total of PCT	***61.64***
9	1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley.	Mod-Good	Forested Wetlands	Coastal Swamp Forests	2.40
-	Non-Native: Exotic Grasslands	-	-	-	55.82
-	Non-Native: Wetland/Dam (with Wetland Vegetation)	-	-	-	11.30
-	Dams (no Wetland Vegetation)	-	-	-	1.47
-	Excluded	-	-	-	221.77
				Total Area	**561.21**

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Q01
Q02
Q28
Q29
Q31
Q32
Q33

Legend

- Study Area
- Development Site
- Plot Transect
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Plant Community Types, Vegetation Zones and Plot Locations

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
4A

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Map Frame B
Borrow Pits 3 and 4

Q34
Q03
Q16
Q17
Q22
Q35
Q10
Q11
Q18
Q15
Q04
Q23
Q21
Q14
Q13
THE MITCHELL LINE

Legend

- Study Area
- Development Site
- Plot Transect
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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DATA SOURCE:
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AGL - 2019
Nearmap - 2019

Plant Community Types, Vegetation Zones and Plot Locations

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
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FIGURE:
4B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

Q08
Q12
Q36
Q05
NEW ENGLAND HWY
Q26
Q20
Q25
Q09
Q06
Q24

Legend

- Study Area
- Development Site
- Plot Transect
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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Nearmap - 2019

Plant Community Types, Vegetation Zones and Plot Locations

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FIGURE:
4C

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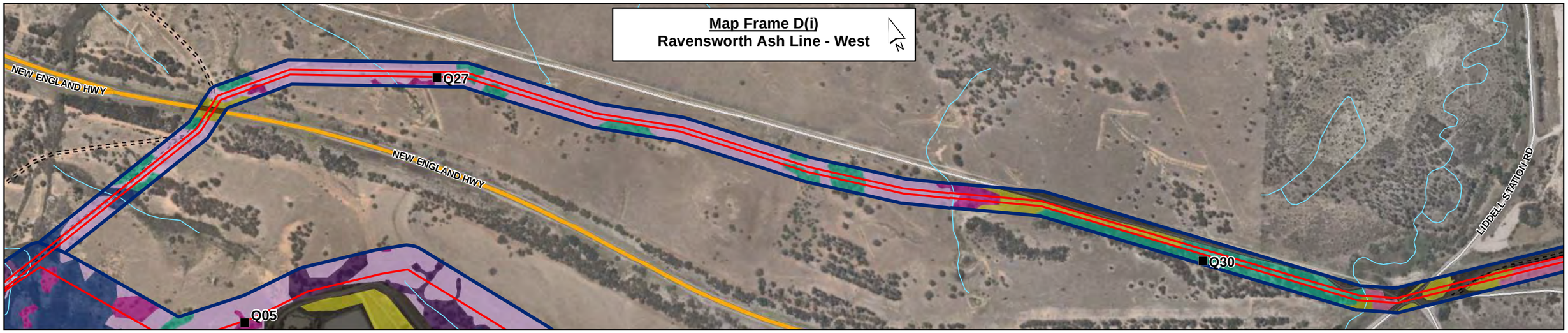

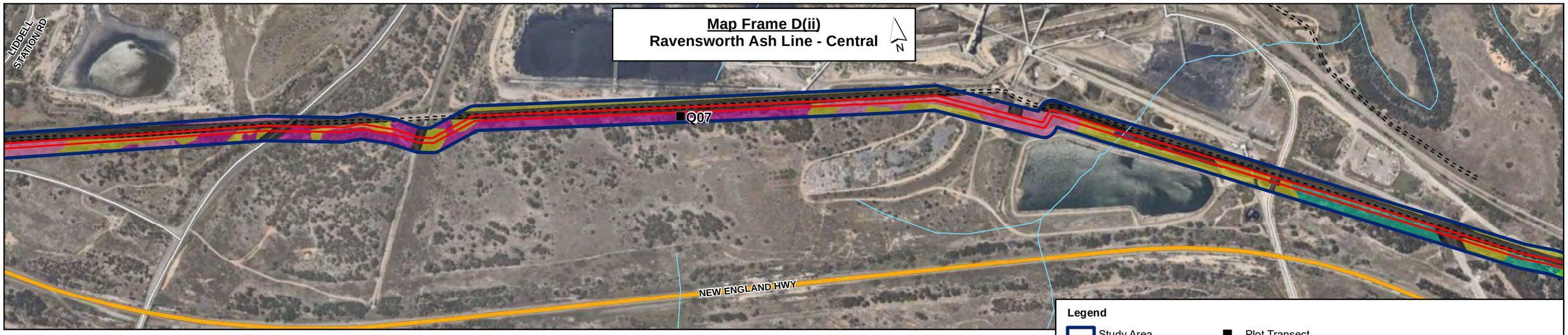

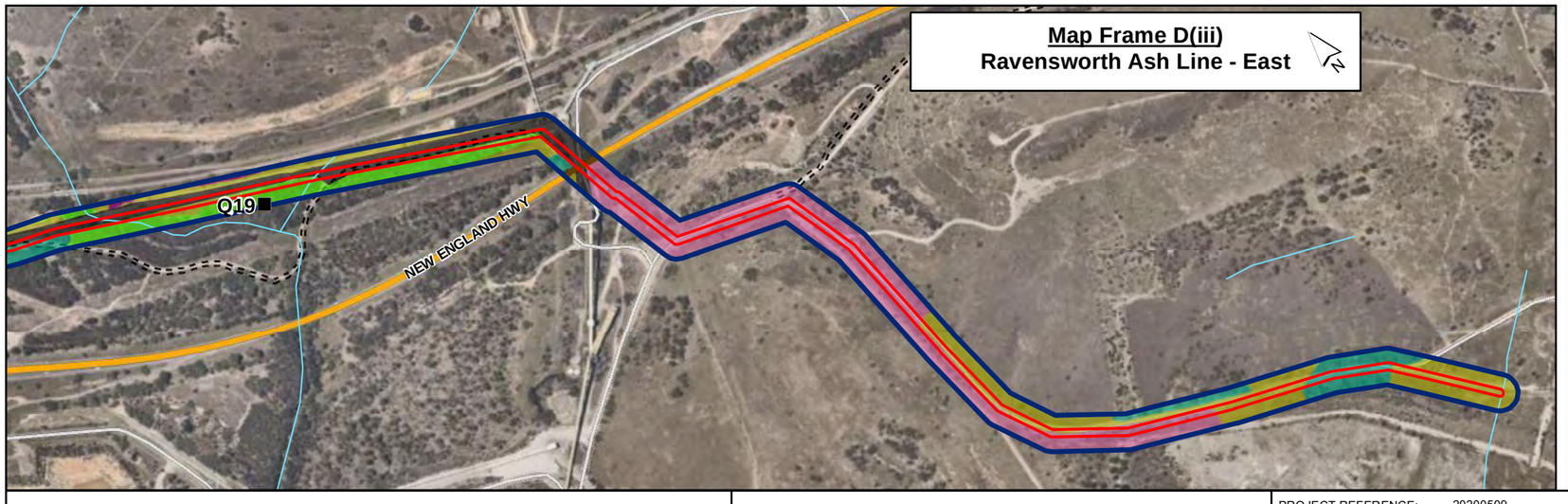

Legend

- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse
- Plot Transect

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1761: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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PROJECT REFERENCE: 20200509
DATE DRAWN: 2019/11/26 12:15 Version 1
DRAWN BY: GJoyce

DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Plant Community Types, Vegetation Zones and Plot Locations

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated Operational Works (WAOAW) Project

FIGURE: 4D

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3.2.1.1 Vegetation Zone 1

Plate 1: Narrow-leaved Ironbark – Grey Box grassy woodland (Moderate-Good-CEEC) within the Development Site, Vegetation Zone 1.

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Moderate_Good-CEEC)	
Vegetation Formation & Class	Grassy Woodlands Coastal Valley Grassy Woodlands
Area within Development Site	8.09 ha
Survey Effort	**Required:** 3 plot/transects.
	Conducted: 4 plot/transects (Q8, - Q11).
Floristic description	The canopy of this community is dominated by *Eucalyptus moluccana* (Grey Box) and *Eucalyptus crebra* (Narrow-leaved Ironbark), with *Eucalyptus tereticornis* (Forest Red Gum), *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus melliodora* (Yellow Box) locally dominating in areas (discussed further below). A scattered to moderately dense mid-storey is dominated by *Allocasuarina luehmannii* (Bulloak), *Acacia salicina* (Native Willow), *Brachychiton populneus* (Kurrajong), *Bursaria spinosa* (Blackthorn), and *Myoporum montanum* (Western Boobialla). The ground layer is dominated by grasses with scattered forbs and small shrubs. Commonly occurring species include *Aristida ramosa* (Purple Wiregrass), *Bothriochloa macra* (Red Grass), *Austrostipa verticillata* (Slender Bamboo Grass), *Microlaena stipoides* var. *stipoides* (Weeping Grass), *Cymbopogon refractus* (Barbed Wire Grass), *Dichondra repens* (Kidney Weed), *Brunoniella australis* (Blue Trumpet), *Cheilanthes distans* (Bristly Cloak Fern), *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern), *Lomandra filiformis* (Wattle Mat-rush), *Lomandra multiflora* (Many-flowered Mat-rush), *Chrysocephalum apiculatum* (Common Everlasting), *Eremophila debilis* (Winter Apple), *Enchylaena tomentosa* (Ruby Saltbush), *Vittadinia cuneata* (Fuzzweed), and *Maireana microphylla* (Small-leaf Bluebush).

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Moderate_Good-CEEC)	
	A number of weed species were recorded within the vegetation community, typically at low abundance within larger patches of the community, with higher densities in areas of disturbance. Common exotic species include *Sida rhombifolia* (Paddy's Lucerne), *Sonchus oleraceus* (Common Sowthistle), *Senecio madagascariensis* (Fireweed), *Opuntia stricta* (Common Prickly Pear), *Chloris gayana* (Rhodes Grass) and *Hyparrhenia hirta* (Coolatai Grass).
Condition within Development Site	This vegetation zone occurs throughout the Development Site, with the largest occurrence in the central Salt cake landfill area (outside the Development Site). This community occurs on flat to undulating terrain. This community occurs predominantly on the Liddell and Bayswater Soil Landscapes, with a small portion in the south occurring on the Brays Hill Soil Landscape. This zone represents areas which have all strata intact and occurs as remnant vegetation. The majority of this Vegetation Zone has been subject to grazing or disturbance from existing infrastructure.
Floristic / Structural Variations	There are two floristic variations within the overstorey dominance within two patches of this PCT which occur along the second order drainage line running through Borrow Pit 4. The area represented in **Figure 4 B** by Q10 is dominated by *Angophora floribunda* (Rough-barked Apple) and the area represented by Q11 is dominated *Eucalyptus melliodora* (Yellow Box). While *A. floribunda* is not listed as a diagnostic overstorey species for PCT 1691, the species is known to occur within, and can dominate areas, of Central Hunter Box-Ironbark Woodland, as per vegetation description in Peake (2006). The area represented by Q10 occurs on similar landforms and soils to the surrounding areas of PCT 1691, and the understorey vegetation has a similar composition to patches dominated by *E. moluccana* and/or *E. crebra*, as such this patch was deemed to be a minor local variation of PCT 1691 occurring within the drainage line. A small patch of native vegetation (<1 ha) within Borrow Pit 4 is dominated by *Eucalyptus melliodora* (Yellow Box). While this canopy species is indicative of the Box – Gum Woodland, this patch of vegetation was classified as the Central Hunter Grey Box – Ironbark Woodland, representing a minor variation. The Box – Gum Woodland EEC/CEEC typically occur on relatively fertile soils on the tablelands and western slopes of NSW (NSW Scientific Committee 2018). The Muswellbrook area is at the eastern edge of the community's extent. The ecological assessment for the Maxwell Project (and previous Drayton South proposal) identified areas of Box – Gum Woodland in the areas adjacent to the Study Area, west of the Plashett Dam (off-site). These areas were deemed to meet the Box – Gum Woodland CEEC as they contained *Eucalyptus albens x Eucalyptus moluccana* intergrades. During vegetation mapping surveys previously conducted by Kleinfelder (2017) across Bayswater and Liddell, samples of a Box with some slight White Box characteristics (white bark and large fruit), and also a Red Gum sample which showed some signs of Blakely's Red Gum (small fruit and small tree) were collected and sent to the NSW Herbarium. The samples were identified as *Eucalyptus moluccana* and *Eucalyptus tereticornis*. Additionally, the area mapped as containing Box – Gum Woodland as part of the Maxwell Project occurs on the Brays Hill Soil Landscape which has a basalt influence in the geology and is described has having Black Earth soils in areas. This basalt influence and presence of Black Earths is more typical of the Box – Gum Woodland and its prevalence on higher fertility soils. This area dominated by *E. melliodora* occurs on similar landforms and soils as the surrounding areas of the Central Hunter Grey Box – Ironbark Woodland. The vegetation occurs within the Bayswater Soil Landscape, which contains Alluvial Soils in the drainage lines, as such it is likely that this area occurs on a localised area Alluvial Soils along a second order tributary of Wisemans Creek, which feeds into Plashett Dam. The understorey is dominated by *Austrostipa verticillata* (Slender Bamboo), which is not listed as a characteristic species under the NSW determination (NSW Scientific Committee 2019c) or the DoEE Conservation Advice for the CEEC (TSSC 2015). The vegetation only contains six of the 95 (6%) of the characteristic species listed under the NSW determination (NSW Scientific Committee 2018).
Justification for PCT selection	The vegetation on site most closely aligns with the Grassy Woodland Vegetation Formation due to the lack of sclerophyllous shrubs in the understory, dominance of Box species in the overstorey and grasses in the understorey (Keith 2006). Within the Grassy Woodland Formation, the

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Moderate_Good-CEEC)	
	vegetation most closely aligns to a Coastal Valley Grassy Woodland due to the location of the Disturbance Footprint. PCT 1691 was determined as the closest equivalent PCT for the vegetation within the Disturbance Footprint. The following key species that have been relied upon for identification of this vegetation type were consistently present and/or recorded at relatively high abundance within vegetation (composition data from all vegetation zones assigned to this PCT were used for determination): *E. moluccana, E. crebra, Brachychiton populneus, Eremophila debilis, Aristida ramosa, Cymbopogon refractus, Chloris ventricosa, Calotis lappulacea, Dichondra repens, Eragrostis leptostachya, Microlaena stipoides,* and *Austrostipa verticillata.* The structure and landscape position of this vegetation within the Development site is also consistent with the description for PCT 1691, comprising of a Eucalypt Woodland where the ground stratum is the prominent understorey and is typically grassy with scattered forbs. This community is distributed across the upper Hunter Valley and adjacent low hills from Broke west to Merriwa and to the north of Scone. It typically occurs on coal-bearing sedimentary geologies (e.g. Wittingham Coal Measures) on flats and mid-slopes at elevations between 70 and 350 m. All other Grassy Woodlands within the Sydney Basin IBRA region were considered in undertaking the above determination. Two other potentially suitable PCTs were identified; PCT 623 and 1603. Both PCT 623 and 1603 have floristic similarities with the vegetation within the Development Site. PCT 623 was excluded as it is described as occurring in the central to upper part of the Hunter Valley around Scone in areas with about 1,000 mm of rainfall. The Development Site does not occur this far north and does not receive that amount of rainfall (approximately 500 – 600 mm annually). PCT 1603 was excluded as it is described as being an open forest dominated by *Eucalyptus crebra*. While the species occurs, and dominates some patches of the vegetation community, the description of 1691 is more accurate for the vegetation within the Development Site.
Status	**BC Act:** This vegetation zone is consistent with the *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act. Inclusion of this vegetation zone within this TEC was determined through comparison with the NSW Scientific Committee's Determination (2019a). The community conforms in locality (NSW Sydney Basin), position in the landscape (Permian Sediments in the Hunter Valley; slopes and undulating hills), and dominant floristic composition and structure (woodland dominated by *E. crebra, E. moluccana, Maireana microphylla, Aristida ramosa, Chloris ventricosa, Austrostipa scabra, Calotis lappulacea, Lomandra multiflora, Eremophila debilis and Chrysocephalum apiculatum*).
	EPBC Act: This vegetation zone is consistent with the *Central Hunter Valley eucalypt forest and woodland* CEEC listed under the EPBC Act. Inclusion of this vegetation zone within this CEEC was determined through comparison with the Conservation Advice (TSSC 2015) for the CEEC (see **Section 3.2.2.1** below for full assessment).
PCT % Cleared	77% (from BioNet Vegetation Classification database).

3.2.1.2 Vegetation Zone 2

Plate 2: Narrow-leaved Ironbark – Grey Box grassy woodland (Moderate-Good) within the Development Site, Vegetation Zone 2.

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Moderate_Good)	
Vegetation Formation & Class	Grassy Woodlands Coastal Valley Grassy Woodlands
Area within Development Site	6.70 ha
Survey Effort	**Required:** 3 plot/transects.
	Conducted: 3 plot/transects (Q5 – Q7).
Floristic description	The canopy of this community is dominated by *Eucalyptus moluccana* (Grey Box) and *Eucalyptus crebra* (Narrow-leaved Ironbark). A scattered mid-storey is dominated by *Allocasuarina luehmannii* (Bulloak) and *Acacia salicina* (Native Willow). The ground layer is dominated by grasses with scattered forbs and small shrubs. Commonly occurring species include *Cynodon dactylon* (Couch), *Chloris ventricosa* (Plump Windmill Grass), *Aristida ramosa* (Purple Wiregrass), *Austrostipa scabra* (Speargrass), *Austrostipa verticillata* (Slender Bamboo Grass), *Sporobolus creber* (Western Rat-tail Grass), *Glycine tabacina, Dichondra repens* (Kidney Weed), *Einadia nutans* subsp. *Linifolia* (Climbing Saltbush) and *E. nutans* subsp. *nutans*, *Enchylaena tomentosa* (Ruby Saltbush), *Solanum cinereum* (Narrawa Burr) and *Atriplex semibaccata* (Creeping Saltbush). A number of weed species were recorded within the vegetation community and they dominate in some areas. Common exotic species include *Galenia pubescens* (Galenia), *Sida rhombifolia* (Paddy's Lucerne), *Senecio madagascariensis* (Fireweed), *Opuntia stricta* (Common Prickly Pear), *Medicago minima* (Woolly Burr Medic), *Hyparrhenia hirta* (Coolatai Grass), and *Olea europaea* subsp. *cuspidata* (African Olive).

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Moderate_Good)	
Condition within Development Site	This vegetation zone has a scattered occurrence within the Development Site, with small patches occurring within Borrow Pit 3 and 4, a number of scattered patches around the Ash Dam, in Borrow Pits 1 and 2, and along the Ravensworth Ash Pipeline Replacement area. This vegetation zone typically represents vegetation that is more highly degraded than Vegetation Zone 1 and is lacking strata in portions of the Zone (midstorey and shrub layer largely absent), and the ground layer has a higher proportion of weed species present.
Justification for PCT selection	This vegetation was determined to be the same PCT as Vegetation Zone 1,but has been modified due to clearing/disturbance. This was determined through assessment of the dominant species occurring within both vegetation zones, Vegetation Zone 2 contains similar species to Vegetation Zone 1, just at different abundances due to modification. As such, the justification for PCT selection is as per Vegetation Zone 1.
Status	**BC Act:** This vegetation zone is consistent with the *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act. Inclusion of this vegetation zone within this TEC was determined through comparison with the NSW Scientific Committee's Determination (2019a). The community conforms in locality (NSW Sydney Basin), position in the landscape (Permian Sediments in the Hunter Valley; slopes and undulating hills), and dominant floristic composition and structure (woodland dominated by *E. crebra, E. moluccana, Maireana microphylla, Aristida ramosa, Chloris ventricosa, Austrostipa scabra, Calotis lappulacea, Lomandra multiflora, Eremophila debilis and Chrysocephalum apiculatum*).
	EPBC Act: Not Listed. This vegetation zone was not included in the *Central Hunter Valley eucalypt forest and woodland* CEEC after assessment against the key diagnostic characteristics and minimum condition criteria outlined in the Conservation Advice (TSSC 2015) (see **Section 3.2.2.1** below for full assessment).
PCT % Cleared	77% (from BioNet Vegetation Classification database).

3.2.1.3 Vegetation Zone 3

Plate 3: PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland (Regrowth) within the Development Site, Vegetation Zone 3.

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Regrowth)	
Vegetation Formation & Class	Grassy Woodlands Coastal Valley Grassy Woodlands
Area within Development Site	40.36 ha
Survey Effort	**Required:** 4 plot/transects.
	Conducted: 5 plot/transects (Q1 – 4 and Q32).
Floristic description	This vegetation zone is typified by areas of sparse to moderately dense shrublands dominated by *Acacia salicina* (Native Willow) with a grassy understorey. The ground layer is dominated by *Aristida ramosa* (Purple Wiregrass), *Bothriochloa macra* (Red Grass), *Chloris ventricosa* (Plump Windmill grass), *Chloris truncata* (Windmill Grass), *Austrostipa verticillata* (Slender Bamboo Grass), *Cymbopogon refractus* (Barbed Wire Grass), *Sporobolus creber* (Western Rat-tail Grass), *Rytidosperma fulvum* (Wallaby Grass), *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern), *Solanum cinereum* (Narrawa Burr), *Sida corrugata* (Corrugated Sida), *Dichondra repens* (Kidney Weed), *Vittadinia cuneata* (Fuzzweed) and *Linum marginale* (Native Flax). A number of exotic species occur within the community, including *Hyparrhenia hirta* (Coolatai Grass), *Senecio madagascariensis* (Fireweed), *Carthamus lanatus* (Saffron Thistle), *Chloris gayana* (Rhodes Grass), *Trifolium campestre* (Hop Clover), *Linum trigynum* (French Flax), *Lysimachia arvensis* (Scarlet Pimpernel), *Plantago lanceolata* (Lamb's Tongues), *Sonchus oleraceus* (Common Sowthistle), *Sida rhombifolia* (Paddy's Lucerne) and *Cirsium vulgare* (Spear Thistle).

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Regrowth)	
Condition within Development Site	This vegetation Zone has been historically cleared and comprises Acacia regrowth vegetation only. The majority of this zone is mixed native/exotic grassland with sparse to moderately dense *Acacia salicina* (Native Willow).
Justification for PCT selection	This vegetation was determined to be the same PCT as Vegetation Zone 1 but has been modified due to clearing. This was determined through assessment of the dominant species occurring within both vegetation zones. Vegetation Zone 3 contains similar species to Vegetation Zone 1 but at different abundances due to modification. Vegetation Zone 3 also occurs within similar areas of the landscape to that of Vegetation Zone 1 and that described under PCT 1691. As such, the justification for PCT selection is as per Vegetation Zone 1.
Status	**BC Act:** Not Listed. Due to the lack of overstorey species within this zone, it is lacking key diagnostic species and the woodland structure to be classified as the *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act.
	EPBC Act: Not Listed. This vegetation zone was not included in the *Central Hunter Valley eucalypt forest and woodland* CEEC after assessment against the key diagnostic characteristics and minimum condition criteria outlined in the Conservation Advice (TSSC 2015) (see **Section 3.2.2.1** below for full assessment).
PCT % Cleared	77% (from BioNet Vegetation Classification database).

3.2.1.4 Vegetation Zone 4

Plate 4: **PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland (Grassland), Vegetation Zone 4.**

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Grassland)	
Vegetation Formation & Class	Grassy Woodlands Coastal Valley Grassy Woodlands
Area within Development Site	147.77 ha
Survey Effort	**Required:** 6 plot/transects.
	Conducted: 7 Plot/transects (Q21 – Q27).
Floristic description	The canopy and midstorey are typically lacking from this vegetation zone, with only very scattered *Eucalyptus moluccana* (Grey Box), *Acacia salicina* (Native Willow) and *Allocasuarina luehmannii* (Bulloak) occurring. The ground layer is dominated by grasses with scattered forbs and occasional shrubs. Dominant species include *Aristida ramosa* (Purple Wiregrass), *Chloris ventricosa* (Plump Windmill Grass), *Bothriochloa macra* (Red Grass), *Sporobolus creber* (Western Rat-tail Grass), *Rytidosperma fulvum* (Wallaby Grass), *Erodium crinitum* (Blue Storksbill), *Chrysocephalum apiculatum* (Common Everlasting), *Brunoniella australis* (Blue Trumpet), *Enchylaena tomentosa* (Ruby Saltbush), *Convolvulus erubescens* (Blushing Bindweed), *Vittadinia cuneata* (Fuzzweed), *Solanum cinereum* (Narrawa Burr) and *Cheilanthes distans* (Bristly Cloak Fern) and *Lomandra filiformis* (Wattle Mat-rush). A range of weed species were recorded within the grasslands, and can dominant in areas of higher disturbance. Common exotic species include *Carthamus lanatus* (Saffron Thistle), *Senecio madagascariensis* (Fireweed), *Hyparrhenia hirta* (Coolatai Grass), *Linum trigynum* (French Flax), *Lysimachia arvensis* (Scarlet Pimpernel), *Sonchus oleraceus* (Common Sowthistle), *Stachys arvensis* (Stager Weed), *Soliva sessilis* (Bindyi), *Sida rhombifolia* (Paddy's Lucerne), and *Medicago minima* (Woolly Burr Medic).
Condition within Development Site	This vegetation Zone has been historically cleared and comprises ground layer vegetation with occasional trees. A number of exotic species occur throughout the community with a higher dominance in some portions of the zone, particularly around the Ash Dam.
Justification for PCT selection	This vegetation was determined to be the same PCT as Vegetation Zone 1 but has been modified due to clearing. This was determined through assessment of the dominant species occurring within both vegetation zones. Vegetation Zone 4 contains similar species to Vegetation Zone 1 but at different abundances due to modification. Vegetation Zone 4 also occurs within similar areas of the landscape to that of Vegetation Zone 1 and that described under PCT 1691. As such, the justification for PCT selection is as per Vegetation Zone 1.
Status	**BC Act:** Not Listed. Due to the lack of overstorey species within this zone, it is lacking key diagnostic species and the woodland structure to be classified as the *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act.
	EPBC Act: Not Listed. This vegetation zone was not included in the *Central Hunter Valley eucalypt forest and woodland* CEEC after assessment against the key diagnostic characteristics and minimum condition criteria outlined in the Conservation Advice (TSSC 2015) (see **Section 3.2.2.1** below for full assessment).
PCT % Cleared	77% (from BioNet Vegetation Classification database).

3.2.1.5 Vegetation Zone 5

Plate 5: PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland (Rehabilitation), Vegetation Zone 5.

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Rehabilitation)	
Vegetation Formation & Class	Grassy Woodlands Coastal Valley Grassy Woodlands
Area within Development Site	3.75 ha
Survey Effort	**Required:** 2 plot/transects.
	Conducted: 3 plot transects (Q30, Q31 and Q33).
Floristic description	Areas of Rehabilitation consist of mixed stands of native species dominated by mixtures of *Corymbia maculata* (Spotted Gum), *Eucalyptus cladocalyx* (Sugar Gum), *Eucalyptus punctata* (Grey Gum), *Eucalyptus moluccana* (Grey Box), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Casuarina cristata* (Belah) in the canopy. A scattered midstorey of *Casuarina glauca* (Swamp Oak) and *Acacia salicina* (Native Willow) occurs. The groundcover is dominated by *Aristida ramosa* (Purple Wiregrass), *Cymbopogon refractus* (Barbed Wire Grass), *Chloris ventricosa* (Plump Windmill Grass), *Cynodon dactylon* (Couch), *Enchylaena tomentosa* (Ruby Saltbush), *Einadia nutans* subsp. *linifolia* (Climbing Saltbush) and *E. nutans* subsp. *nutans, Eremophila debilis* (Winter Apple), and *Vittadinia cuneata* (Fuzzweed). Common weed species within this vegetation zone include *Galenia pubescens* (Galenia), *Opuntia stricta* (Common Prickly Pear) and *Sida rhombifolia* (Paddy's Lucerne).
Condition within Development Site	Areas of Rehabilitation consist of a mixture of native endemic and non-endemic tree species over modified native grasslands.
Justification for PCT selection	As the canopy species within this vegetation zone have been planted, and the composition is not typical of natural vegetation in the area, the landscape position and surrounding vegetation types

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Rehabilitation)	
	have been used to assign the closest equivalent PCT to this vegetation zone. As the dominant woodland vegetation type within the Development Site, and the surrounds, is PCT 1691, this has been assigned to areas of Rehabilitation within the Development Site.
Status	**BC Act:** Not Listed.
	EPBC Act: Not Listed.
PCT % Cleared	77% (from BioNet Vegetation Classification database).

3.2.1.6 Vegetation Zone 6

Plate 6: PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland (Plantation), Vegetation Zone 6.

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Plantation)	
Vegetation Formation & Class	Grassy Woodlands Coastal Valley Grassy Woodlands
Area within Development Site	0.14 ha
Survey Effort	**Required:** 1 plot/transects.
	Conducted: 2 plot/transects (Q28 and Q29).
Floristic description	Typically, this vegetation zone consists of a monoculture of one of the following tree species, *Eucalyptus punctata* (Grey Gum), *Eucalyptus tereticornis* (Forest Red Gum), *Corymbia maculata* (Spotted Gum), *Corymbia henryi* (Large-leaved Spotted Gum) or *Eucalyptus melliodora* (Yellow Box). Occasional midstorey and shrub species include *Notelaea microcarpa* (Native Olive) and *Myoporum montanum* (Western Boobialla).

PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland (Plantation)	
	The groundcover is dominated by *Chloris ventricosa* (Plump Windmill Grass), *Cymbopogon refractus* (Barbed Wire Grass), *Aristida ramosa* (Purple Wiregrass), *Enchylaena tomentosa* (Ruby Saltbush), *Dichondra repens* (Kidney Weed), *Eremophila debilis* (Winter Apple), *Glycine tabacina, Maireana enchylaenoides* (Wingless Bluebush) and *Brunoniella australis* (Blue Trumpet). A number of exotic species occur within the community and can dominate in areas, including *Sida rhombifolia* (Paddy's Lucerne), *Carthamus lanatus* (Saffron Thistle), *Asphodelus fistulosus* (Onion Weed), *Lysimachia arvensis* (Scarlet Pimpernel) and *Plantago lanceolata* (Lamb's Tongues).
Condition within Development Site	Areas of plantation consist of planted areas dominated by local and non-endemic native species. Typically, these areas are monoculture of equally aged eucalypt species planted in rows. These plantations typically occur over Derived/Modified Native Grassland Vegetation.
Justification for PCT selection	As the canopy species within this vegetation zone have been planted, and the composition is not typical of natural vegetation in the area, the landscape position and surrounding vegetation types have been used to assign the closest equivalent PCT to this vegetation zone. As the dominant woodland vegetation type within the Development Site, and the surrounds, is PCT 1691, this has been assigned to areas of Plantation within the Development Site.
Status	**BC Act:** Not Listed.
	EPBC Act: Not Listed.
% Cleared	77% (from BioNet Vegetation Classification database).

3.2.1.7 Vegetation Zone 7

Plate 7: 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate-Good), Vegetation Zone 7.

PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate-Good)	
Vegetation Formation & Class	Grassy Woodlands Coastal Valley Grassy Woodlands
Area within Development Site	56.11 ha
Survey Effort	**Required:** 5 plot/transects.
	Conducted: 5 plot/transects (Q12 – Q16).
Floristic description	The canopy of this community is dominated by *Allocasuarina luehmannii* (Bulloak). *Acacia salicina* (Native Willow), has a scattered occurrence throughout the community. The ground layer is diverse but has a very sparse covering of grasses, forbs and small shrubs. The ground typically contains a high cover of leaf litter (*Allocasuarina* articles), with higher coverage of native species at the edges of a patch or in more open areas of the Vegetation Zone. Commonly occurring species include *Aristida ramosa* (Purple Wiregrass), *Chloris truncata* (Windmill Grass), *Rytidosperma fulvum* (Wallaby Grass), *Eragrostis leptostachya* (Paddock Lovegrass), *Austrostipa verticillata* (Slender Bamboo Grass), *Lomandra filiformis* (Wattle Mat-rush), *Crassula sieberiana* (Australian Stonecrop), *Einadia nutans* subsp. *nutans* (Climbing Saltbush), *Chrysocephalum apiculatum* (Common Everlasting), *Brunoniella australis* (Blue Trumpet), *Dichondra repens* (Kidney Weed), *Enchylaena tomentosa* (Ruby Saltbush), *Maireana microphylla* (Small-leaf Bluebush) and *Eremophila debilis* (Winter Apple). Typically, the exotic species coverage was low within the community, but higher densities occur within areas of disturbance. Some common species include *Senecio madagascariensis* (Fireweed), *Opuntia stricta* (Common Prickly Pear), *Galenia pubescens* (Galenia), and *Plantago lanceolata* (Lamb's Tongues).
Condition within Development Site	The vegetation within this zone is dominated by a monoculture of *A. luehmannii* and contains a relatively sparse cover of groundcover species. Within the zone there is a low coverage of exotic species, however, this increases in open areas and at the peripheries of the zone.
Justification for PCT selection	Within the Sydney Basin IBRA region, there are seven PCTs which contain *A. luehmannii* as a diagnostic species. Of these PCTs only three occur within the correct geographic distribution for the Development Site, and of these three PCTs, 1692 is the only PCT which is dominated by *A. luehmannii*, with the others being Eucalypt dominated communities containing *A. luehmannii*. As such, PCT 1692 was determined to be the best fit for the vegetation present within the Development Site.
Status	**BC Act:** Not Listed. Due to the lack of an overstorey being dominated by Eucalypt species, this vegetation zone lacks the key diagnostic species to be classified as the *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act.
	EPBC Act: Not Listed. This vegetation zone was not included in the *Central Hunter Valley eucalypt forest and woodland* CEEC after assessment against the key diagnostic characteristics and minimum condition criteria outlined in the Conservation Advice (TSSC 2015) (see **Section 3.2.2.1** below for full assessment).
PCT % Cleared	53% (from BioNet Vegetation Classification database).

3.2.1.8 Vegetation Zone 8

Plate 8: 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good-CEEC), Vegetation Zone 8.

Bull Oak grassy woodland of the central Hunter Valley (Moderate-Good-CEEC)	
Vegetation Formation & Class	Grassy Woodland Coastal Valley Grassy Woodlands
Area within Development Site	5.53 ha
Survey Effort	**Required:** 3 plot/transects.
	Conducted: 3 plot/transects (Q17, Q18 and Q35).
Floristic description	The canopy of this community is dominated by *Allocasuarina luehmannii* (Bulloak), with occasional *Eucalyptus moluccana* (Grey Box) and *Eucalyptus melliodora* (Yellow Box) occurring. *Acacia salicina* (Native Willow) has a scattered occurrence throughout the zone. The ground layer is diverse but has a very sparse covering of grasses, forbs and small shrubs. The ground typically contains a high cover of leaf litter (*Allocasuarina* articles), with higher coverage of native species at the edges of a patch or in more open areas of the Vegetation Zone. Commonly occurring species include *Aristida ramosa* (Purple Wiregrass), *Bothriochloa macra* (Red Grass), *Eragrostis leptostachya* (Paddock Lovegrass), *Chrysocephalum apiculatum* (Common Everlasting), *Brunoniella australis* (Blue Trumpet), *Maireana enchylaenoides* (Wingless Bluebush), *Enchylaena tomentosa* (Ruby Saltbush), *Lomandra filiformis* (Wattle Mat-rush), *Sida corrugata* (Corrugated Sida), *Eremophila debilis* (Winter Apple) and *Maireana microphylla* (Small-leaved Bluebush). Typically, the exotic species were low within the community, but higher within areas of disturbance. Some common species include *Senecio madagascariensis* (Fireweed), *Opuntia stricta* (Common Prickly Pear) and *Plantago lanceolata* (Lamb's Tongues).

Bull Oak grassy woodland of the central Hunter Valley (Moderate-Good-CEEC)	
Condition within Development Site	The vegetation within this zone is dominated by a monoculture of *A. luehmannii* with scattered Eucalypt trees and contains a relatively sparse cover of groundcover species. Within the zone there is a low coverage of exotic species, however, this increases in open areas and at the peripheries of the zone.
Justification for PCT selection	As outlined above for Vegetation Zone 7, PCT 1692 is the only PCT in the Sydney Basin which is dominated by *A. luehmannii.* While this zone does contain scattered Eucalypt trees, they are not the dominant canopy within the Zone.
Status	**BC Act:** Not Listed. Due to the lack of an overstorey being dominated by Eucalypt species, this vegetation zone lacks the key diagnostic species to be classified as the *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act. It is noted that this zone does contain some diagnostic Eucalypt trees, however, it is dominated by *A. luehmannii* which is not diagnostic of the EEC.
	EPBC Act: This vegetation zone is consistent with the *Central Hunter Valley eucalypt forest and woodland* CEEC listed under the EPBC Act. This vegetation zone represents small portions of the community which were not solely dominated by *A. luehmannii* and contain Eucalypt species in canopy layer (or regenerating) at the specified density in DoEE Advice, or forms part of the 30 m buffer off areas of the CEEC into Bull Oak Woodland. These areas were classified as constituting the CEEC. Inclusion of his vegetation zone within this CEEC was determined through comparison with the Conservation Advice (TSSC 2015) for the CEEC (see **Section 3.2.2.1** below for full assessment).
% Cleared	53% (from BioNet Vegetation Classification database).

3.2.1.9 Vegetation Zone 9

Plate 9: PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley, Vegetation Zone 9.

1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate-Good)	
Vegetation Formation & Class	Forested Wetlands Coastal Swamp Forests
Area within Development Site	2.40 ha
Survey Effort	**Required:** 2 plot/transects.
	Conducted: 2 plot/transects (Q19 and Q20).
Floristic description	The canopy is dominated by *Casuarina glauca* (Swamp Oak). The understorey is typically sparse and is dominated by exotic species in some areas. Common native species include *Microlaena stipoides* var. *stipoides* (Weeping Grass), *Austrostipa verticillata* (Slender Bamboo), *Dichondra repens* (Kidney Weed), *Glycine tabacina,* and *Cayratia clematidea* (Native Grape). The majority of the patches of Swamp Oak Forest contain significant weed infestations. Dominant weeds include, *Juncus acutus* (Sharp Rush), *Megathyrsus maximus* (Guinea Grass), *Senecio madagascariensis* (Fireweed) and *Opuntia stricta* (Prickly Pear).
Condition within Development Site	The vegetation within the Development Site is typically dominated by exotic species in the understorey as typically the community occurs in disturbed drainage lines and patches of the community within the Development Site are typically small. Additionally, some areas of the vegetation zone appear to be planted.
Justification for PCT selection	Within the Sydney Basin there are six PCTs which are dominated by *C. glauca;* PCT 1232, 1234, 1727, 1728, 1729 and 1731. The following PCTs were excluded as potential options due to low floristic similarity with the vegetation on site:

1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate-Good)	
	• PCT 1728 and 1234 (dominated by saline/brackish species in the understorey). • PCT 1728 and 1232 (dominated by coastal freshwater wetland species in the understorey). PCT 1729 was excluded as a potential option due to incorrect landscape position/distribution (occurs from Tuggerah to Nabiac). As such, PCT 1731 is the best fit PCT for the vegetation within the Development Site.
Status	**BC Act:** Not Listed. The Swamp Oak Floodplain Forest within the Development Site was not assessed as constituting the *Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner* EEC. Although the equivalent PCT assigned to the Swamp Oak Forest within the Development Site is included within the EEC, and while the species composition of the vegetation within the Development Site broadly conforms with that listed under the NSW Scientific Committee's Determination (2019c), the determination states: *"Swamp Oak Floodplain Forest generally occurs below 20 m (rarely above 10 m) elevation in the NSW North Coast, Sydney Basin and South East Corner bioregions".* As the Swamp Oak Forest within the Development Site is well above this elevation (lowest occurrence at 120 m ASL), it is not considered to conform with the landscape position of the occurrence of the EEC.
	EPBC Act: Not Listed. Due to the reasons outlined above (incorrect landscape position) the Swamp Oak Forest within the Development Site does not meet the diagnostic characteristics of the *Coastal Swamp Oak* (Casuarina glauca) *Forest of the New South Wales and South East Queensland Ecological Community* listed under the EPBC Act.
PCT % Cleared	62% (from BioNet Vegetation Classification database).

3.2.1.10 Non-Native Vegetation – Exotic Grasslands

Non-Native Vegetation – Exotic Grasslands	
Vegetation Formation & Class	N/A
Area within Development Site	62.48 ha
Survey Effort	**Required:** No plot/transects required.
	Conducted: None.
Floristic description	This vegetation type is dominated by exotic grasses *Briza subaristata, Paspalum dilatatum* (Paspalum), *Bromus diandrus* (Great Brome), and *Vulpia myuros* (Rat's Tail Fescue), and exotic herbs and subshrubs *Galenia pubescens* (Galenia), *Hypochaeris radicata* (Cat's Ear), *Sida rhombifolia* (Paddy's Lucerne), *Plantago lanceolata* (Lamb's Tongues), *Senecio madagascariensis* (Fireweed) and *Stachys arvensis* (Stagger Weed). Native species commonly occurring in these areas include, *Aristida ramosa* (Purple Wiregrass), *Elymus scaber, Asperula conferta* (Common Woodruff), *Austrostipa verticillata* (Slender Bamboo), Dichondra repens (Kidney Weed) and *Cyperus gracilis* (Slender Flat-sedge).
Condition within Development Site	The zone is dominated by exotic species (>50% exotic cover), as such has been classified as non-native vegetation.
Justification for PCT selection	N/A

Non-Native Vegetation – Exotic Grasslands	
Status	**BC Act:** Not Listed
	EPBC Act: Not Listed
% Cleared	N/A

3.2.1.11 Non-Native Vegetation – Wetlands/Dams (with Wetland Vegetation)

Plate 10: Non-Native Vegetation – Wetlands/Dam (with Wetland Vegetation) within the Study Area.

Non-Native Vegetation – Wetlands/Dams (with Wetland Vegetation)	
Vegetation Formation & Class	N/A
Area within Development Site	12.00 ha
Survey Effort	**Required:** No plot/transects required.
	Conducted: 2 plot/transects were conducted.
Floristic description	These wetland areas are dominated by *Juncus acutus* (Sharp Rush). Native species including *Typha domingensis* (Narrow-leaved Cumbungi) and *Phragmites australis* (Common Reed) occur scattered within the area.
Condition within Development Site	The zone is dominated by exotic species (>50% exotic cover), as such has been classified as non-native vegetation.
Justification for PCT selection	N/A
Status	**BC Act:** Not Listed

Non-Native Vegetation – Wetlands/Dams (with Wetland Vegetation)	
	EPBC Act: Not Listed
% Cleared	N/A

3.2.2 Threatened Ecological Communities

Three vegetation zones within the Development Site were identified as constituting TECs under the BC Act and/or the EPBC Act (**Table 5** and **Figure 5 A** - **Figure 5 D**). Within the Development Site there is a total of 14.79 ha of the *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act, and a total of 13.62 ha of the *Central Hunter Valley eucalypt forest and woodland* CEEC listed under the EPBC Act. A further assessment of how areas of the Commonwealth listed *Central Hunter Valley Eucalypt Forest and Woodland Ecological Community* were defined is outlined below.

Table 5: Threatened Ecological Communities within the Development Site.

Zone	PCT	Area (ha)	Status	
			BC Act	EPBC Act
1	1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	8.09 ha (of which, 0.01 ha occurs along the Ravensworth Ash Pipeline Replacement area)	Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC	Central Hunter Valley eucalypt forest and woodland CEEC
2		6.70 ha (of which, 0.60 ha occurs along the Ravensworth Ash Pipeline Replacement area)		-
8	1692: Bull Oak grassy woodland of the central Hunter Valley	5.53 ha (none of which occurs along the Ravensworth Ash Pipeline Replacement area)	-	Central Hunter Valley eucalypt forest and woodland CEEC

3.2.2.1 Central Hunter Valley Eucalypt Forest and Woodland Ecological Community

As outlined above, portions of two of the PCTs mapped within the Development Site were assessed as forming part of the ecological community. This was determined through assessment of all PCTs mapped on site against the key diagnostic characteristics and the minimum condition thresholds (TSSC 2015). An assessment against the key diagnostic characteristic is outlined in **Table 6**.

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study Area
- Development Site
- Central Hunter Valley eucalypt forest and woodland CEEC
- Central Hunter Grey Box - Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

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Threatened Ecological Communities

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
5A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study Area
- Development Site
- Central Hunter Valley eucalypt forest and woodland CEEC
- Central Hunter Grey Box - Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

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Threatened Ecological Communities

Jacobs Group
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Bayswater Water and Other Associated
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FIGURE:
5B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Study Area
- Development Site
- Central Hunter Valley eucalypt forest and woodland CEEC
- Central Hunter Grey Box - Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC
- Primary Road
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

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Threatened Ecological Communities

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FIGURE:

5C

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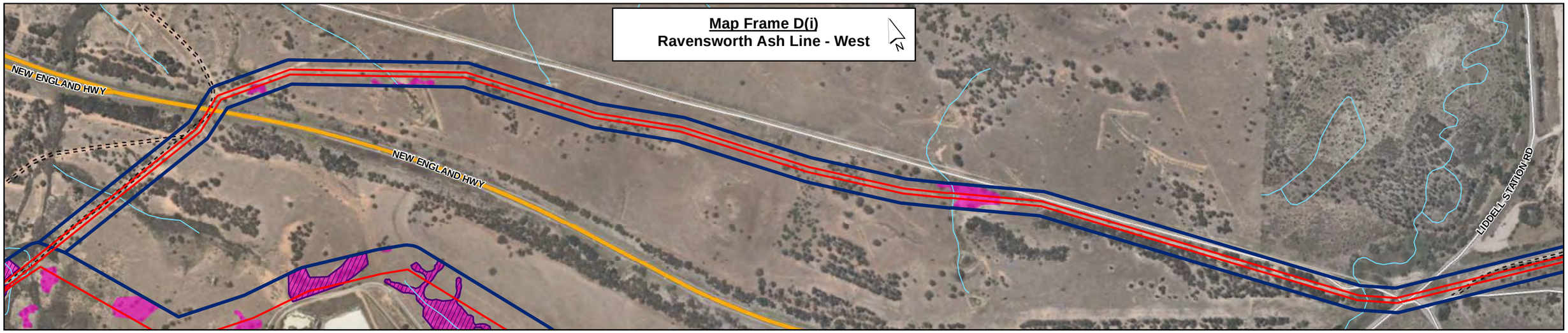

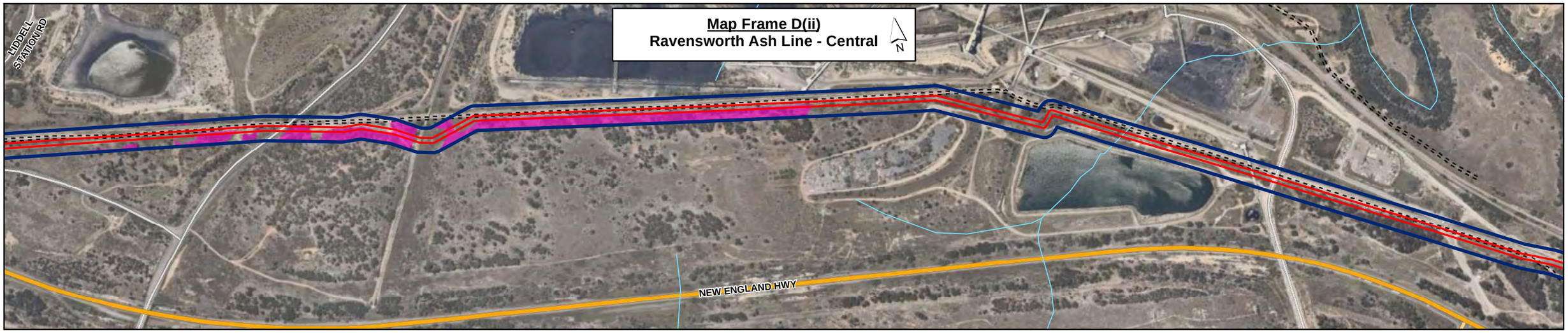

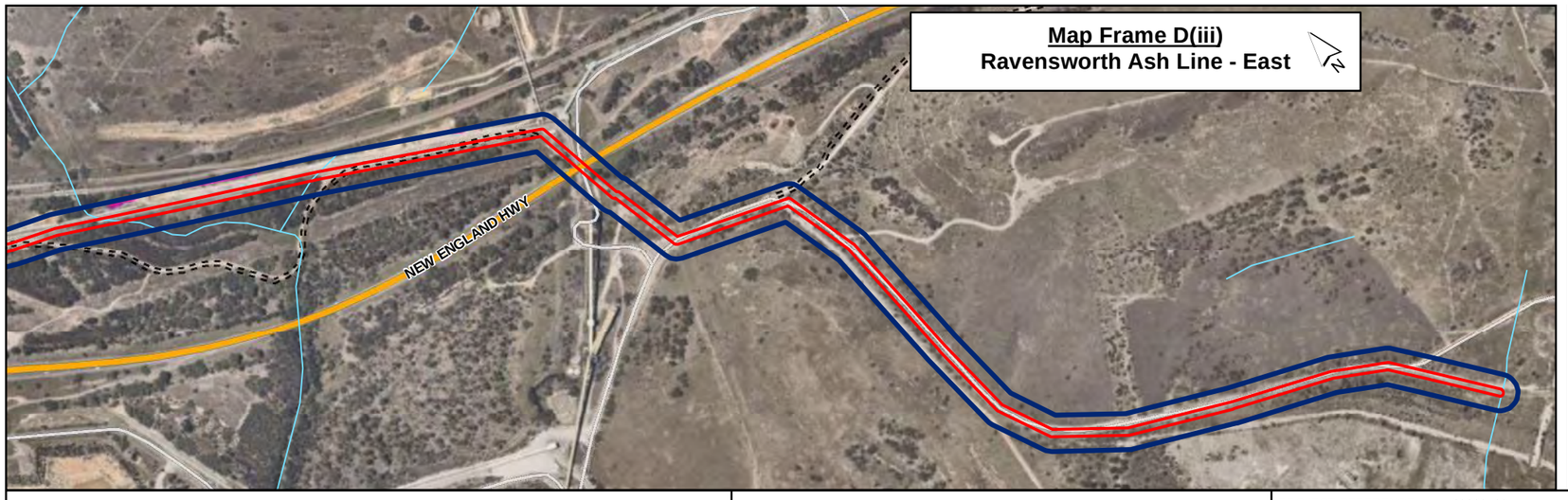

Legend

- Study Area
- Development Site
- Central Hunter Valley eucalypt forest and woodland CEEC
- Central Hunter Grey Box - Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC
- Primary Road
- Local Road
- Track
- Watercourse

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Threatened Ecological Communities

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FIGURE:

5D

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Table 6: Key diagnostic characteristics for the Central Hunter Valley eucalypt forest and woodland ecological community

Key diagnostic characteristics for the ecological community	How criteria are met
It occurs in the Hunter River catchment (typically called the Hunter Valley region); and	The Study Area occurs within the Hunter Central Rivers Catchment area.
It typically occurs on lower hillslopes and low ridges, or valley floors in undulating country; on soils derived from Permian sedimentary rocks; and	The two PCTs identified as the CEEC occur predominantly on the Liddell and Bayswater soil landscapes, and the Central Hunter Foothills Mitchell landscape. These areas are characterised by undulating to steep hills on Permian sandstone conglomerate, shale and coal.
It does not occur on alluvial flats, river terraces, aeolian sands, Triassic sediments, or escarpments; and	The soil landscapes on which the CEEC was identified contains some alluvial soils within drainage lines (not an alluvial flat). The CEEC was not mapped as occurring on any of these landforms or soils.
It is woodland or forest, with a projected canopy cover of trees of 10% or more; or with a native tree density of at least 10 native tree stems per 0.5 ha (at least 20 native tree stems/ha) that are at least one metre in height; and	The plot data collected within the areas of this ecological community show that the canopy cover and tree density parameters are met. Typical canopy cover ranges from 10% to 60% (note: Foliage Projected cover recorded not Projected canopy cover, as such cover estimates likely to be higher).
The canopy of the ecological community is dominated by one or more of the following four eucalypt species: • *Eucalyptus crebra* (Narrow-leaved Ironbark), *Corymbia maculata* (syn. *E. maculata*) (spotted gum), *E. dawsonii* (Slaty Gum) and *E. moluccana* (Grey Box); OR, • a fifth species, *Allocasuarina luehmannii* (Bulloak/ Buloke) dominates in combination with one or more of the above four eucalypt species, in sites previously dominated by one or more of the above four eucalypt species; and	The vegetation communities within the study area identified as constituting this ecological community are dominated by *E. moluccana* and *E. crebra.* Areas of Bull Oak Woodland which contained juvenile or mature diagnostic species were mapped as per the conservation advice, and supplementary advice provided by DoEE (see **Section 3.1.2** above).
Allocasuarina torulosa (Forest Oak/ She-oak, Rose She-oak/oak), *Eucalyptus acmenoides* (White Mahogany) and *E. fibrosa* (Red/broad-leaved ironbark) are largely absent from the canopy of a patch; and	*Allocasuarina torulosa, E. acmenoides* and *E. fibrosa* were not recorded within the site.
A ground layer is present (although it may vary in development and composition), as a sparse to thick layer of native grasses and other native herbs and/or native shrubs.	The understorey of the PCTs identified as the CEEC consists of a native groundcover layer of native grasses, herbs and shrubs. This ranges from sparse to relatively dense. The BAM plot data sampled within these PCTs shows that they contain a native groundcover.

Based on the above assessment, PCT 1691 (Vegetation Zone 1 and 2) and portions of PCT 1692 (Vegetation Zone 8) meet the key diagnostic characteristics. The condition criteria

outlined in **Table 7** were then applied to each mapped patch to identify which patches of the ecological community within the study area meet the definition of the CEEC.

Table 7: Condition categories (classes) and thresholds for Central Hunter Valley eucalypt forest and woodland ecological community.

Category and rationale	Thresholds		
Class A. High quality condition e.g. A larger patch with good quality native understorey	Patch size is ≥5 ha; AND ≥50% of perennial understorey vegetative cover is native; AND the patch contains at least 12 native understorey species.		
Class B. High quality condition e.g. A patch with high quality native understorey	Patch size is ≥0.5 ha AND ≥70% of perennial vegetative cover in each layer present is native; AND the patch contains at least 12 native understorey species.		
Class C. Moderate quality condition e.g. A patch with good quality native understorey	Patch size is ≥0.5 ha; AND ≥50% of perennial understorey vegetative cover is native; AND the patch contains at least 12 native understorey species.		
Class D. Moderate quality condition e.g. A moderate to large sized patch with connectivity to a native vegetation area; or a mature tree; or a tree with hollows.	Patch size is ≥2 ha; AND ≥50% of perennial understorey vegetative cover is native; AND		
	The patch is contiguous with another patch of native woody vegetation ≥1 ha in area	OR	The patch has at least one large locally indigenous tree (≥60 cm dbh), or at least one tree with hollows

Based on the patch definition within the EPBC conservation advice (TSSC 2015), 26 patches of PCT 1691 within the Study Area, were not classified as the CEEC as their patch size is less than 0.5 ha.

Floristic data from BAM plots was used to determine the percentage of perennial native understorey within each plot conducted in areas of the ecological community. Quadrat 7 was the only quadrat conducted within vegetation zones 1, 2, and 8 which did not meet the criteria of ≥50% perennial native understorey cover (with 43% recorded). This plot was conducted along the Ravensworth Ash Pipeline Replacement area, and as such, this patch and similar condition patches along the ash line were deemed to not meet the condition criteria. Additionally, an area to the west of the Ash Dam was deemed to not meet the CEEC condition criteria due to the dominance of exotic grasses in the understorey.

3.2.3 Assessment of Patch Size

All vegetation zones, except 3 and 4, have a patch size of >100 ha as they are zones of intact native vegetation which are connected to larger areas of native vegetation (gaps less than 100 m) in the surrounding areas. Vegetation zones 2 and 3 within the Development Site are not considered intact native vegetation, as the canopy and/or mid-storey/shrub layers are

lacking from the vegetation due to historical clearing and grazing. As such the patch size is zero for these zones. The patch size for each vegetation zone is outlined in **Table 8**.

3.2.4 Vegetation Integrity Score

The current vegetation integrity score of the vegetation zones are outlined in **Table 8**.

Table 8: Current vegetation integrity score for the vegetation zone

Zone	PCT & Class	Area (ha)	Patch Size	Condition scores (Current Score)			Vegetation integrity score
				Composition	Structure	Function	
1	1691: Mod-Good-CEEC	8.56	100	66.6	67.4	67.9	67.3
2	1691: Mod_Good	9.70	100	44.7	69.1	44.7	51.7
3	1691: Regrowth	45.40	0	52.5	38.8	43.8	44.6
4	1691: Grassland	154.45	0	58.7	41.8	15.2	33.4
5	1691: Rehab	8.42	100	44.0	43.4	48.4	45.2
6	1691: Plantation	0.14	100	62.1	68.9	43.9	57.3
7	1692: Mod-Good	56.76	100	60.6	39.5	45.9	47.9
8	1692: Mod-Good-CEEC	5.53	100	56.1	27.8	44.6	41.1
9	1731: Mod_Good	3.58	100	22.4	22.5	45.2	28.3

3.2.5 Paddock Trees

A total of 38 Class 2 and Class 3 Paddock Trees were identified within the Non-native: Exotic Grasslands vegetation.

Four species of Paddock Trees were identified: *Acacia salicina* (Native Willow), *Brachychiton populneus* (Kurrajong), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus moluccana* (Grey Box).

All Paddock Trees were assigned to PCT 1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter. The large tree benchmark for PCT 1691 is 50 cm diameter at breast height (**DBH**).

A summary of the Class 2 and 3 Paddock Trees identified within the Development Site is provided in **Table 9**. Details on the Paddock Trees and the Paddock Tree Report is provided in **Appendix 1**, and they are shown on **Figure 6 A** - **Figure 6 D**.

Table 9: Paddock Trees Identified within the Development Site.

Category	Paddock Trees that do not Contain Hollows	Paddock Trees that Contain Hollows	Total
Class 2 (≥20 cm - <50 cm)	22	1	**23**
Class 3 (>50 cm)	6	13	**19**
Total	**28**	**14**	**42**

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study Area
- Development Site

Paddock Trees

- Eucalyptus moluccana (Class 2)
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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AGL - 2019
Nearmap - 2019

Paddock Trees within the Development Site

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FIGURE:
6A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study Area
- Development Site

Plant Community Type and Vegetation Zone

Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

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Paddock Trees within the Development Site

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FIGURE:
6B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Paddock Trees
- Acacia salicina (Class 2)
- Acacia salicina (Class 3)
- Brachychiton populneus (Class 3)
- Eucalyptus crebra (Class 3)
- Eucalyptus moluccana (Class 2)
- Eucalyptus moluccana (Class 3)

Legend
- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**

- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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Paddock Trees within the Development Site

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FIGURE:
6C

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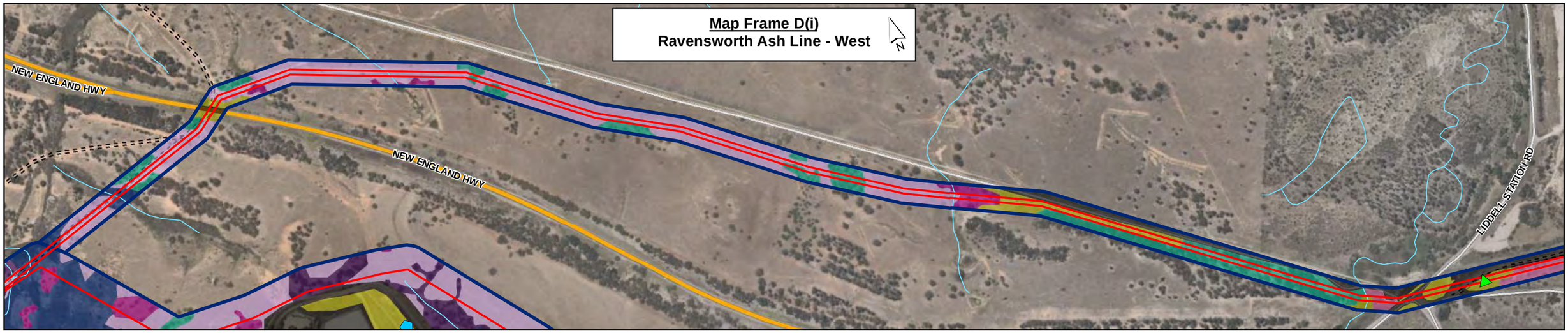

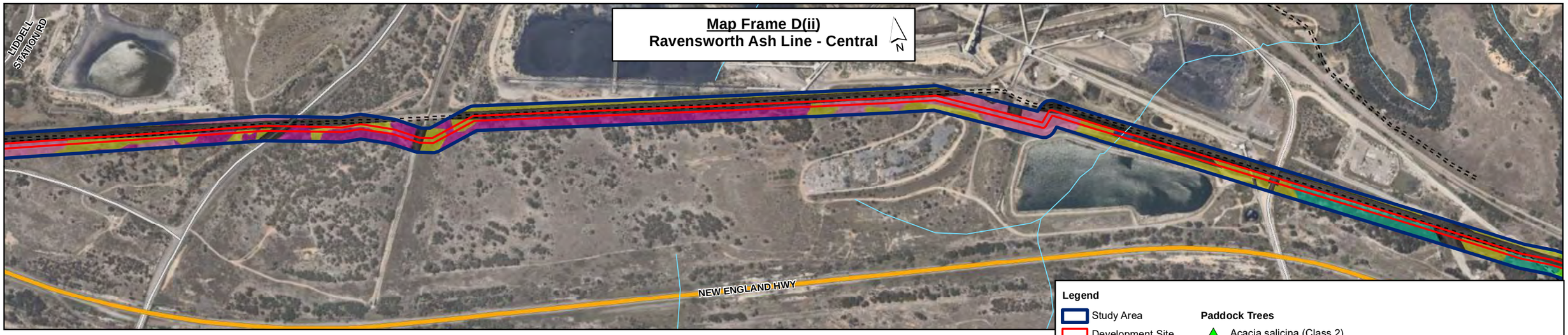

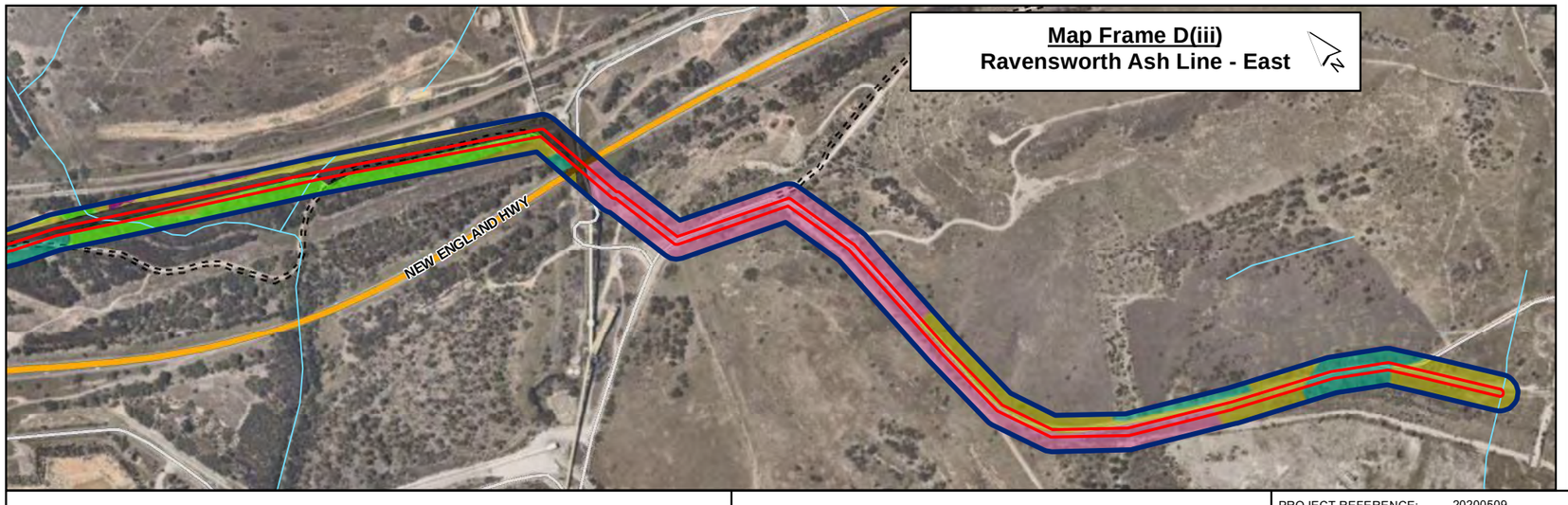

Legend

- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Paddock Trees

- Acacia salicina (Class 2)
- Eucalyptus crebra (Class 3)
- Eucalyptus moluccana (Class 3)

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

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Paddock Trees within the Development Site

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FIGURE: 6D

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4. THREATENED SPECIES

4.1 ASSESSING HABITAT SUITABILITY

To inform the assessment of suitable habitat for threatened species and populations within the Study Area, a database search of the NSW DPIE BioNet Atlas and the DAWE PMST were conducted. The results are provided in **Appendix 2**.

4.1.1 Habitat Assessment

4.1.1.1 Flora

The habitat for candidate threatened flora species within the Study Area is of varying quality due to historical and current disturbances including clearing and cattle grazing. Additionally, at the time of the assessment drought conditions occurred with very little rainfall occurring in the region in recent months. Rainfall in the Muswellbrook area has been below average since 2017.

Habitat for tree and shrub species is present, where canopy and shrub layers are persistent. The *Acacia pendula* Endangered Population within the Hunter Catchment has been identified within the Liddell Power Station site, approximately 1 km to the north of the current Study Area. Habitat for the *Cymbidium canaliculatum* Endangered Population within the Hunter Catchment is limited, with only a few areas of *Eucalyptus crebra* (Narrow-leaved Ironbark) occurring within the Study Area, and where a few large *E. crebra* individuals occur.

Habitat for ground dwelling threatened flora species has been impacted within the Study Area due to drought and grazing impacts. This is particularly relevant to potential orchid habitat within open grassland areas which is substantially degraded by the dry conditions (**Plate 11**).

Plate 11: **Degraded Grassland Habitat within the Study Area (Borrow Pit 4; Vegetation Zone 4).**

4.1.1.2 Fauna

Habitat Assessment

The native vegetation in Zones 1 and 2 of the Development Site contains suitable fauna habitat for many species with some areas connected to surrounding vegetation off-site (primarily within Borrow Pit 4). However, the majority of the vegetation within these zones has a patchy distribution within the Development Site. Zone 1 and 2 also contain many of the habitat features required for native fauna species to breed such as food resources, hollow-bearing trees, leaf litter, logs and rocks with sparse shrub/ground cover layers due to grazing.

Zones 3 and 4 by far are the largest vegetation types by area within the Development Site and contain minimal fauna habitat value. These two zones contain sparse regrowth trees and vast grasslands, which have been affected historically by cattle grazing. In some areas there are a few paddock trees/dead stags which provide hollows for fauna species along with small

scatterings of woody debris/fallen timber throughout that may provide refuge for reptile and small mammal species.

Rehabilitation (Zone 5) and Plantation (Zone 6) are well vegetated but with immature trees with no hollows and few fauna habitat features occur within these areas. Although these two zones do not provide breeding or shelter habitat, they do provide a food source for fauna species in adjacent areas.

Habitat features of Zones 7 and 8 include plenty of leaf litter and isolated scatterings of fallen woody debris from the Bull Oak giving cover for reptile and small mammal species. Within these zones there are a decent number of small hollows for smaller fauna species to take refuge/breeding. Some areas in these zones provide a dense canopy cover for terrestrial species although under this cover there is no to very minimal shrub/grass to provide an additional layer of cover. Although only a small portion of the entire site, Zone 9 provides very dense canopy cover provided by the Swamp Oak with a good shrub layer underneath to provide plenty of cover for fauna species.

Areas of non-native grassland vegetation, which includes the majority of the areas around the Ash Dam, has minimal habitat that is beneficial for fauna species. This area is heavily grazed in areas and the only habitat features is the hollows provided by paddock trees for bird species and tall trees for large raptor nests. Other areas of non-native vegetation include wetland/dam areas covered with *Juncus acutus* which would only provide cover for small terrestrial mammals and frog species.

Throughout the Study Area there are multiple man-made dams with and without water present. The dams with water present that do not have any emergent vegetation within or around the dam provide minimal to no frog habitat. Other dams with emergent vegetation throughout the site do provide good habitat for frog species although some dams are infested with Mosquito Fish (*Gambusia holbrooki*) which can affect the egg and tadpole stage of the frog's life cycle (water bodies discussed further below).

Habitat Tree Survey

A survey of trees within the Development Site, and a 100 m buffer (where this occurred on AGLM Land) was undertaken on 15, 16, 23 – 26 July 2019 to locate hollow-bearing trees, and dead standing stags. Hollow sizes were defined as small (<5 cm diameter), medium (5 – 20 cm diameter) and large (>20 cm diameter). Additionally, during the survey characteristics

which would indicate the hollow is suitable for Large Forest Owls was also recorded, including, height from ground, direction and position within the tree. The location of Habitat Trees and the type of feature it contained was recorded using a handheld GPS.

A total of 367 hollow-bearing trees and dead stags containing large hollows were identified during the surveys within the Study Area (**Figure 7 A** - **Figure 7 D**). Of these, 219 occur within the Development Site, including:

- 187 potential hollow-bearing trees containing:
  - 400 Small Hollows.
  - 295 Medium Hollows.
  - 58 Large Hollows.
- 32 Dead Stags containing:
  - 50 Small Hollows.
  - 64 Medium Hollows.
  - 12 Large Hollows.

Hollows were assessed as either potentially suitable for Large Forest Owls, or not suitable due to size, position or orientation. Potentially suitable hollows were stag-watched as part of nocturnal surveys (**Section 4.2.3.1**).

A number of nests were also identified during the field surveys. None of these nests were suitable for birds of prey.

Waterbodies / Dams

A number of constructed Dams occur within the Study Area, these Dams where assessed for habitat suitability for threatened species, particularly the Green and Golden Bell Frog and Southern Myotis.

Dams which contained open water and fringing vegetation of *Typha domingensis* (Narrow-leaved Cambungi)*, Phragmites australis* (Common Reed) and/or *Juncus acutus* (Sharp Rush) were assessed as suitable habitat for the Green and Golden Bell frog. Within the Study Area a total of eight Dams were identified. Of these eight ponds, three were identified as containing (*Gambusia holbrooki*) (Dams 1, 2 and 7). All identified dams (containing water) are shown on **Figure 7 A** - **Figure 7 D**. Photographs of each of the dams assessed as suitable habitat are provided in **Appendix 4**.

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study Area
- Development Site
- Local Road
- Track
- Watercourse

Habitat Feature

- Hollow-bearing Tree
- Dead Stag
- Nest
- Water Bodies (Dams)- Labelling refers to Green & Golden Bell Frog Habitat

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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Habitat Features

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FIGURE:

7A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study Area
- Development Site
- Local Road
- Track

Plant Community Type and Vegetation Zone

Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
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- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Watercourse

Habitat Feature

- Nest
- Dead Stag
- Hollow-bearing Tree
- Water Bodies (Dams) - Labelling refers to Green & Golden Bell Frog Habitat

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Habitat Features

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FIGURE:
7 B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

1 2 3 4 5 6 7

Legend

- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
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- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**

Habitat Feature

- Nest
- Dead Stag
- Hollow-bearing Tree
- Water Bodies (Dams) - Labelling refers to Green & Golden Bell Frog Habitat

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Habitat Features

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FIGURE:
7C

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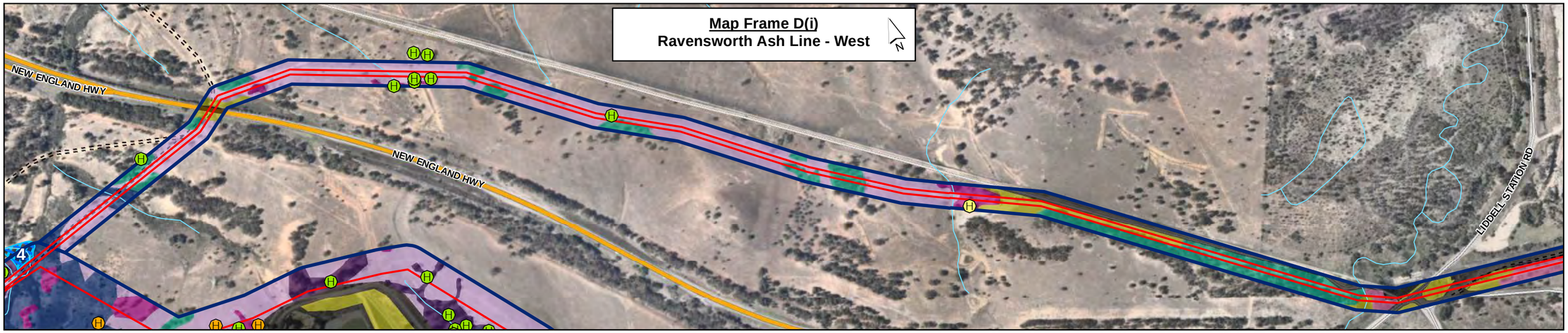

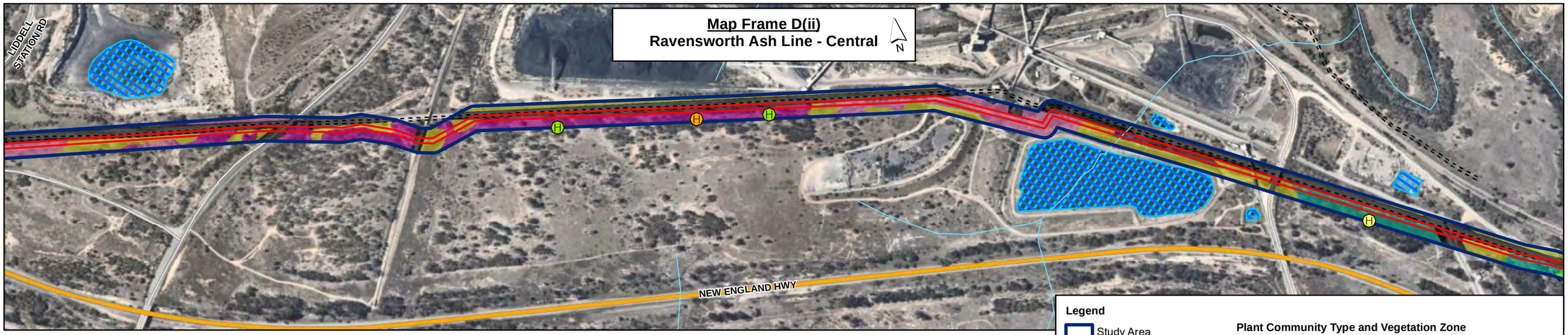

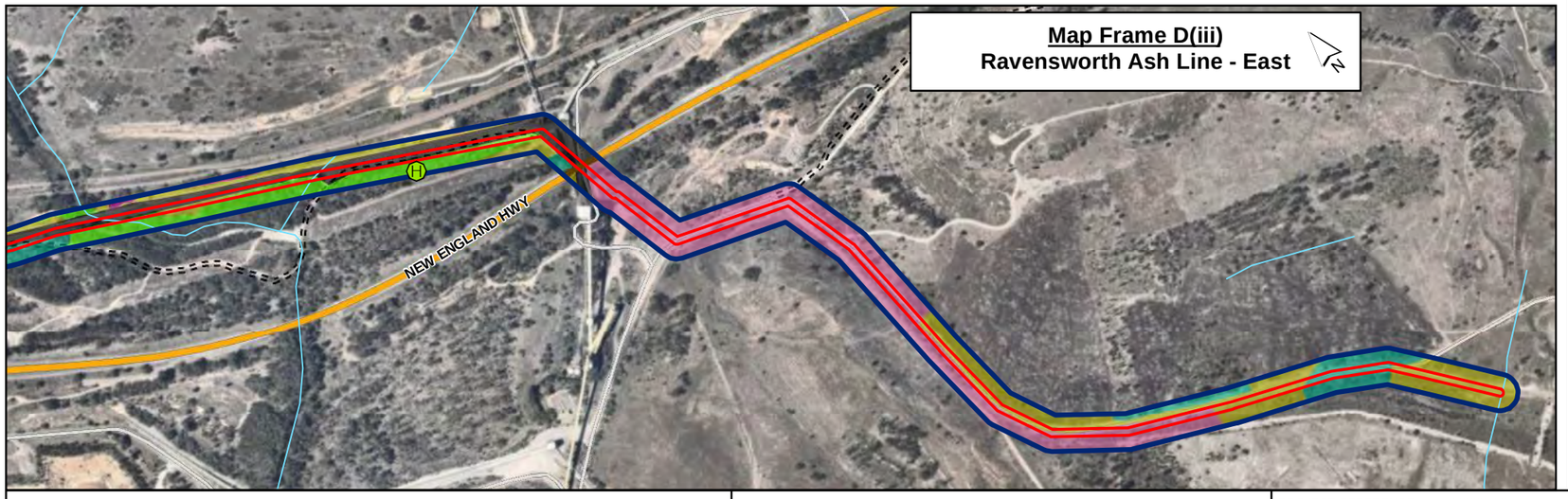

Legend

- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Habitat Feature

- Nest
- Dead Stag
- Hollow-bearing Tree
- Water Bodies (Dams) - Labelling refers to Green & Golden Bell Frog Habitat

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
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- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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Habitat Features

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FIGURE:
7D

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The Green and Golden Bell Frog has previously been recorded within the Sewerage Treatment Plant Polishing Ponds within Bayswater. The last confirmed record of the species in the Upper Hunter was from this location, with a small colony of 4 – 5 adults, and some dozen juveniles, along with tadpoles being observed in the late early 2000's (DECC 2007). These polishing ponds occur directly adjacent to the Study Area (series of 6 ponds to the west of the Ash Dam). These ponds were also assessed as part of surveys for the species. No Mosquito Fish were observed in these ponds.

Any Dam which contained open pools of water 3 m or wider was assessed as suitable foraging for the Southern Myotis (as per the Threatened Biodiversity Data Collection). A total of 28 Dams on or within 200 m of the Development Site were identified. All identified dams (containing water) are shown on **Figure 7 A** - **Figure 7 D**, and dams assessed as Southern Myotis habitat displayed on **Figure 16** - **Figure 16** .

4.1.2 Ecosystem Credit Species

The following assessment of habitat suitability for ecosystem credit species was conducted in accordance with Section 6.2 of the BAM (OEH, 2017a).

Step 1: Identify threatened species for assessment

Step 2: Assessment of the habitat constraints and vagrant species on the subject land

A list of predicted ecosystem credit species for the Development Site was reviewed and assessed according to species specific habitat requirements. The predicted species report is provided in **Appendix 5**.

4.1.3 Species Credit Species

The following assessment of habitat suitability for species credit species was conducted in accordance with Section 6.3 of the BAM (OEH, 2017a).

Step 1: Identify threatened species for assessment

A list of predicted species credit species for the Development Site was reviewed in the BAM calculator and is provided in **Appendix 5**.

Step 2: Assessment of the habitat constrains and vagrant species on the subject land & Step 3: Identify candidate species credit species for further assessment

The following species were considered unlikely to occur on the subject land due to the lack of habitat constraints being present, geographic restrictions or habitat degradation:

- Regent Honeyeater (*Anthochaera phrygia*) (Breeding) – Study Area is not within areas of mapped important habitat (DPIE 2020).
- Swift Parrot (*Lathamus discolor*) (Breeding) – Study Area is not within areas of mapped important habitat (DPIE 2020).
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – Study Area is not within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops or crevices, or within 2 km of old mines or tunnels.
- Large Bentwing-bat (*Miniopterus orianae oceanensis*) (Breeding) – Study Area does not contain caves, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet.
- Brush-tailed Rock-wallaby (*Petrogale penicillata*) – Study Area is not within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines.

A discussion of potential habitat within the study area and the potential for impacts to these species is discussed in **Section 7.1** and has been addressed via assessments of significance in **Appendix 9.**

4.2 THREATENED SPECIES SURVEYS

Step 4: Determine presence or absence of candidate species credit species

4.2.2 Candidate Threatened Flora

4.2.2.1 Survey Methodology

The candidate threatened flora species were surveyed in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH, 2016). All surveys were conducted using systematic parallel transects. Parallel field traverses were separated by 5 to 10 m for orchids, herbs and forbs, 10 to 15 m for sub-shrubs, and 10 to 20 m for species in all other life forms (shrubs and trees).

Survey Timing

The following candidate threatened flora species (**Table 10**) were surveyed across the Study Area by suitably qualified ecologists. Survey tracks for each round of targeted surveys are shown on **Figure 8 A** - **Figure 8 D** (Round 1), **Figure 9 A** - **Figure 9 D** (Round 2 and Round 4), and **Figure 10 A** - **Figure 10 D** (Round 3).

Table 10: Survey of requirements and timing conducted for candidate flora species

Scientific name	Common name	Survey Requirements	Survey Timing
Flora			
Acacia pendula – Endangered Population in the Hunter Catchment	-	All year	22 to 26 July, 23 – 25 September 2019 and 6 January 2020 (**Round 1**).
Asperula asthenes	Trailing Woodruff	Not required under BAM. Surveyed to Address EPBC Act requirements. Can be surveyed for in October to December	21 to 24 October 2019 (**Round 3**).
Cymbidium canaliculatum Endangered Population in the Hunter Catchment	-	All year	22 to 26 July, 23 – 25 September 2019 and 6 January 2020 (**Round 1**).
Diuris tricolor	Pine Donkey Orchid	September to October	Surveys conducted 21 to 24 October 2019 **(Round 3)**. Due to unfavourable conditions, assumed present and an expert report has been prepared (see below).
Eucalyptus glaucina	Slaty Red Gum	All year	22 to 26 July, 23 – 25 September 2019 and 6 January 2020 (**Round 1**).
Eucalyptus nicholii	Narrow-leaved Black Peppermint	Not required under BAM. Surveyed to Address EPBC Act requirements. Can be surveyed for all year.	22 to 26 July, 23 – 25 September 2019 and 6 January 2020 (**Round 1**).
Ozothamnus tesselatus	-	Not required under BAM. Surveyed to Address EPBC Act requirements. Can be surveyed for in September to October.	22 to 26 July, 23 – 25 September 2019 (**Round 1**).
Persicaria elatior	Tall Knotweed	December to May	2 December 2019 (**Round 4**)
Prasophyllum petilum (Synonymous with *Prasophyllum* sp. Wybong)	A Leek Orchid	Not required under BAM. Surveyed to Address EPBC Act requirements.	21 to 24 October 2019 (**Round 3**). Due to unfavourable conditions, an

Scientific name	Common name	Survey Requirements	Survey Timing
		Flowers September to November	expert report has been prepared (see below).
Pterostylis chaetophora	-	September to November	21 to 24 October 2019 **(Round 3)**
Pterostylis gibbosa	Illawarra Greenhood	Not required under BAM. Surveyed to Address EPBC Act requirements. Flowers September to October	8 – 9 October 2019 (**Round 2**).

A reference population of *Pterostylis chaetophora* located at North Rothbury was confirmed to be flowering on 3 October 2019, prior to the surveys on site being conducted. Surveys within the Study Area were conducted within three weeks of confirmation of the reference population flowering.

Expert Report

Due to sub-optimal conditions for the flowering season of *Diuris tricolor* (Pine Donkey Orchid) and *Prasophyllum* sp. Wybong (A Leek Orchid; EPBC Act), and the lack of flowering of these two species at a local reference population (being the Mangoola Mine Site, located approximately 25 km north-west of the Study Area), an expert report was prepared by Dr Stephen Bell to assess the habitat suitability of the Study Area for these species in accordance with Section 6.5.2.3. of the BAM).

The expert report determined that approximately 166 ha (30%) of the proposed 561 ha disturbance area may provide habitat for *Diuris tricolor* (Pine Donkey Orchid) and *Prasophyllum petilum* (Synonymous with *Prasophyllum* sp. Wybong listed under the EPBC Act). In accordance with the findings of the expert report, both *Diuris tricolor* and *Prasophyllum* petilum (synonymous with *Prasophyllum* sp. Wybong) have been assumed to be present within the Development Site. The expert report is provided in **Appendix 8** and the findings are summarised in **Section 4.3** , which includes an estimate of the extent of habitat for each species.

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Targeted Threatened Flora Survey Tracks (22-26 July 2019, 23-25 September 2019, 06 January 2020)
- Study Area
- Development Site
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

N

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Flora Survey Effort
22-26 July 2019, 23-25 September 2019 & 06 January 2020

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FIGURE:
8A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Targeted Threatened Flora Survey Tracks (22-26 July 2019, 23-25 September 2019, 06 January 2020)
- Study Area
- Development Site
- Local Road
- Track

Plant Community Type and Vegetation Zone

Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
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- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Watercourse

0 50 100 200 300 400 500 Metres

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FIGURE:
8B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Targeted Threatened Flora Survey Tracks (22-26 July 2019, 23-25 September 2019 and 06 January 2020)
- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

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- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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FIGURE:
8C

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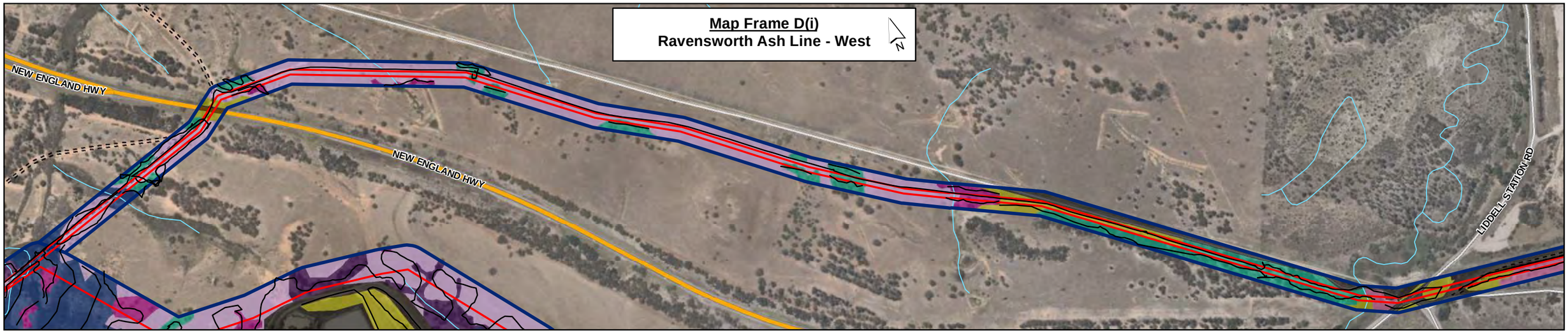

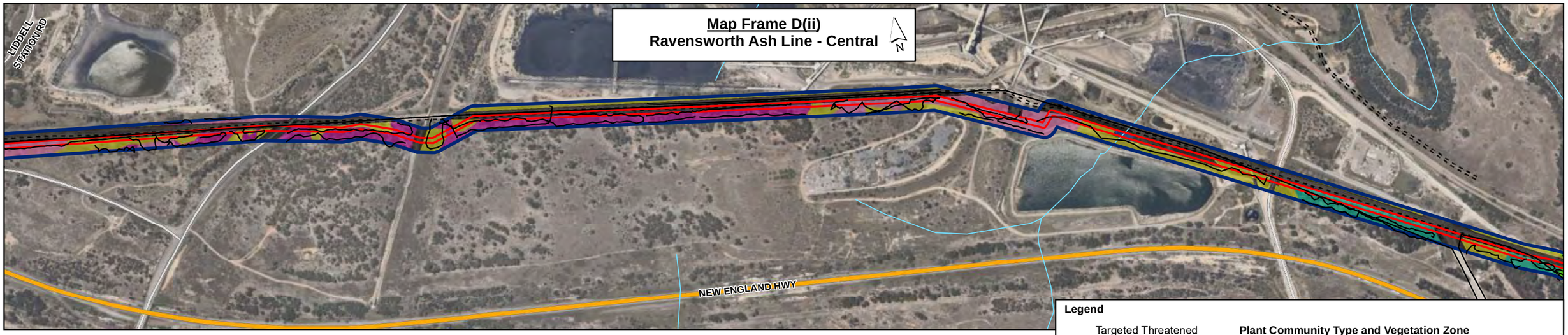

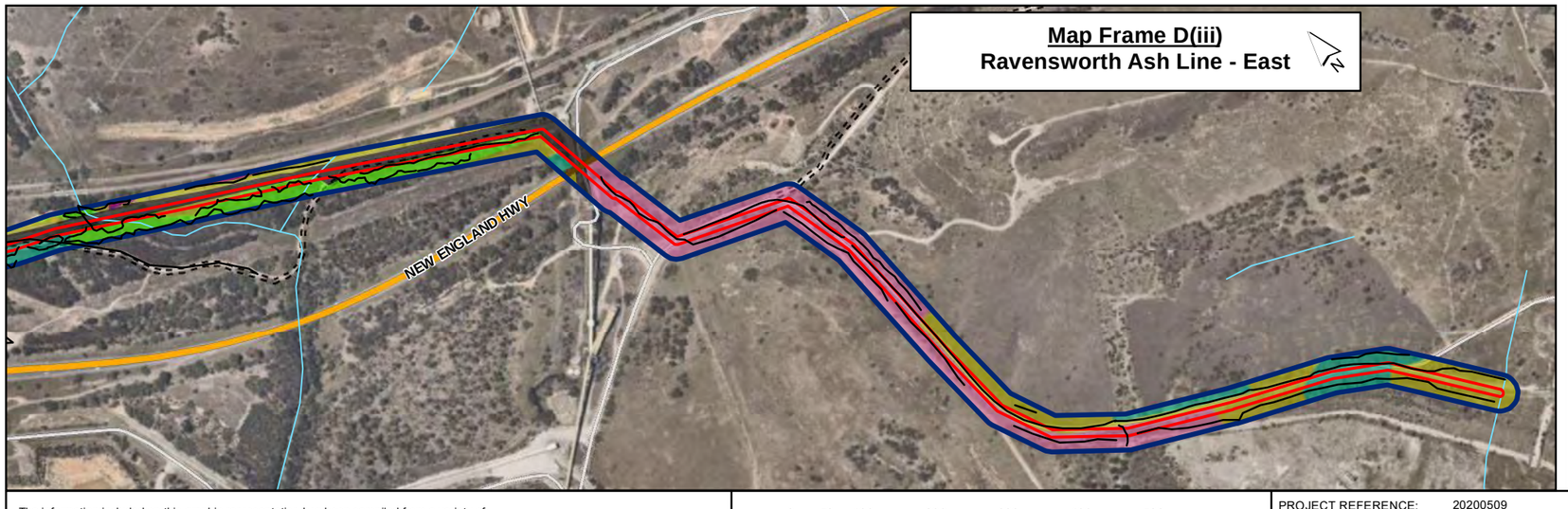

Legend

- Targeted Threatened Flora Survey Tracks (22-26 July 2019, 23-25 September 2019, 06 January 2020)
- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
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- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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FIGURE:
8D

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Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Targeted Threatened Flora Survey Tracks (8-9 October
- Study
- Development Site
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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Nearmap - 2019

Flora Survey Effort
8-9 October 2019

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FIGURE:
9A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

Plant Community Type and Vegetation Zone

Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
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- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Targeted Threatened Flora Survey Tracks (8-9 October
- Study Area
- Development Site
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

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Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
9B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Targeted Threatened Flora Survey Tracks (8-9 October 2019)
- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
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- Non-Native: Exotic Grasslands
- Dam
- Excluded

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8-9 October 2019

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Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
9C

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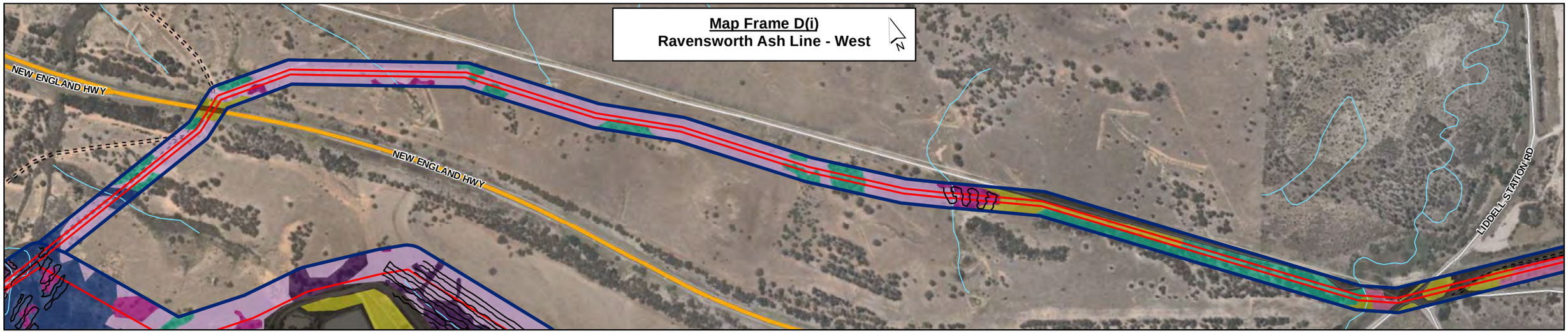

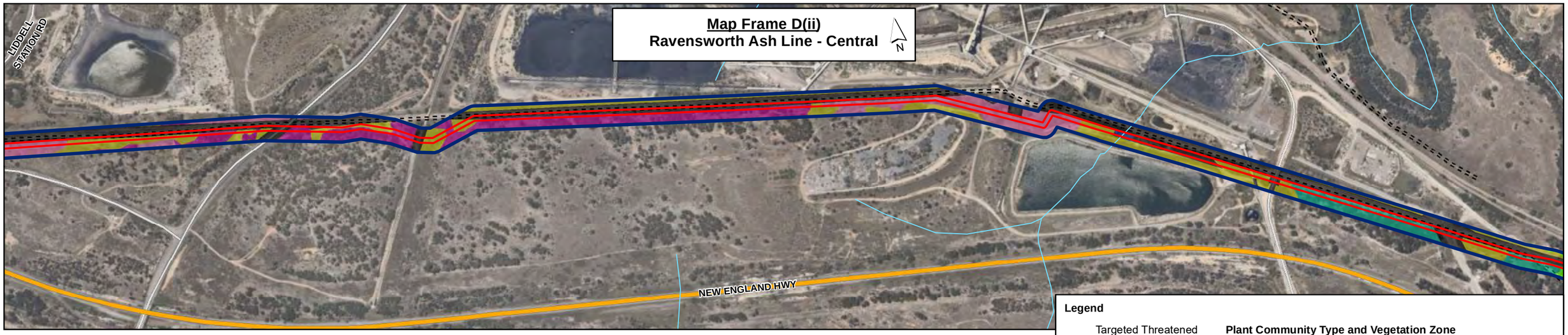

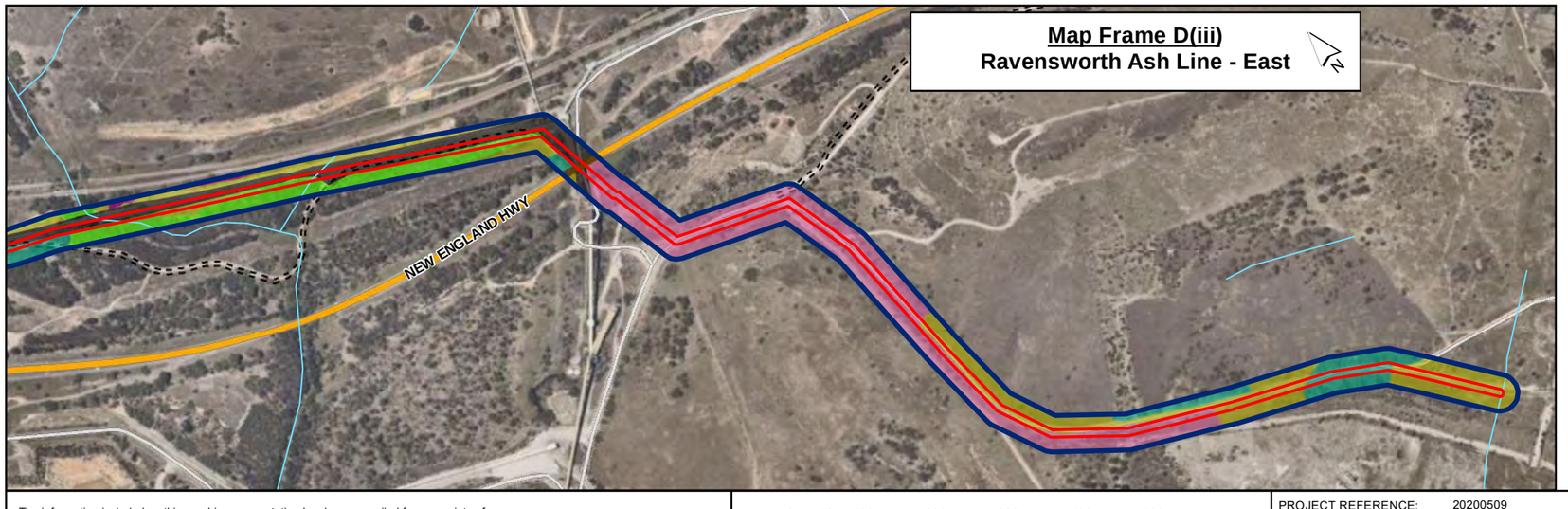

Legend

- Targeted Threatened Flora Survey Tracks (8-9 October 2019)
- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
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- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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8-9 October 2019

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FIGURE:
9D

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Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Targeted Threatened Flora Survey Tracks (21-24 October
- Study Area
- Development Site
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

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- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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21-24 October 2019

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Operational Works (WAOAW) Project

FIGURE:
10A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Targeted Threatened Flora Survey Tracks (21-24 October
- Study Area
- Development Site
- Local Road
- Track

Plant Community Type and Vegetation Zone

Symbology

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- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Watercourse

0 50 100 200 300 400 500 Metres

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Flora Survey Effort
21-24 October 2019

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Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
10B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Targeted Threatened Flora Survey Tracks (21-24 October 2019)
- Study Area
- Development Site
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- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

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- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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Flora Survey Effort
21-24 October 2019

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FIGURE:
10C

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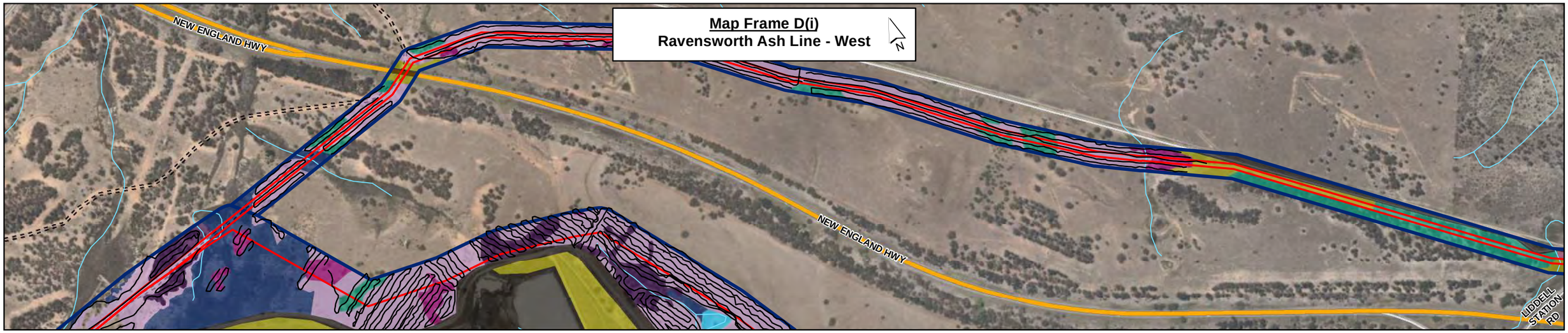

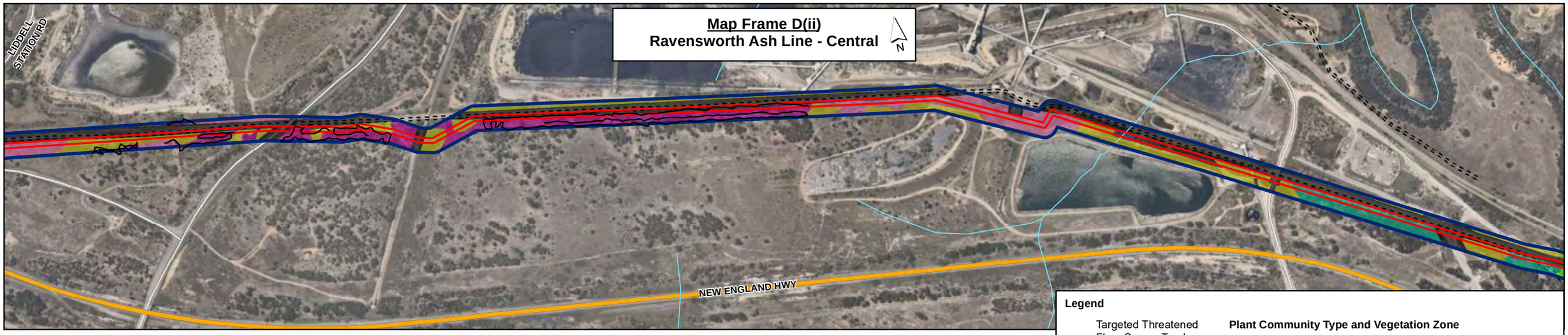

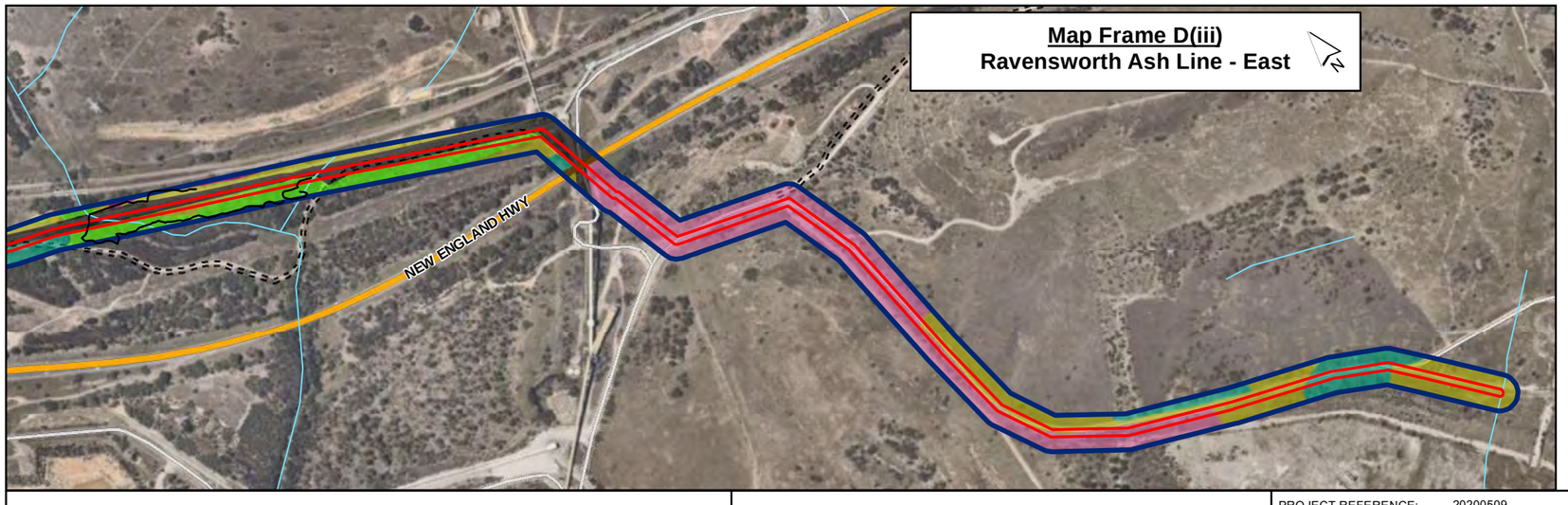

Legend

- Targeted Threatened Flora Survey Tracks (21-24 October 2019)
- Study Area
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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NSW DFSI - 2018
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Flora Survey Effort
21-24 October 2019

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
10D

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4.2.2.2 Flora Survey Results

A total of 193 flora species were identified during field surveys. Sixty-one of these species are considered exotic, of which five are listed under the *Biosecurity Act 2015 (NSW).*

One planted *Acacia pendula* was identified within the Study Area, outside the Development Site (**Figure 12 A**). This individual is within the threatened population, *Acacia pendula Endangered Population in the Hunter Catchment,* listed under the BC Act. The proposed development will not directly impact this species or its habitat (occurs within rehabilitation). No further assessment of impacts was conducted.

Two threatened flora species; *Diuris tricolor* and *Prasophyllum petilum,* were assumed present within the Development Site (as outlined above, also see **Section 4.3**).

A list of the flora species identified within the Study Area is provided in **Appendix 3**.

4.2.3 Candidate Threatened Fauna

4.2.3.1 Survey Methodology

The following sub-sections outline the methods for all fauna surveys conducted across the Study Area. A summary of the Fauna Survey Effort and comparison against the *Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft)* (DEC, 2004) and DoEE Guidelines is provided in **Appendix 6**.

Survey Timing

The following candidate threatened fauna species were surveyed in the appropriate season as per the BAM (**Table 11**).

Table 11: Survey of threatened fauna species

Scientific name	Common name	Survey Requirements	Survey Timing & Type
Amphibians			
Litoria aurea	Green and Golden Bell Frog	November to March	5 – 7 November and 20 - 22 January Targeted waterbody surveys
Birds			
Burhinus grallarius	Bush Stone-curlew	All year	5 – 7 November 2019 Call Playback 2 – 6 December Spotlighting

Scientific name	Common name	Survey Requirements	Survey Timing & Type
Callocephalon fimbriatum	Gang-gang Cockatoo (Breeding)	October to January	5 – 7 November and 4 – 5 December 2019 Dusk Bird Surveys
Calyptorhynchus lathami	Glossy Black-Cockatoo (Breeding)	March to August	24, 29 – 31 July, and 1 and 5 August 2019 Dusk Bird Surveys
Haliaeetus leucogaster	White-bellied Sea-Eagle (Breeding)	July to December	24 – 27 September and 1 – 2 October 2019 Nest Survey
Hieraaetus morphnoides	Little Eagle (Breeding)	August to October	
Lophoictinia isura	Square-tailed Kite (Breeding)	September to January	
Ninox connivens	Barking Owl (Breeding)	May to December	23 – 24, 29 – 31 July, and 1, 5 – 7 August 2019 Stag-watching and Owl Call-playback
Ninox strenua	Powerful Owl (Breeding)	May to August	
Tyto novaehollandiae	Masked Owl (Breeding)	May to August	
Mammals			
Cercartetus nanus	Eastern Pygmy-possum	October to March	4 November – 3 December 2019 Remote Camara Trapping and Nest Boxes
Dasyurus maculatus	Spotted-tailed Quoll	Not required under BAM (Ecosystem Credit Species). Surveyed to Address EPBC requirements; from mid-November to March	3 - 17 December Camera Trapping
Myotis macropus	Southern Myotis	November to March	2 – 6 December 2019 Harp trapping and Anabat Survey
Phascogale tapoatafa	Brush-tailed Phascogale	All Year	4 November to 3 December 2019 Camera Trapping 2 – 6 December Trapping and spotlighting
Planigale maculata	Common Planigale	All Year	4 November to 3 December 2019 Camera Trapping 2 – 6 December Trapping and spotlighting
Pteropus poliocephalus	Grey-headed Flying-fox (Breeding)	October to December	1 – 2 October, 5 – 7 November and 2 – 6 December 2019 Searches for camps Conducted during trapping surveys (and during all other surveys while traversing the site during October to December).

Scientific name	Common name	Survey Requirements	Survey Timing & Type
Reptiles			
Delma impar	Striped Legless Lizard	September to December	24/25 October – 17 December 2019 Tile Arrays Active searches conducted on 1 – 2 October, 26 November and 4 December 2019 Reptile Surveys
Hoplocephalus bitorquatus	Pale-headed Snake	November to March	5 – 7 November and 2 – 6 December 2019 Spotlighting

Site Stratification

Based on the Vegetation Formations of the vegetation within the Study Area, a total of three Stratification Units were defined:

- Grassy Woodlands (total 80.32 ha): PCT 1691 and PCT 1692 (woody vegetation zones). This stratification unit includes areas of Rehabilitation and Plantation as they were linked back to PCT 1691 (closest equivalent), however, these areas were surveyed separately.
- Swamp Forest (total 2.40 ha): PCT 1761.
- Native Grasslands and Acacia Regrowth (total 188.14 ha): Native Grasslands Derived from PCT 1691 and areas of Acacia regrowth (both areas lack Eucalypt canopy layer).

Additionally, waterbodies containing habitat suitable for Amphibians (permanent water and standing vegetation), were identified across the Study Area.

Surveys undertaken within these stratification units are outlined below and survey locations are shown on **Figure 11 A** - **Figure 11 D**.

Arboreal Mammals

Ten Elliott B traps were placed in trees at heights of 3 m, along five transects (50 traps in total) for a period of 5 days in December 2019. Traps were baited with a mixture of rolled oats, honey, peanut butter and treacle. The trunks of trees containing the traps were sprayed with a mixture of honey and water. Traps were checked daily for arboreal species for four nights.

A total of 24 Reconyx HyperfireTM remote trigger cameras were installed at heights of 3 m or 1 m. A total of 17 cameras were installed at 3 m, targeting Brush-tailed Phascogale, and 7

cameras were installed at 1 m, targeting Eastern Pygmy-possum). Cameras were active onsite for 31 consecutive nights from 4 November to 3 December 2019. Cameras were baited with an oats, peanut butter, treacle, vanilla essence and truffle oil mixture in a mesh canister, and the surrounding area (including the tree trunk) was sprayed with honey water. Cameras were re-baited twice during the survey period. Images were analysed to identify species captured on camera.

Spotlighting surveys were conducted on 3 and 4 December 2019 using high-powered headtorches to search for all types of nocturnal fauna. Spotlighting was undertaken via random meanders for 60-minutes on two separate nights at five separate locations (transect locations).

Two Spot Assessment Technique (**SAT**) surveys (Phillips and Callaghan, 2011) were conducted within vegetation dominated by Koala Feed Trees *Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus punctata* (Grey Gum) on 6 January 2019. This technique involves the selection of a centre tree (survey point) which is selected according to the following criteria:

- A tree of any species beneath which one or more Koala faecal pellets have been observed; and/or
- A tree in which a Koala is observed; and/or
- Any other tree known or considered to be potentially important for Koalas, or for other assessment purposes.

A minimum of 30 trees (including the centre tree) with a DBH of 100 mm or greater are then surveyed. Surveys involve the inspection of the ground surface within 100 centimetres from the base of the tree. If faecal scats are identified, the survey concludes.

Terrestrial Mammals

Twenty Elliott A traps were placed along five transects at regular intervals to capture small terrestrial mammal species. Traps were baited with a mix of rolled oats, honey, peanut butter and treacle and set for four consecutive nights with checks for captures occurring each morning.

Four Reconyx HyperfireTM remote trigger cameras were installed at a height below 1 m, targeting terrestrial mammal species. Cameras were baited with an oats, peanut butter, treacle, vanilla essence and truffle oil mixture in a mesh canister, and the surrounding area (tree trunk) was sprayed with honey water. Cameras were active onsite for 31 consecutive

nights from 4 November and 3 December 2019 and were re-baited twice during the survey period.

A total of 12 remote trigger cameras were installed below 1 m and were baited with chicken wings marinated in fish sauce. Cameras were active onsite for 14 consecutive nights from 3 to 17 December 2019 and were re-baited once during the survey period.

Images from the cameras were analysed to identify species captured on camera.

In addition to nocturnal spotlighting (outlined above), opportunistic daytime observations of the signs of recent terrestrial mammal activity such as diggings, droppings or scratch marks were noted.

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study
- Development Site
- Anabat
- Glossy Black Cockatoo Survey
- Harp Trap
- Stag Watch
- SAT Survey
- Tile
- Owl Call Playback
- Pygmy Possum Nestbox
- Remote Camera - Pygmy Possum
- Remote Camera - Spotted Quoll
- Remote Camera -
- Remote Camera - Terrestrial
- Amphibian Survey
- Spotlighting Transect
- Trapping Transect
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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Fauna Survey Effort

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FIGURE:
11A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study Area
- Development Site
- Anabat
- Glossy Black Cockatoo Survey
- Harp Trap
- Stag Watch
- Tile Array
- Owl Call Playback
- Pygmy Possum Nestbox
- Remote Camera - Pygmy Possum
- Remote Camera - Spotted Quoll
- Remote Camera - Arboreal
- Remote Camera - Terrestrial
- Spotlighting Transect
- Trapping Transect
- Local Road
- Track

Plant Community Type and Vegetation Zone Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Watercourse

0 50 100 200 300 400 500 Metres

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FIGURE:
11B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Study Area
- Development Site
- Anabat
- Glossy Black Cockatoo Survey
- Harp Trap
- Stag Watch
- SAT Survey
- Tile Array
- Owl Call Playback
- Pygmy Possum Nestbox
- Remote Camera - Spotted Quoll
- Remote Camera - Arboreal
- Remote Camera - Terrestrial
- Spotlighting Transect
- Trapping Transect
- Amphibian Survey
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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Fauna Survey Effort

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FIGURE:
11C

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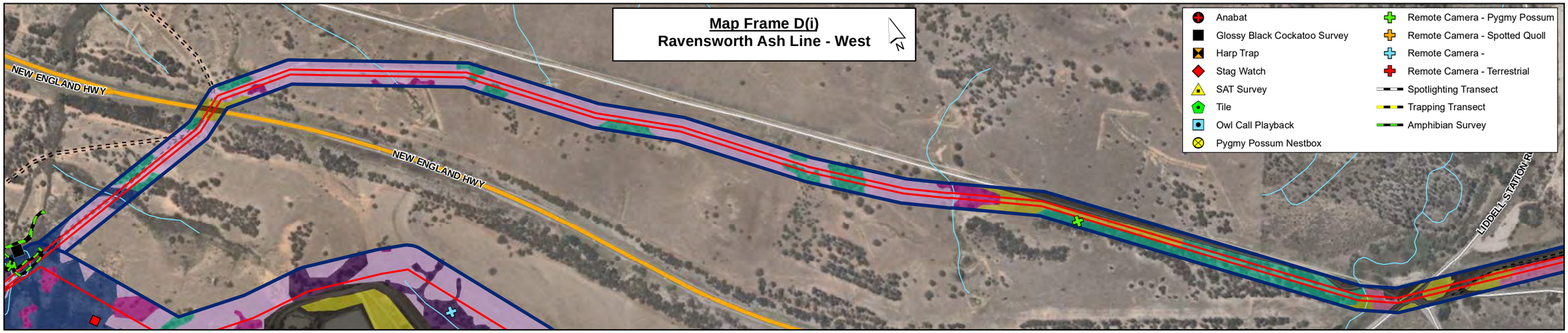

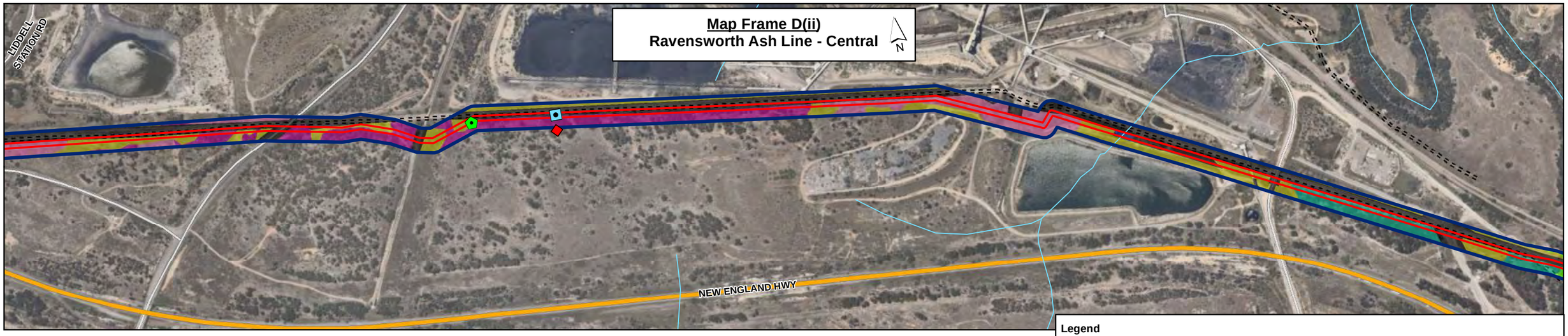

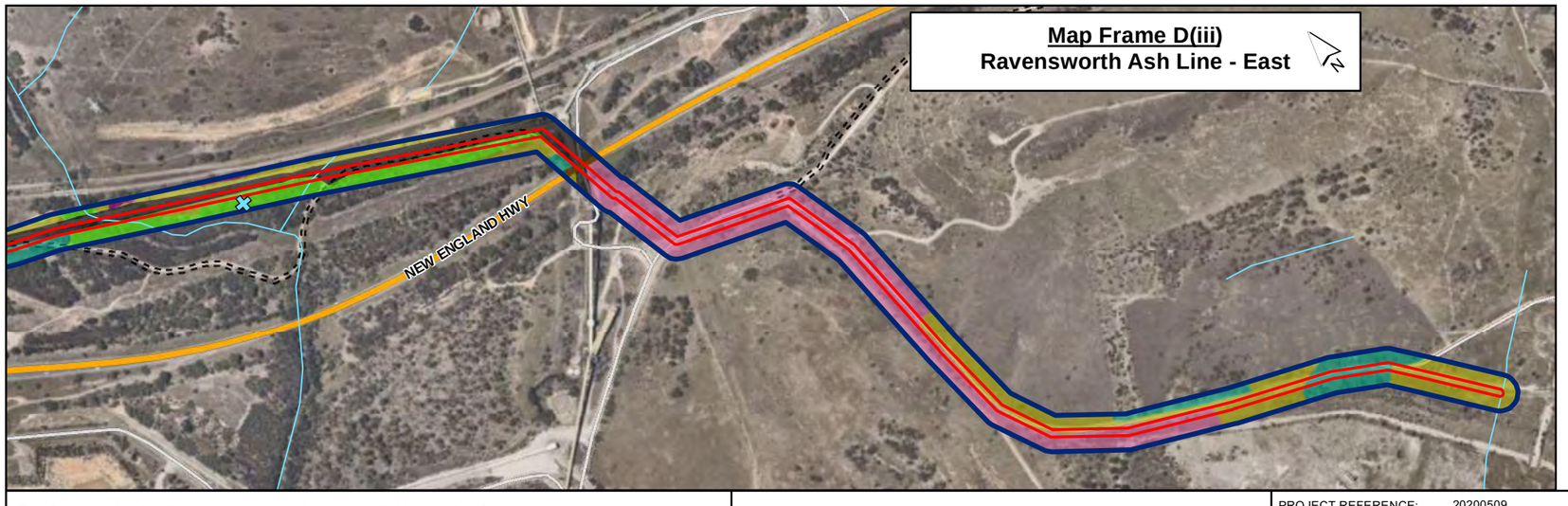

Legend

- Study
- Development Site
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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FIGURE:
11D

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Bats

Four Harp traps and 4 Anabat^{TM} bat-call detectors were used to detect Microchiropteran bats within the Study Area. Surveys for Microchiropteran bats were targeting the Southern Myotis, and paired harp traps and Anabats were placed at suitable waterbodies for four consecutive nights; 2 – 6 December 2019. Nocturnal searches of blossoming trees were also undertaken during spotlighting to detect Megachiropteran bats.

Diurnal Birds

Visual and auditory bird surveys were conducted at 21 locations throughout the Study Area from 24 July 2019 to 5 December 2019. Surveys were targeting breeding habitat of woodland bird species and as such were conducted at dusk. Surveys targeted waterbodies and hollow-bearing trees suitable for Glossy-black Cockatoos and Gang-gang Cockatoos and were conducted between 4:25 pm – 8:20 pm. Species were identified visually with the aid of binoculars or aurally from call identification.

A survey for trees containing nests was undertaken within the Development Site and a 100 m buffer (where this occurred within AGLM Land) on 24 – 27 September and 1 – 2 October 2019. These surveys were undertaken to identify potential breeding habitat of candidate birds of prey.

Nocturnal Birds

Within the Study Area, stag-watching and owl call-playback was conducted over nine nights on 23 – 25, 29 – 31 July, and 1, 5 – 7 August 2019. During these surveys, hollows identified as being potentially suitable for Large Forest Owls were stag watched from dusk (30-minutes prior to last light) for a period of 1-hour. After stag watching was completed, owl call-playback was conducted. Calls of large forest owls (Powerful Owl, Masked Owl and Barking Owl) were broadcast through a megaphone to attract individuals or to incite a response. After an initial listening period of 15-minutes, recorded calls of threatened species were broadcast for 5-minutes each, followed by 1-2 minutes of stationary spotlighting. Directly after the final broadcast, a quiet listening period of 5 minutes was conducted followed by a 30-minute spotlighting survey.

Amphibians

Amphibian surveys were carried out at eight water bodies that were assessed to have the vegetation requirements for the Green and Golden Bell Frog (GGBF) within the Study Area on 3 nights in November 2019 (5 – 7) and a further 3 nights in January 2020 (20 – 22). Nocturnal

surveys involved quiet listening periods where species were identified through aural detection of species-specific calls along with spotlighting searches within emergent vegetation around the edge of the waterbodies. Additionally, call playback for the GGBF was conducted at each dam on all nights with a megaphone and pre-recorded GGBF calls to illicit a response. Adult frogs encountered were identified by visual confirmation or by their distinct advertisement calls. Surveys at each dam were conducted for one-person hour on four separate nights (total four-person hours per water body). Additional surveys were undertaken outside the Study Area within the six Polishing Ponds which occur to the west of the Ash Dam, for the presence of GGBF.

Targeted surveys for the Green and Golden Bell Frog were conducted in November after 21.6 mm of rain over three days (3 – 5 November). Further surveys were conducted in January following 36.8 mm of rain over five days (16 – 20 January). Personal communication with the Conservation Biology Research Group at the University of Newcastle confirmed that Green and Golden Bell Frogs were active but not calling at monitoring sites on Kooragang Island prior to the November surveys. The Research Group confirmed that Green and Golden Bell Frogs at Kooragang Island were actively calling prior to the January surveys conducted within the Study Area.

Reptiles

Reptile searches and tile arrays were carried out at different locations within the site. Ten tile arrays were set out in a 10 x 5 configuration using terracotta roof tiles in potential habitat for the Striped Legless Lizard (*Delma impar*) on the 25 October and were checked on the 26 November, 12 and 17 December 2019 by flipping each tile over and checking for the presence of any reptile species along with evidence of use (diggings and shed skin).

Spotlighting surveys were conducted on the 5 – 7 November (targeting for Pale Headed Snake) 3 – 4 December 2019 (All fauna species) using high-powered headtorches to search for all types of nocturnal fauna. Spotlighting was undertaken via random meanders for 60-minutes on 5 separate nights, at seven separate locations (transect locations and additional random meanders).

Other targeted reptile searches were conducted within the Borrow Pit 4 and the Salt Cake Landfill areas on 27 September, 2 October and 26 November 2019 through random meanders turning over timber, woody debris, rocks, corrugated iron and other industrial items.

Weather Data

Temperature and rainfall data for the survey period is summarised per month in **Table 12**. Temperature data is from Scone Airport weather station (BOM: 061363) and rainfall data is from the Muswellbrook Lindisfarne weather station (BOM: 061168). Additionally, rainfall data from the Liddell weather station is also presented.

Table 12 Weather Data

Month	Temperature (°C)				Rain (mm) BOM	Rain (mm) (Liddell)
	Min	Max	Min (Avg)	Max (avg)		
June 2019	-4.0	24.6	4.3	17.9	7.0	14.2
July 2019	-2.6	22.8	3.9	19.0	4.0	7.6
August 2019	-3.4	27.1	4.2	20.5	10.0	22.4
September 2019	1.2	32.6	7.1	24.5	26.0	31.6
October 2019	5.3	38.7	10.5	29.2	20.0	2.4
November 2019	7.9	39.7	14.1	32.0	28.0	21.6
December 2019	12.1	45.3	16.7	35.3	0.0	0.2
January 2020	15.6	44.6	20.3	35.0	N/A	46.6

4.2.3.2 Fauna Survey Results

A total of 64 species of fauna were detected within the Study Area during field surveys (**Appendix 3**). This includes five amphibian, 20 bird, one fish, 25 mammal, and 13 reptile species. Of these species, four are considered to be feral / introduced being the Mosquito Fish (*Gambusia holbrooki*), House Mouse (*Mus musculus*), Black Rat (*Rattus rattus*), and Red Fox (*Vulpes vulpes*).

Three mammals, four bird and one reptile species detected within the Study Area are listed as Vulnerable under the BC Act (**Figure 12 A** - **Figure 12 D**):

- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) was identified via Anabat recordings from the dam in Borrow Pit 3 (within the Development Site).
- Southern Myotis (*Myotis macropus*) was identified via Anabat recordings from the large dam on the eastern side of the Ash Dam within the Development Site (Dam 1/ Anabat B).
- Squirrel Glider (*Petaurus norfolcensis*) was identified at one location within the Development Site via remote camera within Borrow Pit 4 (**Appendix 4**). This species has been added as a candidate species, as it is not associated with any of the PCTs within the Development Site.

- Little Lorikeet (*Glossopsitta pusilla*) was identified flying over the Study Area during bird surveys in the salt cake landfill area (One bird survey location).
- Hooded Robin (*Melanodryas cucullata*) was identified in Borrow Pit 4 within the Development Site (Opportunistic sighting).
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) was identified at multiple locations within the Development Site and Study Area (outside the Development Site), including multiple nesting locations (Opportunistic sightings and nest surveys).
- Speckled Warbler (*Chthonicola sagittata*) was identified in Borrow Pit 4 within the Development Site (Opportunistic Sighting).
- Striped Legless Lizard (*Delma Impar*) was identified on two occasions in the same area in Borrow Pit 4 within the Development Site (One opportunistic sighting and one targeted search) (**Appendix 4**).

The Large Bentwing-bat is a dual Species and Ecosystem Credit Species. This species is a species credit species for breeding habitat, and an ecosystem credit species for foraging habitat. The habitat constraint listed for this species in the Threatened Biodiversity Data Collection (habitat constraint: Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding), is not present on or within 100 m of the Development Site (as outlined in **Section 4.1.3**). As such, this species credit species was determined to not be a candidate species and no further assessment of impacts was conducted.

The Little Lorikeet, Hooded Robin, Grey-crowned Babbler and Speckled Warbler are all ecosystem credit species which were confirmed as predicted species and, as such, no further assessment for these species is required. The Southern Myotis, Squirrel Glider and Striped Legless Lizard are all Species Credit Species and have been further assessed in the following section.

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study
- Development Site
- *Acacia Pendula* Location
- Grey-crowned Babbler Observation
- Speckled Warbler Observation
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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Threatened Flora and Fauna
Identified within the Study Area

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Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
12A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study Area
- Development Site
- Grey-crowned Babbler Observation
- Hooded Robin Observation
- Large Bent-winged Bat Observation
- Speckled Warbler Observation
- Squirrel Glider Detected
- Striped Legless Lizard Observation

Plant Community Type and Vegetation Zone

Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

N

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PROJECT REFERENCE: 20200509

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DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Threatened Flora and Fauna Identified within the Study Area

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated Operational Works (WAOAW) Project

FIGURE:
12B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Study
- Development Site
- Grey-crowned Babbler Observation
- Southern Myotis Detected
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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Nearmap - 2019

Threatened Flora and Fauna Identified within the Study Area

Jacobs Group
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Bayswater Water and Other Associated Operational Works (WAOAW) Project

FIGURE:
12C

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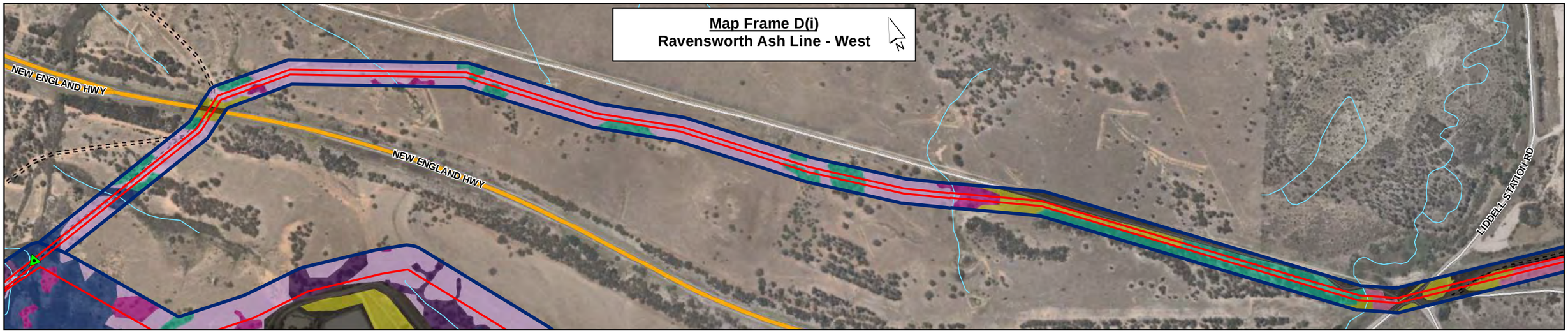

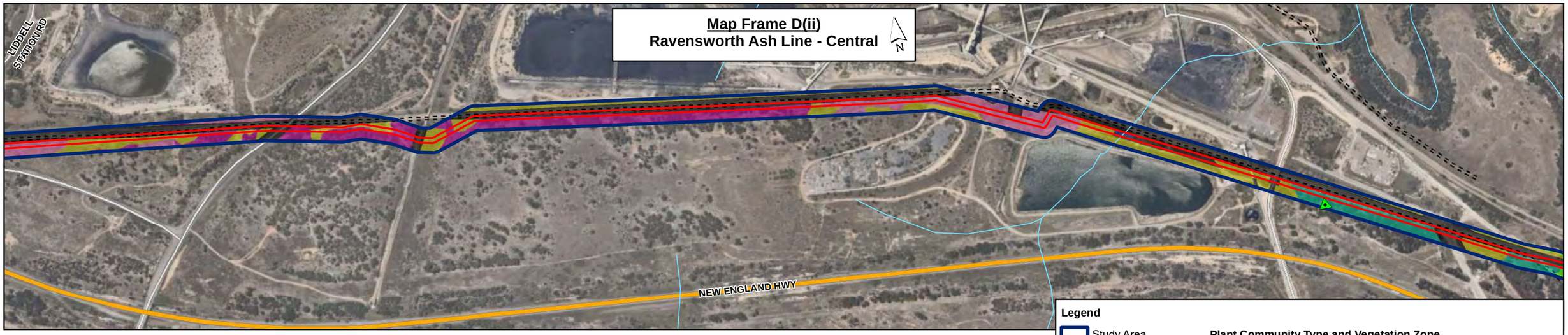

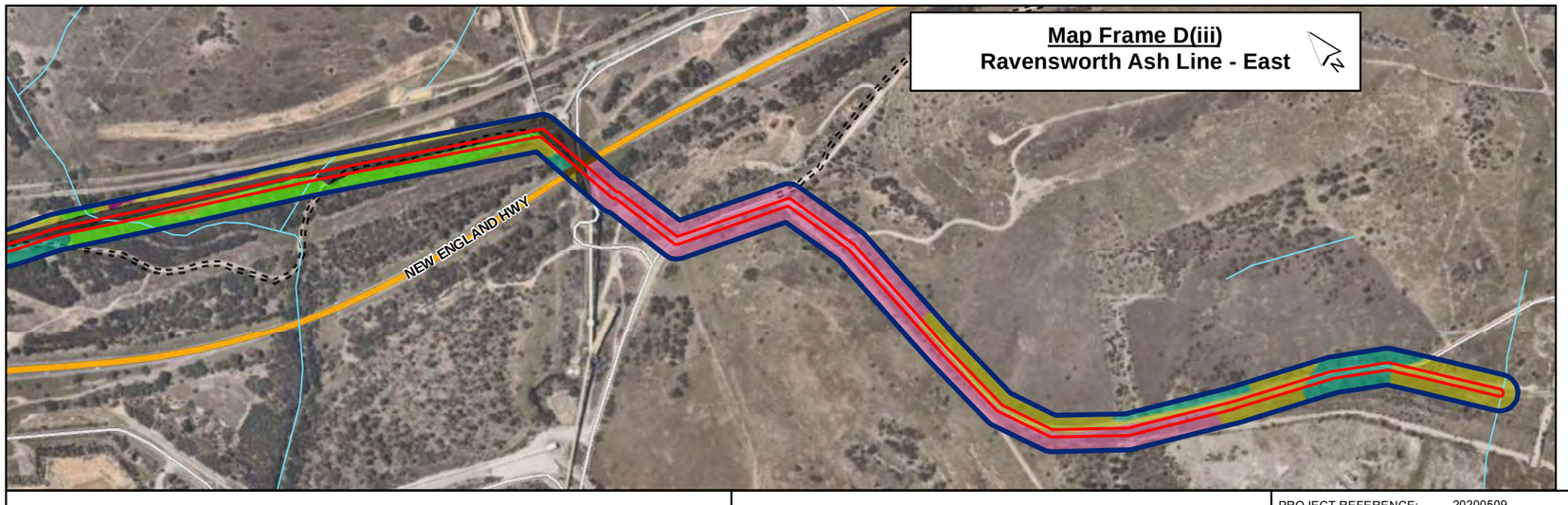

Legend

- Study Area
- Development Site
- Grey-crowned Babbler Observation
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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AGL - 2019
Nearmap - 2019

Threatened Flora and Fauna Identified within the Study Area

Jacobs Group
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Bayswater Water and Other Associated Operational Works (WAOAW) Project

FIGURE: 12D

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4.3 IDENTIFIED THREATENED SPECIES

Step 5: Determine the area or count, and location of suitable habitat for species credit species & Step 6: Determine the habitat condition within the species polygon for species assessed by area

Diuris tricolor *(Pine Donkey Orchid)*

Diuris tricolor was assumed to be present within the Development Site for the purpose of this assessment due to the sub-optimal survey conditions which occurred during the current survey period. An expert report for the species has been prepared (**Appendix 8**), which determined the following:

"I consider the most likely habitat for Diuris tricolor and/or Prasophyllum petilum within the Project Area to comprise vegetation communities mapped by Kleinfelder (2020) as Derived/ Modified Native Grasslands (Zone 4) or Acacia Regrowth (Zone 3). This differs from the suggested orchid habitat contained in Kleinfelder (2020), where all areas of PCT1691 (Zones 1-6) were included with the exception of lands subjected to higher levels of historical disturbance as evidenced by higher weed occurrence. As indicated earlier, Diuris in particular is capable of persisting in moderately disturbed landscapes, and I suggest that all areas of Derived/ Modified Native Grasslands (Zone 4) and areas mapped as Acacia Regrowth (Zone 3), with the exception of the Salt Cake Landfill site, do provide orchid habitat.

Combined, 188 ha of Derived/ Modified Native Grasslands (Zone 4) and Acacia Regrowth (Zone 3) have been mapped by Kleinfelder (2020). However, after inspecting the Salt Cake Landfill site and observing the condition of habitats there, it is unlikely that a viable population of either orchid will be present there. This is also attested to by the single floristic plot positioned there by Kleinfelder (2017), showing it to support 60% cover of the weed Hyparrhenia hirta and only two native species (Aristida ramosa and Vittadinia cuneata, both at 0.1% cover). This, and the observation that there has been considerable ground disturbance in this area over many years, suggests that it is highly unlikely that orchids remain there. Consequently, the 21.85 ha of Acacia Regrowth (Zone 3) within this area can be deducted from the overall total of 188 ha, to leave 166 ha of potential orchid habitat within the Project Area.

Note that this 166 ha of potential orchid habitat is conservative but I consider it unlikely to support large populations of Diuris, and probably no Prasophyllum"

The total area of the species polygon for *Diuris tricolor* within the Development Site has been assumed as 166 ha (**Figure 13 A** - **Figure 13 D**), including:

- 18.23 ha within Vegetation Zone 3.
- 147.77 ha within Vegetation Zone 4.

Prasophyllum petilum

Prasophyllum petilum was assumed to be present within the Development Site for the purpose of this assessment due to the sub-optimal survey conditions which occurred during the current survey period. As stated previously, an expert report for the species has been prepared (**Appendix 8**). The total area of the species polygon for *Prasophyllum petilum* within the Development Site has been assumed as 166 ha (**Figure 14 A** - **Figure 14 D**), including:

- 18.23 ha within Vegetation Zone 3.
- 147.77 ha within Vegetation Zone 4.

***Squirrel Glider* (Petaurus norfolcensis)**

Squirrel Glider (*Petaurus norfolcensis*) was recorded within Vegetation Zone 1 (PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland – Moderate-Good) in Borrow Pit 4 of the Development Site (**Figure 15** - **Figure 15**). None of the PCTs identified within the Study Area are assigned under the Threatened Biodiversity Data Collection (BioNet). As such, a habitat assessment of all vegetation zones within the Study Area was conducted to assess suitable habitat for the species. Habitat for the species has been assessed as occurring within PCT 1691 only. PCT 1692 (Bulloak Woodland) and 1731 (Swamp Oak Forest) were not assessed as habitat due to a lack of suitable vegetation structure, due to the lack of Eucalypt canopy, large trees for gliding, foraging and denning resources. It is noted that Vegetation Zone 8 (PCT 1692: Moderate/Good – CEEC) does contain scattered Eucalypt trees, however, these trees are typically juveniles and occur at a low density.

Vegetation Zones 1 and 2 were assessed as suitable foraging and breeding habitat due to the presence of feed trees and potentially suitable hollows, and Zones 3, 5 and 6 were assessed as suitable foraging habitat only due to lack of small hollows. The total area of the species polygon for the Squirrel Glider is 59.05 ha, including:

- 8.09 ha within Vegetation Zone 1.
- 6.70 ha within Vegetation Zone 2.
- 40.36 ha within Vegetation Zone 3.
- 3.75 ha within Vegetation Zone 5.
- 0.14 ha within Vegetation Zone 6.

***Southern Myotis* (Myotis macropus)**

Southern Myotis was identified via Anabat recordings from the large dam (Dam 1/ Anabat B) at the western aspect of the Ash Dam (**Figure 7 C**). Habitat for the species has been assessed as all PCTs which the species is associated with under the Threatened Biodiversity Data Collection (PCT 1691 and PCT 1962) that occur within 200 m of the foraging habitat (both within the Study Area and within 200 m of the Development Site).

The total area of the species polygon for the Southern Myotis is 8.11 ha (**Figure 16** - **Figure 16**), including:

- 3.09 ha within Vegetation Zone 1.
- 4.59 ha within Vegetation Zone 2.
- 0.43 ha within Vegetation Zone 7.

***Striped Legless Lizard* (Delma impar)**

Striped Legless Lizard (*Delma impar*) was recorded within Vegetation Zone 7 (PCT 1692: Bull Oak Grassy Woodland – Moderate-Good) in Borrow Pit 4 of the Development Site (**Figure 17** - **Figure 17**). Habitat for the species has been assessed as all PCTs which the species is associated with under the Threatened Biodiversity Data Collection (PCT 1691 and PCT 1962).

Within the Development Site the habitat for the species has been assessed as occurring within all vegetation zones of PCTs 1691 and 1692, except the Grassland areas which constitute Zone 4 (PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland)). Vegetation Zone 4 was excluded from the species polygon for the Striped Legless Lizard due to the lack of fallen timber and/or dense tussock grasses (low biomass). Due to grazing and past agricultural activities, the habitat requirements for this species are lacking from the Grassland areas. Justification for this removal is due to the species mostly being reported from areas of relatively undisturbed native grasslands, with a dense cover of perennial tussock grasses, particularly spear grass *Austrostipa bigeniculata* and kangaroo grass *Themeda triandra* (Kukolic 1991; Kukolic & Osborne 1993). Typically, the species is reported from sites where native grass cover is greater than 70% (Kukolic, 1991). It is noted that low grassland structural complexity reduces the probability of striped legless lizards occurring (Howland et al., 2016). While the species is known to sometimes occur in modified grasslands, significant persistent disturbance, such as grazing, is likely to impact habitat suitability (Dorrough and Ash 1999; Robertson and Smith 2010).

The total area of the species polygon for the Striped Legless Lizard is 120.68 ha, including:

- 8.09 ha within Vegetation Zone 1.
- 6.70 ha within Vegetation Zone 2.
- 40.36 ha within Vegetation Zone 3.
- 3.75 ha within Vegetation Zone 5.
- 0.14 ha within Vegetation Zone 6.
- 56.11 ha within Vegetation Zone 7.
- 5.53 ha within Vegetation Zone 8.

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study
- Development Site
- *Diuris tricolor* Species Polygon
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Diuris tricolor Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
13A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study Area
- Development Site
- *Diuris tricolor* Species Polygon

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

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DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Diuris tricolor Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
13B

L:\GIS FOLDER\00 CLIENT FILES\129748_JacobsGroup\20200509_AGLM_BayswaterEIS\Mapping\20200509_BDAR_Fig13B_Habitat_Diuris.mxd

Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Study
- Development
- *Diuris tricolor* Species Polygon
- Primary
- Local Road
- Track

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Diuris tricolor Habitat

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Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
13C

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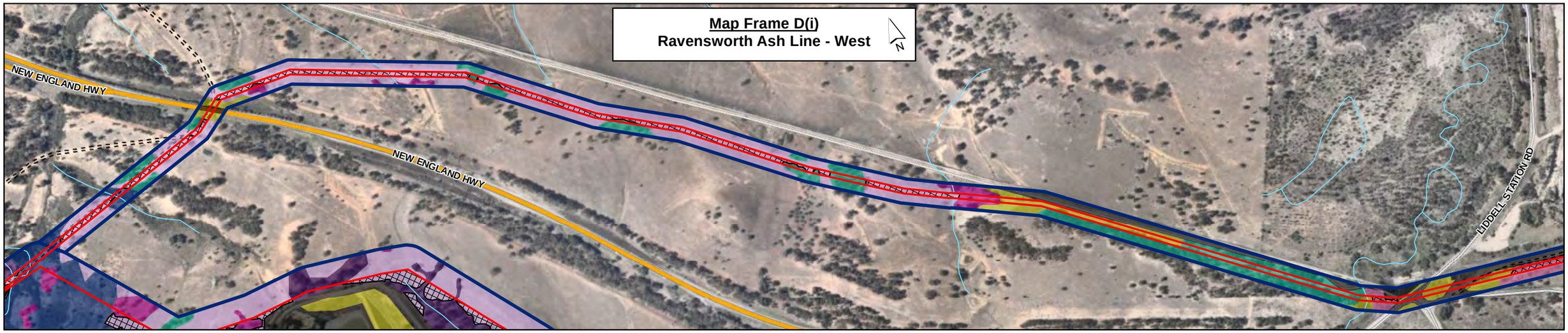

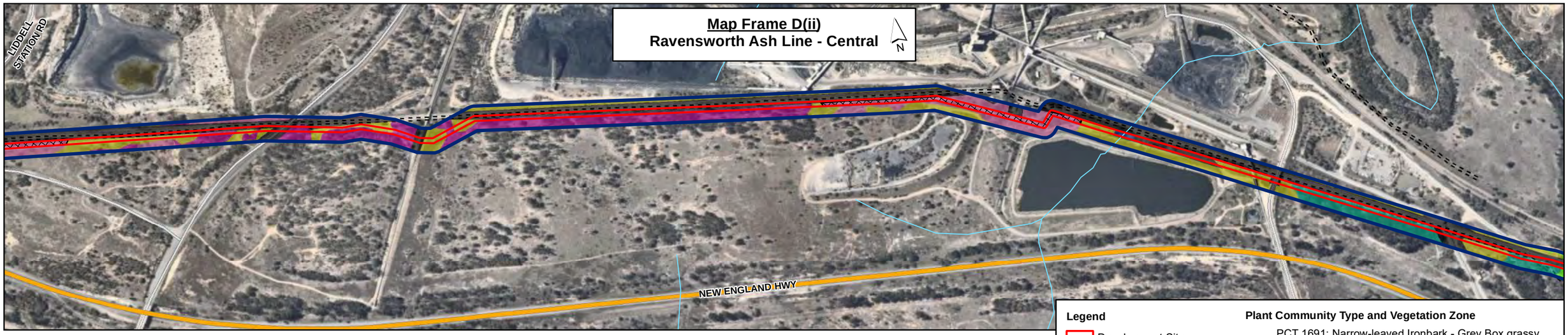

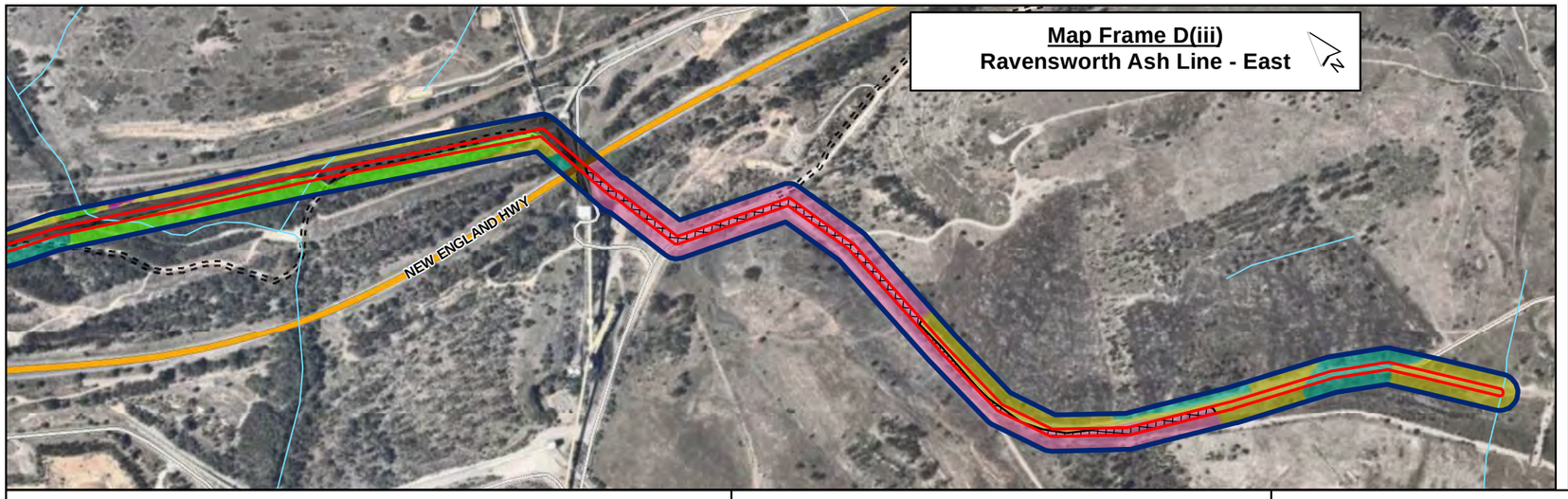

Legend

- Development Site
- Study Area
- Watercourse
- *Diuris tricolor* Species Polygon
- Primary Road
- Local Road
- Track

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Diuris tricolor Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
13D

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Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study
- Development Site
- *Prasophyllum petilum* Species Polygon
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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Nearmap - 2019

Prasophyllum petilum Habitat

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Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
14A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study
- Development Site
- *Prasophyllum petilum* Species Polygon

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

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Prasophyllum petilum Habitat

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Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
14B

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Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Study
- Development Site
- *Prasophyllum petilum* Species Polygon
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

N

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PROJECT REFERENCE: 20200509
DATE DRAWN: 2020/05/14 10:17 Version 1
DRAWN BY: GJoyce

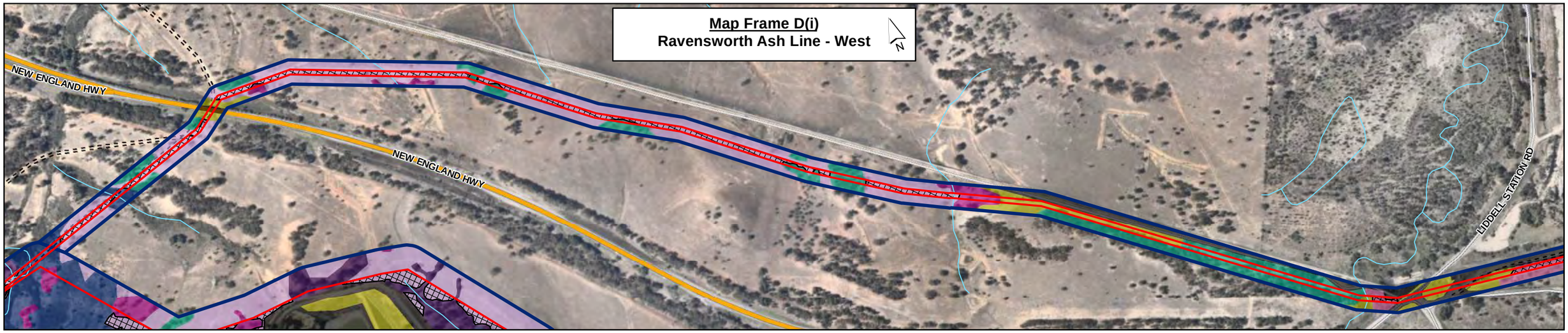
DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

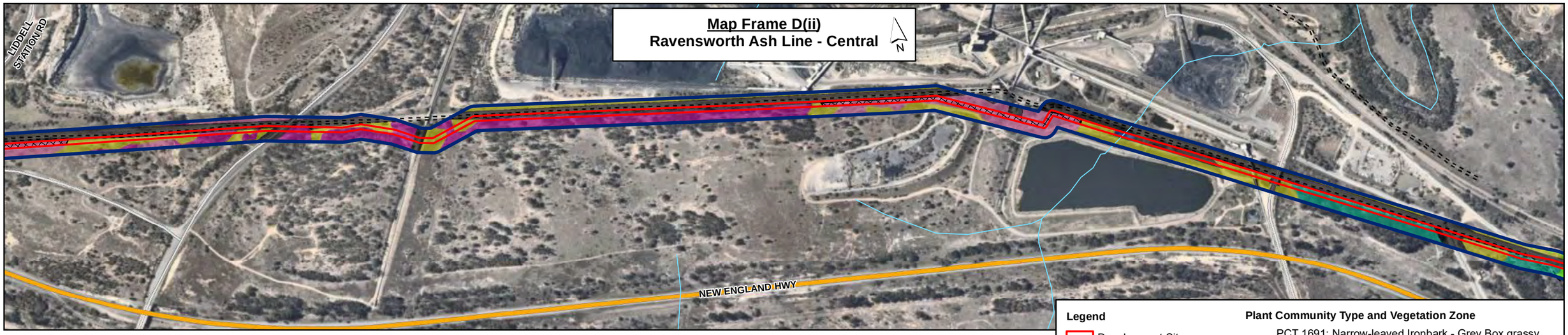
Prasophyllum petilum Habitat

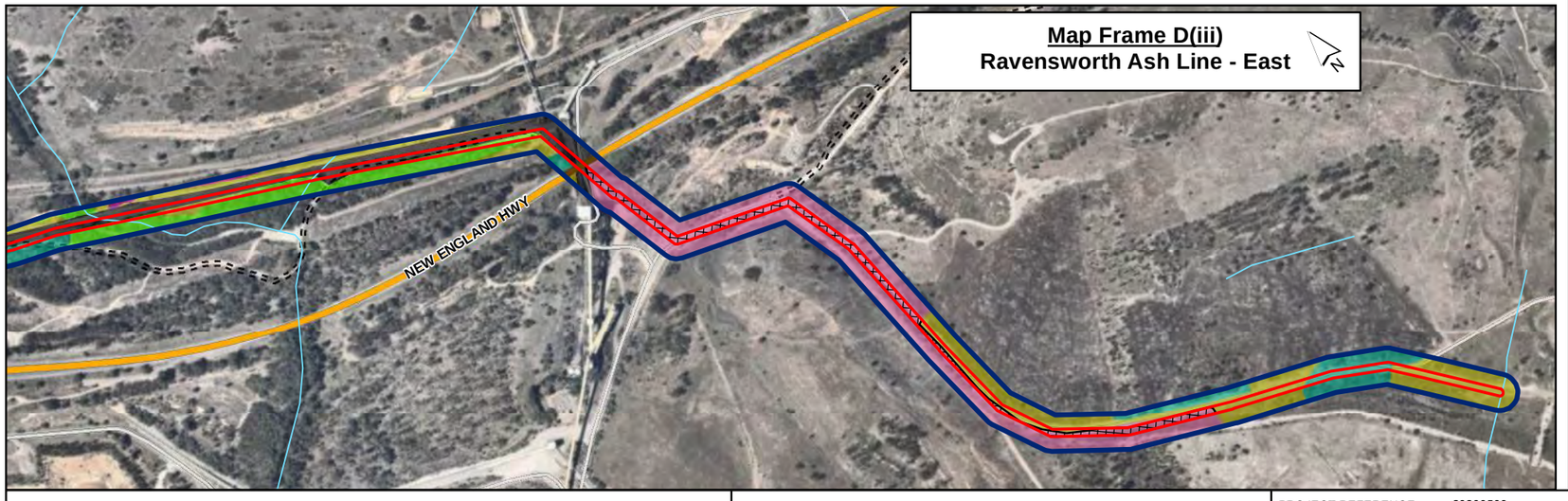
Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
14C

L:\GIS FOLDER\00 CLIENT FILES\129748_JacobsGroup\20200509_AGLM_BayswaterEIS\Mapping\20200509_BDAR_Fig14C_Habitat_Prasophyllum.mxd







Legend

- Development Site
- Study Area
- Watercourse
- *Prasophyllum petilum* Species Polygon
- Primary Road
- Local Road
- Track

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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PROJECT REFERENCE: 20200509
DATE DRAWN: 2020/05/14 10:28 Version 1
DRAWN BY: GJoyce
DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Prasophyllum petilum Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
14D

L:\GIS FOLDER\00 CLIENT FILES\129748_JacobsGroup\20200509_AGLM_BayswaterEIS\Mapping\20200509_BDAR_Fig14D_Habitat_Prasophyllum.mxd

Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study
- Development Site
- Squirrel Glider Species Polygon
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

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PROJECT REFERENCE: 20200509
DATE DRAWN: 10/01/2020 17:47 Version 1
DRAWN BY: SSchulz

DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Squirrel Glider Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
15A

L:\GIS FOLDER\00 CLIENT FILES\129748_JacobsGroup\20200509_AGLM_BayswaterEIS\Mapping\20200509_BDAR_Fig15A_Habitat_SquirrelGlider.mxd

Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study Area
- Development Site
- Squirrel Glider Observation
- Squirrel Glider Species Polygon

Plant Community Type and Vegetation Zone

Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

N

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PROJECT REFERENCE: 20200509
DATE DRAWN: 12/01/2020 13:58 Version 1
DRAWN BY: SSchulz

DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Squirrel Glider Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
15B

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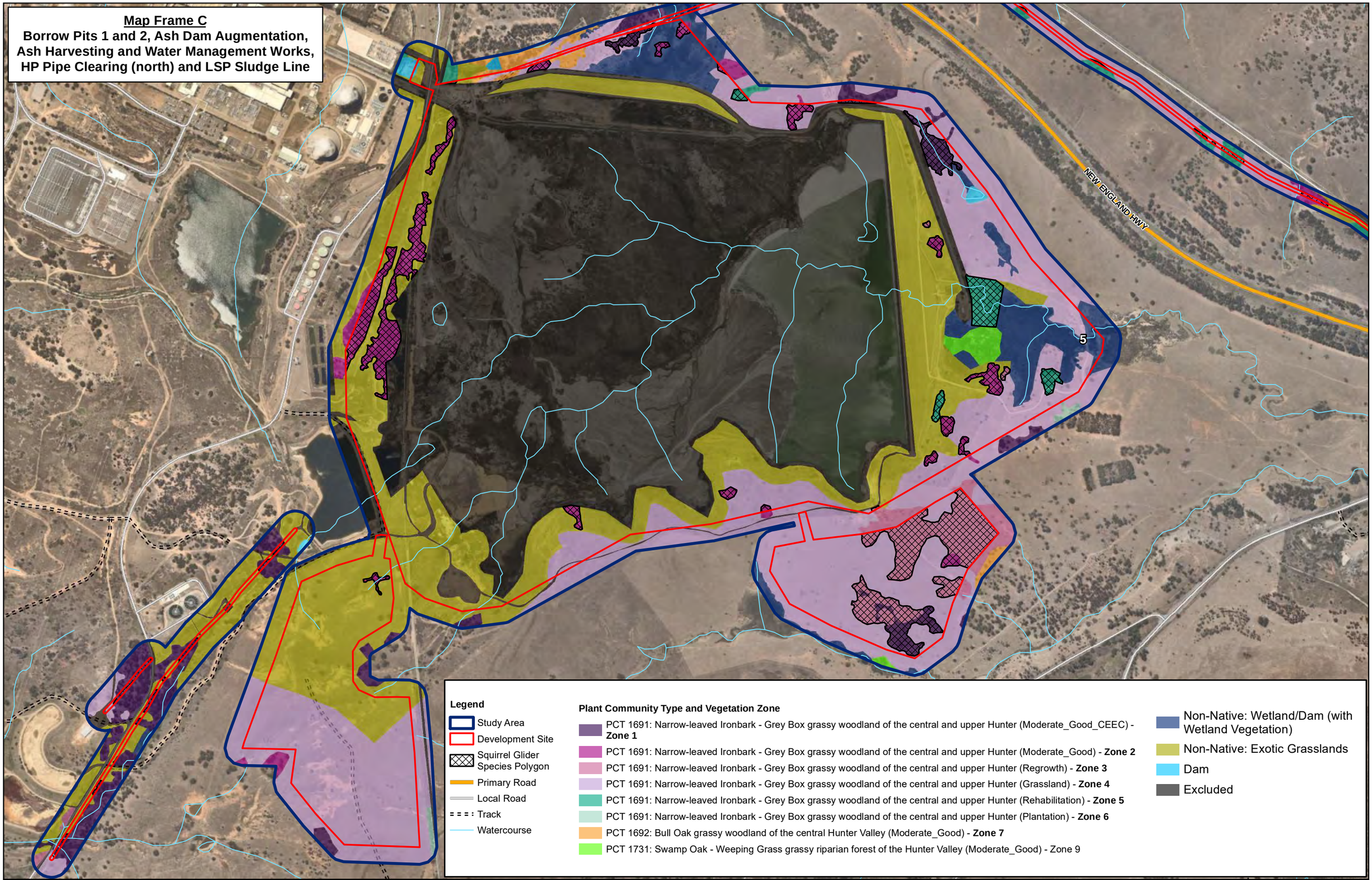
Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line



Legend

- Study Area
- Development Site
- Squirrel Glider Species Polygon
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

N

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DATE DRAWN:	12/01/2020 14:21 Version 1
DRAWN BY:	SSchulz
DATA SOURCE:	NSW DFSI - 2018 AGL - 2019 Nearmap - 2019

Squirrel Glider Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:

15C

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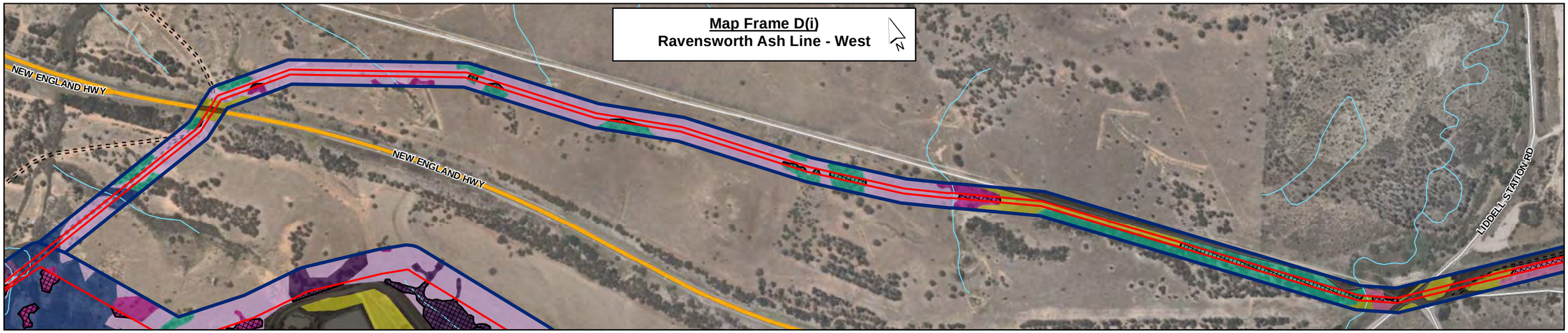

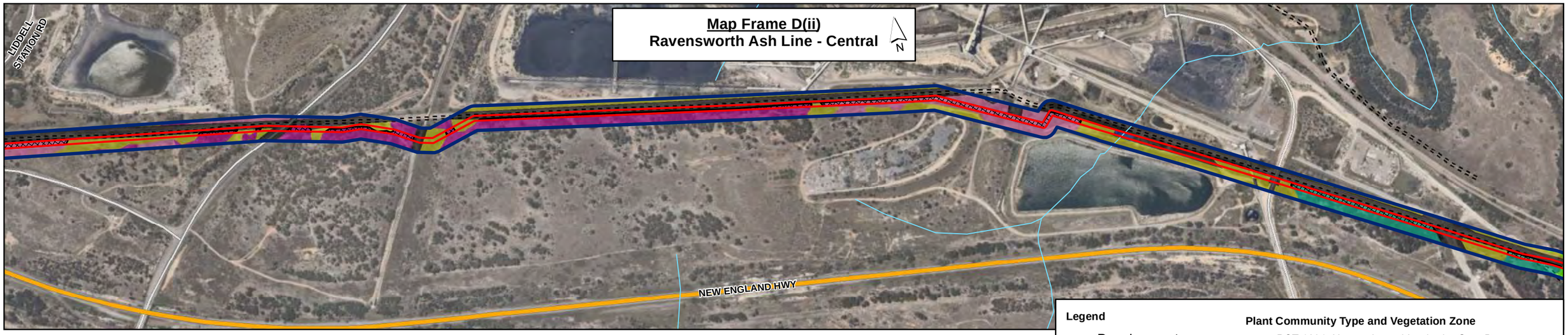

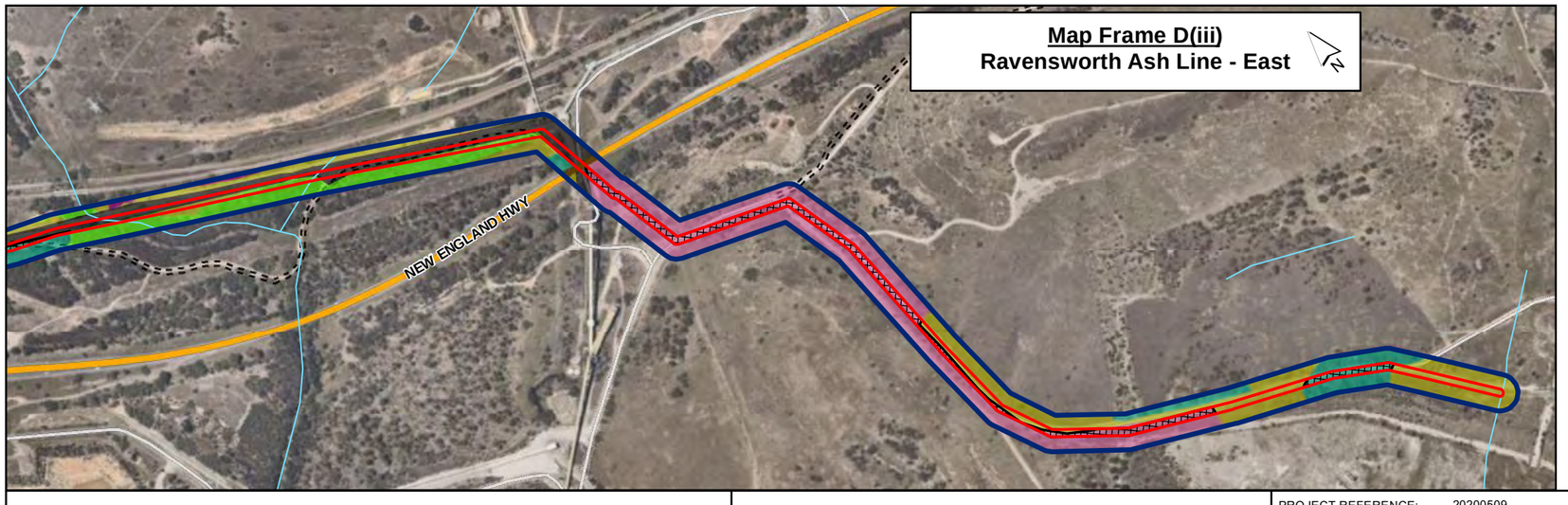

Legend

- Development Site
- Study Area
- Squirrel Glider Species Polygon
- Watercourse
- Primary Road
- Local Road
- Track

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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PROJECT REFERENCE: 20200509
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DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Squirrel Glider Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
15D

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Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study Area
- Development Site
- 200m Buffer from Dam
- Dam Extent
- Southern Myotis Species Polygon
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

N

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DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Southern Myotis Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
16A

L:\GIS FOLDER\00 CLIENT FILES\129748_JacobsGroup\20200509_AGLM_BayswaterEIS\Mapping\20200509_BDAR_Fig16A_Habitat_SouthernMyotis.mxd

Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study
- Development Site
- 200m Buffer from Dam
- Dam Extent
- Southern Myotis Species Polygon

Plant Community Type and Vegetation Zone

Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

N

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PROJECT REFERENCE: 20200509
DATE DRAWN: 12/01/2020 14:08 Version 1
DRAWN BY: SSchulz

DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Southern Myotis Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
16B

L:\GIS FOLDER\00 CLIENT FILES\129748_JacobsGroup\20200509_AGLM_BayswaterEIS\Mapping\20200509_BDAR_Fig16B_Habitat_SouthernMyotis.mxd

Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line

NEW ENGLAND HWY

Legend

- Study
- Development Site
- Southern Myotis Detected
- 200m Buffer from Dam
- Dam Extent
- Southern Myotis Species Polygon
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9

- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

N

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PROJECT REFERENCE: 20200509
DATE DRAWN: 13/01/2020 06:57 Version 1
DRAWN BY: SSchulz

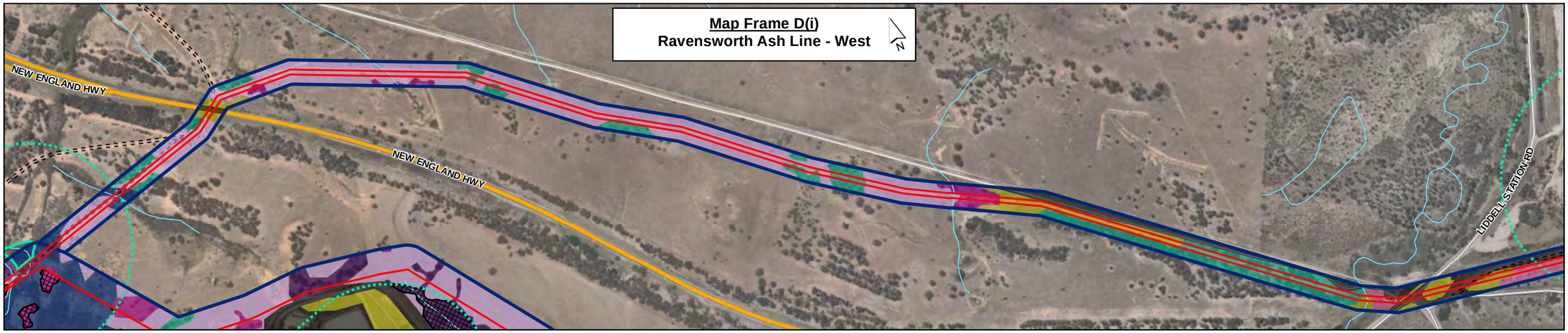
DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

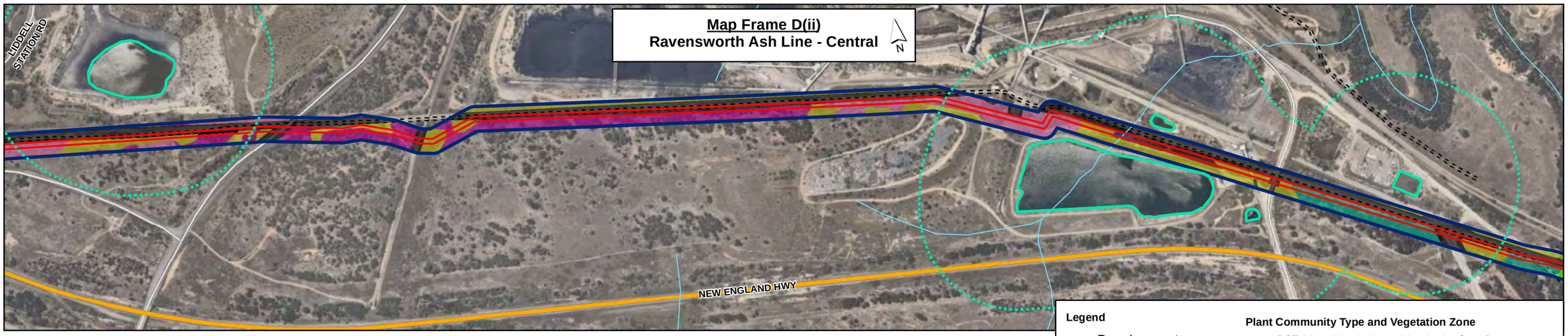
Southern Myotis Habitat

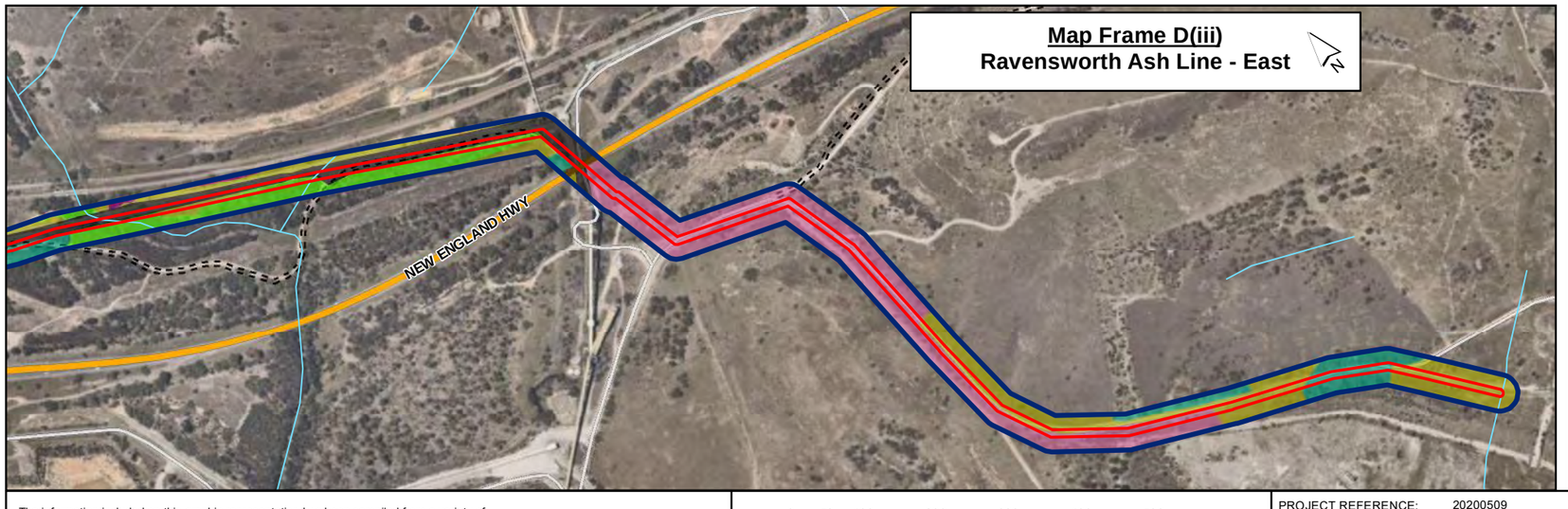
Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
16C

L:\GIS FOLDER\00 CLIENT FILES\129748_JacobsGroup\20200509_AGLM_BayswaterEIS\Mapping\20200509_BDAR_Fig16C_Habitat_SouthernMyotis.mxd







Legend

- Development Site
- Study Area
- 200m Buffer from Dam
- Dam Extent
- Southern Myotis Species Polygon
- Watercourse
- Primary Road
- Local Road
- Track

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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PROJECT REFERENCE: 20200509
DATE DRAWN: 13/01/2020 06:58 Version 1
DRAWN BY: SSchulz

DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Southern Myotis Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated Operational Works (WAOAW) Project

FIGURE: 16D

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Map frame A(i)
HP Pipe Clearing (south)

Map Frame A(ii)
Coal Handling Plant Water and Wastewater Infrastructure Upgrades

Map Frame A(iii)
Salt Cake Landfill

Legend

- Study
- Development Site
- Striped Legless Lizard Species Polygon
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- Non-Native: Exotic Grasslands
- Excluded

0 50 100 200 300 400 500 Metres

N

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PROJECT REFERENCE: 20200509
DATE DRAWN: 12/01/2020 15:07 Version 1
DRAWN BY: SSchulz

DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Striped Legless Lizard Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
17A

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Map Frame B
Borrow Pits 3 and 4

THE MITCHELL LINE

Legend

- Study
- Development Site
- Striped Legless Lizard Observation
- Striped Legless Lizard Species Polygon

Plant Community Type and Vegetation Zone

Symbology

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good_CEEC) - **Zone 8**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - **Zone 9**
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded
- Local Road
- Track
- Watercourse

0 50 100 200 300 400 500 Metres

N

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PROJECT REFERENCE: 20200509
DATE DRAWN: 12/01/2020 14:09 Version 1
DRAWN BY: SSchulz

DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Striped Legless Lizard Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
17B

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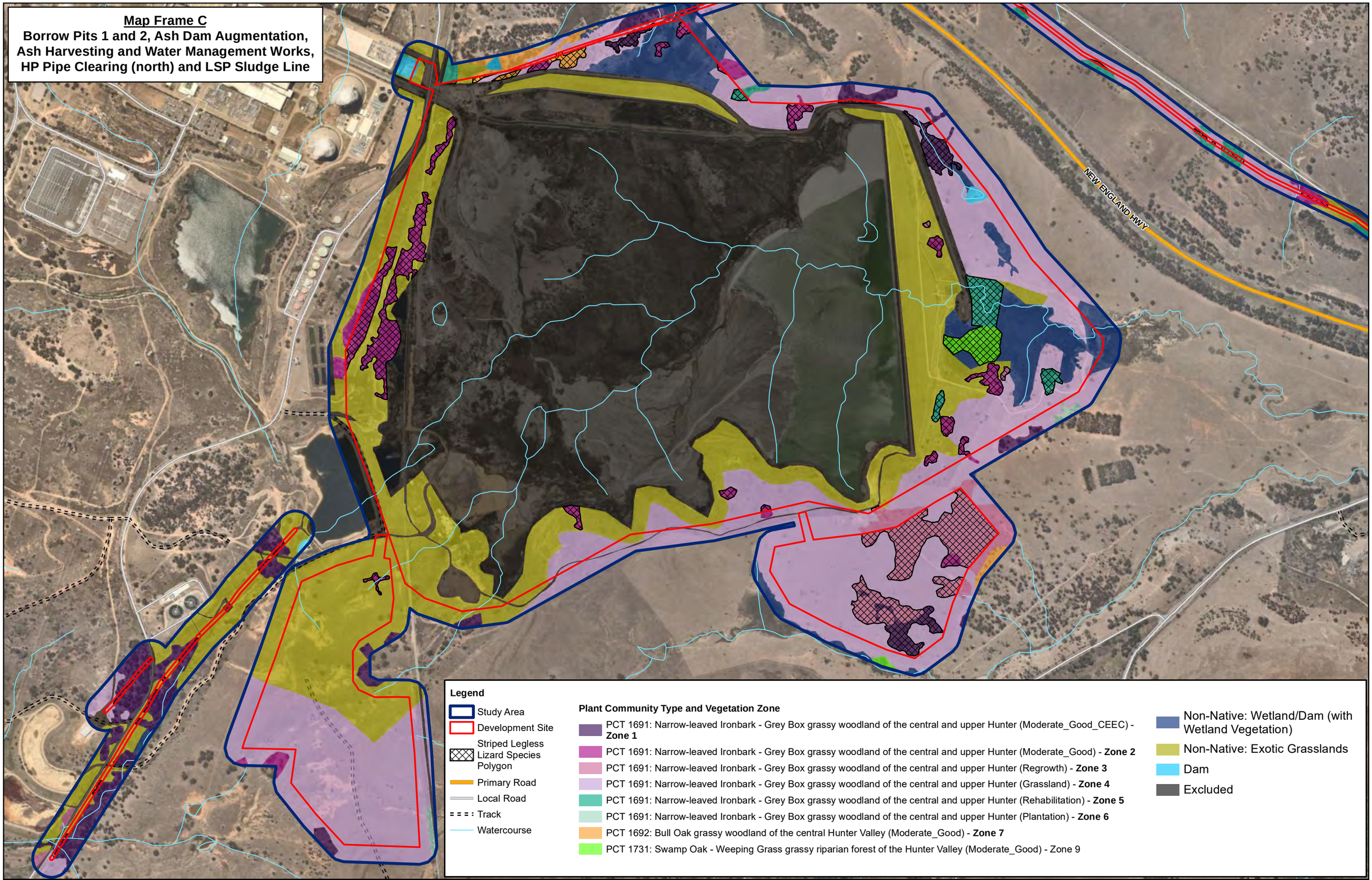
Map Frame C
Borrow Pits 1 and 2, Ash Dam Augmentation, Ash Harvesting and Water Management Works, HP Pipe Clearing (north) and LSP Sludge Line



Legend

- Study Area
- Development Site
- Striped Legless Lizard Species Polygon
- Primary Road
- Local Road
- Track
- Watercourse

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Plantation) - **Zone 6**
- PCT 1692: Bull Oak grassy woodland of the central Hunter Valley (Moderate_Good) - **Zone 7**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

N

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DATE DRAWN: 12/01/2020 14:24 Version 1
DRAWN BY: SSchulz

DATA SOURCE:
NSW DFSI - 2018
AGL - 2019
Nearmap - 2019

Striped Legless Lizard Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated
Operational Works (WAOAW) Project

FIGURE:
17C

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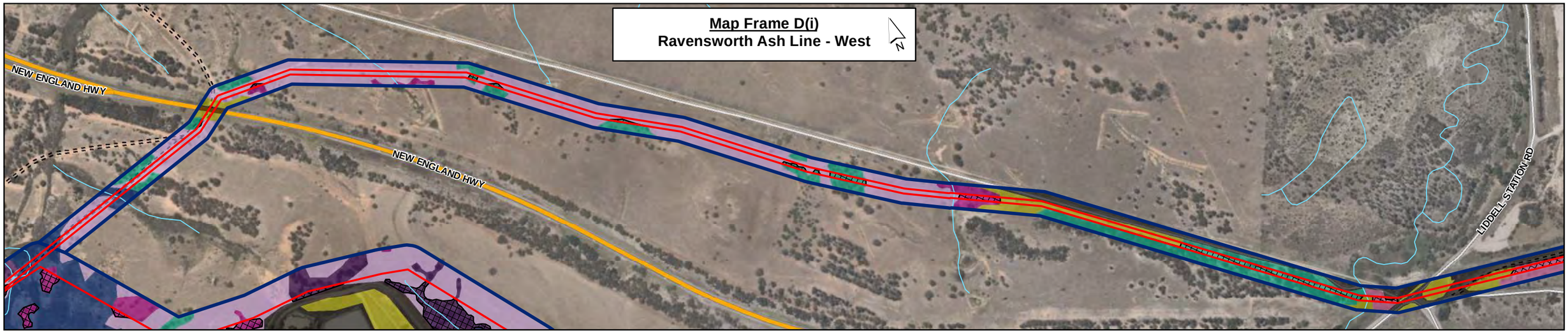

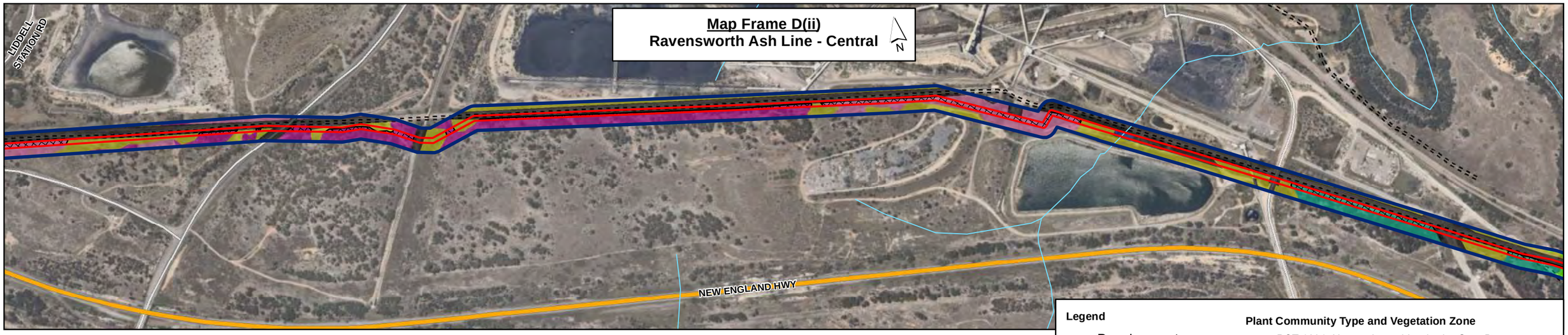

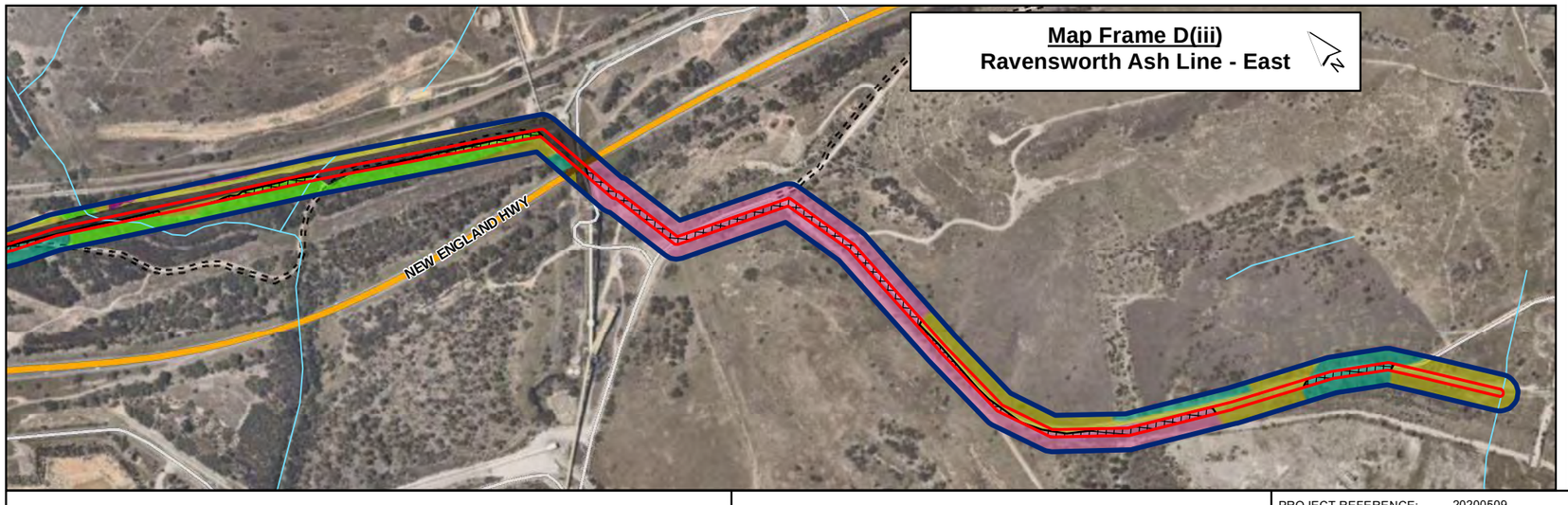

Legend

- Development Site
- Study Area
- Striped Legless Lizard Species Polygon
- Watercourse
- Primary Road
- Local Road
- Track

Plant Community Type and Vegetation Zone

- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good_CEEC) - **Zone 1**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Moderate_Good) - **Zone 2**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Regrowth) - **Zone 3**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Grassland) - **Zone 4**
- PCT 1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (Rehabilitation) - **Zone 5**
- PCT 1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (Moderate_Good) - Zone 9
- Non-Native: Wetland/Dam (with Wetland Vegetation)
- Non-Native: Exotic Grasslands
- Dam
- Excluded

0 50 100 200 300 400 500 Metres

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AGL - 2019
Nearmap - 2019

Striped Legless Lizard Habitat

Jacobs Group
Biodiversity Development Assessment Report
Bayswater Water and Other Associated Operational Works (WAOAW) Project

FIGURE:
17D

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5. IMPACT ASSESSMENT

5.1 AVOIDING AND MINIMISING IMPACTS

5.1.1 Avoid and Minimising Impacts on Native Vegetation and Habitat

AGL Macquarie has reviewed the options regarding various elements of the WOAOW Project which is required to ensure the continued safe, reliable and efficient operation of Bayswater until its planned closure in 2035.

The 'Do Nothing' option was not considered to be a feasible alternative to the overall Project. The existing Ash Dam is forecast, based on current emplacement and beneficial reuse of ash rates, to reach capacity within approximately two years. To enable the ongoing operation of Bayswater it is critical to augment the existing Ash Dam to provide additional emplacement capacity for fly ash and bottom ash from Bayswater as well as increasing the opportunity for beneficial reuse of coal ash. Further, not replacing or upgrading the ageing water and wastewater infrastructure on site would result in disproportionately high maintenance costs and potential environmental costs associated with infrastructure failures. Accordingly, the 'Do Nothing' option could jeopardise the ongoing functionality and performance of Bayswater which is vital for supplying electricity for the State of NSW.

For much of the Project, the location of the works is dictated by the location of the existing infrastructure requiring upgrade. However, were practicable, direct impacts associated within the Project avoided areas of higher quality vegetation. In particular, areas of remnant vegetation, particularly vegetation which meets State and Federal TECs, have been avoided wherever practicable and impacts confined to areas of Grasslands or shrubby regrowth.

For each of the Project elements, opportunities to further reduce the area of disturbance within the Development Site would be considered further during detailed design to further minimise possible impacts associated with the Project. It is anticipated that this may result in a reduction in the extent of vegetation clearance, and thereby ecological impacts.

Technical solutions that were considered for the following Project elements, are discussed below.

Ash Dam Augmentation

In investigating the best solution to increase the capacity of the ash dam, four concept design options were developed and reviewed to justify selection of a preferred option. In addition, the 'Do Nothing' option was considered.

Based on current Projections it is considered that storage of up to 12.5 million m^3 of ash would be required to satisfy the future storage capacity requirements. Each of the options considered were located next to the existing Ash Dam in order to utilise the current infrastructure and site services. The following options were considered:

- Do Nothing - The existing Ash Dam is forecast, based on current emplacement and beneficial reuse of ash rates, to reach capacity within one to two years. To enable the ongoing operation of Bayswater it is critical to augment the existing Ash Dam to provide additional emplacement capacity for fly ash and bottom ash from Bayswater. Without augmentation of the Ash Dam occurring, there would be inadequate storage capacity on site.
- Option 1 - increasing the western levee and saddle dam heights until they provided enough storage capacity, up to the best-case estimates. This option was not selected as it did not have sufficient capacity to meet worst case ash storage requirements. Option 1 would result in one large and exposed ash beach, that has potential to emit dust and little opportunity to supress dust once it starts.
- Option 2 - increasing the western levee and saddle dam heights until they provided enough storage capacity, up to the worst-case estimates. Ash discharges would be from the western levee wall. Similarly to Option 1, this option has the potential to emit dust.
- Option 3 – using ash terracing to progressively stack the ash in one metre increments. This option would also require the construction of ash terraces to a final height of RL 190 m (under worst case ash generation estimates). This option was not selected as the continual raising of the ash would increase the operational costs, and there would be impacts to existing services to the west of the Ash Dam. It would also present difficulties in accessing the ash surface to construct terraces safely.
- Option 4 - dividing the ash storage into two cells using a central embankment and discharging the ash from this central embankment. The central embankment would be progressively raised by one metre at a time. It is preferential to not build retaining walls on the ash surface due to possible stability limitations.

The selected concept design was based on Option 2; however, a number of amendments were made (in part based on the alternative options considered) to improve the environmental and operational performance of the Ash Dam. In order to minimise risks associated with dust emissions identified for Option 2, the preferred option consists of five 'open ended cells'. This would allow for cycling of ash discharge between cells. The advantages to creating cells include:

- Cells would have the opportunity to dry out and consolidate when discharge is cycled to alternate cells, achieving a higher final in-situ density and maximising the overall capacity available.
- The divider walls would provide vehicular and/or plant access towards the centre of the storage to deploy dust suppression if required.
- Individual cells can be flooded with water if dusting becomes an issue within a particular area.
- Ash discharge could be completed from along the cell divider walls in the future to obtain a flatter final landform surface, if required.
- Cell divider walls can provide access for capping operations during rehabilitation.
- One cell could be filled with ash before the others, to allow for staged rehabilitation of one area, prior to station closure.

The opportunity to deliver the Ash Dam augmentation in stages was also considered. The staged augmentation of the Ash Dam would mean that construction could be limited, based on only what is required in the future (i.e. stage 3 may never be required, should the ash generation end up being in the optimistic estimate range). For the purposes of the EIS, full augmentation has been assessed.

The proposed Fly ash recycling upgrade and Coal ash recycling upgrades would enable the beneficial reuse of up to 1,000,000 tonnes of ash per annum of ash during periods of peak demand. This in turn would provide opportunities to minimise the volume of ash required to be deposited in the augmented Ash Dam. The Ash is used as a substitute for sand in certain processes including concrete production, which in turn avoids the requirement to quarry the equivalent amount of sand reducing associated impacts from the extraction process (at different location/s).

Salt cake landfill facility

A variety of alternative options were considered for the disposal of salt (brine) from the approved caking plant. These options included:

- Do Nothing – continue to store salt in the brine concentrator decant basin and Lake Liddell using the Hunter River salinity trading scheme to discharge. This is not a preferred option as the brine concentrator decant basin is almost at capacity and there is a risk that Lake Liddell would significantly increase in salinity if this option were to be implemented.
- Ocean Disposal – transfer the salt cake to ocean either in liquid or solid form. Investigations to date have been unable to identify any existing ocean disposal process which could lawfully take the salt cake.
- Offsite Landfill Disposal - transfer the salt cake to an offsite landfill. This is not considered a viable option as it is unlikely offsite disposal locations would commit to taking the salt cake for the remaining life of Bayswater.
- On Site Disposal (the preferred approach) - transfer the salt cake to an onsite landfill, in solid form. This is the preferred approach causing the least environmental impact with waste being wholly contained and managed on site in an environmentally responsible manner.

Existing infrastructure, its proximity to the proposed Salt Caking Plant, and the extent of disturbance and known environmental constraints (such as contamination, vegetation) were all considered when selecting the location of the Salt Cake Landfill. The proposed location is accessible by existing internal access roads and is located within an area that is already extensively disturbed (rehabilitation vegetation consisting of Acacia regrowth with an exotic dominated understorey), with favourable topography. As such this site was considered the best opportunity to minimise environmental impacts, whilst also reducing the extent of ancillary works (e.g. regrading of the site).

Coal handling plant water management

AGL Macquarie are currently reviewing the management of water and wastewater materials within the Coal handling plant (**CHP**) settling basin and associated drainage system at Bayswater to improve the quality of water in Tinkers Creek, which adjoins the CHP. The majority of the Development Site is within the already disturbed and active operational portion of the CHP, with the Development Site extending into small areas of Rehabilitation and Exotic Grassland vegetation around the peripheries of the existing CHP. These areas of vegetation are already highly degraded and are typically dominated by exotic species.

Borrow Pits

Four Borrow Pit locations have been identified to provide material for the construction of the proposed improvements of the WOAOW Project. The selection of the sites for the Borrow Pits has largely been dependent upon the availability of suitable material for construction works such as augmentation of the Ash Dam wall and the Salt cake landfill. Locations close to the works area (Borrow Pits 1 and 2) also reduce the transportation requirements of the sourced material, and where Borrow Pits are further away from the required works areas, they have been positioned close to existing internal roads (Borrow Pits 3 and 4).

Borrow Pits 1, 2 and 3 largely contain grassland areas, with only scattered remnant patches of vegetation, avoiding higher quality larger patches of remnant vegetation. A large portion of Borrow Pit 4 (just under 50%) contains areas of woody native vegetation, consisting of Bulloak Forest, and small patches of Central Hunter Box – Ironbark Woodland and Central Hunter Swamp Oak Forest. The Central Hunter Box – Ironbark Woodland, and some small portions of the Bulloak Woodland, constitute TECs listed under both the BC Act and the EPBC Act. As such, as much of these areas as possible were avoided. The dominant wooded vegetation type within Borrow Pit 4 is the Bulloak Forest which does not constitute a TEC under the BC Act or the EPBC Act. Large areas of Borrow Pit 4 (just under 50%) consists of Derived/Modified Native Grasslands.

The Borrow Pits would be rehabilitated post works to minimise any long-term impacts of the Project. This has been discussed further within the **Section 5.3** (Mitigation Measures).

There is considered to be no benefit in seeking suitable material from off-site as similar impacts would be anticipated with additional environmental impacts and costs associated with material transport and the spoil material that may be available from coal mines in the region is unlikely to be geotechnically suitable.

HP Pipe clearing and Ravensworth Ash Line

These works areas are restricted to the area directly adjacent to the existing pipelines to allow for the maintenance and upgrade/duplication of the existing lines along the current alignment. As such, the location of these works cannot be reviewed, but will be occurring within the existing easements, which typically contain already disturbed vegetation and regenerating trees.

5.1.2 Avoid and Minimise Impacts on Prescribed Biodiversity Impacts

The following are prescribed impacts which need to be considered as per section 8.2 of the BAM (OEH, 2017a).

Impact of development on the habitat of threatened species or ecological communities associated with significant geological features, human made structure or non-native vegetation.

No significant geological features, human made structures or non-native vegetation associated with threatened species habitat or ecological communities occur within the Study Area.

Impacts of the development on the connectivity of different habitat which facilitates movement of threatened species

Connectivity with the broader context of the Bayswater and Liddell Sites predominately occurs through patches of connected vegetation (less than 100 m gaps) running from the Plashett Dam, northwards through the Power Station Sites, to vegetation in the north of the Liddell landholdings, and vegetation to the north of the landholdings on either side of the Highway. There is also connectivity from the Plashett Dam to the west within vegetation on the previously proposed Drayton South Mine Site, and some patchy connectivity to the south-east of the site to vegetation around the Ravensworth Mine Site. Along the north-south connection through the Bayswater and Liddell Sites, the vegetation corridor narrows to less than 150 m of wooded vegetation between Lake Liddell and the Liddell Ash Dam. While the vegetation is connected, it is not continuous. There are numerous patches which make up this corridor, separated by grasslands, or areas of Acacia Regrowth (shrub land). The vegetation is also intersected by areas of infrastructure associated with the Power Stations, and multiple roads including the New England Highway.

Due to the nature of the Project comprising the upgrade of existing infrastructure, the majority of the Development Site has been located within areas which are already disturbed and contain vegetation which has limited connectivity. The Borrow Pit sites have also been located where possible within areas which contain limited Woodland and Forest Vegetation types. There will be removal of some native Woodland and Forest Vegetation communities which could potentially impact connectivity and movement. These impacts have been addressed in **Section 5.2.2**.

Impact of the development on the movement of threatened species that maintains their life cycle

As outlined above, the majority of the Development Site occurs within already disturbed areas of vegetation which contain patches of wooded vegetation with limited connectivity, or the Development is on the edge of a patch of vegetation. For the most part, the Development Site will not cause the fragmentation of any portions of habitat, with the exception of some small patches of Plantation Vegetation around Borrow Bit 4. These impacts have been addressed in **Section 5.2.2**.

Impacts of the development on water quality, bodies and hydrological processes that sustain threatened species or ecological communities.

Due to the nature of the Project, upgrading the Ash Dam, impact on drainage lines within this portion of the Development Site could not be avoided (Ash Dam occurs along the Pikes Creek Alignment). Conversely, by nature of the Borrow Pit locations on hill tops and rises, these areas have been positioned to avoid impacts on larger drainage lines, groundwater and occur higher up within the catchment (1st and 2nd order streams).

Potential unmitigated impacts to surface water during construction have been assessed as:

- Impacts may arise as a result of removal of vegetation, stripping of topsoil, excavation, stockpiling, concreting, instream works, transportation of cut and fill and accidental spills and leaks.
- The subsequent impact to water quality could be increased turbidity, suspended solids, nutrients and contaminants from mobilisation of soils, which in turn could lead to increased weed growth and algal blooms and smothering of aquatic organisms. Oily films, increased alkalinity and pH, and elevated concentrations of toxicants from concreting works and accidental leaks and spills could result in reduced health of aquatic organisms.
- Waterways at greatest risk are those directly impacted (instream works) or located in close proximity to construction works and include Wisemans Creek, Pikes Creek, Saltwater Creek, Bayswater Creek and Chilcotts Creek.
- During operation, there is the potential for increased seepage from the augmentation of the Ash Dam, uncontrolled stormwater runoff and contaminant leachate from the Salt cake facility and erosion and sedimentation from the operation of the Borrow Pits, all of which have the potential to impact on surface water quality of downstream waterways.

- If the proposed ash line leaks, the ash/water mix could ultimately migrate to nearby creeks and streams, in particular, Lake Liddell, Chillcotts Creek, Pikes Creek and Bayswater Creek.

Provided appropriate mitigation measures designed into the project are implemented, impacts on surface water quality will be minimal (see EIS for details on design).

The Borrow Pits are to be designed so that runoff is diverted away from the site as there is the risk of rainwater falling directly into the pit and ponding. Water that is collected in the Borrow Pits will be managed appropriately so that only water of acceptable quality would be drained. Once Borrow Pits are stabilised, the final landform will be designed to be free draining so that they do not form permanent water bodies. The Borrow Pits will comply with design specifications to minimise interference and disruption of natural surface water flows and water quality, particularly any impacts on turbidity.

The Salt Cake Landfill Area will be capped with an impervious barrier of clay or High Density Poly Ethylene to contain waste material and prevent leaching into surrounding areas and groundwater. Additionally, there will be a leachate collection system as part of the design.

Impact of wind turbine strikes on protected animals

Not applicable to the current application.

Impacts of vehicle strikes on threatened species or on animals that are part of a TEC

Vehicle and machinery movements are necessary during the construction phase of the Project. The site does not have any major access tracks/roads which intersect large areas of woodland/forest vegetation. The Borrow Pits have been positioned to allow access from already established access tracks. As such impacts from vehicle strikes is not anticipated to be a significant impact of the Project. Measures to minimise any potential impacts would be through the implementation of reduced vehicle speeds within construction zones.

5.2 ASSESSMENT OF IMPACTS

5.2.1 Bushfire Impacts

The study area and adjacent areas were not directly impacted by the 2019 bushfires. An examination of recent bushfire mapping (SEED 2020), indicates that the nearest bushfires to the study area occurred approximately 39.47 km to the northeast (Mount Royal National Park), 23.39 km to the south (south of Jerrys Plains), and 64.97 km to the west (Goulburn River National Park). Due to the distance of the bushfires from the study area, it is likely that the 2019 bushfires have had a negligible impact on the biodiversity values within the study area and the locality (10km radius).

5.2.2 Impacts on Native Vegetation, Threatened Ecological Communities and Threatened Species Habitat

5.2.2.1 Direct Impacts

Direct impacts of the Project are expected to occur during the construction phase of the Project during clearing works. Within the Development Site, the Project will equate to the complete removal of all native vegetation (total 270.85 ha of native vegetation). Each vegetation zone equates to one management zone; and the future value of each attribute (composition, structure, and function) will be zero. As such the vegetation integrity score for all management zones within the Development Site following development will be zero. The change in the Vegetation Integrity Score of each Vegetation Zone and Threatened Species Habitat Polygon is provided in **Table 13**.

Table 13: Change in Vegetation Integrity Scores within the Development Site.

Zone	PCT & Class / Species	Area (ha)	Current Vegetation Integrity Score	Future Vegetation Integrity Score	Change in Vegetation Integrity Score
Vegetation Zones					
1	1691: Mod-Good-CEEC	8.09	67.3	0	-67.3
2	1691: Mod_Good	6.70	51.7	0	-51.7
3	1691: Regrowth	40.36	44.6	0	-44.6
4	1691: Grassland	147.77	33.4	0	-33.4
5	1691: Rehab	3.75	45.2	0	-45.2
6	1691: Plantation	0.14	57.3	0	-57.3
7	1692: Mod-Good	56.11	47.9	0	-47.9
8	1692: Mod-Good-CEEC	5.53	41.1	0	-41.1
9	1731: Mod_Good	2.40	28.3	0	-28.3
Diuris tricolor					
3	1691: Regrowth	18.23	44.6	0	-44.6
4	1691: Grassland	147.77	33.4	0	-33.4
Prasophyllum petilum					
3	1691: Regrowth	18.23	44.6	0	-44.6
4	1691: Grassland	147.77	33.4	0	-33.4
Squirrel Glider					
1	1691: Mod-Good-CEEC	8.09	67.3	0	-67.3
2	1691: Mod_Good	6.70	51.7	0	-51.7
3	1691: Regrowth	40.36	44.6	0	-44.6
5	1691: Rehab	3.75	45.2	0	-45.2
6	1691: Plantation	0.14	57.3	0	-57.3
Southern Myotis					
1	1691: Mod-Good-CEEC	3.09	67.3	0	-64.3
2	1691: Mod_Good	4.59	51.7	0	-51.7
7	1692: Mod-Good	0.43	47.9	0	-47.9
Striped Legless Lizard					
1	1691: Mod-Good-CEEC	8.09	67.3	0	-67.3
2	1691: Mod_Good	6.70	51.7	0	-51.7

Zone	PCT & Class / Species	Area (ha)	Current Vegetation Integrity Score	Future Vegetation Integrity Score	Change in Vegetation Integrity Score
3	1691: Regrowth	40.36	44.6	0	-44.6
5	1691: Rehab	3.75	45.2	0	-45.2
6	1691: Plantation	0.14	57.3	0	-57.3
7	1692: Mod-Good	56.11	47.9	0	-47.9
8	1692: Mod-Good-CEEC	5.53	41.1	0	-41.1

5.2.1.2 Indirect Impacts

The Project has the potential to cause the following indirect impacts on land adjacent to the Development Site during construction (see **Section 5.3**):

- Increased levels of dust.
- Increased levels of noise. The majority of operations are expected to be during the day, so increased light levels would be minimal.
- Erosion and sedimentation.
- Downstream modification of hydrology and vegetation downstream of the impact area (addressed in prescribed impacts).
- Transfer of weeds and pathogens.

During operation, indirect impacts would include the potential for modification of hydrology downstream of the Ash Dam (addressed in prescribed impacts).

5.2.2 Prescribed Impacts

An assessment of the Project on Prescribed Impacts is summarised in **Table 14.** Where required, a detailed assessment is provided in the sections following the below table.

Table 14: Assessment of the Project on Prescribed Impacts

Prescribed Impact	Impact of the Proposal
Impact of development on the habitat of threatened species or ecological communities associated with significant geological features, human made structure or non-native vegetation.	No significant geological features, human made structures or non-native vegetation associated with threatened species habitat or ecological communities occur within the Study Area.
Impacts of the development on the connectivity of different habitat which facilities movement of threatened species.	Some minor impacts, not assessed as significant. Discussed further below.
Impact of the development on movement of threatened species that maintains their life cycle.	Some minor impacts, not assessed as significant. Discussed further below.
Impacts of the development on water quality, bodies and hydrological processes that sustain threatened species or ecological communities.	Some minor impacts, not assessed as significant. Discussed further below.
Impact of wind turbine strikes on protected animals	Not applicable to the current application.
Impacts of vehicle strikes on threatened species or on animals that are part of a TEC	Vehicle and machinery activity would be increased during the construction phase of the Project. Limited construction speeds within works area would be enforced which would limit the potential for impacts from vehicle strikes. Currently the highest speed limit at Baywater is 60 km/hr along internal access tracks. As such, increased traffic which will be travelling between construction work areas is unlikely to have a significant impact on locally occurring fauna species through vehicle strikes.

Impacts of the development on the connectivity of different habitat which facilitates movement of threatened species

On a local scale, the vegetation within and surrounding the Ash Dam, Borrow Pits 1, 2 and 3, the northern HP Pipe and LSP Sludge line, and the Ravensworth Ash Line has limited connectivity. The majority of the vegetation patches occurring within these portions of the Development Site are isolated, have limited connectivity to surrounding vegetation (gaps greater than 100 m), or occur on the edge of larger patches of vegetation. As such, impacts to these areas of vegetation is unlikely to impact on the movement of fauna in the local area.

The vegetation within the Salt Cake Landfill consists of Acacia regrowth and does not provide a canopy link for fauna movement. The site would provide covered movement for ground dwelling fauna species. This portion of the Development Site is surrounded by patches of woody vegetation, and local connectivity and movement corridors would be maintained if this vegetation was removed, particularly to the west of the Salt Cake Landfill.

The majority of the woodland vegetation removal is expected to occur from within Borrow Bit 4 with woodland vegetation predominantly occurring in the northern and central portions of the

Borrow Pit 4, and some area of Bulloak Forest extending into the south. This vegetation is connected to the south-east (patchy) and to the north and north-west (more continuous patches) of the Borrow Pit 4. The removal of the vegetation within Borrow Pit 4 would not limit movement of fauna on a broader scale. Connectivity of vegetation to the south and north-west of the Borrow Pit would be maintained around the edges of Plashett Dam through Plantation Vegetation. There could be the potential loss of movement to small patches of Rehabilitation Vegetation directly adjacent to the east/south-east of Borrow Pit 4.

Due to the limited width of the clearing proposed along the Southern HP Pipe clearing area (maximum 10 m wide) any impacts on vegetation within this portion of the Development Site is unlikely to impact on the movement of threatened species in the local area.

Impact of the development on movement of threatened species that maintains their life cycle

As discussed above, the Project would have limited impacts on the movement of threatened species in the local area. While areas of native vegetation would be removed, movement corridors within the local area would be maintained.

The majority of the woodland vegetation removal will occur from within Borrow Pit 4 and removal of this vegetation has the potential to isolate two patches of Plantation vegetation directly to the east/south-east of the Borrow Pit. Plantation vegetation consists of mono-culture patches of trees with limited understorey (midstorey and shrub layer) and lack hollows as they only contain young trees. As a result, Plantation vegetation areas contain limited habitat resources to potentially occurring threatened fauna species. These patches of Plantation vegetation are likely to be utilised opportunistically for foraging resources but are unlikely to be utilised as a core part of a threatened species home range due to the lack of availability of diverse habitat features.

As such, the Project will not cause the fragmentation of the local landscape, such that areas of habitat for threatened species would become isolated and the life cycle of a local population would be placed at the risk of extinction.

Impacts of the development on water quality, bodies and hydrological processes that sustain threatened species or ecological communities.

Ash Dam

The Ash Dam occurs along the Pikes Creek alignment, and the majority of the seepage reports to the seepage containment system and is pumped back to the Ash Dam. The hydrology of this drainage line is already modified through the existing Ash Dam. Increasing the size of the Ash Dam does have the potential to increase downstream impacts along Pikes Creek through further modification of the hydrology along the creek however the Project includes upgrades to the seepage management system. The alignment of Pikes Creek downstream (east and north-east) of the Ash Dam is largely devoid of remnant native vegetation and is dominated by Exotic Grasslands (potentially areas of Native Grasslands). Along the alignment of Pikes Creek there are small patches of Remnant Central Hunter Box – Ironbark Woodland EEC and some areas of Rehabilitation. These are unlikely to lead to significant impact on the downstream occurrence of the EEC in this area due to the already degraded nature of the patches of the community. The Project also includes seepage management works that would reduce the level of impact downstream of the Ash Dam.

Coal Handling Plant

Existing operations within the CHP result in a level of stormwater impacting on Tinkers Creek. Works are proposed to improve water quality and reduce the quantity of water released. An improvement in water quality would have a beneficial effect on any downstream vegetation and potentially occurring threatened species. The decrease in water quantity could potentially have a negative effect downstream. However, the CHP occurs at the upper reaches of the catchment of Tinkers Creek, and a reduction in the amount of storm water discharged is unlikely to have a significant downstream effect, considering the larger vegetated area of the catchment area occurring north-west of the CHP (on the western side of Tinkers Creek).

Salt Cake Landfill

The Salt Cake Landfill will be capped with a low permeability barrier to prevent leaching into surrounding areas and groundwater. However, in the event of any salt leaching from the landfill, the vegetation surrounding the Salt Cake Landfill is considered only likely to be impacted if the vegetation is Groundwater Dependant Ecosystem (**GDE**). It is considered that this is unlikely to be the case. At most this vegetation would be facultative phreatophyte (opportunistically groundwater dependant). Due to the location of the vegetation (higher in the landscape), and dominant soil type (clay) it is unlikely that the roots of the vegetation would be able to penetrate to the groundwater. However, where depth to the groundwater is reduced, and more penetrable soils (sandy) are present, there is the potential for this vegetation to be

facultative phreatophyte (opportunistically groundwater dependant) and could potentially be impacted by increased salinity levels.

Additionally, based on the modelling undertaken by Jacobs for the Project, in the unlikely event of a breach of the low permeability barrier layer, salt concentrations at the top of the water table are not anticipated to increase above current background levels. As a result, it is not considered that there would be a significant impact on the vegetation in the vicinity of the Salt Cake Landfill due to salinity.

Borrow Pits

Borrow Pit 1 will be located upslope within the catchment of a 3rd order stream, which is a tributary of Pikes Creek. The downstream vegetation along this drainage line is predominately cleared with some patches of Remnant Native Vegetation which constitute the Central Hunter Box – Ironbark Woodland EEC.

Due to the landform of Borrow Pit 2 (hill crest) it drains in three directions; to the north into three 1st order streams which flow into the Ash Dam (Pikes Creek catchment), to the east into 1st order streams which are part of the Pikes Creek Catchments (downstream of the Ash Dam), and the other to the south-west into 1st order stream which are tributaries of Wisemans Creek (which flows into Plashett Dam).

Borrow Pit 3 will be located within the catchment of tributaries of Wisemans Creek which flow through the Borrow Pit 4 Disturbance Area. The vegetation along these drainage lines between Borrow Pit 3 and Borrow Pit 4 is dominated by grasslands.

In the central and northern portion of Borrow Pit 4, there are first and second order tributaries of Wisemans Creek and the northern boundary of the Borrow Pit intersects the mapped alignment of Wisemans Creek (3rd order stream at this point). The vegetation along Wisemans Creek, before is flows into the Plashett Dam is dominated by Swamp Oak Forest (not a TEC), areas of Acacia Regrowth (not a TEC) and Bulloak Forest (small portions have the potential to meet the Central Hunter Box – Ironbark Woodland EEC), and areas of the Central Hunter Box – Ironbark Woodland EEC occur close to the alignment of the creek.

While the Borrow Pits are being actively utilised there is the potential to impact on the water quality downstream through sedimentation. Implementation of appropriate erosion and

sedimentation control measures as part of the Project will minimise the potential for impact (see **Section 5.3** – Mitigation Measures).

HP Pipe, LSP Sludge line and Ravensworth Ash Pipeline Replacement area

As these portions of the Disturbance Area occur along the alignment of existing pipeline infrastructure and would involve the installation of above ground pipelines, there is limited potential for impacts on hydrology. Any works which involve exposed soil surfaces during the installation, replacement and maintenance of the pipelines would be managed through implementation of appropriate erosion and sedimentation controls (see **Section 5.3** – Mitigation Measures).

5.3 MITIGATING AND MANAGING IMPACTS ON BIODIVERSITY VALUES

A site-specific Management Plan will be prepared prior to commencement of any clearing or construction works to ensure that impacts are minimised. This would include the measures outlined in **Table 15**.

Table 15: Summary mitigation and management measures for the Project

Impact	Action and Outcome	Responsibility	Timing
Direct impact / prescribed impact			
Clearing of native vegetation	• Avoid and minimise clearing impacts to native vegetation where practicable. • Clearly delineate the boundaries of the Development Site to ensure no accidental incursions within retained vegetation. • Ensure vehicle and equipment parking areas and stockpile areas are identified and sited to avoid areas containing ecological value wherever practicable. • Appropriate signage such as 'No Go Zone' or 'Environmental Protection Area' should be installed. • Identify and communicate the location of any 'No Go Zones' in site inductions. • Clearing will be avoided, where practicable, during breeding and through egg hatching periods for the Striped Legless Lizard, November to February. If clearing is to occur during this period (November to February): o Pre-clearing surveys within areas of Striped Legless Lizard habitat will be conducted. o Any individuals captured during these pre-clearing surveys will be relocated into similar habitat outside the Development Site.	Construction site manager	Prior to and during vegetation clearing.

Impact	Action and Outcome	Responsibility	Timing
Removal of hollow-bearing trees / habitat trees, resulting in fauna injury and mortality.	• Limit removal of trees to that required within the Development Site. • A pre-clearing protocol will be implemented during clearing works, as follows: o Pre-clearance surveys will be undertaken to determine if any inhabiting fauna are present. o A suitably qualified and trained fauna handler will be present during hollow-bearing tree clearing to rescue and relocate displaced fauna.	Construction site manager, AGLM Environment Staff or delegate and suitably qualified/trained fauna handler.	Prior to and during tree clearing.
Impacts to surface and groundwater quality and quantity due to sediment run-off and/or contaminant runoff into adjacent watercourses	• Source controls such as sediment fences, mulching and jute matting will be utilised where appropriate. • Site-based vehicles will carry spill kits. • A Erosion and Sediment Control Plan will be required with each stage of development as part of the CEMP in accordance with Managing Urban Stormwater: Soils and Construction (Landcom, 2004) prior to commencement of construction. • A Groundwater Management Plan is to be included in the CEMP. • A Surface Water Management Plan is to be included in the CEMP. • Limit the use of pesticides in the Development Site where necessary to avoid contamination of nearby watercourses/wetland areas.	Construction site manager	During vegetation clearing, construction and operation.
Vehicle collision with fauna	• Speed limits within the Development Site will be limited to 40 km/hr. • This limit should be stated in the CEMP and be communicated in site inductions.	Construction site manager	During construction and operation
Rehabilitation of Borrow Pits	• Upon the completion of clay extraction works within each Borrow Pit, these areas will be rehabilitated. A rehabilitation plan for each Borrow Pit will be prepared. Where the areas are to be returned to native vegetation, locally endemic species will be used for rehabilitation of appropriate vegetation communities, using locally sourced seeds/plants where possible.	Construction site manager	Progressively during operation and post-clay extraction
Indirect Impact			
Transfer of weeds and pathogens to and from site.	• Fungal pathogens, including *Phytophora cinnamomi* and Myrtle Rust (*Puccinia psidii*), can have devastating impacts on native plant communities and inhabiting fauna if not managed. • Appropriate wash down facilities will be available to clean vehicles and equipment prior to arrival on-site and prior to departure. • Ensure soil and seed material is not transferred in accordance with measures outlined in the CEMP. • Weed infestations within the construction footprint are to be identified and mapped prior to construction. • A Plan of Management for the control of noxious weeds is to be included in the CEMP. This is to include weed control works to be conducted throughout the	Construction site manager	During vegetation clearing and construction.

Impact	Action and Outcome	Responsibility	Timing
	construction phase of the Project, and follow-up weed control within the Development Site post construction.		
Noise, vibration, waste and air pollution impacts to adjacent sensitive habitat areas.	• Increased human activity (from workers and traffic levels) directly adjacent to sensitive habitat areas may cause disturbance to flora and fauna species in adjoining habitat. • Impacts from operational activities, such as disturbance to an animal's normal behaviour patterns due to noise, vibration, and dust may cause areas of previously suitable habitat to become sub-optimal and may cause fauna species to vacate areas of previously suitable habitat. • The CEMP will consider measures to mitigate impacts on flora and fauna from noise, vibration, waste, and air pollution such as: o Preparation of a waste and traffic management plan. Enforce 'carry-in, carry-out' policy regarding rubbish and waste materials generated on site to avoid waste materials entering adjacent vegetation. o Restriction of public access and associated impacts from domestic pets, waste dumping and damage to adjoining vegetation must be enforced pre, during and post construction. o Fence sensitive areas to delineate 'no go' zones. o Noise minimization practices should be included in the CEMP in accordance with OEH recommendations. o Dust control measures will include: covering loads where required; amending operations under excessive wind conditions including ceasing operations if required; use of water tankers as required to control dust; rehabilitation through vegetation of surfaces to be left unsealed; and, truck wheel washes or other dust removal measures.	Construction site manager	During construction and operation.

6. IMPACT SUMMARY

6.1 SERIOUS AND IRREVERSIBLE IMPACTS

No Serious and Irreversible Impacts (**SAIIs**) were identified within the Development Site.

6.2 IDENTIFICATION OF IMPACTS REQUIRING OFFSETS

This section provides an assessment of the impacts requiring offsetting in accordance with Section 10.3 of the BAM (OEH, 2017a).

6.2.1 Impacts on Native Vegetation

A summary of the impacts within the Development Site on native vegetation and the required ecosystem credit is provided in **Table 16**. The Biodiversity Credit Report is provided in **Appendix 7**.

Table 16: Summary of ecosystem credit requirements

Zone	PCT & Class	Area (ha)*	Current Vegetation Integrity Score	Future Vegetation Integrity Score	Credits Required
1	1691: Mod-Good-CEEC	8.09	64.7	0	272
2	1691: Mod_Good	6.70	51.7	0	173
3	1691: Regrowth	40.36	44.7	0	899
4	1691: Grassland	147.77	33.4	0	2,471
5	1691: Rehab	3.75	45.2	0	85
6	1691: Plantation	0.14	57.7	0	4
Sub-total for PCT 1691		***206.82***			***3,904***
7	1692: Mod-Good	56.11	48.2	0	1,175
8	1692: Mod-Good-CEEC	5.53	37.5	0	100
Sub-total for PCT 1692		***61.64***			***1,275***
9	1731: Mod_Good	2.40	28.3	0	30
Total Native Vegetation Zones		***270.85***			***5,209***
-	PCT 1691: Paddock Trees	-	-	-	31
Grand Total					**5,240**

6.2.2 Impacts on Threatened Species

A summary of the impacts on threatened species and the required species credit is provided in **Table 17**. The Biodiversity Credit Reports are provided in **Appendix 7**.

Table 17: Summary of species credit requirements

Species	Impact		Credits Required
	Zone	Area (ha) / Count	
Diuris tricolor (Pine Donkey Orchid)	3	18.23	305
	4	147.77	1853
	Total	**166 ha**	**2158**
Prasophyllum petilum	3	18.23	406
	4	147.77	2471
	Total	**166 ha**	**2877**
Squirrel Glider (*Petaurus norfolcensis*)	1	8.09	272
	2	6.70	173
	3	40.36	899
	5	3.75	85
	6	0.14	4
	Total	**59.05 ha**	**1,433**
Southern Myotis (*Myotis macropus*)	1	3.09	104
	2	4.59	119
	7	0.43	10
	Total	**8.11 ha**	**233**
Striped Legless Lizard (*Delma impar*)	1	8.09	204
	2	6.70	130
	3	40.36	675
	5	3.75	64
	6	0.14	3
	7	56.11	1008
	8	5.53	85
	Total	**120.68 ha**	**2,169**

6.2.3 Retirement of Biodiversity Credits

Credit retirement for biodiversity credits required as part of the Project will occur in a staged manner. As clearing for each portion of the Project will not occur immediately, a staged approached is more favourable. Additionally, the full area of clearing for each borrow pit may not be required.

The biodiversity credit obligation for species that have been assumed present (*Diuris tricolor* and *Prasophyllum petilum*) will be reassessed following completion of targeted surveys for these species during the optimum period of detection (September to November 2020). This will be important in finalising the biodiversity credit obligation for the project given that the expert report states that although 166 ha of potential orchid habitat has been conservatively estimated, these areas are unlikely to support large populations of *Diuris tricolor*, and probably no *Prasophyllum petilum*.

A clearing staging plan will be prepared prior to the commencement of works. From this plan the required biodiversity credits for each stage will be determined based on areas of impacts to each vegetation zone, and the retirement of biodiversity credits will occur prior to the commencement of each stage. This plan will be set out in a separate document to this BDAR and will be approved by DPIE prior to commencement of disturbance works.

6.3 IMPACTS NOT REQUIRING FURTHER ASSESSMENT

Areas not requiring further assessment in accordance with Section 10.4 of the BAM (OEH, 2017a) within the Development Site include:

- Existing roads.
- Non-native vegetation.
- Existing infrastructure areas.

7. ASSESSMENT OF BIODIVERSITY LEGISLATION

7.1 *ENVIRONMENT AND BIODIVERSITY CONSERVATION ACT 1999*

7.1.1 Assessment Requirements

The EPBC Act requires that developments or undertakings that are likely to have a significant impact on MNES be referred for a determination as to whether they are a controlled action which requires approval under the EPBC Act (Section 1.5.1). Of the nine MNES listed under the Act, those considered relevant to the Study Area are potential impacts on listed threatened species or communities and potential impacts on migratory species listed under international agreements. The results of a search of the relevant threatened species database and an assessment of the likelihood of occurrence of threatened and migratory species is provided in **Appendix 2**.

A delegate of the Commonwealth Minister for the Environment determined that the project is a controlled action under the EPBC Act. The EPBC Act controlling provisions for the proposed action are listed threatened species and communities (sections 18 and 18A). The project will be assessed under the Bilateral Agreement (Amending Agreement No.1, 2020) between the Commonwealth and NSW Governments.

7.1.2 Supplementary Assessment Requirements

7.1.2.1 Summary

The BDAR has been amended in accordance with the supplementary assessment requirements provided by DAWE. A summary of the supplementary assessment requirements is presented in **Table 19**.

Table 18: Summary of supplementary assessment requirements

Requirement	Location that this is addressed
Introduction	
1. On 20 April 2020, a delegate of the Federal Minister for the Department of the Agriculture, Water and the Environment (DAWE) determined that the Bayswater Power Station Water Infrastructure Upgrade Project was a controlled action under section 75 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The EPBC Act controlling provisions for the proposed action are: i. Listed threatened species and communities (sections 18 and 18A).	The BDAR has been prepared in accordance with the EPBC Act controlling provisions.
2. The proposed action will be assessed in accordance with the bilateral assessment agreement between the Australian and NSW governments (Amending Agreement No.1, 2020). The assessment documentation must include: i. an assessment of all impacts that the action is likely to have on each matter protected by a provision of Part 3 of the EPBC Act; ii. enough information about the proposal and its relevant impacts to allow the Federal Minister to make an informed decision on whether or not to approve; and iii. information addressing the matters outlined in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (EPBC Regulations).	See below for breakdown of how each point is addressed.
3. The Applicant must undertake an assessment of all protected matters that may be impacted by the development under the controlling provisions identified in paragraph 1. DAWE considers that there is likely to be a significant impact on the following: i. Central Hunter Valley Eucalypt Forest and Woodland (CHVEFW) – Critically Endangered; ii. Regent Honeyeater (Anthochaera phrygia) – Critically Endangered; iii. Swift Parrot (Lathamus discolor) – Critically Endangered; and iv. Striped Legless Lizard (Delma impar) – Vulnerable.	The BDAR has been prepared in accordance with the Biodiversity Assessment Method and addresses impacts to threatened species and ecological communities. Refer to Appendix 9 for information pertaining to the potential for significant impacts to each of the relevant EPBC listed threatened species and ecological communities.

4. Based on DAWE's Reporting Tool and information provided by the Species Profiles and Threats Database (SPRAT), DAWE also considers that the proposed action may result in significant impacts to the following species: i. Wybong Leek Orchid (Prasophyllum sp. Wybong) – Critically Endangered; ii. Ozothamnus tesselatus – Vulnerable; iii. Koala (Phascolarctos cinereus) – Vulnerable; iv. Pink-tailed Worm-lizard (Aprasia parapulchella) – Vulnerable; v. Spot-tailed Quoll (Dasyurus maculatus) – Endangered; vi. Brush-tailed Rock Wallaby (Petrogale penicillata) – Vulnerable; vii. Grey-headed Flying-fox (Pteropus poliocephalus) – Vulnerable; viii. Large-eared Pied Bat (Chalinolobus dwyeri) – Vulnerable; and ix. White-Box Yellow-Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland – Critically Endangered. These species require further assessment, surveys and analysis to determine whether they are likely to be significantly impacted. Note that this may not be a complete list and it is the responsibility of the Applicant to ensure any protected matters under this controlling provision are assessed for the Commonwealth decision-makers consideration.	The Biodiversity Development Assessment Report has been prepared in accordance with the Biodiversity Assessment Method and addresses impacts to relevant threatened and ecological communities species. An assessment of potential impacts for each of the relevant EPBC listed species and ecological communities has been addressed in accordance with the Significant Impact Guidelines 1.1 –Matters of National Environmental Significance (DoE, 2013) Refer to Appendix 9.
5. The Applicant must consider each of the protected matters under the triggered controlling provisions that may be impacted by the action. Note that this may not be a complete list and it is the responsibility of the Applicant to undertake an analysis of the significance of the relevant impacts and ensure that all protected matters that are likely to be significantly impacted are assessed for the Commonwealth Minister's consideration.	Additional species for which habitat was identified within the development site have also been addressed in accordance with the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DoE, 2013). Refer to Appendix 9.
General Requirements	
6. The Environmental Impact Statement (EIS) must address the matters outlined in Schedule 4 of the EPBC Regulations and the matters outlined below in relation to the controlling provisions.	Refer to Section 3.20 of the EIS.
7. The title of the action, background of the action and current status.	Bayswater Power Station Water Infrastructure Upgrade Project also referred to as the Bayswater Water and Other Associated Operational Works Project. Refer to Section 1.1 of the EIS for full project background. The action is in the design stage. It is noted that the EIS addresses the voluntary surrender of existing approvals that relate to the ongoing operation of Bayswater but these approvals do not have associated approvals under the EPBC Act. The status of developments associated with approvals to be surrendered is provided in Table 2 2 of the EIS.
8. The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on Matters of National Environmental Significance (MNES).	The location of the action is described in Figure 2 1 and Table 2 1 of the EIS.

9. How the action relates to any other actions that have been, or are being taken in the region affected by the action.	The action is related to the existing Bayswater Power Station which was constructed and commenced operation prior to the EPBC Act coming into force. The action is not related to any other action proposed or being undertaken in the region. The controlling provisions impacted by the action are considered likely to be cumulative to other actions occurring in the region.
10. How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.	Refer to Section 2 of the EIS.
11. The EIS must include an assessment of the relevant impacts1 of the action on the matters protected by the controlling provisions, including: i. a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long-term relevant impacts; ii. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; iii. analysis of the significance of the relevant impacts; and iv. any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Refer to Appendix 9 of the BDAR.
Avoidance, mitigation and offsetting 12. For each of the relevant matters protected that are likely to be significantly impacted by the action, the EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including: i. a description, and an assessment of the expected or predicted effectiveness of the mitigation measures, ii. any statutory policy basis for the mitigation measures; iii. the cost of the mitigation measures;	Refer to Section 5 of the BDAR.
13. Where a significant residual adverse impact to a relevant protected matter is considered likely, the EIS must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy.	The offset strategy would be developed in accordance the NSW Biodiversity Assessment Method and Biodiversity Offset System requirements. A biodiversity credit obligation for impacts to biodiversity is presented in Section 6 of the BDAR.
14. For each of the relevant matters likely to be impacted by the action the EIS must provide reference to, and consideration of, relevant Commonwealth guidelines and policy statements including any: i. conservation advice or recovery plan for the species or community; ii. relevant threat abatement plan for a process that threatens the species or community; iii. wildlife conservation plan for the species; and iv. any strategic assessment.	Refer to Appendix 9 of the BDAR
Key Issues - Biodiversity (threatened species and communities and migratory species)	

Comments 15. From the Commonwealth perspective, key risks and significant impacts associated with the proposed action on threatened species and ecological community relate to the extent of native vegetation clearing, increase in fragmentation of the remaining native vegetation (and subsequent indirect impacts), as well as likely impacts of the 2019-2020 bushfires. These impacts must be appropriately offset for the EPBC Act purposes.	A biodiversity credit obligation for impacts to biodiversity is presented in Section 6 of the BDAR.
Assessment Requirements For each of the EPBC Act listed species predicted to occur in the project site, and each of the EPBC Act listed ecological communities likely to be significantly impacted, the EIS must provide: 16. Survey results, including details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Commonwealth guidelines and policy statements and/or the relevant NSW offsetting method. 17. A description and quantification of habitat in the study area (including suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advices, conservation advices, recovery plans, and threat abatement plans. 18. Maps displaying the above information (specific to each EPBC protected matter) overlaid with the proposed action. It is acceptable, where possible, to use the mapping and assessment of Plant Community Types (PCTs) and the species surveys prescribed by the BAM as the basis for identifying EPBC Act-listed species and communities. The EIS must clearly identify which PCTs are considered to align with habitat for the relevant EPBC Act listed species or community, and provide individual maps for each species or community. 19. Description of the nature, geographic extent, magnitude, timing and duration of any likely direct, indirect and consequential impacts on any relevant EPBC Act listed species and communities, including impacts of 2019-2020 bushfire to advise whether the remaining habitat within the proposed action area is of substantially greater importance to listed threatened species following the fires. This information, once obtained, can be considered pertaining to avoidance, mitigation and offset measures for these species. It must clearly identify the location and quantify the extent of all impact areas to each relevant EPBC Act listed species or community.	The BDAR has been prepared in consideration of all of the assessment requirements listed. This includes survey results, including habitat mapping for relevant threatened biota and a detailed discussion of potential impacts.
Other approvals and conditions	

20. Information in relation to any other approvals or conditions required must include the information prescribed in Schedule 4 Clause 5 (a) (b) (c) and (d) of the EPBC Regulations.	Refer to Section 3.1 and Table 3-4 of the EIS
Environmental Record of person proposing to take the action	
21. Information in relation to the environmental record of a person proposing to take the action must include details as prescribed in Schedule 4 Clause 6 of the EPBC Regulations.	Refer to Table 3-4 of the EIS
Information Sources	
22. For information given in an EIS, the EIS must state the source of the information, how recent the information is, how the reliability of the information was tested; and what uncertainties (if any) are in the information.	Refer to Table 3-4 of the EIS

7.1.2.2 Relevant Matters of National Environmental Significance

Potential impacts to threatened species for which DAWE considers that there is likely to be a significant impact have been addressed in accordance with the *Significant Impact Guidelines 1.1 –Matters of National Environmental Significance* (DoE, 2013) (**Appendix 9**). Additionally, assessments of significance have also been prepared for EPBC listed species which had a moderate or higher likelihood of occurrence.

EPBC listed threatened species and TECs that have been addressed

- Critically Endangered and Endangered Species
  - Wybong Leek Orchid (*Prasophyllum* sp. Wybong)
  - Regent Honeyeater (*Anthochaera phrygia*)
  - Swift Parrot (*Lathamus discolor*)
  - Spot-tailed Quoll (*Dasyurus maculatus*)
- Vulnerable Species
  - *Ozothamnus tesselatus*
  - Green and Golden Bell Frog (*Litoria aurea*)
  - Large-eared Pied Bat (*Chalinolobus dwyeri*)
  - Corben's Long-eared Bat (*Nyctophilus corbeni*)
  - Grey-headed Flying-fox (*Pteropus poliocephalus*)
  - Koala (*Phascolarctos cinereus*)
  - Brush-tailed Rock Wallaby (*Petrogale penicillata*)
  - Striped Legless Lizard (*Delma impar*)
  - Pink-tailed Worm-lizard (*Aprasia parapulchella*)
- **Critically Endangered Ecological Communities**
  - Central Hunter Valley Eucalypt Forest and Woodland (CHVEFW)

- White-Box Yellow-Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

- **Migratory Species**
  - White-throated Needletail (*Hirundapus caudacutus*).

Key issues and other information required to address potential impacts to threatened species, ecological communities and migratory species have been addressed in assessments of significance in **Appendix 9;** however, a summary of impacts to habitat for each of the above listed biota is presented in **Table 19.**

Table 19: Potential habitat on site of potentially occurring Commonwealth listed threatened species, populations, and ecological communities.

Species	Legal status		Likelihood of occurrence	Habitat Type/s within study area	PCT association	Impacts to habitat
	BC Act	EPBC Act				
Flora						
Prasophyllum sp. Wybong *(C.Phelps ORG 5269)* (EPBC)	E	CE	Low-Moderate	Native Grasslands Derived from the Central Hunter Box – Ironbark Woodland (Vegetation Zones 3 and 4).	1691	166 ha
Ozothamnus tesselatus – Vulnerable	V	V	Low	Central Hunter Box – Ironbark Woodland (Vegetation Zones 1 and 2).	1691	14.68 ha
Threatened Ecological Communities						
Central Hunter Valley eucalypt forest and woodland	E	CE	Known	Central Hunter Box - Ironbark Woodland (in part), and portions of the Bull Oak Woodland (Vegetation Zones 1 and 8).	1691, 1692 (in part)	13.62 ha
White-Box Yellow-Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland	E	CE	Nil	Nil	N/A	Nil
Amphibians						

Species	Legal status		Likelihood of occurrence	Habitat Type/s within study area	PCT association	Impacts to habitat
	BC Act	EPBC Act				
Litoria aurea Green and Golden Bell Frog	E	V	Low	Suitable habitat is present within the impact area consists of constructed Dams which contain permanent water and suitable wetland vegetation (primarily *Typha* and *Juncus acutus*). A total of eight Dams were identified within the Study Area (total of 4.99 ha). One area occurs within the exiting Ash Dam (3.90 ha; within the approved disturbance area of the Dam), two occur within the Study Area outside the disturbance area (0.35 ha, and 5 occur within the Impact Area (total of 0.74 ha).	N/A	4.99 ha within the Study Area (of which 0.35 ha occurs along the Ash Line). Impact: 3.90 ha; within the approved disturbance area of the Ash Dam), 0.35 ha no impact, and 0.74 ha impacted.
Birds						
Anthochaera phrygia Regent Honeyeater	E	CE	Moderate – Low	Central Hunter Box – Ironbark Woodland (Vegetation Zones 1 and 2).	1691	14.68 ha
Lathamus discolor Swift Parrot	E	CE	Moderate - Low	Central Hunter Box – Ironbark Woodland (Vegetation Zones 1 and 2).	1691	14.68 ha
Mammals						
Chalinolobus dwyeri Large-eared Pied Bat	V	V	Moderate	Central Hunter Box – Ironbark Woodland, Rehabilitation, Plantation, Central Hunter Bull Oak Forest, Swamp Oak Forest (Vegetation Zones 1, 2, 5, 6, 7, 8 and 9).	1691, 1692, 1731	82.60 ha
Dasyurus maculatus Spotted-tailed Quoll	V	E	Moderate - Low	Central Hunter Box – Ironbark Woodland, Rehabilitation, Plantation, Central Hunter Bull Oak Forest, Swamp Oak Forest (Vegetation Zones 1, 2, 5, 6, 7, 8 and 9).	1691, 1692, 1731	82.60 ha
Nyctophilus corbeni Corben's Long-eared Bat	V	V	Moderate - Low	Central Hunter Box – Ironbark Woodland, Rehabilitation, Plantation, Central Hunter Bull Oak Forest, Swamp Oak Forest (Vegetation Zones 1, 2, 5, 6, 7, 8 and 9).	1691, 1692, 1731	82.60 ha

Species	Legal status		Likelihood of occurrence	Habitat Type/s within study area	PCT association	Impacts to habitat
	BC Act	EPBC Act				
Petrogale penicillata Brush-tailed Rock Wallaby	E	V	Low	Nil	N/A	Nil
Phascolarctos cinereus Koala	V	V	Low	Central Hunter Box – Ironbark Woodland, Rehabilitation, Plantation (Vegetation Zone 1 and 6).	1691	8.23 ha
Pteropus poliocephalus Grey-headed Flying-fox	V	V	Moderate - High	Central Hunter Box – Ironbark Woodland, Rehabilitation, Plantation (Vegetation Zones 1, 2, 5 and 6).	1691	18.57 ha
Reptiles						
Delma impar Striped Legless Lizard	V	V	Known	Central Hunter Box – Ironbark Woodland, Acacia Regrowth, Rehabilitation, Plantation, Central Hunter Bull Oak Forest, Swamp Oak Forest (Vegetation Zones 1, 2, 3, 5, 6, 7, 8 and 9).	1691, 1692, 1731	122.97 ha
Aprasia parapulchella Pink-tailed Worm-lizard	V	V	Low	Not mapped due to minimal habitat present.	N/A	N/A
Migratory Species						
Hirundapus caudacutus White-throated Needletail	-	M	Moderate-low	Central Hunter Box – Ironbark Woodland, Acacia Regrowth, Rehabilitation, Plantation, Central Hunter Bull Oak Forest, Swamp Oak Forest (Vegetation Zones 1, 2, 3, 5, 6, 7, 8 and 9).	1691, 1692, 1731	122.97 ha

Status: BC Act = NSW Biodiversity Conservation Act, 2016. EPBC Act = Environment Protection and Biodiversity Conservation Act, 1999. CE = Critically Endangered; E = Endangered; V = Vulnerable (NSW BC Act and Commonwealth EPBC Act); M = Migratory (EPBC Act

7.1.3 Impact Assessment

Assessments of significance in accordance with the *Significant Impact Guidelines 1.1 –Matters of National Environmental Significance* (DoE, 2013) have been undertaken for all of the above listed TECs and threatened species considered relevant to the assessment (see **Section 7.1.2** and **Appendix 9**). It was concluded that for the majority of the threatened species, the ecological communities and migratory species identified within the Impact Site or identified as having suitable habitat within the disturbance footprint, the Project is unlikely to have a significant impact. There were two species; Striped Legless Lizard and *Prasophyllum* sp. Wybong, for which impacts are unknown.

Due to the study area occurring at the northern extent of the known distribution of the Striped Legless Lizard (*Delma impar*) there is the potential for the Project to significantly impact on this species. However, surveys conducted within the study area have not identified a large population of the species (only two captures of the species from the same location), as such, the population within the study area may not be extensive and occupying all potential habitat. Potential impacts to this species are therefore uncertain.

Due to sub-optimal conditions for the flowering of *Prasophyllum* sp. Wybong (A Leek Orchid), the species was not recorded as flowering at a local reference population during the 2019 season, and as such surveys within the Study Area could not be conducted. The expert report that has been prepared for the species determined that approximately 166 ha of habitat for *Prasophyllum* sp. Wybong occurs within the impact area; however, this area is unlikely to contain a population of the species. Due to the lack of information regarding the occurrence of the species within the Development Site, potential impacts to this species are currently uncertain.

7.2 SEPP (KOALA HABITAT PROTECTION) 2019

Two tree species listed under SEPP (Koala Habitat Protection) 2019, *Eucalyptus tereticornis* and *Eucalyptus punctata*, occur within the Study Area. Within the Study Area these two tree species only constitute >15% of the canopy cover within small portions of the site (within Vegetation Zone 1 – PCT 1691: Moderate-Good-CEEC, and Vegetation Zone 6 – PCT 1691: Plantation).

No evidence of Koala activity was identified during surveys conducted within the Study Area. Due to the limited extent of habitat and the patchy occurrence of feed trees within the Study Area, it is unlikely that the Study Area represents Core Koala Habitat. As such, no further assessment under the SEPP is required.

7.3 BIOSECURITY ACT 2015

Species which require control to ensure they are not spread due to works prior to and post construction of the Development Site include species identified as priority weeds in the Hunter; *Senecio madagascariensis* (Fireweed), *Opuntia stricta* (Prickly Pear), *Olea europaea* subsp., *cuspidata* (African Olive), *Hyparrhenia hirta* (Coolatai Grass) and *Lycium ferocissimum* (African Box Thorn). Additionally, Fireweed, Prickly Pear and African Box Thorn are listed as Weeds of National Significance.

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APPENDIX 1. PADDOCK TREES AND PADDOCK TREE REPORT

No.	Tree Species	Diameter at Brest Height (cm)	Hollows	Class
1.	*Acacia salicina*	20	No	2
2.	*Acacia salicina*	20	No	2
3.	*Acacia salicina*	20	No	2
4.	*Acacia salicina*	20	No	2
5.	*Acacia salicina*	22	No	2
6.	*Acacia salicina*	23	No	2
7.	*Acacia salicina*	25	No	2
8.	*Acacia salicina*	25	No	2
9.	*Acacia salicina*	27	No	2
10.	*Acacia salicina*	29	No	2
11.	*Acacia salicina*	29	No	2
12.	*Acacia salicina*	30	No	2
13.	*Acacia salicina*	30	No	2
14.	*Acacia salicina*	39	No	2
15.	*Acacia salicina*	40	No	2
16.	*Acacia salicina*	40	No	2
17.	*Eucalyptus moluccana*	30	No	2
18.	*Eucalyptus moluccana*	34	No	2
19.	*Eucalyptus moluccana*	35	No	2
20.	*Eucalyptus moluccana*	40	No	2
21.	*Eucalyptus moluccana*	40	No	2
22.	*Eucalyptus moluccana*	49	No	2
23.	*Eucalyptus moluccana*	40	Yes	2
24.	*Acacia salicina*	54	No	3
25.	*Acacia salicina*	66	No	3
26.	*Brachychiton populneus*	67	No	3
27.	*Eucalyptus crebra*	50	No	3
28.	*Eucalyptus moluccana*	59	No	3
29.	*Eucalyptus moluccana*	73	No	3
30.	*Eucalyptus moluccana*	50	Yes	3
31.	*Eucalyptus moluccana*	50	Yes	3
32.	*Eucalyptus moluccana*	50	Yes	3

Paddock Tree Report

Proposal Details

Assessment Id
00018204/BAAS17039/20/00018875

Assessment name
Bayswater Power Station WOAOW Project - Paddock Trees

BAM data last updated *
26/11/2019

Assessor Name

Report Created
13/05/2020

BAM Data version *
22

Assessor Number

BAM Case Status
Open

Date Finalised
To be finalised

Assessment Revision
0

Assessment Type
Paddock Trees

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Paddock Trees

PCT code	PCT name	No. of trees	Species	DBHOB Category	Contain hollows	Class	Assessment required
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	16	Acacia salicina	>= 20cm and <50cm	False	2	Visual assessment for hollows, presence of important habitat features and habitat suitability for threatened species

Paddock Tree Report

1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	6	Eucalyptus moluccana	>= 20cm and <50cm	False	2	Visual assessment for hollows, presence of important habitat features and habitat suitability for threatened species
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	1	Eucalyptus moluccana	>= 20cm and <50cm	True	2	Visual assessment for hollows, presence of important habitat features and habitat suitability for threatened species
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	2	Acacia salicina	> 50cm	False	3	Visual assessment for hollows, presence of important habitat features and habitat suitability for threatened species
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	1	Brachychiton populneus	> 50cm	False	3	Visual assessment for hollows, presence of important habitat features and habitat suitability for threatened species
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	1	Eucalyptus crebra	> 50cm	False	3	Visual assessment for hollows, presence of important habitat features and habitat suitability for threatened species
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	2	Eucalyptus moluccana	> 50cm	False	3	Visual assessment for hollows, presence of important habitat features and habitat suitability for threatened species

Paddock Tree Report

1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	13	Eucalyptus moluccana	> 50cm	True	3	Visual assessment for hollows, presence of important habitat features and habitat suitability for threatened species

No.	Tree Species	Diameter at Brest Height (cm)	Hollows	Class
33.	*Eucalyptus moluccana*	54	Yes	3
34.	*Eucalyptus moluccana*	70	Yes	3
35.	*Eucalyptus moluccana*	70	Yes	3
36.	*Eucalyptus moluccana*	72	Yes	3
37.	*Eucalyptus moluccana*	73	Yes	3
38.	*Eucalyptus moluccana*	90	Yes	3
39.	*Eucalyptus moluccana*	91	Yes	3
40.	*Eucalyptus moluccana*	94	Yes	3
41.	*Eucalyptus moluccana*	120	Yes	3
42.	*Eucalyptus moluccana*	120	Yes	3

APPENDIX 2. THREATENED SPECIES DATABASE SEARCH

A list of threatened species, populations and ecological communities that have been reported or modelled to occur from within a five-kilometre radius of the Study Area was obtained from the following databases:

- NSW Office of Environment and Heritage (OEH) BioNet Atlas: (http://www.bionet.nsw.gov.au/).
- Department of Environment and Energy (DoEE) Protected Matters search tool: (www.environment.gov.au/erin/ert/epbc/index.html).

Note: Pelagic and shorebird species have not been included in the list due to the lack of potential habitat within the Study Area.

An assessment was then made of the likelihood of the threatened species, populations, and / or ecological communities reported or modelled to occur in the locality occurring within the Study Area or using the habitat within the Study Area as an essential part of a foraging range.

The table below summarises the likelihood of threatened species and EPBC Act listed migratory species occurring within the Study Area based on the habitat requirements of each species. A brief definition of the likelihood of occurrence criteria is provided below:

- Known – species identified within the site during surveys.
- High – species known from the area (OEH Wildlife Atlas records), suitable habitat (such as roosting and foraging habitat) present within the site.
- Moderate – species may be known from the area, potential habitat is present within the site.
- Low – species not known from the area and/or marginal habitat is present within the site.
- Nil – habitat requirements not met for this species within the site.

An assessment of the likelihood of threatened species, populations and ecological communities occurring within the Study Area

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Flora						
Allocasuarina glareicola	E	E	-	PMST	Grows in Castlereagh woodland on lateritic soil. Found in open woodland with *Eucalyptus parramattensis*, *Eucalyptus fibrosa*, *Angophora bakeri*, *Eucalyptus sclerophylla* and *Melaleuca decora*. **No suitable habitat present within the Study Area. No known records within the locality.**	Nil
Androcalva procumbens (*Commersonia procumbens*)	-	V	-	PMST	Occurs in sandy soils, often in disturbed habitats such as road verges, quarry boundaries, gravel stockpiles, and power line easements. Often found in communities of *Eucalyptus dealbata–E. sideroxylon* woodland, *Melaleuca uncinata* shrubland, and mallee eucalypt with *Calytrix tetragona* understorey. Associated species include *Acacia triptera*, *Callitris endlicheri*, *Eucalyptus melliodora*, *Allocasuarina diminut*a, *Philotheca salsolifolia*, *Xanthorrhoea* spp., *Exocarpos cupressiformis*, *Leptospermum parvifolium*, and *Kunzea parvifolia*. **No suitable habitat present within the Study Area. Species not known from the locality.**	Nil
Asperula asthenes Trailing Woodruff	V	V	1	OEH Atlas, PMST	Inhabits damp areas, often along riverbanks. **Suitable habitat present within the study area. Only one record of the species in the locality. Surveys for the species conducted in October 2019, not identified within the Study Area.**	Low
Cryptostylis hunteriana *Leafless Tongue-orchid*	V	V	-	PMST	Occurs 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 (grassy sub-formation). Soils are generally considered to be moist and sandy, however, this species is also known to grow in dry or peaty soils. **Suitable habitat present within the Study Area. However, no known records within locality.**	Low

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Cymbidium canaliculatum population in the Hunter Catchment	E	-	18	OEH Atlas	Typically grows in the hollows, fissures, trunks and forks of trees in dry sclerophyll forest or woodland, where its host trees typically occur on Permian Sediments of the Hunter Valley floor. It usually occurs singly or as a single clump, which can form large colonies on trees, between two and six metres from the ground. Within the Hunter Catchment, Cymbidium canaliculatum is most commonly found in Eucalyptus albens (White Box) dominated woodlands (including those dominated by the intergrade E. albens-moluccana), much of which may constitute the endangered ecological community (EEC) 'White Box Yellow Box Blakely's Red Gum Woodland'. It has been found, less commonly, to grow on E. dawsonii (Slaty Box), E. crebra (Narrow-leaved Ironbark), E. moluccana (Grey Box), Angophora floribunda (Rough-barked Apple), Acacia salicina (Cooba) and on some other species, including dead stags. It is also known to use man-made structures, such as fence posts and wooden bridges as its host. **Suitable habitat present within the Study Area.**	**Moderate**
Cynanchum elegans White-flowered Wax Plant	E	E	-	PMST	Occurs on a variety of lithologies and soil types, usually on steep slopes with varying degrees of soil fertility. Geology is not a limiting factor for this species and associated substrate varies at different locations. **Suitable habitat present within the Study Area. However, no known records within locality.**	Low
Dichanthium setosum Bluegrass	V	V	-	PMST	Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. It is often collected from disturbed open grassy woodlands on the northern tablelands, where the habitat has been variously grazed, nutrient-enriched and water-enriched. **Suitable habitat present within the Study Area. However, no known records within locality.**	Low

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Diuris tricolor	V	-	674	OEH Atlas	Associated species include *Callitris glaucophylla*, *Eucalyptus populnea*, *Eucalyptus intertexta*, Ironbark and Acacia shrubland. The understorey is often grassy with herbaceous plants such as Bulbine species. The Pine Donkey Orchid grows in sclerophyll forest among grass, often with native Cypress Pine (*Callitris* spp.). It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. **Suitable habitat present within the Study Area.**	**Assumed Present**
Eucalyptus camaldulensis population in the Hunter catchment	E	-	458	OEH Atlas	May occur with *Eucalyptus tereticornis*, *Eucalyptus melliodora*, *Casuarina cunninghamiana* subsp. *cunninghamiana* and *Angophora floribunda*. **Suitable habitat present within the Study Area.**	**Moderate**
Eucalyptus glaucina Slaty Red Gum	V	V	14	OEH Atlas, PMST	Observed in a variety of habitats: shallow soils or stony hillsides, but not on poor sandstones; grassy woodlands on deep, moderately fertile and well watered soil; gentle slopes near drainage lines in alluvial and clayey soils. Associated with the following vegetation classes: Hunter-Macleay Dry Sclerophyll Forests; Northern Gorge Dry Sclerophyll Forests; North Coast Dry Sclerophyll Forests; Sydney Sand Flats Dry Sclerophyll Forests; Western Slopes Grasslands; Coastal Valley Grassy Woodlands; Northern Hinterland Wet Sclerophyll Forests; North Coast Wet Sclerophyll Forests. **Suitable habitat present within the study area. Two records of the species occur within the Bayswater Power Station Site (2003). Species not identified during surveys within the study area (Conducted in July and September 2019).**	Low
Eucalyptus nicholii Narrow-leaved Black Peppermint	V	V	2	OEH Atlas	Occurs in grassy or sclerophyll woodland, in association with other eucalypts that grow in the region, including New England Blackbutt (*E. andrewsii*) and many of the stringybarks, such as Broad-leaved Stringybark (*E. caliginosa*). Found on shallow, relatively infertile soils on shale and slate geology. **Cultivated specimens recorded within Plantation areas to the south/south-west of Borrow Pit 4. Species not identified during surveys within the study area (Conducted in July and September 2019).**	Low

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Euphrasia arguta	CE	CE	-	PMST	Could be found in grassy areas near rivers at elevations up to 700 m above sea level, with an annual rainfall of 600 mm. **Suitable habitat present within the Study Area. However, no known records within locality.**	Low
Homoranthus darwinioides	V	V	-	PMST	Grows in in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Associated species include *Callitris endlicheri*, *Eucalyptus crebra*, *E. fibrosa*, *C. trachyphloia*, *E. dwyeri*, *E. rossii*, *Leptospermum divaricatum*, *Melaleuca uncinata*, *Calytrix tetragona*, *Allocasuarina* spp. and *Micromyrtus* spp. **Marginal habitat present within the Study Area. However, no known records within locality.**	Low
Olearia cordata	V	V	-	PMST	Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges. **No suitable habitat present within the Study Area. Species not known from the locality.**	Nil
Ozothamnus tesselatus	V	V	1	OEH Atlas	Restricted to a few locations north of Rylstone, NSW. Grows in eucalypt woodland. **Suitable habitat present within the study area. Species identified during surveys within the study area (conducted in July and September 2018.**	Low
Philotheca ericifolia	-	V	-	PMST	Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and in gullies. Has been collected from a variety of habitats including open woodland, heathland, dry sandy creek beds and rocky ridge and cliff tops. Associated species include *Melaleuca uncinata*, *Acacia triptera*, *Eucalyptus crebra*, *Corymbia trachyphloia*, *Acacia burrowii*, *Beyeria viscosa* and *Philotheca australis*. Also recorded growing in association with *Eucalyptus rossii*, *Eucalyptus punctata*, *Leucopogon muticus* and *Calytrix tetragona*. Appears to favour moist sites, may tolerate some level of disturbance (e.g. clearing, wildfire). **No suitable habitat present within the Study Area, and no known records within the locality.**	Nil

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Pomaderris brunnea Rufous Pomaderris	E	V	-	PMST	Grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines. as been found in association with *Eucalyptus amplifolia*, *Angophora floribunda*, *Acacia parramattensis*, *Bursaria spinosa* and *Kunzea ambigua* **No suitable habitat present within the Study Area, and no known records within the locality.**	Nil
Prasophyllum sp. Wybong (C.Phelps ORG 5269) (EPBC Act) / *Prasophyllum petilum* (BC Act) *A Leek-orchid*	E	CE	-	PMST	Known from open eucalypt woodland and grassland. **While no known records within locality and the nearest record of this species is over 25 km to the north-west. Potential habitat for the species occurs within the study area. Surveys for this species were conducted during the flowering period (surveys conducted 21-24 October 2019), however, flowering of the species at a local reference population was not confirmed. As such, an expert report regarding the habitat suitability and potential occurrence of the species on site is to be conducted.**	**Assumed Present**
Prostanthera cineolifera Singleton Mint Bush	V	V	-	PMST	Occurs in sclerophyll forests and open woodlands on exposed sandstone ridges and is often found in association with shallow or skeletal sands. **No habitat present within the study area and species not known records within locality.**	Nil
Prostanthera cryptandroides subsp. cryptandroides Wollemi Mint-bush	V	V	-	PMST	Occurs in dry sclerophyll forested slopes and gullies, in rocky areas, especially at the base of scree slopes and sandstone boulders, and in shallow sandy loam, as an understorey species to *Eucalyptus* spp. and *Acacia* spp. Associated vegetation communities include Narrabeen Rocky Heath, Narrabeen Acacia Woodland, Narrabeen Exposed Woodland, Open Heath of Common Fringe-myrtle (*Calytrix tetragona*), *Leptospermum parvifolium*, Nepean Conebush (*Isopogon dawsonii*), and Open Scrubland of Dwyer's Red Gum (*Eucalyptus dwyeri*), *Harmogia densifolia*, *Dillwynia floribunda*, *Aotus ericoides* and *Hemigenia cuneifolia.* **No suitable habitat present within the study area, no known records within locality.**	Nil

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Pterostylis gibbosa Illawarra Greenhood	E	E	-	PMST	In the Hunter region, this species grows in open woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Forest Red Gum (*E. tereticornis*) and Black Cypress Pine (*Callitris endlicheri*). **Potential habitat present within the study area, however no known records within the locality. The nearest record of this species is approximately 30 km south of the study area. Surveys for this specie conducted during the flowering period (surveys conducted 8-9 October 2019).**	Low
Rhodamnia rubescens	-	E	1	OEH Atlas	Often found in wet sclerophyll associations in rainforest transition zones and creekside riparian vegetation. The species occupies a range of volcanically derived and sedimentary soils and is also a common pioneer species in eucalypt forests. **Suitable habitat present within the Study Area.**	**Moderate**
Thesium australe Austral Toadflax	V	V	-	PMST	Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. **Marginal habitat present within the study area and no records within locality.**	Low
Wollemia nobilis Wollemi Pine	CE	CE	-	PMST	Occurs in warm temperate rainforest and rain forest margins in remote sandstone canyons. **No suitable habitat present within the Study Area. No known records within locality.**	Nil
Ecological Communities						
Central Hunter Valley eucalypt forest and woodland	E[1]	CE	-	PMST	**Recorded in the Study Area.**	**Known**
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland	CE	CE	-	PMST	**Known from areas adjacent the study area. Not detected within the study area. One individual *Acacia pendula* occurs as a planted individual within the Study Area. This individual does not constitute the CEEC.**	Low

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Lowland Rainforest of Subtropical Australia	E	CE	-	PMST	**No suitable habitat present within the Study Area.**	Nil
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	E	CE	-	PMST	**Suitable habitat present within the Study Area, not identified within the Study Area.**	Low
Amphibians						
Heleioporus australiacus Giant Burrowing Frog	V	V	-	PMST	Dependent on native vegetation - has not been recorded from cleared lands. Occurs in hanging swamps on sandstone shelves and beside perennial creeks. It occurs in semi-permanent to ephemeral sand or rock based streams, and infrequently in semi-permanent to permanent constructed dams with a sandy silt or clay base. It is also found in ephemeral to permanent artificial drainage ditches and culverts on roadsides. Not restricted to watercourses. **No suitable habitat present within the study area, no known records within locality.**	Nil
Litoria aurea Green and Golden Bell Frog	E	V	7	OEH Atlas, PMST	This species prefers open water bodies, fringed by reeds and other aquatic vegetation for breeding and foraging. Needs fallen logs and debris for shelter and over-wintering purposes. **Suitable habitat present within the study area. The species has previously been identified within the Sewage Treatment Plant Polishing Ponds within the Bayswater Site (last recorded in early 2000's) and Lake Liddell (last confirmed in late 1970's) (DECC, 2007).** **One round of surveys conducted in November 2019 and three rounds in January 2020. Species not identified during field surveys.**	**Moderate - Low**

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Litoria booroolongensis Booroolong Frog	E	E	-	PMST	Occurs along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Streams range from small slow-flowing creeks to large rivers. The species is associated with wet sclerophyll forests (shrubby and grassy sub-formation), dry sclerophyll forest (shrub/grass and shrubby sub-formation), grassy woodland, heathland, forested wetland, freshwater wetland, rainforest, cleared grazing land and pasture. **No suitable habitat present within the study area, however, no known records within locality.**	Nil
Litoria littlejohni Littlejohn's Tree Frog	V	V	-	PMST	Breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath based forests and woodlands where it shelters under leaf litter and low vegetation. **No suitable habitat present within the Study Area. No known records within the locality.**	Nil
Birds						
Anseranas semipalmata Magpie Goose	V	-	1	OEH Atlas	Inhabits shallows of dams, swampy well-vegetated margins of deep waterways. **Suitable habitat present within the Study Area.**	**Moderate**
Anthochaera phrygia Regent Honeyeater	E	CE	1	OEH Atlas, PMST	Mostly recorded in box-ironbark eucalypt associations. At times of food shortage, the species also uses other woodland types and wet lowland coastal forest dominated by Swamp Mahogany or Spotted Gum. **Suitable foraging habitat present within the study area. Has been recorded within the locality.**	**Moderate - Low**
Artamus cyanopterus cyanopterus Dusky Woodswallow	V	-	3	OEH Atlas	Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland. **Potential foraging habitat within the Study Area.**	**Moderate**

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Botaurus poiciloptilus Australasian Bittern	E	E	-	PMST	Occurs in reeds and marshes in terrestrial freshwater wetlands and, occasionally estuarine habitats. Nests in stands of Phragmites, Typha, and rushes (*Juncus*, *Baumea* spp.). **Marginal habitat present within the Study Area, however, no known records within locality.**	Low
Calidris ferruginea Curlew Sandpiper	E	CE, M	-	PMST	Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. **No suitable habitat present within the Study Area. No known records within the locality.**	Nil
Calyptorhynchus lathami Glossy Black-Cockatoo	V	-	2	OEH Atlas	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Feeds almost exclusively on the seeds of several species of she-oak (particularly Black She-oak, Forest She-oak, or Drooping She-oak). Dependent on large hollow-bearing eucalypts for nest sites. **Suitable habitat present within the Study Area.**	**Moderate**
Chthonicola sagittata Speckled Warbler	V	-	153	OEH Atlas	Prefers in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. **Suitable habitat present within the Study Area.**	**Moderate**
Circus assimilis Spotted Harrier	V	-	20	OEH Atlas	Occurs in grassy open woodland including *Acacia* and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. **Suitable habitat present within the Study Area.**	**Moderate**

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Climacteris picumnus victoriae Brown Treecreeper (eastern subspecies)	V	-	45	OEH Atlas	Inhabits Box-Gum woodlands and dry open forest of inland slopes and plains. Preferred woodlands dominated by stringybarks or other rough-barked eucalypts. Forages in trees and on the ground. Endemic to eastern Australia, occurring from the coast to inland plains and western slopes of the Great Dividing Range. Nests in tree or stump hollows greater than 6 cm. **Suitable habitat present within the Study Area.**	**Moderate**
Daphoenositta chrysoptera Varied Sittella	V	-	16	OEH Atlas	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. **Suitable habitat present within the Study Area.**	**Moderate**
Ephippiorhynchus asiaticus Black-necked Stork	E	-	1	OEH Atlas	Black-necked Storks are mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. **Marginal foraging habitat within the Study Area.**	**Moderate**
Erythrotriorchis radiatus Red Goshawk	CE	V	-	PMST	Occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia, and frequently riverine forests. Such habitats typically support high bird numbers and biodiversity, especially medium to large species which the goshawk requires for prey. Nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within one km of permanent water. **Marginal habitat present within the Study Area, however, no known records within locality.**	Low
Glossopsitta pusilla Little Lorikeet	V	-	10	OEH Atlas	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. **Suitable habitat present within the Study Area.**	**Moderate**

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Grantiella picta Painted Honeyeater	V	V	-	PMST	Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. The Painted Honeyeater specialises on mistletoes. **No suitable habitat present. No known records within the locality.**	Nil
Haliaeetus leucogaster White-bellied Sea-Eagle	V	-	22	OEH Atlas	Inhabits coastal areas including offshore islands and hunts over estuaries and waterways. **No suitable habitat present.**	Nil
Hieraaetus morphnoides Little Eagle	V	-	10	OEH Atlas	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. **Suitable habitat present within the Study Area.**	**Moderate**
Lathamus discolor Swift Parrot	E	CE	9	OEH Atlas, PMST	This migratory species has been recorded on the mainland from a variety of habitat types including dry and wet sclerophyll forest, forested wetlands, coastal swamp forests and heathlands. **Suitable foraging habitat present within the study area. Has been recorded within the locality.**	**Moderate - Low**
Lophoictinia isura Square-tailed Kite	V	-	1	OEH Atlas	It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. **Marginal suitable habitat present within the Study Area.**	**Moderate-Low**
Melanodryas cucullata cucullata Hooded Robin (south-eastern form)	V	-	14	OEH Atlas	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. **Suitable habitat present within the Study Area.**	**Known**

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Melithreptus gularis gularis Black-chinned Honeyeater (eastern subspecies)	V	-	5	OEH Atlas	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), *E. microcarpa* (Inland Grey Box), *E.* melliodora (Yellow Box), *E. blakelyi* (Blakely's Red Gum) and *E. tereticornis* (Forest Red Gum). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river she-oaks (nesting habitat) and tea-trees. **Suitable habitat present within the Study Area.**	**Moderate**
Neophema pulchella Turquoise Parrot	V	-	2	OEH Atlas	Inhabits fringes of eucalypt woodlands, often adjacent to clearings, ridges and farmland creeks. Typically forages on the ground under trees. Distributed from southern Queensland to northern Victoria, extending from the coast to the western slopes of the Great Dividing Range. Nesting occurs from December to August in tree hollows. **Suitable habitat present within the Study Area.**	**Moderate**
Ninox connivens Barking Owl	V	-	1	OEH Atlas	Preferred habitat is typically dominated by eucalypts, often red gum species. It usually roosts in or under dense foliage in large trees including rainforest species and typically breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands. **Suitable habitat present within the Study Area.**	**Moderate**
Ninox strenua Powerful Owl	V	-	2	OEH Atlas	The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. 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 comprising species such as Turpentine, Black She-oak, Blackwood, Rough-barked Apple, Cherry Ballart and a number of eucalypt species. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. **Suitable habitat present within the Study Area.**	**Moderate**

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Numenius madagascariensis Eastern Curlew	-	CE, M	-	PMST	The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. **No suitable habitat within the Study Area. No known records within the locality.**	Nil
Oxyura australis Blue-billed Duck	V	-	4	OEH Atlas	Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. **Suitable habitat present within the Study Area.**	**Moderate**
Petroica boodang Scarlet Robin	V	-	12	OEH Atlas	In NSW, it occurs from the coast to the inland slopes. The species lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. The species habitat usually contains abundant logs and fallen timber. **Potential habitat within the Study Area.**	**Moderate**
Petroica phoenicea Flame Robin	V	-	4	OEH Atlas	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. The ground layer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes. In winter, birds migrate to drier more open habitats in the lowlands (i.e. valleys below the ranges, and to the western slopes and plains). In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees, occasionally in heathland or other shrublands in coastal areas. **No suitable habitat present within the Study Area.**	Nil

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Pomatostomus temporalis temporalis Grey-crowned Babbler (eastern subspecies)	V	-	327	OEH Atlas	Inhabits Box-Gum woodlands on slopes, and Box-Cypress pine and Open-Box woodlands when on Alluvial plains. Distribution along most of the eastern side of Australia, particularly the western slopes of the Great Dividing Range. **Suitable habitat present within the Study Area.**	**Known**
Rostratula australis Australian Painted Snipe	E	E	-	PMST	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, often seen feeding at the water's edge or on mudflats. **Marginal habitat present within the Study Area. No known records within locality.**	Low
Stagonopleura guttata Diamond Firetail	V	-	18	OEH Atlas	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. **Suitable habitat present within the Study Area.**	**Moderate**
Stictonetta naevosa Freckled Duck	V	-	1	OEH Atlas	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. **No suitable habitat within the Study Area.**	Nil
Tyto longimembris Eastern Grass Owl	V	-	1	OEH Atlas	Eastern Grass Owls are found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. **Marginal habitat within the Study Area.**	**Low-Moderate**

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Tyto novaehollandiae Masked Owl	V	-	12	OEH Atlas	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. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. **Suitable habitat present within the Study Area.**	**Moderate**
Mammals						
Chalinolobus dwyeri Large-eared Pied Bat	V	V	18	OEH Atlas, PMST	Prefers dry forest close to sandstone ridgelines. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. **Suitable foraging habitat present within the Study Area. Has been recorded within the locality.**	**Moderate**
Dasyurus maculatus Spotted-tailed Quoll	V	E	65	OEH Atlas, PMST	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, small caves, rock outcrops and rocky-cliff faces as den sites. **Suitable habitat present within the study area. Has been recorded within the locality. Species not detected during field surveys.**	**Moderate - Low**
Falsistrellus tasmaniensis Eastern False Pipistrelle	V	-	10	OEH Atlas	Prefers moist habitats, with trees taller than 20 m and generally roosts in tree hollows. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. **Marginal habitat present within Study Area.**	**Low-Moderate**
Miniopterus australis Little Bentwing-bat	V	-	11	OEH Atlas	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Roosts in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. **No suitable habitat present within Study Area.**	Nil

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Miniopterus schreibersii oceanensis Eastern Bentwing-bat	V	-	86	OEH Atlas	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Roosts in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. **Suitable habitat present within the Study Area.**	**Moderate**
Mormopterus norfolkensis Eastern Freetail-bat	V	-	159	OEH Atlas	Inhabits dry sclerophyll forest and woodland, where it hunts for insects above the canopy or within clearings at forest edges. This species normally roosts in tree hollows or under loose bark on a variety of tree species. **Suitable habitat present within the Study Area.**	**Moderate**
Myotis macropus Southern Myotis	V	-	35	OEH Atlas	Generally, roost 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. Typically occurs in vegetated areas. **Suitable habitat present within the Study Area.**	**Moderate**
Nyctophilus corbeni Corben's Long-eared Bat	V	V	1	PMST	Inhabits a variety of vegetation types, including mallee, Bulloak *Allocasuarina luehmannii* and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW. Roosts in tree hollows, crevices, and under loose bark. **Suitable habitat present within the study area. Has been recorded within the locality, however, core areas of distribution further west.**	**Moderate - Low**
Petauroides volans Greater Glider	-	V	-	PMST	Feeds exclusively on eucalypt leaves, buds, flowers and mistletoe. Shelter during the day in tree hollows and will use up to 18 hollows in their home range. **Suitable habitat present within the Study Area. However, no known records within locality.**	Low

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Petaurus norfolcensis Squirrel Glider	V	-	46	OEH Atlas	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. Prefers mixed species stands with a shrub or Acacia midstorey. Requires abundant tree hollows for refuge and nest sites. **Suitable habitat present within the Study Area.**	**Moderate**
Petrogale penicillate Brush-tailed Rock-wallaby	E	V	5	OEH Atlas, PMST	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. **No suitable habitat present with the Study Area due to lack of rocky escarpments. Suitable habitat present within the larger AGL Macquarie land holdings. Has been recorded within the locality.**	Low
Phascogale tapoatafa Brush-tailed Phascogale	V	-	66	OEH Atlas	Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. **Marginal suitable habitat present within the Study Area.**	**Moderate**
Phascolarctos cinereus Koala	V	V	10	OEH Atlas, PMST	Inhabits eucalypt woodlands and forests with suitable feed tree species. **Two patches of suitable habitat present within the study area (due to patches being dominated by *Eucalyptus tereticornis* or *E. punctata*). No evidence of Koala activity was detected during the field surveys.**	Low
Pseudomys novaehollandiae New Holland Mouse	-	V	18	OEH Atlas, PMST	Known from coastal dune, heaths and heathy woodlands. **No suitable habitat present within Study Area.**	Nil
Pteropus poliocephalus Grey-headed Flying-fox	V	V	13	OEH Atlas, PMST	Occurs across a wide range of habitat types along the eastern seaboard of Australia, depending on food availability. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Nectar and fruit from myrtaceous and rainforest trees form the major components of their diet. **Suitable foraging habitat present within the study area. Has been recorded within the locality. No camps observed onsite during surveys.**	**Moderate - High**

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat	V	-	12	OEH Atlas	Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Roosts in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. **Suitable habitat present within Study Area.**	**Moderate**
Vespadelus troughtoni Eastern Cave Bat	V	-	23	OEH Atlas	A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals. Occasionally found along cliff-lines in wet eucalypt forest and rainforest. **No suitable habitat present within the Study Area.**	Nil
Reptiles						
Delma impar Striped Legless Lizard	V	V	23	OEH Atlas	Found mainly in natural temperate grassland but has also been captured in grasslands that have a high exotic component, secondary grassland near natural temperate grassland and occasionally in open box-gum woodland. Habitat is where grassland is dominated by perennial, tussock-forming grasses such as Kangaroo Grass *Themeda australis*, spear-grasses *Austrostipa* spp. and poa tussocks *Poa* spp., and occasionally wallaby grasses *Austrodanthonia* spp. **Suitable habitat present within the study area. Has been recorded within the locality to the west. Species identified within Borrow Pit 4 within the Site.**	**Known**
Migratory Species						
Actitis hypoleucos Common Sandpiper	-	M	-	PMST	Utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. Has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow, and may be steep. Often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags. **Suitable habitat present within the Study Area, however, no known records within locality.**	Low

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Apus pacificus Fork-tailed Swift	-	M	-	PMST	Almost exclusively aerial. Mostly occur over inland plains but sometimes above foothills or in coastal areas. Occurs over cliffs and beaches and also over islands and sometimes well out to sea. Also occurs over settled areas, including towns, urban areas and cities. Mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. Also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. Sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines. **Suitable habitat present within the Study Area, however, almost exclusively aerial and no known records within locality.**	Low
Calidris acuminate Sharp-tailed Sandpiper	-	M	-	PMST	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. Also occur in saltworks and sewage farms. Use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. Use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. **Suitable habitat present within the Study Area, however, no known records within locality.**	Low
Calidris ferruginea Curlew Sandpiper	E	CE, M	-	PMST	Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. **No suitable habitat present within the Study Area. No known records within the locality.**	Nil

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Calidris melanotos Pectoral Sandpiper	-	M	-	PMST	Prefers shallow fresh to saline wetlands. Found in coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. Has also been recorded in swamp overgrown with lignum. Forage in shallow water or soft mud at the edge of wetlands. **Suitable habitat present within the Study Area, however, no known records within locality.**	Low
Calidris ruficollis Red-necked Stint	-	M	1	OEH Atlas	Mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Also occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats. Sometimes use flooded paddocks or damp grasslands. **Marginal habitat present within the study area. One record in the locality.**	Low
Gallinago hardwickii Latham's Snipe	-	M	-	PMST	Occurs in permanent and ephemeral wetlands. Usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity. **Suitable habitat present within the Study Area, however, no known records within locality.**	Low

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Hirundapus caudacutus White-throated Needletail	-	M	8	OEH Atlas, PMST	Almost exclusively aerial. Occur over most types of habitat, recorded most often above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, and less commonly recorded flying above woodland. Commonly occur over heathland, but less often over treeless areas, such as grassland or swamps. When flying above farmland, more often recorded above partly cleared pasture, plantations or remnant vegetation at the edge of paddocks. **Although exclusively aerial, may utilise suitable habitat within the study area. Has been recorded within the locality.**	**Moderate - Low**
Hydroprogne caspia Caspian Tern	-	M	2	OEH Atlas	Found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. Also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks. Also use artificial wetlands, including reservoirs, sewage ponds and saltworks. Forages in open wetlands, including lakes and rivers. **Marginal habitat present within the study area. Two records of the species in the locality.**	Low
Monarcha melanopsis Black-faced Monarch	-	M	-	PMST	Mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest. It is also sometimes found in nearby open eucalypt forests (mainly wet sclerophyll forests), especially in gullies with a dense, shrubby understorey as well as in dry sclerophyll forests and woodlands, often with a patchy understorey. **No suitable habitat present as no rainforest or wet sclerophyll forest within the study area or surrounds. No known records within the locality.**	Nil

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Motacilla flava Yellow Wagtail	-	M	-	PMST	Known from artificial/aquatic wastewater treatment areas, arable land, pastureland, temperate grassland, tundra grassland, temperate shrubland, bogs, marshes, swamps, fens, peatlands, permanent freshwater lakes (over 8 hectares) and permanent rivers/streams/creeks. **Suitable habitat present within the Study Area, however, no known records within locality.**	Low
Myiagra cyanoleuca Satin Flycatcher	-	M	-	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. Mainly inhabit eucalypt forests, often near wetlands or watercourses. Also occurs in eucalypt woodlands with open understorey and grass ground cover, especially wet sclerophyll forest. They sometimes also occur in dry sclerophyll forests and woodlands. On passage, they sometimes occur in riparian River Red Gums, *E. camaldulensis*. **Suitable habitat present within the Study Area, however, no known records within locality.**	Low
Numenius madagascariensis Eastern Curlew	-	CE, M	-	PMST	The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. **No suitable habitat within the Study Area. No known records within the locality.**	Nil
Pandion cristatus Eastern Osprey	V	M	-	PMST	Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea. **No suitable habitat within the Study Area. No known records within the locality.**	Nil

Species	Legal Status		Number of records (10 km)	Source[#]	Habitat Preferences	Likelihood of occurrence
	BC Act	EPBC Act				
Rhipidura rufifrons Rufous Fantail	-	M	-	PMST	Mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallowwood (*Eucalyptus microcorys*), Mountain Grey Gum (*E. cypellocarpa*), Narrow-leaved Peppermint (*E. radiata*), Mountain Ash (*E. regnans*), Alpine Ash (*E. delegatensis*), Blackbutt (*E. pilularis*) or Red Mahogany *(E. resinifera*); usually with a dense shrubby understorey often including ferns. They also occur in subtropical and temperate rainforests. They occasionally occur in secondary regrowth, following logging or disturbance in forests or rainforests. When on passage, they are sometimes recorded in drier sclerophyll forests and woodlands, including Spotted Gum (*Eucalyptus maculata*), Yellow Box (*E. melliodora*), ironbarks or stringybarks, often with a shrubby or heath understorey. **No suitable habitat present within the study area, however, no known records within locality.**	Nil
Tringa nebularia Common Greenshank	-	M	-	PMST	Found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. Uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. It will also use artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. **Suitable habitat present within the Study Area, however, no known records within locality.**	Low
Tringa stagnatilis Marsh Sandpiper	-	M	1	OEH Atlas	Lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. Recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. In south-east Australia they prefer inland saline lakes and coastal saltworks. **Marginal habitat present within the study area. One record of the species in the locality.**	Low

* Legal Status: V = Vulnerable, E = Endangered, CE = Critically Endangered under BC Act and EPBC Act; M = Migratory under EPBC Act.

APPENDIX 3. FLORA AND FAUNA SPECIES LIST

Flora Species List

No.	Family	Scientific Name	BAM Growth Form	*Biosecurity Act 2015* Status
	Introduced Species			
1	Aizoaceae	*Galenia pubescens*	High Threat	
2	Asteraceae	*Bidens pilosa*	High Threat	
3	Asteraceae	*Carthamus lanatus*	High Threat	
4	Asteraceae	*Senecio madagascariensis*	High Threat	Priority Weed in Hunter, Weed of National Significance
5	Cactaceae	*Opuntia stricta*	High Threat	Priority Weed in Hunter, Weed of National Significance
6	Iridaceae	*Romulea rosea*	High Threat	
7	Juncaceae	*Juncus acutus*	High Threat	
8	Oleaceae	*Olea europaea* subsp. *cuspidata*	High Threat	Priority Weed in Hunter
9	Poaceae	*Axonopus fissifolius*	High Threat	
10	Poaceae	*Bromus diandrus*	High Threat	
11	Poaceae	*Chloris gayana*	High Threat	
12	Poaceae	*Ehrharta erecta*	High Threat	
13	Poaceae	*Eragrostis curvula*	High Threat	
14	Poaceae	*Hyparrhenia hirta*	High Threat	Priority Weed in Hunter
15	Poaceae	*Megathyrsus maximus*	High Threat	
16	Solanaceae	*Lycium ferocissimum*	High Threat	Priority Weed in Hunter, Weed of National Significance
17	Apiaceae	*Cyclospermum leptophyllum*	Exotic	
18	Apocynaceae	*Gomphocarpus fruticosus*	Exotic	
19	Asphodelaceae	*Asphodelus fistulosus*	Exotic	
20	Asteraceae	*Aster subulatus*	Exotic	
21	Asteraceae	*Cirsium vulgare*	Exotic	
22	Asteraceae	*Conyza bonariensis*	Exotic	
23	Asteraceae	*Gamochaeta calviceps*	Exotic	
24	Asteraceae	*Hypochaeris radicata*	Exotic	
25	Asteraceae	*Leontodon rhagadioloides*	Exotic	

No.	Family	Scientific Name	BAM Growth Form	*Biosecurity Act 2015* Status
26	Asteraceae	*Soliva sessilis*	Exotic	
27	Asteraceae	*Sonchus asper*	Exotic	
28	Asteraceae	*Sonchus oleraceus*	Exotic	
29	Asteraceae	*Taraxacum officinale*	Exotic	
30	Brassicaceae	*Brassica* spp.	Exotic	
31	Brassicaceae	*Lepidium africanum*	Exotic	
32	Brassicaceae	*Rorippa microphylla*	Exotic	
33	Brassicaceae	*Sisymbrium* spp.	Exotic	
34	Caryophyllaceae	*Paronychia brasiliana*	Exotic	
35	Caryophyllaceae	*Petrorhagia nanteuilii*	Exotic	
36	Caryophyllaceae	*Silene gallica*	Exotic	
37	Fabaceae (Faboideae)	*Medicago minima*	Exotic	
38	Fabaceae (Faboideae)	*Medicago* spp.	Exotic	
39	Fabaceae (Faboideae)	*Trifolium campestre*	Exotic	
40	Fabaceae (Faboideae)	*Trifolium repens*	Exotic	
41	Fabaceae (Faboideae)	*Trifolium subterraneum*	Exotic	
42	Lamiaceae	*Stachys arvensis*	Exotic	
43	Linaceae	*Linum trigynum*	Exotic	
44	Malvaceae	*Modiola caroliniana*	Exotic	
45	Malvaceae	*Pavonia hastata*	Exotic	
46	Malvaceae	*Sida rhombifolia*	Exotic	
47	Myrsinaceae	*Lysimachia arvensis*	Exotic	
48	Phyllanthaceae	*Phyllanthus tenellus*	Exotic	
49	Plantaginaceae	*Plantago lanceolata*	Exotic	
50	Poaceae	*Briza minor*	Exotic	
51	Poaceae	*Bromus catharticus*	Exotic	
52	Poaceae	*Lolium perenne*	Exotic	
53	Poaceae	*Lolium rigidum*	Exotic	
54	Poaceae	*Melinis repens*	Exotic	
55	Rubiaceae	*Richardia brasiliensis*	Exotic	
56	Rubiaceae	*Richardia stellaris*	Exotic	
57	Rutaceae	*Murraya paniculata*	Exotic	
58	Solanaceae	*Solanum nigrum*	Exotic	
59	Verbenaceae	*Verbena bonariensis*	Exotic	
60	Verbenaceae	*Verbena hispida*	Exotic	

No.	Family	Scientific Name	BAM Growth Form	*Biosecurity Act 2015* Status
61	Verbenaceae	*Verbena rigida*	Exotic	
	Endangered Population (BC Act)			
62	Fabaceae (Mimosoideae)	*Acacia pendula*	Tree (TG)	
	Native Species			
63	Acanthaceae	*Brunoniella australis*	Forb (FG)	
64	Anthericaceae	*Arthropodium milleflorum*	Forb (FG)	
65	Apiaceae	*Daucus glochidiatus*	Forb (FG)	
66	Asteraceae	*Brachyscome dentata*	Forb (FG)	
67	Asteraceae	*Calotis cuneifolia*	Forb (FG)	
68	Asteraceae	*Calotis lappulacea*	Forb (FG)	
69	Asteraceae	*Chrysocephalum apiculatum*	Forb (FG)	
70	Asteraceae	*Chrysocephalum semipapposum*	Forb (FG)	
71	Asteraceae	*Cotula australis*	Forb (FG)	
72	Asteraceae	*Cyanthillium cinereum*	Forb (FG)	
73	Asteraceae	*Cymbonotus lawsonianus*	Forb (FG)	
74	Asteraceae	*Euchiton sphaericus*	Forb (FG)	
75	Asteraceae	*Glossocardia bidens*	Forb (FG)	
76	Asteraceae	*Lagenophora stipitata*	Forb (FG)	
77	Asteraceae	*Vittadinia cuneata*	Forb (FG)	
78	Asteraceae	*Vittadinia muelleri*	Forb (FG)	
79	Campanulaceae	*Wahlenbergia communis*	Forb (FG)	
80	Campanulaceae	*Wahlenbergia gracilis*	Forb (FG)	
81	Campanulaceae	*Wahlenbergia* spp.	Forb (FG)	
82	Caryophyllaceae	*Spergularia marina*	Forb (FG)	
83	Casuarinaceae	*Allocasuarina luehmannii*	Tree (TG)	
84	Casuarinaceae	*Casuarina cristata*	Tree (TG)	
85	Casuarinaceae	*Casuarina glauca*	Tree (TG)	
86	Chenopodiaceae	*Atriplex semibaccata*	Shrub (SG)	
87	Chenopodiaceae	*Atriplex* spp.	Shrub (SG)	
88	Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	Forb (FG)	
89	Chenopodiaceae	*Einadia nutans* subsp. *nutans*	Forb (FG)	
90	Chenopodiaceae	*Enchylaena tomentosa*	Shrub (SG)	
91	Chenopodiaceae	*Maireana enchylaenoides*	Forb (FG)	
92	Chenopodiaceae	*Maireana microphylla*	Shrub (SG)	
93	Chenopodiaceae	*Sclerolaena muricata*	Shrub (SG)	

No.	Family	Scientific Name	BAM Growth Form	*Biosecurity Act 2015* Status
94	Clusiaceae	*Hypericum gramineum*	Forb (FG)	
95	Commelinaceae	*Commelina cyanea*	Forb (FG)	
96	Convolvulaceae	*Convolvulus erubescens*	Other (OG)	
97	Convolvulaceae	*Dichondra repens*	Forb (FG)	
98	Crassulaceae	*Crassula sieberiana*	Forb (FG)	
99	Cyperaceae	*Carex inversa*	Grass & grasslike (GG)	
100	Cyperaceae	*Cyperus gracilis*	Grass & grasslike (GG)	
101	Cyperaceae	*Cyperus* spp.	Grass & grasslike (GG)	
102	Cyperaceae	*Fimbristylis dichotoma*	Grass & grasslike (GG)	
103	Euphorbiaceae	*Chamaesyce drummondii*	Forb (FG)	
104	Fabaceae (Caesalpinioideae)	*Senna barclayana*	Forb (FG)	
105	Fabaceae (Faboideae)	*Desmodium brachypodum*	Forb (FG)	
106	Fabaceae (Faboideae)	*Desmodium gunnii*	Forb (FG)	
107	Fabaceae (Faboideae)	*Desmodium* spp.	Other (OG)	
108	Fabaceae (Faboideae)	*Desmodium varians*	Other (OG)	
109	Fabaceae (Faboideae)	*Glycine clandestina*	Other (OG)	
110	Fabaceae (Faboideae)	*Glycine microphylla*	Other (OG)	
111	Fabaceae (Faboideae)	*Glycine tabacina*	Other (OG)	
112	Fabaceae (Faboideae)	*Templetonia stenophylla*	Forb (FG)	
113	Fabaceae (Mimosoideae)	*Acacia implexa*	Shrub (SG)	
114	Fabaceae (Mimosoideae)	*Acacia salicina*	Tree (TG)	
115	Geraniaceae	*Erodium crinitum*	Forb (FG)	
116	Geraniaceae	*Geranium homeanum*	Forb (FG)	
117	Goodeniaceae	*Goodenia hederacea*	Forb (FG)	
118	Goodeniaceae	*Goodenia heterophylla*	Forb (FG)	
119	Lamiaceae	*Ajuga australis*	Forb (FG)	
120	Lamiaceae	*Scutellaria humilis*	Forb (FG)	
121	Lamiaceae	*Spartothamnella juncea*	Shrub (SG)	
122	Linaceae	*Linum marginale*	Forb (FG)	
123	Lobeliaceae	*Pratia purpurascens*	Forb (FG)	

No.	Family	Scientific Name	BAM Growth Form	*Biosecurity Act 2015* Status
124	Lomandraceae	*Lomandra filiformis*	Grass & grasslike (GG)	
125	Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	Grass & grasslike (GG)	
126	Loranthaceae	*Amyema cambagei*	Other (OG)	
127	Malvaceae	*Abutilon oxycarpum*	Shrub (SG)	
128	Malvaceae	*Brachychiton populneus*	Tree (TG)	
129	Malvaceae	*Sida corrugata*	Forb (FG)	
130	Malvaceae	*Sida hackettiana*	Forb (FG)	
131	Myrtaceae	*Angophora floribunda*	Tree (TG)	
132	Myrtaceae	*Corymbia maculata*	Tree (TG)	
133	Myrtaceae	*Eucalyptus crebra*	Tree (TG)	
134	Myrtaceae	*Eucalyptus melliodora*	Tree (TG)	
135	Myrtaceae	*Eucalyptus moluccana*	Tree (TG)	
136	Myrtaceae	*Eucalyptus punctata*	Tree (TG)	
137	Myrtaceae	*Eucalyptus* spp.	Tree (TG)	
138	Myrtaceae	*Eucalyptus tereticornis*	Tree (TG)	
139	Oleaceae	*Jasminum suavissimum*	Other (OG)	
140	Oleaceae	*Notelaea microcarpa*	Tree (TG)	
141	Other	Unknown herb	Forb (FG)	
142	Other	Unknown herb - Succulent	Forb (FG)	
143	Other	Unknown herb #2	Forb (FG)	
144	Oxalidaceae	*Oxalis perennans*	Forb (FG)	
145	Phormiaceae	*Dianella revoluta*	Forb (FG)	
146	Phyllanthaceae	*Phyllanthus virgatus*	Forb (FG)	
147	Pittosporaceae	*Bursaria spinosa*	Shrub (SG)	
148	Pittosporaceae	*Rhytidosporum* spp.	Shrub (SG)	
149	Plantaginaceae	*Plantago debilis*	Forb (FG)	
150	Plantaginaceae	*Plantago hispida*	Forb (FG)	
151	Poaceae	*Anthosachne scabra*	Grass & grasslike (GG)	
152	Poaceae	*Aristida echinata*	Grass & grasslike (GG)	
153	Poaceae	*Aristida ramosa*	Grass & grasslike (GG)	
154	Poaceae	*Austrostipa scabra*	Grass & grasslike (GG)	
155	Poaceae	*Austrostipa* spp.	Grass & grasslike (GG)	
156	Poaceae	*Austrostipa verticillata*	Grass & grasslike (GG)	
157	Poaceae	*Bothriochloa macra*	Grass & grasslike (GG)	
158	Poaceae	*Chloris* spp.	Grass & grasslike (GG)	
159	Poaceae	*Chloris truncata*	Grass & grasslike (GG)	
160	Poaceae	*Chloris ventricosa*	Grass & grasslike (GG)	
161	Poaceae	*Cymbopogon refractus*	Grass & grasslike (GG)	

No.	Family	Scientific Name	BAM Growth Form	*Biosecurity Act 2015* Status
162	Poaceae	*Cynodon dactylon*	Grass & grasslike (GG)	
163	Poaceae	*Dichelachne micrantha*	Grass & grasslike (GG)	
164	Poaceae	*Digitaria diffusa*	Grass & grasslike (GG)	
165	Poaceae	*Echinopogon caespitosus*	Grass & grasslike (GG)	
166	Poaceae	*Eragrostis brownii*	Grass & grasslike (GG)	
167	Poaceae	*Eragrostis leptostachya*	Grass & grasslike (GG)	
168	Poaceae	*Microlaena stipoides* var. *stipoides*	Grass & grasslike (GG)	
169	Poaceae	*Panicum effusum*	Grass & grasslike (GG)	
170	Poaceae	*Panicum simile*	Grass & grasslike (GG)	
171	Poaceae	*Panicum* spp.	Grass & grasslike (GG)	
172	Poaceae	*Phragmites australis*	Grass & grasslike (GG)	
173	Poaceae	*Poa sieberiana*	Grass & grasslike (GG)	
174	Poaceae	*Poa* spp.	Grass & grasslike (GG)	
175	Poaceae	*Rytidosperma fulvum*	Grass & grasslike (GG)	
176	Poaceae	*Sporobolus creber*	Grass & grasslike (GG)	
177	Poaceae	*Themeda triandra*	Grass & grasslike (GG)	
178	Polygonaceae	*Persicaria* spp.	Forb (FG)	
179	Polygonaceae	*Rumex brownii*	Forb (FG)	
180	Pteridaceae	*Cheilanthes distans*	Fern (EG)	
181	Pteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	Fern (EG)	
182	Rubiaceae	*Asperula conferta*	Forb (FG)	
183	Rubiaceae	*Opercularia diphylla*	Forb (FG)	
184	Rubiaceae	*Psydrax odorata*	Shrub (SG)	
185	Scrophulariaceae	*Eremophila debilis*	Shrub (SG)	
186	Scrophulariaceae	*Myoporum montanum*	Shrub (SG)	
187	Scrophulariaceae	*Veronica plebeia*	Forb (FG)	
188	Solanaceae	*Solanum cinereum*	Shrub (SG)	
189	Solanaceae	*Solanum prinophyllum*	Forb (FG)	
190	Solanaceae	*Solanum* spp.	Forb (FG)	
191	Stackhousiaceae	*Stackhousia viminea*	Forb (FG)	
192	Typhaceae	*Typha domingensis*	Grass & grasslike (GG)	
193	Vitaceae	*Cayratia clematidea*	Other (OG)	

Fauna Species List

No.	Scientific Name	Common Name	Status
	Amphibians		
1.	*Crinia Signifera*	Common Eastern Froglet	
2.	*Limnodynastes tasmaniensis*	Spotted Grass Frog	
3.	*Litoria Fallax*	Eastern Dwarf Tree Frog	
4.	*Litoria latopalmata*	Broad-palmed Frog	
5.	*Litoria peronii*	Peron's Tree Frog	
	Birds		
6.	*Aegotheles cristatus*	Owlet Nightjar	
7.	*Aquila audax*	Wedge-tailed Eagle	
8.	*Chthonicola sagittata*	Speckled Warbler	Vulnerable (BC Act)
9.	*Corcorax melanorhamphos*	White Winged Chough	
10.	*Corvus coronoides*	Australian Raven	
11.	*Cracticus nigrogularis*	Butcher Bird	
12.	*Cracticus torquatus*	Grey Butcherbird	
13.	*Elanus axillaris*	Black-shouldered Kite	
14.	*Eolophus roseicapilla*	Gallah	
15.	*Glossopsitta pusilla*	Little Lorikeet	Vulnerable (BC Act)
16.	*Glossopsitta concinna*	Musk Lorikeet	
17.	*Trichoglossus moluccanus*	Rainbow Lorikeet	
18.	*Chenonetta jubata*	Australian Wood Duck	
19.	*Grallina cyanoleuca*	Magpie Lark	
20.	*Manorina melanocephala*	Noisy Miner	
21.	*Megalurus mathewsi*	Rufous Songlark	
22.	*Melanodryas cucullata*	Hooded Robin	Vulnerable (BC Act)
23.	*Podargus strigoides*	Tawny Frogmouth	
24.	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler	Vulnerable (BC Act)
25.	*Rhipidura leucophrys*	Willy Wagtail	
	Fish		
26.	*Gambusia holbrooki*	Mosquito Fish	Feral
	Mammals		
27.	*Antechinus stuartii*	Brown Antechinus	
28.	*Canis familiaris*	Wild Dog	
29.	*Chalinolobus gouldii*	Gould's Wattled Bat	
30.	*Chalinolobus morio*	Chocolate Wattled Bat	
31.	*Isoodon macrourus*	Northern Brown Bandicoot	
32.	*Lepus europaeus*	European Hare	
33.	*Macropus giganteus*	Eastern Grey Kangaroo	

No.	Scientific Name	Common Name	Status
34.	*Macropus robustus*	Wallaroo	
35.	*Macropus rufogriseus*	Red-necked Wallaby	
36.	*Miniopterus orianae oceanensis*	Large Bent-winged Bat	Vulnerable (BC Act)
37.	*Mormopterus* Sp. 2	Undescribed Freetail-bat	
38.	*Mormopterus* Sp. 4	Southern Free-tailed Bat	
39.	*Mus musculus*	House Mouse	Feral
40.	*Myotis macropus*	Southern Myotis	Vulnerable (BC Act)
41.	*Nyctophilus* sp.	Long-eared Bat	
42.	*Oryctolagus cuniculus*	European Rabbit	
43.	*Petaurus breviceps*	Sugar Glider	
44.	*Petaurus norfolcensis*	Squirrel Glider	Vulnerable (BC Act)
45.	*Pteropus poliocephalus*	Grey Headed Flying Fox	
46.	*Rattus rattus*	Black Rat	Feral
47.	*Sminthopsis murina*	Common Dunnart	
48.	*Tachyglossus aculeatus*	Echidna	
49.	*Trichosurus vulpecula*	Brush-tailed Possum	
50.	*Vespadelus pumilus*	Eastern Forest Bat	
51.	*Vulpes vulpes*	Red Fox	Feral
	Reptiles		
52.	*Anomalopus leuckartii*	Two-clawed Worm-skink	
53.	*Chelodina longicollis*	Snake-necked Turtle	
54.	*Ctenotus robustus*	Eastern Stripped Skink	
55.	*Delma impar*	Stripped Legless Lizard	Vulnerable (BC Act and EPBC Act)
56.	*Delma plebeia*	Leaden Delma	
57.	*Diplodactylus vittatus*	Eastern Stone Gecko	
58.	*Egernia striolata*	Tree Skink	
59.	*Intellagama lesueurii*	Eastern Water Dragon	
60.	*Parasuta dwyeri*	Dwyer's Snake	
61.	*Pogona barbata*	Eastern Bearded Dragon	
62.	*Pseudonaja textilis*	Brown Snake	
63.	*Underwoodisaurus milii*	Thick-tailed Gecko	
64.	*Varanus varius*	Lace Monitor	

APPENDIX 4. FAUNA SITE PHOTOGRAPHS

Squirrel Glider identified via remote camera within Borrow Pit 4.

Striped Legless Lizard identified within Borrow Pit 4 (27/09/2019).

Striped Legless Lizard identified within Borrow Pit 4 (2/12/2019).

Striped Legless Lizard identified within Borrow Pit 4 (2/12/2019), profile showing nasal scales.

Green and Golden Bell Frog Habitat, Dam 1

Green and Golden Bell Frog Habitat, Dam 2

Green and Golden Bell Frog Habitat, Dam 3

Green and Golden Bell Frog Habitat, Dam 4

Green and Golden Bell Frog Habitat, Dam 5

Green and Golden Bell Frog Habitat, Dam 6

Green and Golden Bell Frog Habitat, Dam 7

Green and Golden Bell Frog Habitat, Dam 8

APPENDIX 5. PREDICTED AND CANDIDATE SPECIES REPORTS

BAM Predicted Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00018204/BAAS18041/19/00018207	Bayswater Power Station WOAOW Project	05/05/2020
Assessor Name	**Report Created**	**BAM Data version ***
	14/05/2020	26
Assessor Number	**Assessment Type**	**BAM Case Status**
	Major Projects	Open
	Assessment Revision	**Date Finalised**
	2	To be finalised

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Threatened species reliably predicted to utilise the site. No surveys are required for these species. Ecosystem credits apply to these species.

Common Name	Scientific Name	Vegetation Types(s)
Barking Owl	Ninox connivens	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
		1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
Black-chinned Honeyeater (eastern subspecies)	Melithreptus gularis gularis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Brown Treecreeper (eastern subspecies)	Climacteris picumnus victoriae	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Eastern Coastal Free-tailed Bat	Micronomus norfolkensis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Eastern False Pipistrelle	Falsistrellus tasmaniensis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Eastern Grass Owl	Tyto longimembris	1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley

Flame Robin	Petroica phoenicea	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Gang-gang Cockatoo	Callocephalon fimbriatum	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
		1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
Glossy Black-Cockatoo	Calyptorhynchus lathami	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Greater Broad-nosed Bat	Scoteanax rueppellii	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Grey-headed Flying-fox	Pteropus poliocephalus	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Hooded Robin (south-eastern form)	Melanodryas cucullata cucullata	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Large Bent-winged Bat	Miniopterus orianae oceanensis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Little Eagle	Hieraaetus morphnoides	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
		1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
Little Lorikeet	Glossopsitta pusilla	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Masked Owl	Tyto novaehollandiae	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley

Powerful Owl	Ninox strenua	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Regent Honeyeater	Anthochaera phrygia	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Scarlet Robin	Petroica boodang	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Speckled Warbler	Chthonicola sagittata	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Spotted Harrier	Circus assimilis	1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
Spotted-tailed Quoll	Dasyurus maculatus	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
		1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
Square-tailed Kite	Lophoictinia isura	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Swift Parrot	Lathamus discolor	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Turquoise Parrot	Neophema pulchella	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
Varied Sittella	Daphoenositta chrysoptera	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
White-bellied Sea-Eagle	Haliaeetus leucogaster	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley
		1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	1692-Bull Oak grassy woodland of the central Hunter Valley

Threatened species not within the area of these PCT's

Common Name	Scientific Name	Vegetation Types(s)
Painted Honeyeater	Grantiella picta	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
		1692-Bull Oak grassy woodland of the central Hunter Valley

BAM Candidate Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00018204/BAAS18041/19/00018207	Bayswater Power Station WOAOW Project	05/05/2020
Assessor Name	**Report Created**	**BAM Data version ***
	14/05/2020	26
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	Major Projects	Open
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	2	To be finalised

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List of Species Requiring Survey

Name	Presence	Survey Months
Burhinus grallarius Bush Stone-curlew	No (surveyed)	**Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec**
Calyptorhynchus lathami Glossy Black-Cockatoo	No (surveyed)	Jan Feb Mar **Apr May Jun Jul Aug** Sep Oct Nov Dec
Cercartetus nanus Eastern Pygmy-possum	No (surveyed)	**Jan Feb Mar** Apr May Jun Jul Aug Sep **Oct Nov Dec**
Eucalyptus glaucina Slaty Red Gum	No (surveyed)	**Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec**
Diuris tricolor Pine Donkey Orchid	No (expert report)	Jan Feb Mar Apr May Jun Jul Aug **Sep Oct** Nov Dec

Hoplocephalus bitorquatus Pale-headed Snake	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Litoria aurea Green and Golden Bell Frog	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Persicaria elatior Tall Knotweed	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Lophoictinia isura Square-tailed Kite	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Myotis macropus Southern Myotis	Yes (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Ninox connivens Barking Owl	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Ninox strenua Powerful Owl	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Phascogale tapoatafa Brush-tailed Phascogale	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Planigale maculata Common Planigale	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Pteropus poliocephalus Grey-headed Flying-fox	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Tyto novaehollandiae Masked Owl	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Callocephalon fimbriatum Gang-gang Cockatoo	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep **Oct** **Nov** **Dec**
Hieraaetus morphnoides Little Eagle	No (surveyed)	Jan Feb Mar Apr May Jun Jul **Aug** **Sep** **Oct** Nov Dec
Haliaeetus leucogaster White-bellied Sea-Eagle	No (surveyed)	Jan Feb Mar Apr May Jun **Jul** **Aug** **Sep** **Oct** **Nov** **Dec**
Acacia pendula - endangered population Acacia pendula population in the Hunter catchment	No (surveyed)	**Jan** **Feb** **Mar** **Apr** **May** **Jun** **Jul** **Aug** **Sep** **Oct** **Nov** **Dec**
Cymbidium canaliculatum - endangered population Cymbidium canaliculatum population in the Hunter Catchment	No (surveyed)	**Jan** **Feb** **Mar** **Apr** **May** **Jun** **Jul** **Aug** **Sep** **Oct** **Nov** **Dec**
Delma impar Striped Legless Lizard	Yes (surveyed)	Jan Feb Mar Apr May Jun Jul Aug **Sep** **Oct** **Nov** **Dec**
Pterostylis chaetophora Pterostylis chaetophora	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug **Sep** **Oct** **Nov** Dec
Petaurus norfolcensis Squirrel Glider	Yes (surveyed)	**Jan** **Feb** **Mar** **Apr** **May** **Jun** **Jul** **Aug** **Sep** **Oct** **Nov** **Dec**
Prasophyllum petilum Tarengo Leek Orchid	No (expert report)	Jan Feb Mar Apr May Jun Jul Aug **Sep** **Oct** **Nov** **Dec**

List of Species Not On Site

Name
Chalinolobus dwyeri Large-eared Pied Bat

Lathamus discolor Swift Parrot
Miniopterus orianae oceanensis Large Bent-winged Bat
Petrogale penicillata Brush-tailed Rock-wallaby
Anthochaera phrygia Regent Honeyeater

BAM Predicted Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00018204/BAAS18041/20/00018902	Bayswater Power Station WOAOW Project - 1691 Non-TEC	05/05/2020
Assessor Name	**Report Created**	**BAM Data version ***
	14/05/2020	26
Assessor Number	**Assessment Type**	**BAM Case Status**
	Major Projects	Open
	Assessment Revision	**Date Finalised**
	1	To be finalised

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Threatened species reliably predicted to utilise the site. No surveys are required for these species. Ecosystem credits apply to these species.

Common Name	Scientific Name	Vegetation Types(s)
Barking Owl	Ninox connivens	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Black-chinned Honeyeater (eastern subspecies)	Melithreptus gularis gularis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Brown Treecreeper (eastern subspecies)	Climacteris picumnus victoriae	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Eastern Coastal Free-tailed Bat	Micronomus norfolkensis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Eastern False Pipistrelle	Falsistrellus tasmaniensis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Flame Robin	Petroica phoenicea	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Gang-gang Cockatoo	Callocephalon fimbriatum	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Glossy Black-Cockatoo	Calyptorhynchus lathami	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Greater Broad-nosed Bat	Scoteanax rueppellii	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Grey-headed Flying-fox	Pteropus poliocephalus	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Hooded Robin (south-eastern form)	Melanodryas cucullata cucullata	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Large Bent-winged Bat	Miniopterus orianae oceanensis	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Little Eagle	Hieraaetus morphnoides	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Little Lorikeet	Glossopsitta pusilla	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Masked Owl	Tyto novaehollandiae	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Powerful Owl	Ninox strenua	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Regent Honeyeater	Anthochaera phrygia	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Scarlet Robin	Petroica boodang	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Speckled Warbler	Chthonicola sagittata	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Spotted-tailed Quoll	Dasyurus maculatus	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Square-tailed Kite	Lophoictinia isura	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Swift Parrot	Lathamus discolor	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Turquoise Parrot	Neophema pulchella	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Varied Sittella	Daphoenositta chrysoptera	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
White-bellied Sea-Eagle	Haliaeetus leucogaster	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Threatened species not within the area of these PCT's

BAM Predicted Species Report

Common Name	Scientific Name	Vegetation Types(s)
Painted Honeyeater	Grantiella picta	1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

BAM Candidate Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00018204/BAAS18041/20/00018902	Bayswater Power Station WOAOW Project - 1691 Non-TEC	05/05/2020
Assessor Name	**Report Created**	**BAM Data version ***
	14/05/2020	26
Assessor Number	**Assessment Type**	**BAM Case Status**
	Major Projects	Open
	Assessment Revision	**Date Finalised**
	1	To be finalised

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List of Species Requiring Survey

Name	Presence	Survey Months
Burhinus grallarius Bush Stone-curlew	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Calyptorhynchus lathami Glossy Black-Cockatoo	No (surveyed)	Apr May Jun Jul Aug
Cercartetus nanus Eastern Pygmy-possum	No (surveyed)	Jan Feb Mar Oct Nov Dec
Eucalyptus glaucina Slaty Red Gum	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Diuris tricolor Pine Donkey Orchid	Yes (expert report)	Sep Oct

Hoplocephalus bitorquatus Pale-headed Snake	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Litoria aurea Green and Golden Bell Frog	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Lophoictinia isura Square-tailed Kite	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Myotis macropus Southern Myotis	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Ninox connivens Barking Owl	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Ninox strenua Powerful Owl	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Phascogale tapoatafa Brush-tailed Phascogale	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Planigale maculata Common Planigale	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Pteropus poliocephalus Grey-headed Flying-fox	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Tyto novaehollandiae Masked Owl	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Callocephalon fimbriatum Gang-gang Cockatoo	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Hieraaetus morphnoides Little Eagle	No (surveyed)	Jan Feb Mar Apr May Jun Jul **Aug** **Sep** **Oct** Nov Dec
Haliaeetus leucogaster White-bellied Sea-Eagle	No (surveyed)	Jan Feb Mar Apr May Jun **Jul** **Aug** **Sep** **Oct** **Nov** **Dec**
Acacia pendula - endangered population Acacia pendula population in the Hunter catchment	No (surveyed)	**Jan** **Feb** **Mar** **Apr** **May** **Jun** **Jul** **Aug** **Sep** **Oct** **Nov** **Dec**
Cymbidium canaliculatum - endangered population Cymbidium canaliculatum population in the Hunter Catchment	No (surveyed)	**Jan** **Feb** **Mar** **Apr** **May** **Jun** **Jul** **Aug** **Sep** **Oct** **Nov** **Dec**
Delma impar Striped Legless Lizard	Yes (surveyed)	Jan Feb Mar Apr May Jun Jul Aug **Sep** **Oct** **Nov** **Dec**
Pterostylis chaetophora Pterostylis chaetophora	No (surveyed)	Jan Feb Mar Apr May Jun Jul Aug **Sep** **Oct** **Nov** Dec
Petaurus norfolcensis Squirrel Glider	Yes (surveyed)	**Jan** **Feb** **Mar** **Apr** **May** **Jun** **Jul** **Aug** **Sep** **Oct** **Nov** **Dec**
Prasophyllum petilum Tarengo Leek Orchid	Yes (expert report)	Jan Feb Mar Apr May Jun Jul Aug **Sep** **Oct** **Nov** **Dec**

List of Species Not On Site

Name
Chalinolobus dwyeri Large-eared Pied Bat
Lathamus discolor Swift Parrot
Miniopterus orianae oceanensis Large Bent-winged Bat
Petrogale penicillata Brush-tailed Rock-wallaby

Anthochaera phrygia Regent Honeyeater

BAM Predicted Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00018204/BAAS17039/20/00018875	Bayswater Power Station WOAOW Project - Paddock Trees	26/11/2019
Assessor Name	**Report Created**	**BAM Data version ***
	13/05/2020	22
Assessor Number	**BAM Case Status**	**Date Finalised**
	Open	To be finalised
Assessment Revision	**Assessment Type**	
0	Paddock Trees	

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Threatened species reliably predicted to utilise the site. No surveys are required for these species. Ecosystem credits apply to these species.

Common Name	Scientific Name
Barking Owl	Ninox connivens
Black-chinned Honeyeater (eastern subspecies)	Melithreptus gularis gularis
Brown Treecreeper (eastern subspecies)	Climacteris picumnus victoriae
Eastern Coastal Free-tailed Bat	Micronomus norfolkensis
Eastern False Pipistrelle	Falsistrellus tasmaniensis
Flame Robin	Petroica phoenicea
Glossy Black-Cockatoo	Calyptorhynchus lathami
Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis
Hooded Robin (south-eastern form)	Melanodryas cucullata cucullata
Little Eagle	Hieraaetus morphnoides
Little Lorikeet	Glossopsitta pusilla
Masked Owl	Tyto novaehollandiae
Painted Honeyeater	Grantiella picta
Scarlet Robin	Petroica boodang
Speckled Warbler	Chthonicola sagittata
Swift Parrot	Lathamus discolor
Varied Sittella	Daphoenositta chrysoptera

White-bellied Sea-Eagle	Haliaeetus leucogaster
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris

APPENDIX 6. FAUNA SURVEY EFFORT WITHIN THE STUDY AREA

Detailed comparison of fauna trapping effort against relevant guidelines

Fauna Transect	Trap type	No.	Nights/ Days	Total nights/days	Totals for Formations	DECCW Required Effort
Grassy Woodland Stratification Unit (76.43 ha)						
Transect 2: PCT 1691 – Vegetation Zone 1 and PCT 1692 – Vegetation Zones 7 and 8						
	Elliott A	20	4	80	160	Meets requirements
	Elliott B arboreal	10	4	40	80	Meets requirements
	SAT Test (Koala)	1	-	-	1	
Transect 3: PCT 1691 – Vegetation Zone 1						
	Elliott A	20	4	80	160	Meets requirements
	Elliott B arboreal	10	4	40	80	Meets requirements
Grassy Woodland Stratification Unit (Rehabilitation and Plantation Portion; 3.89 ha)						
Transect 5: PCT 1691 (Rehabilitation) – Vegetation Zone 5.						
	Elliott A	20	4	80	80	Meets requirements
	Elliott B arboreal	10	4	40	40	Meets requirements
Transect 1: PCT 1691 (Plantation), Vegetation Zone 6.						
	Elliott A	20	4	80	160	Meets requirements
	Elliott B arboreal	10	4	40	80	Meets requirements
Swamp Forest Stratification Unit (2.40 ha)						
Transect 4: PCT 1731 – Vegetation Zone 9						
	Elliott A	20	4	80	80	Meets requirements

Fauna Transect	Trap type	No.	Nights/ Days	Total nights/days	Totals for Formations	DECCW Required Effort
	Elliott B arboreal	10	4	40	40	Meets requirements
Native Grasslands and Acacia Regrowth Stratification Unit (188.13 ha)						
No trapping conducted due to lack of habitat requirements.						

Comparison of fauna survey effort (excluding trapping transects) against DECCW (2004) Guidelines.

Method	Completed	Requirements	Comment
Bird surveys	Bird census around water bodies for 1 hour at dusk on 6 separate days. Totalling 8 hours. Area searches throughout the site completed on 6 separate evenings. Totalling 8.5 hours	No specific methodology detailed – however, states that the 2 ha/20 min area search is an accepted methodology per stratification unit	-
Owl call playback	Owl Call playback and spotlighting was conducted on nine nights in June and July; and eight nights in August	At least 7 visits for the Powerful Owl, 8 visits for Sooty Owl and 9 visits for Masked owl.	-
Anabat Recordings	Anabat units were placed at 4 locations over 4 full nights. Totalling 16 recording nights	Two devices used for the entire night (min 4 hrs) starting at dusk for 2 nights	-
Harp Traps	Harp traps were placed at 4 locations over 4 full nights Totalling 16 trap nights	4 trap nights over two consecutive nights	-
Camera Trapping	Remote Cameras at 3 m: 17 cameras for 31 consecutive nights, totalling 527 trap nights. Remote Cameras at 1 m: 7 cameras for 31 consecutive nights, totalling 217 trap nights. Remote Cameras for Quoll: 12 cameras for 14 consecutive nights, totalling 168 trap nights.	No requirements in guidelines.	-
Nest Boxes	Total of seven nest boxes left in habitat for 66 consecutive nights and checked during trapping surveys.	No requirements in guidelines.	-

Method	Completed	Requirements	Comment
Spotlighting	Nocturnal surveys over 5 nights from early-November to mid-December across 7 locations. Totalling 13 hours	10 hrs. across 4 formations	-
Amphibian surveys	Nocturnal surveys over 3 nights in early-November 2019 and 3 nights in January 2020 after rainfall across 8 waterbodies. Totalling 32 hours.	Combination of diurnal and nocturnal census (listening for calls, spotlighting, call recording and habitat searches).	*Opportunistic records of all amphibian and reptile species detected in spotlighting surveys of all formations were noted.
Reptile surveys	Nocturnal surveys over 5 nights from early-November to mid-December across 7 locations. Totalling 13 hours Habitat searches on 4 separate days Totalling 10hours Ten tile arrays of 50 tiles per array, established on 25 October. Arrays were checked once at end of November and twice in December.	Combination of active diurnal searches and spotlighting on foot. Diurnal – 30-minute search on two separate days. Nocturnal – 30-minute search on two separate nights.	*Opportunistic records of all reptile species detected in spotlighting surveys of all formations were noted.

Comparison of fauna survey effort (excluding trapping) against DoEE Guidelines

Species	Completed	Requirements
Litoria aurea Green and Golden Bell Frog	Surveys completed include 8 different water bodies checked once over a 3 night period in November 2019 (8hrs) and checked 3 times on three separate nights in January 2020 for 1 person hour per water body (24hrs).	Using a combination of call detection, call playback and spotlight surveys over a minimum of 4 nights. Accompanied by a habitat assessment.
Anthochaera phrygia Regent Honeyeater	Bird census around water bodies for 1 hour at dusk on 6 separate days. Totalling 8 hours. Area searches throughout the site completed on 6 separate evenings. Totalling 8.5 hours	Area searches for 20 hours over 2 days and Targeted searches for 20 hours of 5 days.
Lathamus discolor Swift Parrot	Bird census around water bodies for 1 hour at dusk on 6 separate days. Totalling 8 hours. Area searches throughout the site completed on 6 separate evenings.	Area searches or transect surveys for 20hours over 8 days and targeted surveys for 20 hours over 8 days.

Species	Completed	Requirements
	Totalling 8.5 hours	
Chalinolobus dwyeri Large-eared Pied Bat	Harp traps and anabats were placed at 4 locations over 4 full nights Totalling 16 nights for each method.	Anabat detectors for 16 detectors nights Harp traps for 16 trap nights.
Dasyurus maculatus Spotted-tailed Quoll	Twelve baited remote cameras were placed for 14 nights. Totalling 168 trap nights	Daytime searches for suitable habitat resources. Daytime searches for signs of activity i.e. scates and latrines. Hair funnel traps for a minimum of 14 consecutive nights. Remote camera traps for minimum of three weeks with 10 per hectare.
Nyctophilus corbeni Corben's Long-eared Bat	Harp traps and anabats were placed at 4 locations over 4 full nights Totalling 16 nights for each method.	Harp traps for 20 trap nights and/or Mistnets for 20 traps nights.
Pteropus poliocephalus Grey-headed Flying-fox	Nocturnal surveys over 5 nights from early-November to mid-December across 7 locations. Totalling 13 hours Searches for camps were conducted over the entire subject area.	Seek information about the location of historic camps from DECC (NSW). A comprehensive vegetation survey has been completed for the area and an assessment of the food plants with the Project area in relation to the broader area.
Delma impar Striped Legless Lizard	Active searches on 4 separate days Totalling 10 hours Ten tile arrays of 50 tiles per array, established on 25 October. Arrays were checked once at end of November and twice in December.	Active searches in areas of surface rock, artificial debris flipping over and searching. For greater than 30 hectares 10 tile arrays 50 tiles should be installed one month prior to surveys and checked at least twice a month.

APPENDIX 7. BIODIVERSITY CREDIT REPORTS

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00018204/BAAS18041/19/00018207

Proposal Name
Bayswater Power Station WOAOW Project

BAM data last updated *
05/05/2020

Assessor Name

Assessor Number

BAM Data version *
26

Proponent Names

Report Created
14/05/2020

BAM Case Status
Open

Assessment Revision
2

Assessment Type
Major Projects

Date Finalised
To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Nil

Nil

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

BAM Biodiversity Credit Report (Like for like)

Predicted Threatened Species Not On Site

Name
Grantiella picta / Painted Honeyeater

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	Number of credits to be retired
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	14.8	445.00
1692-Bull Oak grassy woodland of the central Hunter Valley	Not a TEC	61.6	1275.00
1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Not a TEC	2.4	30.00

1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Like-for-like credit retirement options

Name of offset trading group	Trading group	HBT	IBRA region
Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions This includes PCT's: 1603, 1605, 1691, 1692	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter				
1692-Bull Oak grassy woodland of the central Hunter Valley	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region
	Coastal Valley Grassy Woodlands This includes PCT's: 116, 618, 622, 623, 760, 761, 762, 829, 830, 834, 837, 838, 849, 850, 1326, 1395, 1603, 1604, 1691, 1692	Coastal Valley Grassy Woodlands >=50% and <70%	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region

	Coastal Swamp Forests This includes PCT's: 839, 1064, 1227, 1230, 1231, 1232, 1716, 1717, 1718, 1719, 1723, 1730, 1731, 1795, 1798	Coastal Swamp Forests >=50% and <70%	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Area	Credits
Delma impar / Striped Legless Lizard	76.4	1427.00
Myotis macropus / Southern Myotis	8.1	233.00
Petaurus norfolcensis / Squirrel Glider	14.8	445.00

Delma impar/ Striped Legless Lizard	1691_Mod_Good	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW

Delma impar/ Striped Legless Lizard	1691_Mod_Good		
	1691_Mod_Good_CEEC	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1692_Mod_Good	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1692_Mod_Good_CEEC	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW

Myotis macropus/ Southern Myotis	1691_Mod_Good	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Myotis macropus/Southern Myotis	Any in NSW
	1691_Mod_Good_CEEC	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Myotis macropus/Southern Myotis	Any in NSW
	1692_Mod_Good	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Myotis macropus/Southern Myotis	Any in NSW
Petaurus norfolcensis/ Squirrel Glider	1691_Mod_Good	**Like-for-like credit retirement options**	
		Spp	IBRA region

		Petaurus norfolcensis/Squirrel Glider	Any in NSW
	1691_Mod_Good_CEEC	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00018204/BAAS18041/20/00018902

Proposal Name
Bayswater Power Station WOAOW Project - 1691 Non-TEC

BAM data last updated *
05/05/2020

Assessor Name

Assessor Number

BAM Data version *
26

Proponent Names

Report Created
14/05/2020

BAM Case Status
Open

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Nil

Nil

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

BAM Biodiversity Credit Report (Like for like)

Predicted Threatened Species Not On Site

Name
Grantiella picta / Painted Honeyeater

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	Number of credits to be retired
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Not a TEC	192.0	3459.00

1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Like-for-like credit retirement options

Class	Trading group	HBT	IBRA region
Coastal Valley Grassy Woodlands This includes PCT's: 116, 618, 760, 761, 762, 830, 834, 838, 849, 850, 1326, 1395, 1603, 1604, 1691	Coastal Valley Grassy Woodlands >=70% and <90%	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

Species	Area	Credits
Delma impar / Striped Legless Lizard	44.3	742.00
Diuris tricolor / Pine Donkey Orchid	166.0	2158.00
Petaurus norfolcensis / Squirrel Glider	44.3	988.00
Prasophyllum petilum / Tarengo Leek Orchid	166.0	2877.00

Delma impar/ Striped Legless Lizard	1691_Plantation	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1691_Regrowth	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1691_Rehabilitation	**Like-for-like credit retirement options**	
		Spp	IBRA region

		Delma impar/Striped Legless Lizard	Any in NSW
Diuris tricolor/ Pine Donkey Orchid	1691_Grassland	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Diuris tricolor/Pine Donkey Orchid	Any in NSW
	1691_Regrowth	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Diuris tricolor/Pine Donkey Orchid	Any in NSW
Petaurus norfolcensis/ Squirrel Glider	1691_Plantation	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW

Petaurus norfolcensis/ Squirrel Glider	1691_Plantation		
	1691_Regrowth	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW
	1691_Rehabilitation	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW
Prasophyllum petilum/ Tarengo Leek Orchid	1691_Grassland	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Prasophyllum petilum/Tarengo Leek Orchid	Any in NSW
	1691_Regrowth	**Like-for-like credit retirement options**	

		Spp	IBRA region
		Prasophyllum petilum/Tarengo Leek Orchid	Any in NSW

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00018204/BAAS17039/20/00018875

Proposal Name
Bayswater Power Station WOAOW Project - Paddock Trees

BAM data last updated *
26/11/2019

Assessor Name

Assessor Number

BAM Data version *
22

Proponent Names

Report Created
13/05/2020

Date Finalised
To be finalised

Assessment Revision
0

Assessment Type
Paddock Trees

BAM Case Status
Open

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Nil

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

BAM Biodiversity Credit Report (Like for like)

Ecosystem Credit Summary

PCT	TEC	Credits
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	31.00

Credit classes for 1691

Like-for-like options

TEC	Trading group	HBT	IBRA region
Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

APPENDIX 8. EXPERT REPORT

Expert Report

Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor* & *Prasophyllum petilum*):

Bayswater Water and Other Associated Operational Works Project

May 2020

Final Report

Kleinfelder
95 Mitchell Road
Cardiff NSW 2285

Dr Stephen Bell

Eastcoast Flora Survey
PO Box 216
Kotara Fair NSW 2289

SUMMARY

AGL Macquarie Pty Ltd (AGLM) operate the Bayswater and Liddell Power Stations, and are one of Australia's major electricity generators. Both power stations are situated between Singleton and Muswellbrook in the Hunter Valley of New South Wales, in close proximity to major coal fields which supply the required coal reserves. Bayswater Power Station, the subject of this expert report, was commissioned in 1985 and continual upgrades are required to maintain its level of production and improve environmental outputs. As part of planned operational works, AGLM intend to undertake a range of actions which will impact on the existing natural environment across seven defined work areas (the Project Area), and potentially on the habitat of two threatened orchid species.

With the endorsement of the Department of Planning, Infrastructure and Environment (DPIE), I have been engaged by Kleinfelder on behalf of AGLM to complete an expert review in relation to the two threatened orchids (*Diuris tricolor* and *Prasophyllum petilum*), to be incorporated into a Biodiversity Development Assessment Report for the Project. The expert review is as required and in accordance with Section 6.5.2.3 of the NSW Governments Biodiversity Assessment Method, and has been undertaken in lieu of field surveys which have been constrained by ongoing drought conditions. This report will also satisfy obligations within the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* pertaining to *Prasophyllum* sp. Wybong (C. Phelps ORG5269), a recognised synonym of *Prasophyllum petilum*.

No known records of *Diuris tricolor* or *Prasophyllum petilum* exist for the Project Area, however after assessment I consider that approximately **166 ha (30%) of the proposed 561 ha disturbance area may provide habitat** for these species. Both species occupy extensive geographical ranges in New South Wales, and both are represented in the Hunter Valley as disjunct and isolated populations. Records for *Diuris tricolor* exist c. 5-9 km to the north-west and west of the Project Area, and also c. 50 km to the south-east at North Rothbury. The North Rothbury record (from 2016) suggests that other currently unknown populations of *Diuris tricolor* may exist between that location and Muswellbrook, including within the Project Area. There are no validated populations of *Prasophyllum petilum* outside of the Wybong (Mangoola Coal mine) locality (c. 28 km WNW).

Following a single day site inspection of the Project Area in February 2020, I noted observable differences in the floristic composition of grasslands to other areas where the two orchids occur, and the predominance of *Eucalyptus 'albemol'* (a purported hybrid between *E. albens* and *E. moluccana*) as the main remnant canopy species within these largely cleared lands. Differences were supported by a review of ecological information prepared by Kleinfelder for the Project Area, the mapping of which I found to be accurate and acceptable. Analysis of defined vegetation communities and their component sample plots revealed clear differences to habitat elsewhere in the Hunter Valley supporting these species. Despite this, I conservatively considered that vegetation units defined by Kleinfelder as Derived/ Modified Native Grasslands (Zone 4) and Acacia Regrowth (Zone 3) provided the best potential of supporting *Diuris tricolor* and/or *Prasophyllum petilum* (albeit unlikely in large numbers), which with the removal of heavily disturbed portions comprise the 166 ha of potential habitat.

In support, a detailed assessment of the well-studied Mangoola Coal mine populations of both species (c. 28 km WNW) showed that 60% of all *Diuris tricolor* individuals (n=3089) occured within present or former *Eucalyptus crebra* woodland, 33% were within *Eucalyptus dawsonii* woodland, but only 6% were within *Eucalyptus 'albemol'* woodland. The first two communities combined supported 93% of all *Diuris* records across that site. Similarly, 59% of all individuals of *Prasophyllum petilum* (n=2413) were found to occur within present or former *Eucalyptus crebra* woodland, 20% in *Eucalyptus dawsonii* woodland, and 19% in *Eucalyptus 'albemol'* woodland. Based on this analysis, landscapes derived from former *Eucalyptus 'albemol'* woodland are therefore more likely to support populations of *Prasophyllum* than *Diuris*.

Observable floristic differences were also supported by mapped soil landscapes across the Project Area, which showed a poor correlation between orchid presence at Mangoola Coal mine and potential habitat within the Project Area. The clay- (rather than sand-) based soils in the Project Area argued against the presence of substantial populations of *Diuris tricolor*, given the preponderance of this species elsewhere in sandy or sandy-clay soils. These same clay soils would tend to favour *Prasophyllum petilum*, given field observations of that species occupying slightly damper situations in the landscape, however an absence of any confirmed proximate records <28 km distant suggests a low probability of occurrence.

The combination of landscape, floristic, condition and soil features, together with proximity to and habitat traits at known validated populations, suggest that the Project Area is unlikely to support extensive populations of *Diuris tricolor* or *Prasophyllum petilum*. The areas where I consider these *may* occur occupy 30% of the total disturbance footprint, predominantly within the four borrow pits (142 ha of the 166 ha, or 86%), but even here I do not expect large populations to be present.

Report produced by:

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This document should be cited as:

Bell, S.A.J. (2020) *Expert Report - Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor *&* Prasophyllum petilum*): Bayswater Water and Other Associated Operational Works Project.* Unpublished Report to Kleinfelder. May 2020. Eastcoast Flora Survey.

Document cover: A view across Borrow Pit 2 within the Project Area (top), and target orchids *Diuris tricolor* (lower left) and *Prasophyllum petilum* (lower right).

Report produced for:

Kleinfelder
95 Mitchell Road
Cardiff NSW 2285

Project Manager: Samara Schultz (Senior Ecologist / Ecology Team Leader)

Table of Contents

1. Introduction

1.1 Background

1. I have been engaged by Kleinfelder on behalf of AGL Macquarie Pty Ltd (AGLM) to undertake an expert review in relation to two threatened orchids (*Diuris tricolor* and *Prasophyllum petilum*). This review will be incorporated into a Biodiversity Development Assessment Report (BDAR) currently in draft form and being prepared by Kleinfelder, which addresses the proposed Bayswater Power Station Water and Other Associated Operational Works (the Project). This expert review is as required and in accordance with s. 6.3.1.3 of the NSW Governments Biodiversity Assessment Method (OEH 2017). It aims to determine the habitat suitability of the proposed development lands for the subject orchids.

2. As part of my brief, I have been asked to examine the potential for *Diuris tricolor* and *Prasophyllum petilum* to occur within lands designated for disturbance. These lands occupy 561 ha, of which 271 ha comprises native vegetation (Kleinfelder 2020). My assessment is required as drought conditions within the Project Area in recent years have impinged on comprehensive surveys for both orchid species. On 21 February 2020, I undertook an inspection of the Project Area to examine habitat quality and disturbance levels, expanded upon in Section 4.

1.2 Project Overview

3. AGL Macquarie Pty Ltd (AGLM) operate the Bayswater and Liddell Power Stations, and are one of Australia's major electricity generators. Both power stations are situated between Singleton and Muswellbrook in the Hunter Valley of New South Wales, in close proximity to major coal fields which supply the required raw materials. Bayswater Power Station, the subject of this expert report, was commissioned in 1985 and continual upgrades are required to maintain its level of production and improve environmental outcomes.

4. As part of planned operational works, AGLM intend to undertake a range of actions which will impact on the existing natural environment across seven defined work areas (see further detail in Kleinfelder 2020):

    - upgrading of the existing coal handling plant wastewater management facilities
    - construction and operation of a Salt Cake landfill site to improve salt cake disposal
    - construction and operation of four borrow pits to provide earth material to undertake the required constructions
    - augmentation of the existing ash dam, to provide additional storage of coal ash and upgrade of the water management infrastructure
    - increase ash harvesting for improved recycling of coal ash
    - vegetation clearing along the existing HP pipe and LSP sludge line to allow for maintenance activities and repositioning of pipeline above ground
    - replacement of the existing 9.3 km Ravensworth ash pipeline with new mainly above ground pipes parallel to existing lines

5. The focus of my report is on the 561 ha of proposed Project lands lying largely between Lake Liddell and Plashett Reservoir, east of Denman and south-east of Muswellbrook (Figure 1 and 2). To assist in later discussions, this area has been designated into eight separate parcels of land (Table 1).

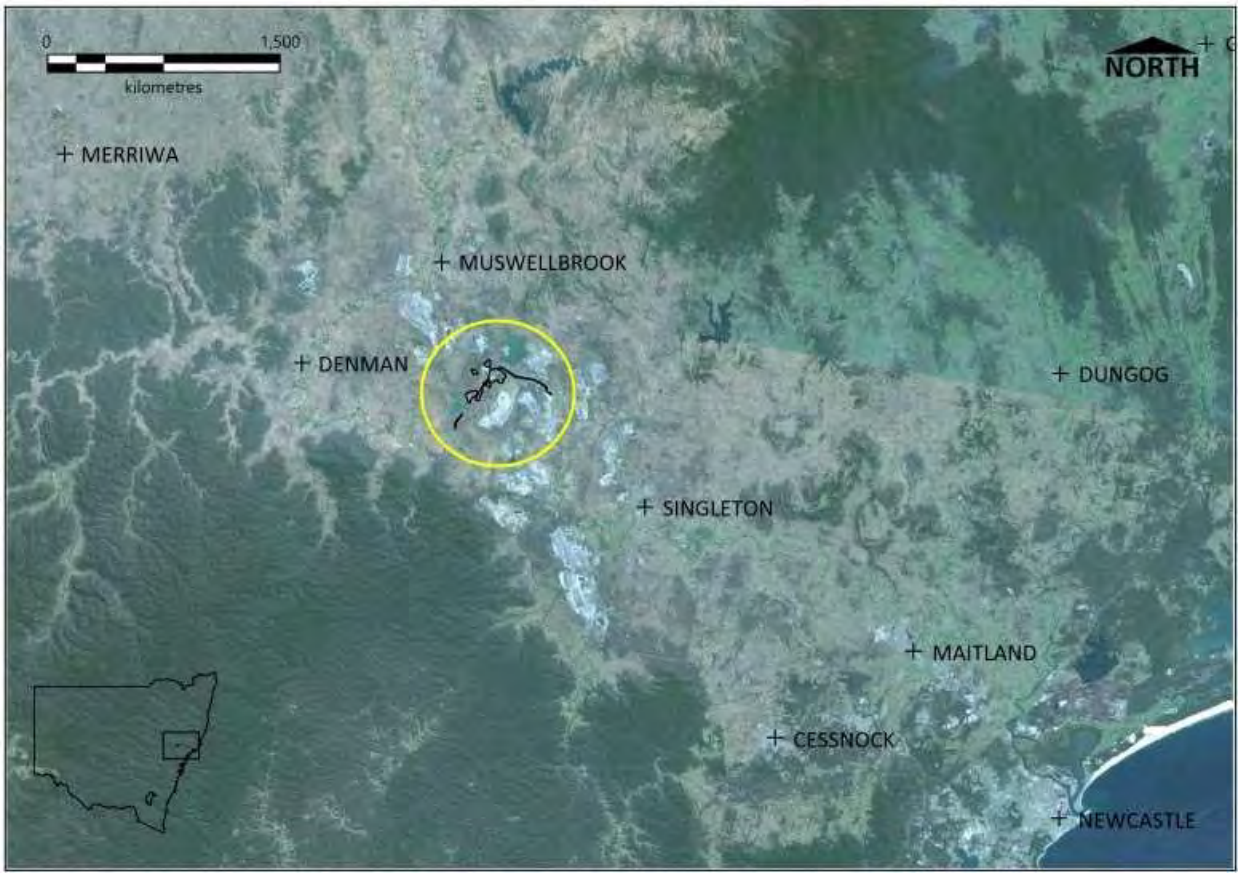

Figure 1 Location of the Project Area (circled) in the context of the Hunter Valley coal field.

Table 1 Land parcels comprising the Project Area.

Land Parcel	Size (ha)	Details
Borrow Pit 1	18.13	adjacent to the south of the existing ash dam and water management works
Borrow Pit 2	26.46	adjacent to the south-west of the existing ash dam and water management works
Borrow Pit 3	43.00	immediately east of south-westerly running road to Plashett Reservoir
Borrow Pit 4	136.90	immediately west of south-westerly running road to Plashett Reservoir
Salt Cake Landfill	27.21	west of existing power plant
CHP & Wastewater Infrastructure	47.48	immediately north of existing power plant
Ash Dam Augmentation Area	249.70	immediately east of existing power plant
Pipeline Easements	12.69	four areas of narrow (c. 10m wide) existing pipeline easements in previously disturbed areas

Total	561.57

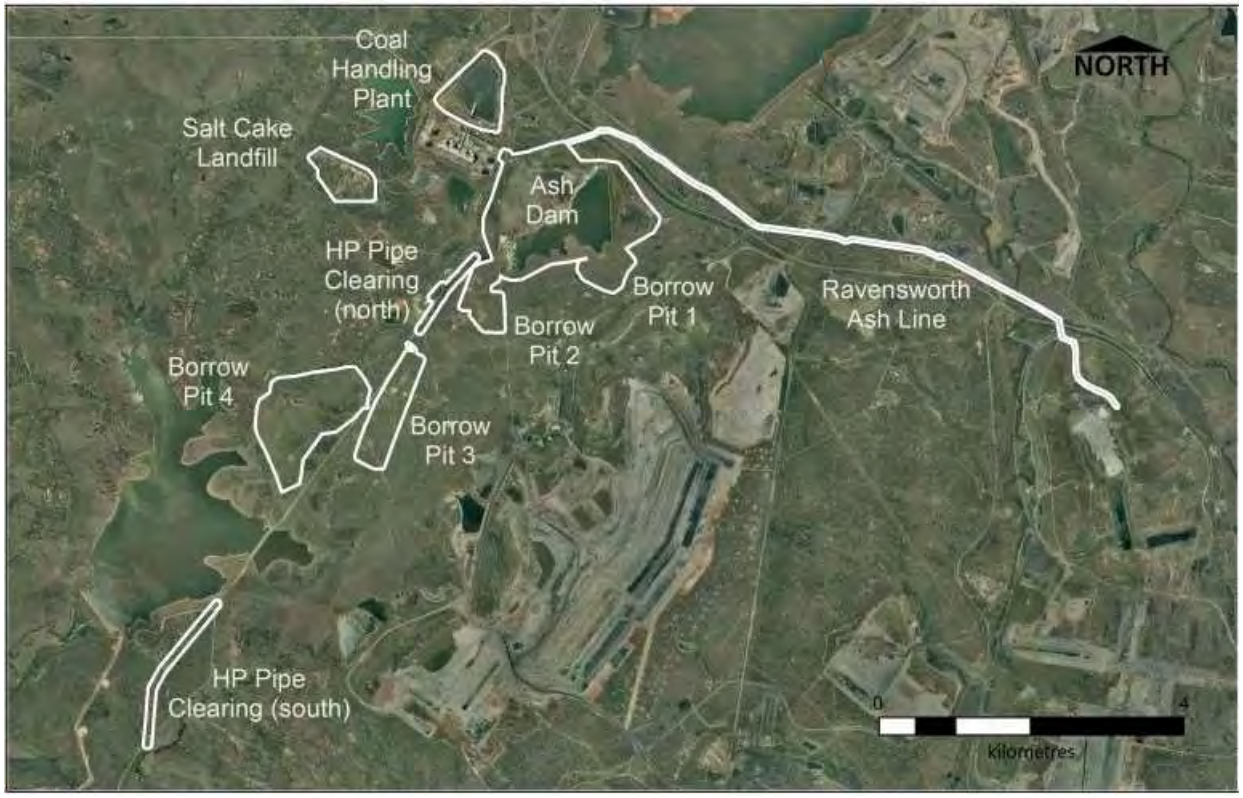

Figure 2 The Project Area, showing layout of proposed disturbance areas.

1.3 Report Criteria & Structure

6. As detailed in the Biodiversity Assessment Method (OEH 2017), an expert report is required to address the following criteria (s. 6.5.2.8 in OEH 2017), and these form the basis of the structure of this report:

   a. identify the relevant species or population (see **Section 2**);

   b. provide a justification for the use of an expert report (see **Section 3**);

   c. indicate and justify the likelihood of presence of the species or population and prepare a species polygon showing the location and area of the species polygon (see **Section 4**);

   d. estimate the area of habitat (as identified in the Credit Calculator) for the subject land (see **Section 5**), or

   e. estimate the maximum number of mature individuals (as identified in the Credit Calculator) for the subject land. Where the expert report is required because the species is assumed to be present, provide evidence such as a reference site, for this estimation (option d. above undertaken);

   f. include the information considered in relation to the determination made in the report (see **Section 6**), and;

   g. identify the expert and provide evidence of their credentials (see **Section 7**).

1.4 DPIE Approval to Prepare Expert Report

7. I have been approved to prepare this expert report by the relevant officers at the Newcastle office of the Department of Planning, Industry and Environment (formerly OEH), see https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/biodiversity-offsets-scheme/experts

2. Criterion (a) - The Relevant Species

2.1 Legal Status

8. *Diuris tricolor* and *Prasophyllum petilum* are both threatened species included in relevant State, Territory and Commonwealth legislation. *Diuris tricolor* is listed both as vulnerable in NSW and as an endangered population in the Muswellbrook local government area (LGA) under the *Biodiversity Conservation Act 2016* (BC Act), while *Prasophyllum petilum* is listed as endangered in NSW (BC Act), the ACT (*Nature Conservation Act 2014*) and the Commonwealth (*Environment Protection and Biodiversity Conservation Act 1999*, EPBC Act). Note that the Project Area straddles both the Muswellbrook and Singleton LGAs.

9. In recent years, there has been some taxonomic confusion over the identity of *Prasophyllum* plants growing in the upper Hunter (Wybong) area. Following an informal review of these plants by NSW orchid taxonomists over the past decade, these plants were placed in synonmy with the more widespread *Prasophyllum petilum* (see PlantNet), a finding also supported by other orchid experts elsewhere in Australia (e.g. Backhouse et al. 2016a). As a consequence, *Prasophyllum* sp. Wybong (C. Phelps ORG5269) is now an accepted synonym of *Prasophyllum petilum*, but remains listed as critically endangered on the EPBC Act.

2.2 Distribution and Known Populations

10. *Diuris tricolor* and *Prasophyllum petilum* (Figure 3) are present and co-occur in the Hunter Valley region of New South Wales (NSW), but the two species also occupy considerably wider geographical ranges throughout eastern Australia.

2.2.1 Diuris tricolor

11. *Diuris tricolor* (Pine Donkey Orchid) is a widespread terrestrial orchid, occurring on the western slopes and plains and tablelands of NSW, and also in the Moreton and Darling Downs districts of Queensland (Stanley & Ross 1989; Jones 1993). Populations of *Diuris tricolor* in the upper Hunter Valley between Denman and Muswellbrook form the eastern extent of an east-west trending meta-population extending along the Goulburn River valley to Mudgee (Figure 4). Records exist for this species at ~20 km intervals along this 200 km extent, suggesting that some exchange of genetic material may be occurring with more westerly stands. The Type material of *Diuris tricolor* was collected at Mudgee in the late 1800s.

12. The nearest record of *Diuris tricolor* to the Project Area is an observation in 2009 from land off Saddlers Creek (c. 9 km west, Bionet; also noted in Kleinfelder 2017), and several populations from 2011-2012 within the Mt Arthur complex approximately 5-8 km to the north-west or west (Hunter Eco 2013). A single, small disjunct population of *Diuris tricolor* has also recently (2016) been discovered at North Rothbury (noted in Bell 2017a), and represents the most easterly

population known within New South Wales. North Rothbury lies approximately 50 km to the south-east of the Project Area.

Figure 3 ***Diuris tricolor*** **(left) and** ***Prasophyllum petilum*** **(right), photographed** ***in situ*** **at Mangoola Coal mine.**

13. Elsewhere in New South Wales, *Diuris tricolor* is extensive across the north, central and south western slopes, and extends into south-eastern Queensland. A single record from the Hume region of Victoria suggests that the species is very rare in that state, and indeed Backhouse et al. (2016b) indicate that it is known from just three plants.

2.2.2 Prasophyllum petilum

14. *Prasophyllum petilum* (Tarengo Leek Orchid) occupies a smaller distributional range, with most records from the Australian Capital Territory (ACT) but with outliers in the Kandos, Denman, Premer and Inverell districts on the tablelands and western slopes of NSW. Until recently, Hunter Valley plants were considered a distinct but un-named taxon, *Prasophyllum* sp. 'Wybong' (C.Phelps ORG 5269), but are now placed in synonymy with *P. petilum* by NSW taxonomic authorities. Additionally, Backhouse et al. (2016a) do not include *Prasophyllum* sp. 'Wybong' in their comprehensive list of Australian orchid taxa, despite the inclusion of three other un-named taxa with close affinities to *P. petilum*, therefore supporting the NSW concept of synonymy in this group. The Type material of *P. petilum* was collected from Hall (in the ACT) in 1988.

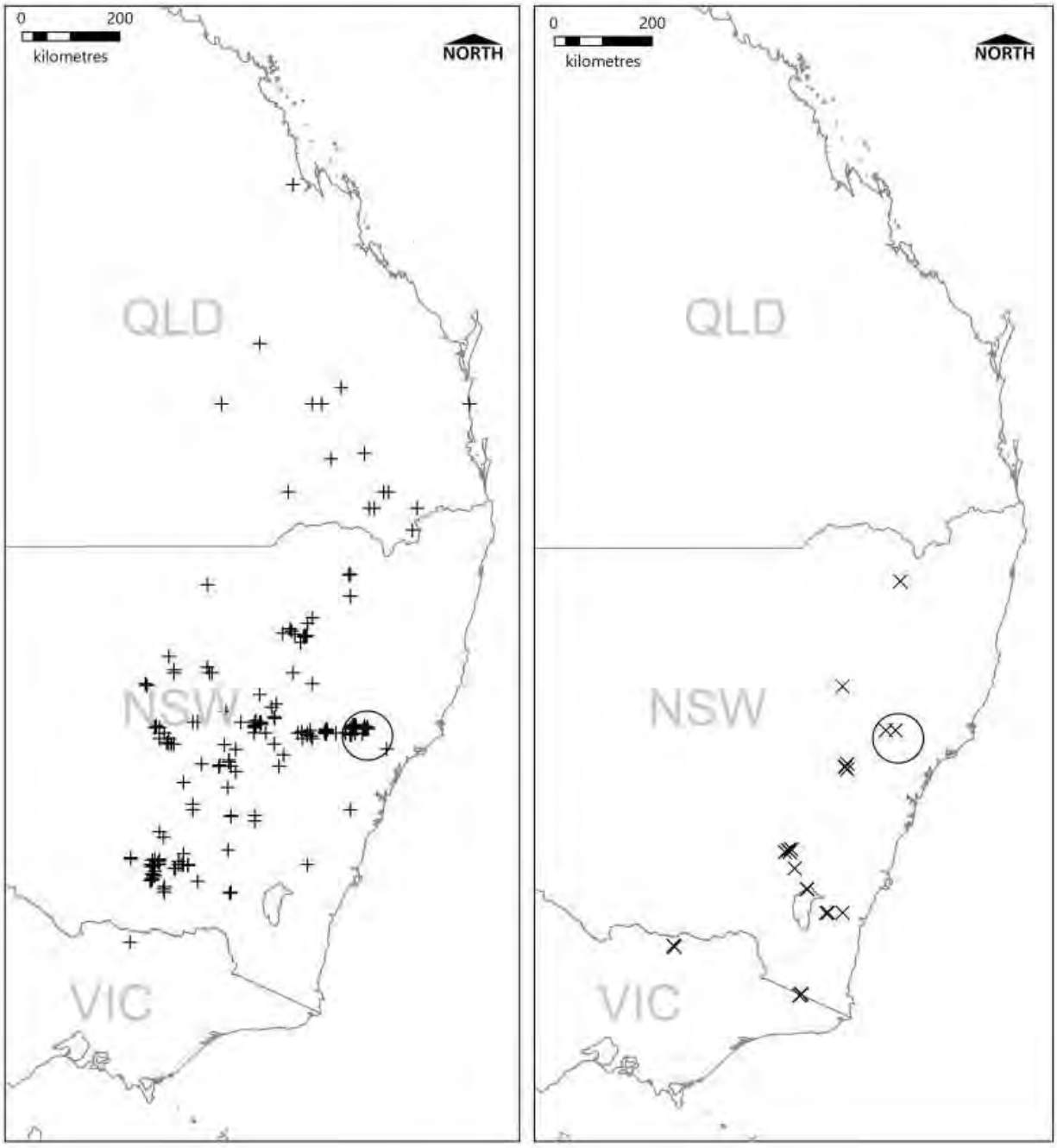

Figure 4 **Distribution of *Diuris tricolor* (**left**) and *Prasophyllum petilum* (right) across eastern Australia, shown relative to the Project Area (circled, 50 km radius).** Data from Australia's Virtual Herbarium (AVH) and the NSW Wildlife Atlas database (Bionet), extracted 3 March 2020. Note that near-coastal records of *Diuris tricolor* in south-eastern NSW are erroneous (historical collections with poor positional accuracy), and that Victorian records of *Prasophyllum petilum* represent a different taxon (now described as *P. argillaceum*: Jones & Rouse 2018).

15. The nearest known occurences of *Prasophyllum petilum* to the Project Area are at Mangoola Coal mine (Wybong), approximately 28 km to the west-north-west, and no other observations are evident from other parts of the Hunter Valley (NSW Bionet; AVH). Plants have been

recorded at Mangoola in most years since 2009, although numbers were very low during the drought years of 2017-2019 (Bell 2020).

16. Relative to the Mangoola district the next nearest populations of *Prasophyllum petilum* occur near Kandos, some 140 km to the south-west, and Premer 190 km to the north-west (Figure 4). Hunter Valley populations of *Prasophyllum* are consequently isolated from all others, and opportunities for genetic exchange are minimal. Note that Jeanes (2015a) considered similar populations of *Prasophyllum* in Victoria to represent a different taxon (now described as *P. argillaceum*: Jones & Rouse 2018), implying that *Prasophyllum petilum* is endemic to New South Wales, a view also supported by Backhouse et al. (2016a).

2.3 Habitat

2.3.1 Diuris tricolor

17. A range of habitats have been documented for *Diuris tricolor* throughout its range (Table 2), although few studies provide sufficient detail on co-occurring ground layer species. This makes it difficult to identify potential habitat at the local scale. Most texts document favoured habitat as grassy *Callitris* woodlands, although in Queensland it is 'eucalypt open forest'. In a study of remnant vegetation stands in the South Western Slopes of New South Wales, Burrows (1999) recorded *Diuris tricolor* at several sites, but all within *Callitris glaucophylla* dominated vegetation. J. Hunter (2010) located the species in areas associated with ironbark and Bulloak in the Pilliga area, while Cunningham et al. (2011) noted habitat as *Eucalyptus populnea* for the Tottenham area (west of Dubbo). Clearly, a diversity of habitats support *Diuris tricolor* across the State, and this information alone cannot be used to generalise occupied habitat at specific locations.

18. First-hand experience of *Diuris* in the Hunter Valley is therefore influential in determining the suitability of an area to support this species. Field evidence and unpublished data from subpopulations of *Diuris* near Denman (Mangoola Coal mine) suggest that it occurs most commonly within grassy woodlands and grasslands derived from former Ironbark (*Eucalyptus crebra*) and Dawson's Box (*Eucalyptus dawsonii*) woodlands, and with minimal amounts in Box (*Eucalyptus 'albemol'*, a purported hybrid between *E. albens* and *E. moluccana*) woodlands. Note that in the central and upper Hunter, populations of *Eucalyptus 'albemol'* have historically and contemporally been referred to as either or both of the two supposed parent species (Kleinfelder 2020 defer largely to *E. moluccana*), but ongoing taxonomic work suggests this entity to be a distinct species with no evidence of hybridisation (unpubl. data). On the outskirts of Muswellbrook, *Diuris tricolor* occurs in derived grassland associated with *Eucalyptus crebra* (Bell et al. 2020). At the currently known eastern limit of distribution (North Rothbury), *Diuris tricolor* was recorded in 2016 in open forest of *Eucalyptus crebra, Corymbia maculata* and *Eucalyptus fibrosa*, although no individuals have been seen at that location since (Bell 2017a).

19. Using the Mangoola Coal mine as a case study, an assessment of the vegetation communities supporting 975 GPS-recorded *Diuris* locations (n=5120 individual orchids) was undertaken. This involved intersecting in GIS each point location against a pre-1750 vegetation map prepared for the site in 2013 (unpubl. data). In that study, twelve vegetation communities were mapped on the basis of extensive field reconnaissance, where remnant paddock trees and landscape position were used to extrapolate across highly cleared lands as required. Of those twelve communities, *Diuris* was found to occur in five, with 61% of all records (n=599) and 60% of all

individuals (n=3089) occurring within present or former Ironbark (*Eucalyptus crebra*) Woodland (Figure 5).

Table 2 Habitat documented for *Diuris tricolor*.

Habitat	Location	Source
Hunter Valley		
native grassland in areas not subject to intensive grazing	Hunter Valley generally	Umwelt 2011a, 2011b, 2013
derived grasslands of *Aristida/Cymbopogon*; *Bothriochloa/Carthamnus/Danthonia; Dichanthium/Sporobolous/Chloris* woodlands of *Eucalyptus crebra, E. dawsonii* or *Allocasuarina luehmannii*	Wybong	Bell 2012a
disturbed grassland, often adjoining woodland and forest	Wybong	Umwelt 2012
grassland/open woodland	Wybong	Herd & Herd 2005
grassland	Wybong	Abel Ecology 2005
disturbed grassland	Wybong	Umwelt 2006
grassy woodland within Hunter Floodplain Red Gum Woodland [TEC]	Muswellbrook LGA	Cumberland Ecology 2014
Eucalyptus crebra, Corymbia maculata, E. fibrosa grassy forest	North Rothbury	Bell 2017a
ungrazed grasslands on soils of low fertility	Ulan	Ecovision Consulting 2008
derived grassland within *Eucalyptus crebra*	Condran offset (Muswellbrook)	Bell et al. 2020
Outside of the Hunter Valley		
grassy *Callitris glaucophylla* woodlands	general	Jones 1993; Burrows 1999; Bishop 2000; Cameron et al. 2014; Jeanes 2015b
Callitris glaucophylla, Eucalyptus populnea, Eucalyptus intertexta, Ironbark and *Acacia* shrubland. The understorey is often grassy with herbaceous plants such as *Bulbine* species	general	URS 2009; Jacobs 2017
open grassy woodland often associated with Box-Gum Woodland [TEC]	general	Cumberland Ecology 2014
eucalypt open forest	Queensland	Stanley & Ross 1989
Eucalyptus sideroxylon, E. crebra and *Allocasuarina luehmannii*	Pilliga (NSW)	J. Hunter 2010
Eucalyptus populnea	west of Dubbo (NSW)	Cunningham et al. 2011

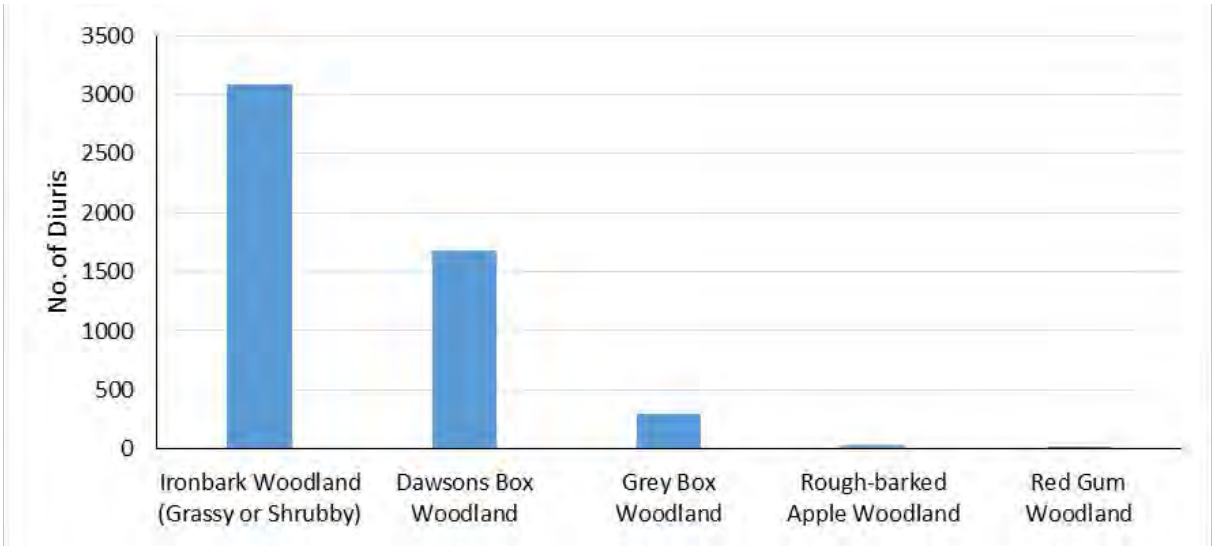

Figure 5 **Number of *Diuris tricolor* individuals (n=5120) by vegetation type within the 1492 ha Mangoola Coal study area (unpubl. data).**

20. The next most favoured habitat at Mangoola was Dawson's Box (*Eucalyptus dawsonii*) Woodland with 29% of records (n=280) and 33% of individuals (n=1684), and these two communities combined supported >90% of all *Diuris* records and individuals. Three other communities comprised relatively minor *Diuris* habitat: Box (*Eucalyptus 'albemol'*) Woodland (6%), Rough-barked Apple (*Angophora floribunda*) Woodland (0.6%), and Red Gum (*Eucalyptus blakelyi*) Woodland (0.3%). In the absence of other similar habitat data from elsewhere in the Hunter Valley, the Mangoola study area provides a strong landscape-scale indication that *Diuris* is most closely associated with *Eucalyptus crebra* grassy woodlands.

21. At a finer scale, a floristic analysis of derived grasslands undertaken at Mangoola coal mine between 2009 and 2011 (comprising 168 plots sampled over 2000 ha) found that *Diuris tricolor* occurred within three of seventeen grassland types, in descending order of importance (Bell 2012a, Bell submitted):

- *Aristida*/ *Cymbopogon* Grassland (Unit 2);
- *Bothriochloa biloba*/ *Carthamnus*/ *Danthonia* Grassland (Unit 4);
- *Dichanthium*/ *Sporobolus*/ *Chloris* Grassland (Unit 1a).

22. *Diuris tricolor* was also sparingly present in three woodland communities, those characterised by *Eucalyptus crebra, Eucalyptus dawsonii* or *Allocasuarina luehmannii*. Combined, the three derived grassland habitats defined encompassed a significantly large proportion of the grasslands included in that study (84% of 1069 ha). Detailed floristic compositions for each of these key grassland communities are replicated in Appendix 1. Knowledge gained from the Mangoola floristic analysis of grassland types has been incorporated into my assessments of suitable *Diuris* habitat at Bayswater discussed later in this report.

2.3.2 Prasophyllum petilum

23. Information on the habitat of *Prasophyllum petilum* throughout its range is brief but documents variable associations (Table 3). When describing the species, Jones (1991) reported the known habitat at that time (the Type locality only, in the ACT) as being "*moist grassy patches in sparse*

woodland developed on fertile soils", while Bishop (2000) describes it as remnant *Themeda* grassland on silty clay loams. The national recovery plan for this species (DECCW 2010) provides more detail on floristic associations at the five known sites for which it was written, mostly on the Southern and Central Tablelands of NSW.

Table 3 Habitat documented for *Prasophyllum petilum*.

Habitat	Location	Source
Hunter Valley		
derived grasslands of *Aristida/Cymbopogon*; *Bothriochloa/Carthamnus/Danthonia; Dichanthium/Sporobolous/Chloris;* woodlands of *Eucalyptus crebra, E. dawsonii* or *Allocasuarina luehmannii*	Wybong	Bell 2012a
open eucalypt woodland and grassland	general	Wildthing 2012
Outside of the Hunter Valley		
remnant *Themeda* grassland on silty clay loams	general	Bishop 2000
shrubby and grassy habitats in dry to wet soil, in open eucalypt woodland and grassland	general	Umwelt 2013; Ecological Australia 2015
Grassy Box Woodlands with fertile to moderately fertile soils on undulating terrain	general	FloraSearch 2014
wet grassy woodlands on fertile ground	Southern Tablelands region (NSW & ACT)	Rouse 2002
moist grassy patches in sparse woodland developed on fertile soils	Type location (ACT)	Jones 1991
grassy woodland of *Eucalyptus pauciflora* and *E. aggregata*, with a sparse shrub layer of *Hakea microcarpa, Acacia dealbata* and *Leptospermum brevipes* and a ground layer of *Poa sieberiana, Themeda australis* and *Schoenus apogon*	Captains Flat cemetery (NSW)	DECCW 2010
grassy woodland of *Eucalyptus blakelyi* and *E. melliodora*, over *Poa sieberiana* and *Themeda australis*	Hall cemetery (ACT)	DECCW 2010
grassy woodland of *Eucalyptus blakelyi* and *E. melliodora*, over *Themeda australis* and *Sorghum leiocladum*	Ilford cemetery (NSW)	DECCW 2010
natural grassland of *Bothriochloa macra, Pentapogon quadrifidus, Austrodanthonia* spp., *Themeda australis, Schoenus apogon, Drosera peltata, Sebaea ovata* and *Haloragis heterophylla* on a treeless grassy plain	Tarengo TSR (NSW)	DECCW 2010
a treeless frost hollow, surrounded by *Eucalyptus pauciflora*	Steves TSR (NSW)	DECCW 2010

24. Notes associated with collections included in Australia's Virtual Herbarium (AVH) indicate that most southern records of *Prasophyllum petilum* occur in grasslands dominated by *Themeda australis, Bothriochloa* spp. and *Danthonia* spp, with associated forbs of *Bulbine* sp., *Dichopogon* sp., *Wurmbea* sp., *Swainsonia* sp., *Pimelea curviflora*, *Chrysocephalum* sp., *Ajuga australis*, *Craspedia* sp., *Stackhousia monogyna*, *Eryngium* sp., *Burchardia* sp., *Arthropodium* sp., and *Juncus* sp. Northern records occur in grassland of *Aristida* sp., *Themeda australis* and *Stackhousia monogyna*. With the exception of populations on the North Western Slopes, these habitats at collection locations are very different to those where *Prasophyllum petilum* occurs in the Hunter Valley. In this region plants occur most commonly in grasslands derived from former Ironbark (*Eucalyptus crebra*), Dawson's Box (*Eucalyptus dawsonii*) and Box (*Eucalyptus 'albemol'*) woodlands, co-occurring with species such as *Cymbopogon refractus, Aristida ramosa, Dichanthium sericeum* and *Chloris ventricosa*.

25. Once again, using the Mangoola Coal mine as a case study, an assessment of the vegetation communities supporting 759 GPS-recorded *Prasophyllum* locations (n=4073 individual orchids) was undertaken. This involved intersecting in GIS each point location against a pre-1750 vegetation map prepared for the site in 2013 (unpubl. data). In that study, twelve vegetation communities were mapped on the basis of extensive field reconnaissance, where remnant paddock trees and landscape position were used to extrapolate across highly cleared lands as required. Of those twelve communities, *Prasophyllum* was also found to occur in five (the same as for *Diuris*), with 58% of all records (n=442) and 59% of all individuals (n=2413) occurring within present or former Ironbark (*Eucalyptus crebra*) Woodland (Figure 6).

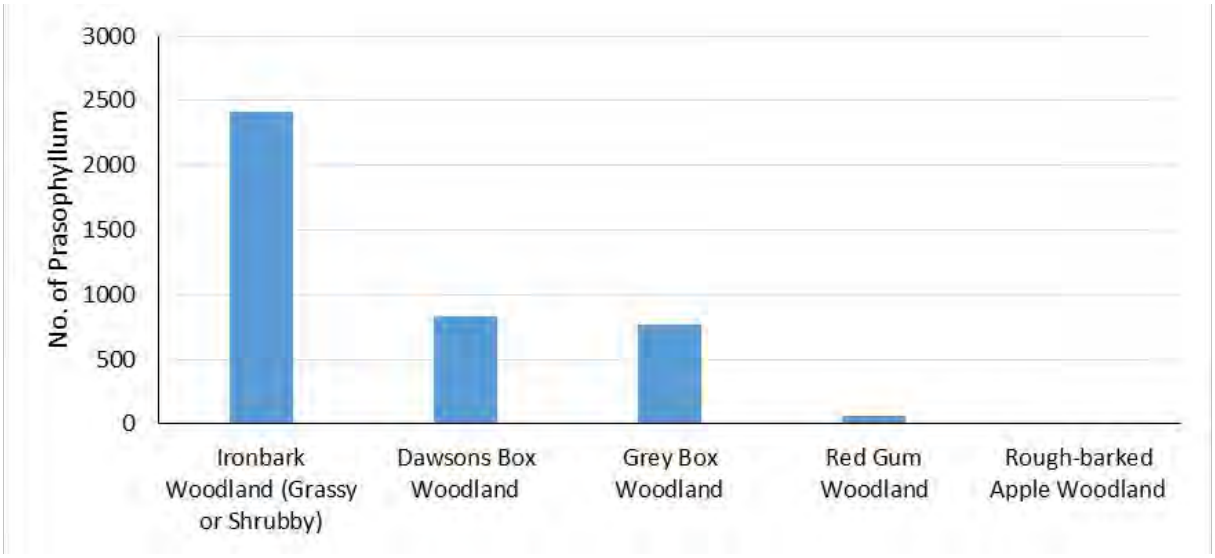

Figure 6 **Number of *Prasophyllum petilum* individuals (n=4073) by vegetation type within the 1492 ha Mangoola Coal study area (unpubl. data).**

26. As for *Diuris*, the next most favoured habitat was Dawson's Box (*Eucalyptus dawsonii*) Woodland with 22% of records (n=164) and 20% of individuals (n=831), and these two communities combined supported 80% of all *Prasophyllum* records and individuals. Box (*Eucalyptus 'albemol'*) Woodland supported 17% of records (n=130) and 19% of individuals (n=764). Two other communities comprised minor *Prasophyllum* habitat: Red Gum (*Eucalyptus blakelyi*) Woodland, and Rough-barked Apple (*Angophora floribunda*) Woodland (<4% combined). In the absence of other similar habitat data from elsewhere in the Hunter Valley,

the Mangoola study area provides a strong landscape-scale indication that *Prasophyllum* is most closely associated with *Eucalyptus crebra* grassy woodlands.

27. Floristic analysis of derived grasslands undertaken at Mangoola coal mine between 2009 and 2011 (comprising 168 plots sampled over 2000 ha) found *Prasophyllum petilum* occurring in three of seventeen grassland types, in descending order of importance (Bell 2012a; Bell submitted):

- *Aristida*/ *Cymbopogon* Grassland (Unit 2);
- *Bothriochloa biloba*/ *Carthamnus*/ *Danthonia* Grassland (Unit 4);
- *Dichanthium*/ *Sporobolus*/ *Chloris* Grassland (Unit 1a).

28. *Prasophyllum petilum* was also occassionally present in three woodland communities, those characterised by *Eucalyptus crebra, Eucalyptus dawsonii* or *Allocasuarina luehmannii*. Combined, the three derived grassland habitats defined encompassed a significantly large proportion of the grasslands included in that study (84% of 1069 ha). Knowledge gained from the Mangoola floristic analysis of grassland types (see Appendix 1) has been incorporated into my assessments of suitable orchid habitat at Bayswater discussed later in this report.

2.4 Ecology

2.4.1 Flowering & Orchid Detection

29. The unpredictability of flowering in orchids from year-to-year is a widely recognised trait in this group of plants (e.g. Gillman & Dodd 1998; Kindlmann & Balounova 2001; McCormick & Jacquemyn 2014), and flowering in terrestrial orchids is commonly governed by weather (e.g. Wells et al. 1998; Kindlmann & Balounova 2001; Pfeifer et al. 2006). As a rule of thumb, dry winters in the Hunter Valley generally result in below average flowering in terrestrial orchids, and this has been shown for both *Diuris tricolor* and *Prasophyllum petilum* (Bell 2019a,b). Low rainfall in the three months leading up to flowering place individual orchids under stress, meaning that flowering may be postponed for that season for all but the most robust individuals. Because of this trait, terrestrial orchids have been described as 'time-travellers' (Brundrett 2016), encapsulating the uncertainty in determining their presence in any given area. However, part of the difficulty of detection experienced during drought years is the added stress placed on emerging orchids by herbivores searching for palatable foods: orchids may well emerge every year but may be quickly consumed by grazing mammals, birds or invertebrates.

30. Rainfall and flowering in *Diuris tricolor* and *Prasophyllum petilum* has been highlighted over a ten year translocation project undertaken at Mangoola Coal mine (Bell 2019a,b; Bell submitted; also reported annually in reports to Mangoola Coal). Over the course of nine years of monitoring, the July-to-August pre-flowering rainfall transitioned from three years of near- or below-average rainfall, three years of above-average rainfall, and three years of well-below average rainfall. Dry years have been reflected in low rates of detection within recipient plots, while wetter years have shown an increase in detection (Figure 7). There are of course other factors contributing to the extent of orchid detection observed (expanded upon in Bell submitted), but there is a clear trend associated with winter rainfall. Of the nine recipient plots, all displayed lower detection rates in the drought years of 2017-2019, following three seasons of above average winter falls. A similar downward trend was observed for the five recipient plots (n=440) established within mine rehabilitation, monitored over 3-4 years since 2015, and

four control plots of naturally occurring orchids monitored since 2016 (data not presented here).

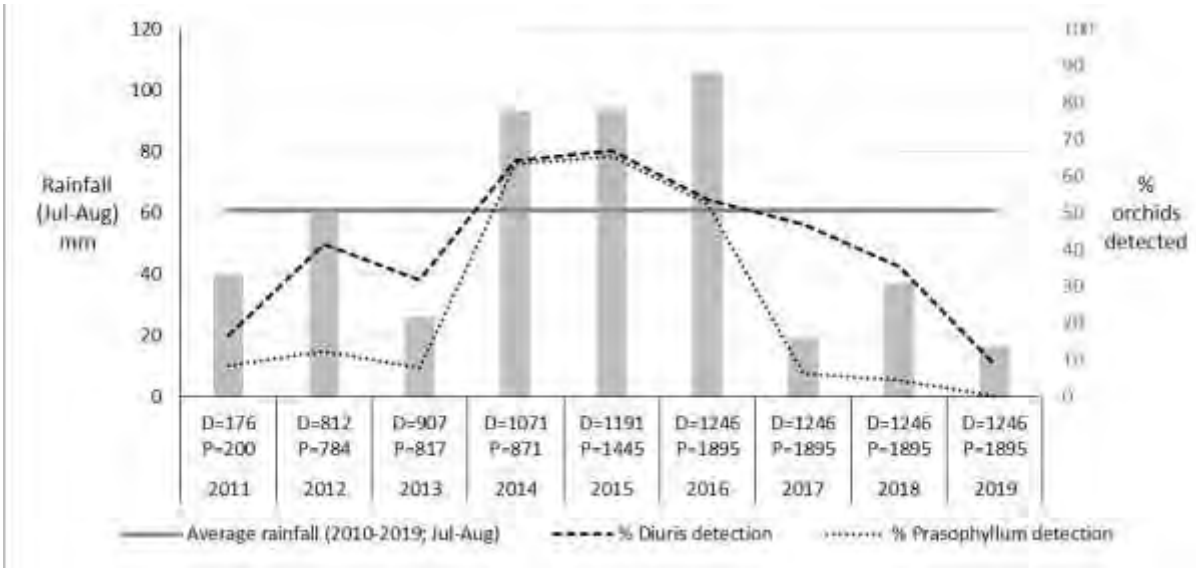

Figure 7 Rainfall received (July to August) and orchid detection (n=2,592) during the course of monitoring across nine recipient plots within derived grassland at Mangoola Coal mine, over a period of four to nine years (after Bell 2019a).

31. Surveying for orchids requires repeat visits to an area to be confident in the presence and magnitude of any residing orchid populations. This is particularly the case for those species where flowering can be protracted over several weeks, although most do experience a 'peak' period (e.g. Yare et al. in press). Vizer (2013) found peak flowering in *Diuris tricolor* and *Prasophyllum petilum* at Mangoola to occur from mid- to late-September, but that less than 20% of plants would be flowering on any particular day at this time. This implies that a 'one-off' survey, even if conducted on the day of peak flowering, would likely overlook more than 80% of individuals in that population. Capsule production was also found during his study to occur in less than 3% of plants for both species, with herbivory identified as an important limiting factor in seed production. However, peak flowering time likely varies year-to-year, and will depend on available soil moisture and other site conditions. During the 2015 flowering season at Mangoola, *Diuris* was found to peak in the second week of September, but *Prasophyllum* flowering was still increasing in the first week of October (Bell submitted).

32. For *Prasophyllum petilum*, Wilson et al. (2016) analysed annual monitoring data over a 25 year period from the largest known population on the southern tablelands of NSW, and identified the incidence of frost (nights ≤ -4°C) as being instrumental in preventing flowering in any one season. Frost damage to emerging plant parts prior to reaching flowering stage prevents detection during monitoring surveys, influencing annual counts. Warm winters are consequently of benefit to the orchids in that population, although it is unknown if the same applies to the Hunter Valley population where frosts are rarer.

2.4.2 Mycorrhizal Fungi

33. Orchid presence in any area is dependent on the availability of co-occurring mycorrhizal fungi present within the soil, and different fungi are required by different orchid species. Indeed, Weston et al. (2005) noted a high degree of specificity between a particular species of orchid

and their associated species of mycorrhiza, but that there are also commonalities between and within genera. For *Diuris*, they indicate that the *Tulasnella* genus is important, while for *Prasophyllum* it is *Ceratobasidium*.

34. Without intensive survey for the relevant mycorrhizal fungi, there is no way of knowing whether or not a specific site is capable of supporting an orchid population. Research has shown that mycorrhizal fungi may be widespread in the landscape and occur in a range of habitats, but that it may be patchy and is not necessarily reflected in observable orchid populations (e.g. Brundrett et al. 2003; McCormick & Jacquemyn 2014). At Mangoola Coal mine, seed-baiting techniques were used by Vizer (2013) in an attempt to map the distribution of mycorrhizal fungi, and he found that the distribution of *Diuris tricolor* was actually more restricted than the relevant fungi. This implies that there may be extensive suitable habitat, complete with mycorrhizal fungi, within a wider area than is currently known to support the species. Mycorrhizal seed-baiting for *Prasophyllum petilum* was not successful in the study of Vizer (2013), which is not unusual for this genus. There was some doubt, however, if the specific mycorrhiza required for this species was correctly isolated, reflected in poor germination of seed under laboratory conditions. Further research on the fungi associated with *Prasophyllum* is required.

2.4.3 Pollination and Capsule Development

35. Pollination in both *Diuris* and *Prasophyllum* (and most other orchids) is enacted by insects (Adams & Lawson 1993; Weston et al. 2005; Hawkeswood 2006). Many orchids rely on mimicry to trick unsuspecting insects, either by the development of flowers that appear identical to those of co-occurring species in their habitat (food mimicry), or by individual flowers resembling the females of certain insects (sexual mimicry). Other species offer a nectivorous reward and lure pollinators by scent. Most *Diuris* mimic co-occurring species of pea (Fabaceae) to attract pollinators, and for *D. tricolor* in the Hunter Valley this is likely to be *Templetonia stenophylla* or *Daviesia genistifolia* (pers. obs.; Vizer 2013). *Prasophyllum* employ a different strategy to attract pollinators, using nectar and scent. Weston et al. (2005) indicate that the pollinators of *Diuris* are likely to be various colletid bees from the *Trichocolletes* and *Leioproctus* genera, while colletid and halictid bees, ichneumonid, tiphiid, scoliid and sphecid wasps, syrphid flies, and beetles are the likely pollinators of *Prasophyllum*.

36. Once pollination has been enacted, the development of seed capsules progresses over the following weeks. Based on observations made at translocation sites at Mangoola Coal mine over several years (e.g. Bell 2016), capsule development is unhindered and many individual orchids have produced seed. Fruit : Flower ratios of around 30% were achieved in a pilot study of capsule production for both target species at this location (Bell 2013). Evidently, despite the level of historical and current-day disturbance to landscapes in the upper Hunter Valley, the necessary pollinators persist in the area.

3. Criterion (b) – Justification for an Expert Report

3.1 Survey Effort

37. Two periods of vegetation survey have been undertaken by staff from Kleinfelder across the Project Area in recent years. Field investigations associated with a vegetation mapping program for the broader Bayswater-Liddell area began in April 2016 and concluded in December of that

year (Kleinfelder 2017). This involved the collection of 1,112 Rapid Data Points and 71 survey plots, and was focused on vegetation community delineation and mapping rather than threatened species. A more recent round of surveys was also undertaken in preparation for the BDAR for the current Project (Kleinfelder 2020). Targeted surveys for *Diuris* and *Prasophyllum* were undertaken in late October 2019, most likely after peak flowering. However, Kleinfelder (2020) acknowledges that unfavourable conditions for orchid growth due to drought impinged on survey planning for these species (see Section 3.2). Dates of field survey for both projects are as shown in Table 4. Some survey undertaken in 2019 did coincide with orchid flowering, however based on Table 11 in Kleinfelder (2020) these surveys were targeting other species (*Pterostylis chaetophora*). After all surveys, only one orchid species (*Microtis* sp.) was recorded within survey plots.

Table 4 Kleinfelder survey effort and orchid flowering periods.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016												
2019												
2020												
D.tricolor												
P.petilum												

3.2 Impact of Drought

38. As noted earlier, terrestrial orchids are sensitive to environmental conditions, and in the Hunter Valley prevailing climate is influential in their detection during surveys. The past three years in the central Hunter Valley have been particularly dry. Figure 8 shows that, apart from the very wet months of March 2017, March 2019, and September 2019, below average rainfall has been received at Muswellbrook from 2017. Such dry conditions will place all plants under severe water stress, and for emergent geophytes like Spring-flowering orchids, dry Winter periods over successive years commonly result in little or no emergence.

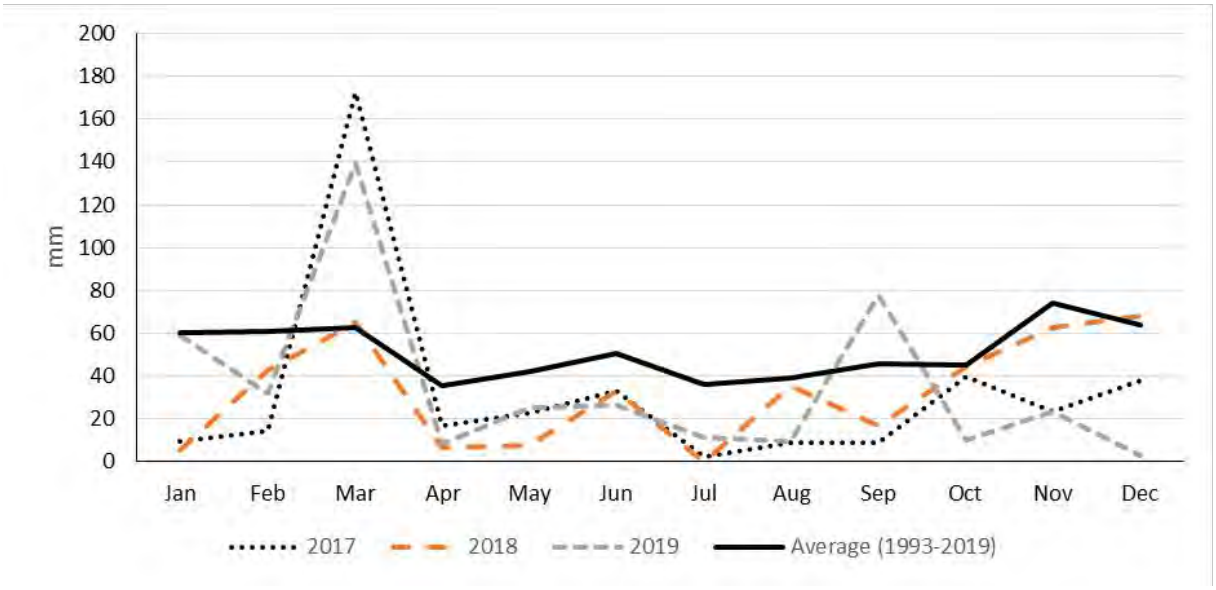

Figure 8 **Monthly and average rainfall for Muswellbrook (station # 61374; c. 25 km from the Project Area) over the past three years.** (Source: Bureau of Meterology, http://www.bom.gov.au/climate/data/).

39. The NSW DPI Combined Drought Indicator (CDI) provides a further dataset that can help to explain how orchids and other plants respond to climatic conditions. The CDI categorises months into one of six phases of drought on the basis of three indices (rainfall index, plant growth index, soil water index). The Howick Parish (which includes the Project Area) formally experienced drought from July 2017 to February 2020 (time of writing) after a period of non-drought between May 2015 to July 2017 (Figure 9). Intense drought was experienced between April 2018 and October 2018 (encompassing the 2018 orchid flowering period), and again from December 2019 to January 2020. The 2019 orchid flowering season and the months leading up to it were also drought affected. Clearly, any targeted orchid surveys undertaken during the 2017, 2018, or 2019 flowering seasons would be unlikely to detect representative populations of these species if present.

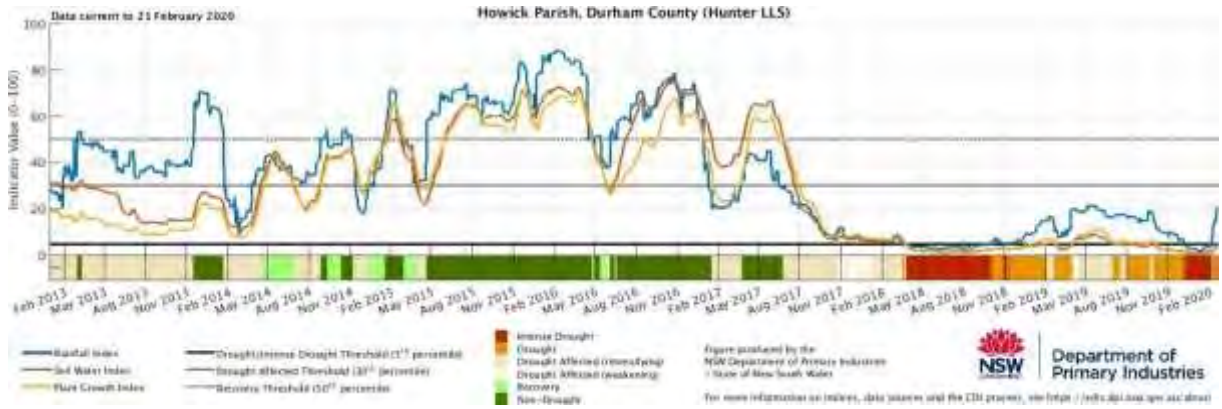

Figure 9 **Drought indices for the Howick Parish, February 2013 to February 2020, showing drought conditions prevailing from August 2017 to February 2020.** (Source: DPI Seasonal Conditions Information Portal, https://edis.dpi.nsw.gov.au/statistics).

40. Most orchid species will not emerge to flower during stressful periods, or if leaves are produced at this time then flower stalks may not form. Given the drought conditions experienced from mid-2017 to the present, and in particular during the Winter period prior to flowering, there is clear justification for the preparation of this expert report. Additionally, pressure from herbivory during drought periods escalates considerably (Duncan et al. 2005), not only from vertebrate grazers such as macropods and rabbits, but also invertebrates including grasshoppers and caterpillars (Light & MacConnaill 2011; Vizer 2013). Bird species too are known to selectively feed on orchid species, with White-winged Choughs for example extracting orchids out of the ground to consume tubers (Duncan et al. 2005; Faast & Facelli 2009; Bell submitted). Any vegetation present during dry times will be the focus of herbivore browsing, meaning a reduction in the time orchids will be present above ground and hence reduced detection rates during survey. Desiccation through heat and wind in periods of drought will also reduce above-ground periods of flowering orchids.

41. Persistent dry conditions and drought, including below-average falls during the crucial Winter period, over the last three seasons (2017 to 2019) justify the need for an Expert report to determine the likely presence of *Diuris tricolor* and *Prasophyllum petilum* within the Project Area.

4. Criterion (c) – Likelihood of Species Presence in the Project Area

42. To assist in determining the likely presence or absence of populations of *Diuris tricolor* or *Prasophyllum petilum* within the Project Area, I have examined aspects of previous land-use history, known existing records for both species within the region, the floristic composition and soil landscapes of habitats within the Project Area and other areas known to support both species. I have also incorporated my own observations made on a single-day site inspection in mid-February 2020.

4.1 Land-use History of the Project Area

43. The Project Area is almost entirely comprised of derived grasslands, regrowth native and exotic woody vegetation, or planted species (Kleinfelder 2017, 2020). This part of the Hunter Valley was one of the first to be opened up for European occupation, spanning out from the nearby settlement of Jerrys Plains in the early 1800s (C. Hunter 2010). Much of the land was used for the grazing of cattle and sheep, and where necessary the original woodlands were thinned of trees to increase pasture growth. Current day vegetation is the result of 200 years of agricultural occupation, part of which in the mid 1980s was set aside for the creation of Bayswater Power Station.

44. Although cattle have historically grazed the Project Area since before Bayswater Power Station was first constructed, they were removed or rotated to other areas from late 2019 in response to ongoing drought and the lack of feed. All of the derived grasslands which now predominate throughout the Project Area appear to provide potential habitat for *Diuris tricolor* and *Prasophyllum petilum*, given their preference for open grassy areas (Bell submitted), but this is further explored in the following sections.

4.2 Existing Orchid Records within the Project Area and Surrounds

45. No populations of *Diuris tricolor* or *Prasophyllum petilum* have been recorded within the Project Area, nor within the wider buffer lands (Kleinfelder 2017, 2020). As noted in Section 3.2, drought conditions coincided with the preparation of documents relating to the proposed development in the area, and as a consequence there is a low likelihood that these species, if present, would be detected. Despite this, Figures 8A to 8D, 9A to 9D and 10A to 10D in Kleinfelder (2020) show evidence of extensive targeted surveys across the Project Area during 2019 (although that shown in Figures 10A to 10D fall outside of expected flowering periods for *Diuris* and *Prasophyllum*: see Table 4). Due to the prevailing drought conditions, it is not possible to conclude that the target species are absent from the Project Area on the basis of this survey effort.

46. Examination of surrounding records of the species may shed some light on the expected presence of *Diuris* and *Prasophyllum* within the Project Area. The nearest proximate records are shown in Figure 10, sourced from available databases (AVH and Bionet, extracted 3 March

2020). *Diuris tricolor* has been reported on numerous occasions to the north-west and once to the west of the Project Area (c. 5-9 km distant), however there are no equivalent records of *Prasophyllum petilum* (de-natured and erroneous records falling just south of Muswellbrook refer to the Mangoola locality). *Diuris tricolor* has also been observed c. 50 km to the south-east of the Project Area at North Rothbury, suggesting that other unrecorded populations may also occur within the intervening lands. Based on these proximate records, it is therefore more likely that *Diuris tricolor* may be present within the Project Area than *Prasophyllum petilum*.

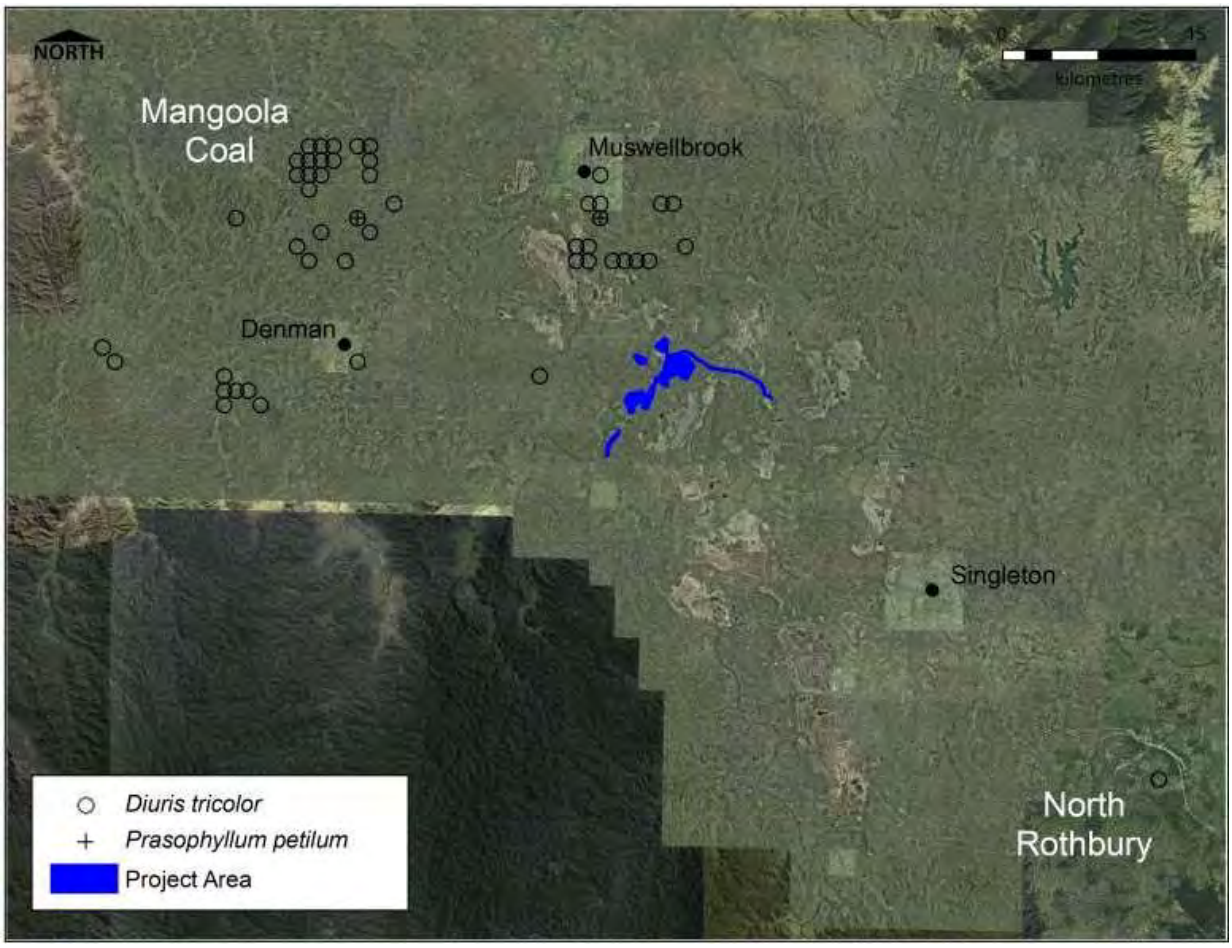

Figure 10 Surrounding records of *Diuris tricolor* and *Prasophyllum petilum*. Data sourced from AVH and Bionet, extracted 3 March 2020.

4.3 Analysis of Floristic Data from within the Project Area

47. Understanding the floristic patterns in the Project Area is important in gaining an impression of how suitable the lands are to support one or both of the target orchid species. Although 2019 was a very dry year, examining floristic data collected prior to that in the wetter 2016 as part of wider ecological studies can be informative. I have consequently inspected the information and data included in Kleinfelder (2017, 2020), in addition to notes made from my one day field inspection (see Section 4.5), to assist in formulating an opinion on the likelihood of *Diuris* or *Prasophyllum* presence within the Project Area.

4.3.1 Plant Community Types

48. Kleinfelder (2017) outlines the results obtained in their vegetation survey and mapping project of the wider Bayswater and Liddell Power Station lands. They identified two dry sclerophyll forests, three grassy woodlands, three forested wetlands, three grasslands and one unit of *Acacia* regrowth. For the BDAR report, Kleinfelder (2020) reports the relevant communities as one of three PCTs for the Project Area (Table 5), with varying levels of condition. Grassland areas within PCT1691 (*Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter*) comprises the largest individual condition class, at 147.77 ha (71% of the 206.82 ha mapped). Based on experience elsewhere, it is these Grassland areas that would provide the most likely habitat for the target orchid species.

49. Examining the floristic composition and condition of the relevant PCTS shows that for Grassland areas of PCT1691 (based on 7 survey plots), dominant ground layer species include *Aristida ramosa, Chloris ventricosa, Bothriochloa macra, Sporobolus creber, Rytidosperma fulvum, Erodium crinitum, Chrysocephalum apiculatum, Brunoniella australis, Enchylaena tomentosa, Convolvulus erubescens, Vittadinia cuneata, Solanum cinereum, Cheilanthes distans* and *Lomandra filiformis* (Kleinfelder 2020). Of these species, only five (36%) occur within grassland types identified at Mangoola Coal mine as favoured by *Diuris tricolor* or *Prasophyllum petilum*: Unit 1a (Dichanthium/ Sporobolus/ Chloris Grassland) and Unit 2 (Aristida/ Cymbopogon Grassland) of Bell (submitted). While there may be some identification descrepancies between the two districts (e.g. *Bothriochloa macra* vs *B. decipiens; Chloris ventricosa* vs *C. truncata, Rytidosperma fulvum* vs *R. tenuius*), there remains enough uncertainty in the commonality of species to be cautious of determining the grasslands within the Project Area as prime habitat for *Diuris tricolor* and/or *Prasophyllum petilum*.

50. To further explore floristic compositions between the Project Area and known orchid habitat at Mangoola Coal mine, I undertook numerical analyses using *Primer* software (Clarke & Gorley 2006). Rather than using raw data (which utilised different survey methods: 0.04 ha plots for the Project Area but 0.01 ha plots at Mangoola), I compared floristic compositions of the community profiles derived for each project (Vegetation Zones 1-9 + Exotic Grassland for the Project Area; Units 1a and 2 for Mangoola Coal). All data was analysed on a presence-absence basis, meaning that dominant species held equal value to rare species. While not ideal, this process allowed me to determine if the ground flora diversity present in the Project Area (collected during the wet year of 2016) correlated well with that for Mangoola where orchids were known to occur (collected between 2009 and 2011, c. average rainfall years), irrespective of dominance influenced by variable climatic conditions. Weed species were retained in the dataset, as these form an important component in the diagnosis of grassland communities in long-disturbed landscapes in the Hunter region.

51. I used the SIMPROF routine in combination with the CLUSTER module to identify statistically significant splits in the dataset ($p<0.01$). This provided a cluster diagram where sites supporting similar floristic combinations were grouped and linked to their most similar neighbours. I also ran the MDS (non-metric Multi Dimensional Scaling) routine with a minimum stress level of 0.01 and 25 restarts to produce an ordination plot of the same data (Figure 11). Clustering of similar sample plots (communities or vegetation zones) can be better appreciated across this two-dimensional ordination space than in a cluster diagram, hence the latter is not shown. The stress level of 0.11 shown in Figure 11 is an indication of the difficulty in which all data can be accommodated within two-dimensions. In general, a stress level of <0.2 is considered

acceptable in these sorts of analyses, but increases in line with complexities associated with multiple observers and seasons.

Table 5 Vegetation communities and Plant Community Types identified for the wider Bayswater/Liddell area (grey) and Project Area (black), excluding dams and other 'excluded lands' (from Kleinfelder 2017, 2020). Condition classes within PCTs not shown.

Community	Plant Community Type (PCT)	Extent in Project Area (ha)
Within Project Area		
Central Hunter Box – Ironbark Woodland	1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	206.82
Central Hunter Bull Oak Forest	1692: Bull Oak grassy woodland of the central Hunter Valley	61.64
Swamp Oak Forest	1731: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	2.40
Outside Project Area		
Central Hunter Ironbark-Spotted Gum-Grey Box Forest	1601: Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	
Slaty Gum Woodland	1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley	
Hunter Valley Weeping Myall Woodland	116 Weeping Myall – Coobah – Scrub Wilga shrubland of the Hunter Valley	
River Oak Forest	485: River Oak riparian grassy tall woodland of the western Hunter Valley	
Hunter Floodplain Red Gum Woodland Complex	42: River Red Gum/River Oak riparian woodland wetland in the Hunter Valley	
Native Grasslands	Derived from 1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter OR 1601: Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	
Exotic Grasslands	No equivalent	
Acacia Regrowth	Derived from 1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter OR 1601: Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	

52. From Figure 11, it is evident that the two orchid-supporting grassland communities defined for Mangoola (Units 1a and 2), although broadly placed within the same PCT (PCT1691), are floristically significantly different ($p<0.01$) to those in the Project Area, irrespective of the dominance that may be shown by certain species (i.e. as a result of a presence-absence analysis, rather than one based on cover abundance data). Furthermore, there is little floristic difference between eight of the ten Vegetation Zones (VZ) delineated for the Project Area, including the

two Vegetation Zones (VZ7 & VZ8) allocated to PCT1692. This suggests to me that all eight of those Vegetation Zones are representative of the one community, perhaps sharing a common disturbance (grazing) history. Swamp Oak – Weeping Grass grassy Riparian Forest (PCT1731; VZ9) and Exotic Grasslands are equally distinct from the bulk of defined Vegetation Zones.

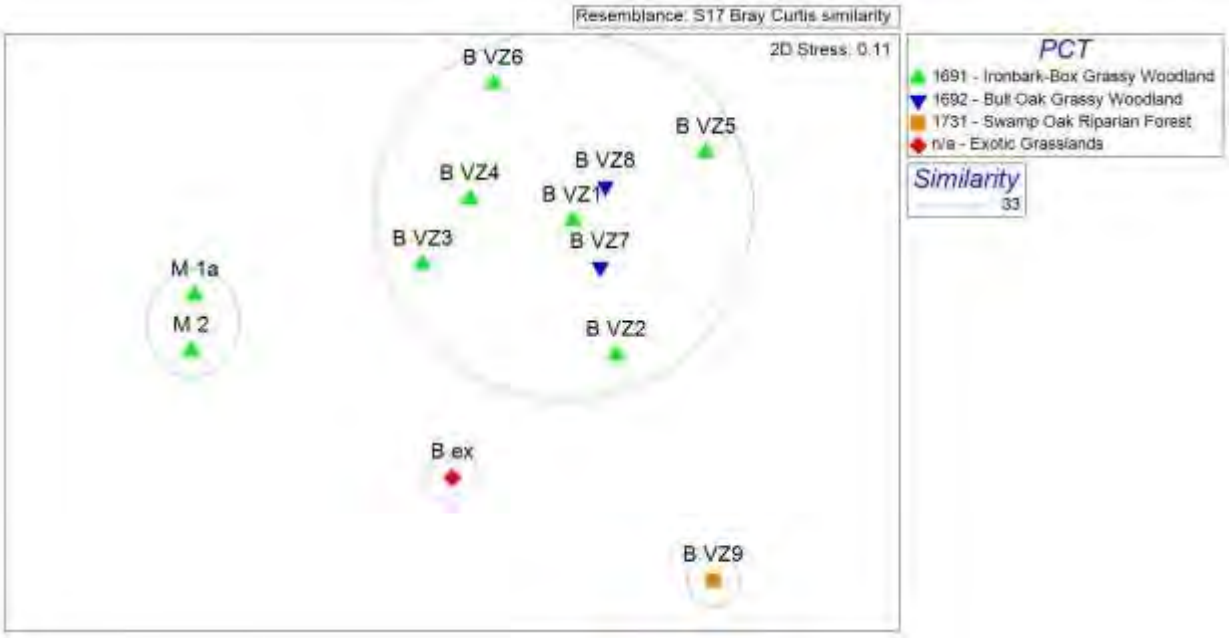

Figure 11 nMDS ordination of floristic compositions comprising Plant Community Types from the Project Area (B) in relation to favoured *Diuris* and *Prasophyllum* habitat at Mangoola Coal (M). Dotted elipses show significant groups (p<0.01) defined at a similarity level of 33%. VZ = Vegetation Zone; 1a, 2 = grassland type (see text for details). Data for the Project Area from Kleinfelder (2017, 2020), that from Mangoola from Bell (submitted).

53. One conclusion to reach from this analysis is that the floristic composition of all Vegetation Zones defined for the Project Area differ significantly from those grassland communities at Mangoola known to support populations of both *Diuris* and *Prasophyllum*. Acknowledging the different years of data collection between these two locations (2009-11 vs 2016), the different observers collecting the data and the different methods of community profile development employed (numerical vs subjective analysis), I am reasonably confident that there are significant differences between the grasslands and grassy woodlands within the Project Area and those at Mangoola Coal mine. This is supported in part by my own field observations of the Project Area (see Section 4.5). Floristic data for *Diuris* and *Prasophyllum* from other sites in the Hunter Valley are not available to test this result against other populations, however anecdotal observations from some sites would suggest a similar outcome.

4.3.2 Raw Floristic Data

54. Inspection of the raw data behind these community definitions can also be informative, as site detail can be lost during the community classification process. Kleinfelder (2020) based their vegetation map of the Project Area on the analysis of 36 floristic survey plots/transects, from within a larger dataset of 71 plots (Kleinfelder 2017). Seven of these were positioned within their Derived/Modified Native Grasslands unit, with the remainder within Central Hunter Bulloak Forest (8), Central Hunter Box – Ironbark Woodland (7), Acacia Regrowth (5),

Rehabilitation (3), Central Hunter Swamp Oak Forest (2), Wetland/ Dam (2) and Plantation (2) (Table 6).

Table 6 Summary of plots/transects within the Project Area (from Kleinfelder 2020).

Component	Total plots	Vegetation Community (Zone)	No. plots
Borrow Pit 1	1	Derived/ Modified Native Grasslands (Zone 4)	1
		Central Hunter Box – Ironbark Woodland (Zone 1/2)	-
		Central Hunter Bulloak Forest (Zone 7/8)	-
		Acacia Regrowth (Zone 3)	-
		Central Hunter Swamp Oak Forest (Zone 9)	-
		Wetland/ Dam (-)	-
Borrow Pit 2	2	Derived/ Modified Native Grasslands (Zone 4)	1
		Central Hunter Box – Ironbark Woodland (Zone 1/2)	1
		Exotic Grasslands (-)	-
Borrow Pit 3	1	Derived/ Modified Native Grasslands (Zone 4)	1
		Central Hunter Bulloak Forest (Zone 7/8)	-
		Central Hunter Box – Ironbark Woodland (Zone 1/2)	-
		Acacia Regrowth (Zone 3)	-
Borrow Pit 4	14	Central Hunter Bulloak Forest (Zone 7/8)	7
		Derived/ Modified Native Grasslands (Zone 4)	2
		Acacia regrowth (Zone 3)	2
		Central Hunter Box – Ironbark Woodland (Zone 1/2)	2
		Wetland/ Dam (-)	1
		Central Hunter Swamp Oak Forest (Zone 9)	-
HP Pipe Clearing (Nth)	1	Central Hunter Box – Ironbark Woodland (Zone 1/2)	1
		Exotic Grasslands (-)	-
		Derived/ Modified Native Grasslands (Zone 4)	-
		Wetland/ Dam (-)	-
		Acacia Regrowth (Zone 3)	-
HP Pipe Clearing (Sth)	4	Acacia Regrowth (Zone 3)	2
		Plantation (Zone 6)	2
		Exotic Grasslands (-)	-
		Central Hunter Box – Ironbark Woodland (Zone 1/2)	-
		Derived/ Modified Native Grasslands (Zone 4)	-
Ash Dam	6	Central Hunter Box – Ironbark Woodland (Zone 1/2)	2
		Wetland/ Dam (-)	1
		Central Hunter Bulloak Forest (Zone 7/8)	1
		Derived/ Modified Native Grasslands (Zone 4)	1
		Central Hunter Swamp Oak Forest (Zone 9)	1
		Exotic Grassland (-)	-
		Rehabilitation (Zone 5)	-
		Plantation (Zone 6)	-
Coal Handling Plant	2	Rehabilitation (Zone 5)	2
		Exotic Grasslands (-)	-
		Acacia Regrowth (Zone 3)	-
Salt Cake Landfill	1	Acacia Regrowth (Zone 3)	1
		Central Hunter Box – Ironbark Woodland (Zone 1/2)	-
		Derived/ Modified Native Grasslands (Zone 4)	-
		Exotic Grasslands (-)	-
Ravensworth Ash Line	4	Derived/ Modified Native Grasslands (Zone 4)	1

Component	Total plots	Vegetation Community (Zone)	No. plots
		Central Hunter Box – Ironbark Woodland (Zone 1/2)	1
		Central Hunter Swamp Oak Forest (Zone 9)	1
		Rehabilitation (Zone 5)	1
		Wetland/ Dam (-)	-
		Exotic Grasslands (-)	-
		Acacia Regrowth (Zone 3)	-
Total	36		36

55. Of these, I consider those described as Derived/ Modified Native Grasslands (Zone 4) and Acacia Regrowth (Zone 3) as the most likely habitats to support substantial populations of *Diuris tricolor* and/or *Prasophyllum petilum*. I have included Acacia Regrowth (Zone 3) as many of the areas shown as this community have a very sparse cover of *Acacia saligna* or *Acacia salicina*, and there is ample potential habitat for orchids in these situations. Other habitats, such as Rehabilitation and Plantation, may support occasional individuals but I have not seen these species growing extensively in such disturbed habitats elsewhere. A further possibility is the Central Hunter Bulloak Forest, which is itself essentially a regrowth community following past clearing. However, similarly I have not seen this habitat supporting large numbers of orchids elsewhere (likely due to shading), hence do not consider it likely to support a viable population of the target orchids.

56. Examination of the 7 plots within **Derived/ Modified Native Grasslands (Zone 4)** shows that two are dominated by *Chloris truncata* and/ or *Chloris ventricosa* (35% cover), two by *Aristida ramosa* (40-50% cover) but with *Chloris truncata* and *Chloris ventricosa* sub-dominant (10-20% cover), two by *Erodium crinitum* (25-40% cover) with weed species (*Plantago hispida, Solvia sessilis, Carthamnus lanatus*), and one by *Bothriochloa macra* with *Carthamnus lanatus* (40% cover). The preponderance of *Chloris* spp. and *Bothriochloa* within most of these plots is indicative of a richer soil that has not been grazed heavily in recent years, and is typical of landscapes characterised by *Eucalyptus 'albemol'* in the upper Hunter Valley.

57. For **Acacia Regrowth (Zone 3)**, Kleinfelder (2020) sampled 5 plots/transects. Examination of these 5 plots shows the weed *Hyparrhenia hirta* to be dominant in two (55-60% cover), *Chloris ventricosa* and/ or *Chloris truncata* dominating with *Bothriochloa macra* in two others (30% cover), and one dominated by *Aristida ramosa* with *Hyparrhenia hirta* sub-dominant (10-20% cover). The aggressive invading tall shrub *Acacia saligna* was present in all of these plots, at 5-30% cover. These areas may support *Diuris tricolor* and *Prasophyllum petilum*, although the dominance of *Hyparrhenia hirta* will negatively impact on potential habitat in some areas.

58. In total, the Derived/ Modified Native Grasslands (Zone 4) and Acacia Regrowth (Zone 3) units comprise 188 ha of the Project Area Kleinfelder (2020). Although I consider there to be a low likelihood of occurrence of *Diuris tricolor* and/or *Prasophyllum petilum* in these areas, to be conservative I suggest that it is these areas that may support populations of either species within the Project Area. Other areas mapped by Kleinfelder (2020) as Central Hunter Bulloak Forest (61.6 ha), Central Hunter Box – Ironbark Woodland (14.8 ha), Wetland/ Dam (11.3 ha), Rehabilitation (3.75 ha), Central Hunter Swamp Oak Forest (2.4 ha) and Plantation (0.14 ha) do not represent important habitat for *Diuris* or *Prasophyllum*.

4.4 Analysis of Soil Landscapes within the Project Area

59. Given observed differences in key canopy species between the Project Area (mostly *Eucalyptus 'albemol'*) and other locations supporting *Diuris tricolor* and *Prasophyllum petilum* (mostly *Eucalyptus crebra* and *E. dawsonii*: see Section 2.3), it is informative to examine available soil mapping to determine if key soil differences may explain this. Soil landscape mapping (Kovac & Lawrie 1991) at 1:250,000 scale provides a landscape-scale dataset, but there is no higher resolution soils mapping available for the upper Hunter region. This 250k mapping shows the Project Area to fall almost exclusively within the Liddell soil landscape, the exceptions being all of Borrow Pit 4 and c. 95% of Borrow Pit 3 in the Bayswater soil landscape, and c. 25% of the HP Pipe Clearing South lying on the Brays Hill soil landscape. These soil landscapes are described by Kovac and Lawrie (1991) as follows:

    - Liddell – yellow soloths on slopes with some yellow solodic soils on concave slopes; earthy and siliceous sands on mid to lower slopes where parent material is sandy; some red soloths, red solodic soils and red podzolic soils.
    - Bayswater – yellow solodic soils on slopes with alluvial soils in drainage lines; brown and yellow earths and prairie soils in some drainage lines; red, yellow and brown podzolic soils on slopes; yellow soil x red-brown earth intergrades
    - Brays Hill – red clays on mid to upper slopes, with black earths and grey clays on mid to lower slopes ; brown clays may also occur on midslopes, with yellow (orange)solodic soilson lower slopes and alluvial soils in drainage depressions; red-brown earths on some crests and upper slopes with rendzinas, red clays and black earths; black earths common on steeper slopes; solodic soils on non-calcareous parent material

60. None of these soil landscapes are known to support *Diuris tricolor* or *Prasophyllum petilum* in the Mangoola Coal mine area (Bell 2019b), and only limited representation is known for populations elsewhere. The most easterly occurrence of *Diuris tricolor* at North Rothbury lies on the Rothbury soil landscape, to the immediate north-west of the Project Area populations occur on the Roxburgh soil landscape, and in the Jerrys Plains vicinity they occur on the Jerrys Plains soil landscape. However, to the south-west *Diuris* is present on the Bayswater and/or Brays Hill soil landscapes, and to the north one population is known from the Liddell soil landscape (Bell et al. 2020).

61. For the Mangoola (Wybong) area, an assessment of all point records (n=8684 *Diuris*; n=1812 *Prasophyllum*) against soil landscape was undertaken and presented in Bell (2019b). This was contingent on the amount of search effort and timing of surveys that has been extended across all soil landscapes in the area, but nevertheless provided a sound basis on which to assess likely occurrence. Six soil landscapes were identified as supporting one or both of the target species for that area. Figure 12 summarises the relative distribution of each orchid across the six soil landscapes in which they were recorded. The majority of occurrences were on the Wappinguy and Sandy Hollow landscapes, which both support solodic soils. Based on existing records at that time, *Diuris* more-or-less equally occured on Wappinguy and Sandy Hollow soils (93% of all records combined), while *Prasophyllum* showed a strong preference for Sandy Hollow soils, with Wappinguy and Castle Rock soils also important for this species (99% combined). Minor occurrences on Lees Pinch, Growee and Dartbrook soil landscapes were considered an artefact of the poor resolution of soils mapping (1:250k scale).

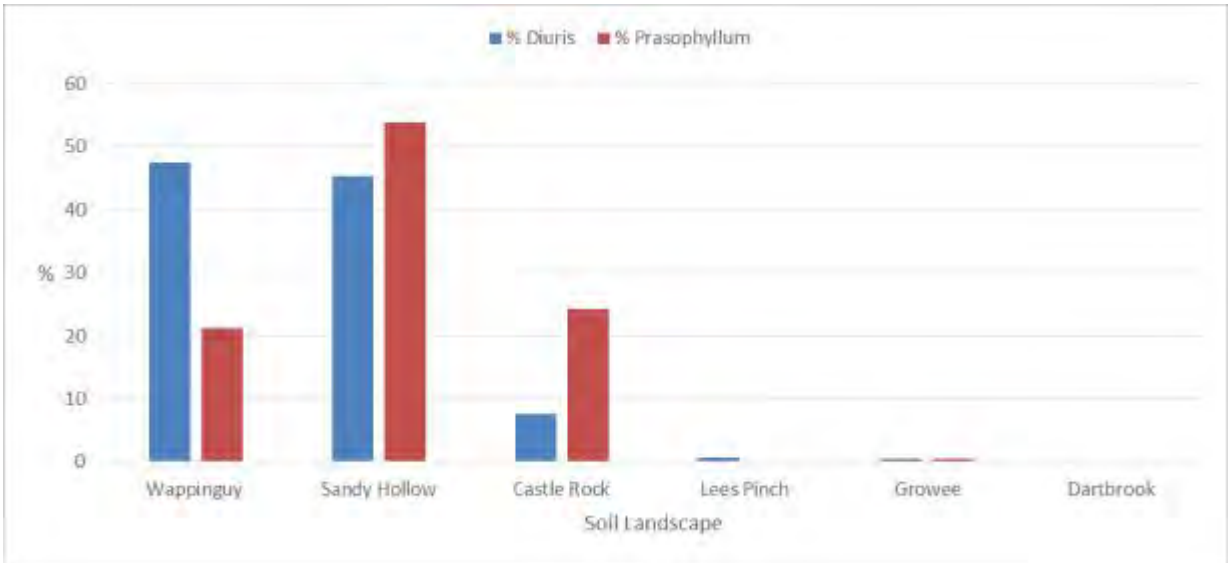

Figure 12 Relative proportion of known orchid presence (2009 – 2017) across six soil landscapes in the Mangoola Coal area (n=8684 *Diuris*; n=1812 *Prasophyllum*). From Bell (2019b).

62. There is some uncertainty, therefore, in the value of small scale soil landscape mapping alone to determine the likely presence of *Diuris* and *Prasophyllum*, although when combined with analyses of other environmental and floristic variables it can be of useful additive value. In the case of *Prasophyllum petilum*, there are no known records of this species within soil landscapes mapped as Liddell, Bayswater or Brays Hill (despite similar soils), strongly suggesting that this species is likely to be absent from the Project Area. I am less confident in dismissing potential habitat based on soil landscapes for *Diuris* however, due to the Project Area and other known locations sharing similar soils and the proximity to other known populations. Soloth soils differ mainly from solodic soils in the former being acidic throughout the profile, the latter only acidic in A horizons (Stace et al. 1968).

4.5 Field Inspection of the Project Area

63. I inspected most parcels of land that comprise the Project Area on 21 February 2020, in the company of Samara Schultz (Kleinfelder). I did not inspect the Ravensworth Ash Line or the HP Pipe Clearing (south) in any detail, but given these areas are long-established easements subject to regular disturbances, their potential to support orchid populations is lessened.

64. Field inspections involved traversing each area in a vehicle, with periodic stops to inspect the ground vegetation and its condition. Notes were made on key species present, and representative photographs taken of habitat. A subjective assessment of the likelihood of orchid presence (low, medium, high) was also made at this time, based soley on composition and condition of grassland areas. Observations of the extent or otherwise of different management intensities in the different parcels of lands were also made, particularly in relation to positioning of stock fencing.

65. My initial impression of the grasslands within the Project Area during my inspection were that, although in excellent condition following the recent rains, the floristic composition was markedly different to that occurring elsewhere where *Diuris* and *Prasophyllum* occur. Dominant grass species across most areas included *Chloris truncata, Eriochloa pseudoacrotricha, Panicum effusum, Digitaria coenicola, Bothriochloa decipiens* and *Microlaena stipoides* var. *stipoides*,

with occasional patches of *Bothriochloa biloba* (Figure 13). Within this matrix was an array of flowering herbs and forbs, including *Calotis cuneifolia, Glycina tabacina, Stackhousia muricata, Sida corrugata, Minuria leptophylla, Eremophila debilis, Fimbristylis dichotoma* and *Chrysocephalum apiculatum*. Weed species were generally sparse or localised around former stock camps or near gates.

Figure 13 Grassland within Borrow Pit 4, showing low grassland dominated by *Chloris truncata* and *Microlaena stipoides* var. *stipoides*.

66. Even in areas of Central Hunter Bulloak Forest, there was an array of herbs and grasses beneath the canopy of *Allocasuarina luehmannii* which in other Hunter Valley areas I have surveyed over many years are typically devoid of such species. I can only suggest that the soils within the Project Area are richer and therefore capable of supporting a greater ground flora, a further reflection of the differing soil properties occurring in the Project Area when compared to other Hunter locations supporting the target orchids. However, I suspect the shading qualities of *Allocasuarina luehmannii* may be too excessive to allow persistence of any *Diuris* or *Prasophyllum* populations that may have once occurred there.

67. As summarised earlier, grassland habitats supporting *Diuris tricolor* and *Prasophyllum petilum* elsewhere in the Hunter Valley tend to be dominated by *Aristida ramosa, Cymbopogon refractus, Bothriochloa decipiens* and *Sporobolus creber* (all present in the Project Area, but never dominating), with other grass species present but subdominant (Figure 14, cf. Figure 13). Herbs and forbs do occur in those habitats, but they are rarely conspicuous or dominant. The grasslands observed within the Project Area appeared more diverse, in keeping with observations made in other parts of the Hunter that landscapes derived from former *Eucalyptus 'albemol'* or *Eucalyptus moluccana* woodland support more species than those derived from

Eucalyptus crebra (e.g. such as seen at Rixs Creek; Bell 2012b). Indeed, observations of remnant canopy species made during my inspection revealed that almost all of the Project Area appeared to have once supported a woodland of *Eucalyptus 'albemol'*, except for a restricted area around the northern parts of the existing Ash Dam where *Eucalyptus crebra* replaced *E. 'albemol'*.

Figure 14 Grassland supporting *Diuris tricolor* and *Prasophyllum petilum* at Mangoola Coal, dominated by *Aristida ramosa* and *Cymbopogon refractus*.

68. Despite these observations, I am conscious of the possibility that these observed differences in floristic composition may be a reflection on the recent growth following good falls of rain. However, apart from a few areas within Borrow Pit 3 (Figure 15) where the hardy and grazing-tolerant *Aristida ramosa, Cymbopogon refractus* and *Sporobolus creber* co-dominated some slopes, the bulk of lands were devoid of these species.

69. On the GIS, I then examined the vegetation community mapping presented in Kleinfelder (2020) to determine if it accurately portrayed the diversity and distribution of vegetation that I inspected. I found this mapping to represent well the vegetation patterns within the Project Area [excluding the Ravensworth Ash Line or the HP Pipe Clearing (south), which I did not inspect]. The distinction between grassland areas dominated by native species and those dominated by exotic species was good, except for the odd occasion where small areas of *Cynodon dactylon* (or possibly *C. incompletus*, although both are considered naturalised weeds in Australia: Fensham & Laffineur 2019) formed near-monocultures around paddock trees on the ridgeline in Borrow Pit 2. Additionally, some areas mapped as Acacia Regrowth (Zone 3) supported very few individuals of *Acacia* (e.g. Borrow Pit 1), and I would consider these areas more a component of Derived/ Modified Native Grasslands (Zone 4).

Figure 15 Grassland within Borrow Pit 3, showing (predominantly) scattered clumps of *Aristida ramosa* over low grassland of *Microlaena stipoides* var. *stipoides* and *Chloris truncata*.

70. After this review, I was satisfied that I could use the Kleinfelder vegetation community mapping to create maps of likely orchid habitat, so that estimates of the number of hectares anticipated to support viable orchid populations could be calculated (Section 5). Additional guidance was provided by my own field notes, the plot data collected by Kleinfelder and aerial imagery to refine boundaries between areas of differing quality, such as where clearly distinct photopatterns were evident along fenced paddock boundaries.

71. In determining the suitability of the Project Area as orchid habitat, I drew on my experience from surveying for both species in the Mangoola area over ten years. Part of this experience included observations of orchids growing in somewhat surprising situations, which may otherwise be glossed over as unsuitable. For example, observations of *Diuris tricolor* growing on contour banks constructed by previous land owners (Figure 16), in heavily weed-infested derived grasslands where no other native species were apparent (Figure 17), and proliferating on the manicured lawns of farm homesteads (Figure 18). I have also observed *Diuris* growing within a former vineyard on raised garden beds, and along the margins of management trails. Collectively, observations of orchids growing in such disturbed habitats suggest that few areas of appropriate habitat can be confidently excluded from supporting any orchids, and that other factors should be considered.

72. Kleinfelder (2020) suggested that some components of the Project Area should be excluded from potential orchid habitat on the basis of higher historical disturbances and weed invasion. However, given my previous observations of *Diuris tricolor* persisting in such habitats (see preceeding paragraph), I cannot agree.

Figure 16 ***Diuris tricolor*** **and other orchids growing over a constructed contour bank, Mangoola.**

Figure 17 ***Diuris tricolor*** **growing with exotic weeds in low quality grassland near Mangoola Coal.**

Figure 18 ***Diuris tricolor*** **proliferating in mown lawns of a farm homestead near Mangoola Coal.**

5. Criterion (d) – Size of Population or Habitat

73. In order to determine the extent of potential habitat for *Diuris tricolor* and *Prasophyllum petilum* within the Project Area, I considered the following elements as outlined earlier in this report:

- the dominance of *Diuris* in *Eucalyptus crebra* and *Eucalyptus dawsonii* landscapes rather than *Eucalyptus 'albemol'* landscapes at known populations in the Hunter Valley, and the dominance of *Prasophyllum* predominantly in *Eucalyptus crebra* and *Eucalyptus dawsonii* landscapes but also in *Eucalyptus 'albemol'* landscapes at Mangoola Coal (see Section 2.3)
- the influence of drought conditions and recent rains on the likely presence of *Diuris* and *Prasophyllum*, and the subsequent condition of grassland habitats potentially supporting them (see Section 3.2)
- the proximity of several *Diuris* records <10 km from the Project Area, but the absence of known and confirmed populations of *Prasophyllum* outside of the Mangoola Coal mine area (see Section 4.2)
- the differing floristic composition and condition of grasslands known to support *Diuris* and *Prasophyllum* elsewhere when compared to the Project Area, exemplified in the results from the numerical analysis examining presence/absence data (see Section 4.3)
- the vegetation classification and mapping of Kleinfelder (2017, 2020), and the floristic compositions described therein (see Section 4.3)

- the broadly similar soil types in known *Diuris* and *Prasophyllum* habitat compared to those present in the Project Area, despite poor correlation with soil landscape types (see Section 4.4)
- the generally good condition of derived grasslands across the Project Area, albeit influenced by recent rainfall and with varying densities of weed species (see Section 4.5)
- other field observations from my site inspection on 21 February 2020 (see Section 4.5)

74. As indicated in Section 4.3.2, I consider the most likely habitat for *Diuris tricolor* and/or *Prasophyllum petilum* within the Project Area to comprise vegetation communities mapped by Kleinfelder (2020) as Derived/ Modified Native Grasslands (Zone 4) or Acacia Regrowth (Zone 3). This differs from the suggested orchid habitat contained in Kleinfelder (2020), where all areas of PCT1691 (Zones 1-6) were included with the exception of lands subjected to higher levels of historical disturbance as evidenced by higher weed occurrence. As indicated earlier, *Diuris* in particular is capable of persisting in moderately disturbed landscapes, and I suggest that all areas of Derived/ Modified Native Grasslands (Zone 4) and areas mapped as Acacia Regrowth (Zone 3), with the exception of the Salt Cake Landfill site, do provide orchid habitat.

75. Combined, 188 ha of Derived/ Modified Native Grasslands (Zone 4) and Acacia Regrowth (Zone 3) have been mapped by Kleinfelder (2020). However, after inspecting the Salt Cake Landfill site and observing the condition of habitats there, it is unlikely that a viable population of either orchid will be present there. This is also attested to by the single floristic plot positioned there by Kleinfelder (2017), showing it to support 60% cover of the weed *Hyparrhenia hirta* and only two native species (*Aristida ramosa* and *Vittadinia cuneata*, both at 0.1% cover). This, and the observation that there has been considerable ground disturbance in this area over many years, suggests that it is highly unlikely that orchids remain there. Consequently, the 21.85 ha of Acacia Regowth (Zone 3) within this area can be deducted from the overall total of 188 ha, to leave 166 ha of potential orchid habitat within the Project Area.

76. Note that this 166 ha of potential orchid habitat is conservative but I consider it unlikely to support large populations of *Diuris*, and probably no *Prasophyllum*. Relative to other Hunter populations of both species, the floristic composition of grasslands within the Project Area are very different and occur on different soil landscapes supporting richer soils. The Project Area is also almost exclusively within former woodland of *Eucalyptus 'albemol'* (a reflection of richer soils), and a habitat that supports very few of the target orchids elsewhere (e.g. 6% of *Diuris* and 19% of *Prasophyllum* at Mangoola). Several known populations in other parts of the Hunter Valley occur in former *Eucalyptus crebra* or *Eucalyptus dawsonii* woodlands within landscapes characterised by nearby Triassic Narrabeen sandstone ridges. These landscapes produce soils with a higher sand content than those within the Project Area due to the proximity of these sandstone ridgelines.

77. Outside of the Hunter, *Diuris tricolor* is known from *Callitris glaucophylla* woodlands, which grow on well-drained sandy soils (Thompson & Eldridge 2005), and in habitats characterised by ironbarks and *Eucalyptus populnea* (Burrows 1999; J. Hunter 2010; Cunningham et al. 2011). These facts lend support to my contention that *Diuris tricolor* is unlikely to be present in great numbers within the Project Area, but that in view of nearby records (5-9 km) there remains the possibility that some plants may be present.

78. *Prasophyllum petilum* occurs in very different habitat on the Tablelands and Western Slopes than it does in the Hunter Valley, although often on richer soils with high ground flora diversity (see Section 2.3.2). Consequently, known populations in the Hunter are an anomaly, perhaps

explaining why they were once thought to comprise a different species (*Prasophyllum* sp. Wybong). Grassy landscapes derived from former *Eucalyptus 'albemol'* woodlands at Mangoola Coal mine were found to comprise 19% of all records of *Prasophyllum petilum* (behind *Eucalyptus crebra* landscapes with 59%, and *Eucalyptus dawsonii* landscapes with 20%), so there remains a possibility that the similar landscapes within the Project Area may support this species. However, the absence of any records outside of the Mangoola Coal mine area suggests this not to be the case, and I consider it unlikely that large populations will be present.

79. Although unlikely to support large populations of *Diuris tricolor* or *Prasophyllum petilum*, the Project Area does provide some potential habitat for both species across **166 ha of derived grassland.** The distribution of this habitat is shown in Figure 19, encompassing most of Borrow Pits 1 (16.9 ha) and 3 (41.1 ha), approximately half of Borrow Pits 2 (14.4 ha) and 4 (69.5 ha), and small areas of the Ash Dam (19.6 ha), Ravensworth Ash Line (3.7 ha) and HP Pipe Clearings south (1.2 ha) and north (0.2 ha). No potential habitat occurs within the Salt Cake Landfill or Coal Handling Plant facilities.

6. Criterion (e) – Documents & Data Reviewed

80. I have been provided with following reports and datasets from Kleinfelder to assist in this review:

- GIS files showing Project boundaries, vegetation community mapping and positions of floristic plots/ transects
- an Excel spreadsheet containing all floristic plot data collected during field investigations
- vegetation mapping report for the Bayswater and Liddell Power Stations (Kleinfelder 2017), and draft Biodiversity Development Assessment Report for the Project (Kleinfelder 2020).

Other published and unpublished reports and papers that form part of this report have been cited in the normal way, with publication details contained in Section 9.

7. Criterion (f) – Expert Credentials

81. Under the requirements of the Biodiversity Assessment Method, an expert report can be prepared by an endorsed person in the place of undertaking field survey. This report must include information on the credentials of the expert, including the following:

a. *the expert's qualifications such as relevant degrees, post graduate qualifications*;

I possess three degrees in the science field: a Bachelor of Science (1988), Bachelor of Science (Honours) (1990) and a Doctor of Philosophy in vegetation science (2013).

b. *the expert's history of experience in the ecological research and survey method, for the relevant species*;

In regard to the threatened orchid species that are the subject of this expert report (*Diuris tricolor, Prasophyllum petilum*), I have been surveying and monitoring both of these species over 11 consecutive years at the Mangoola site, including the annual monitoring of over 3000 translocated specimens since 2010.

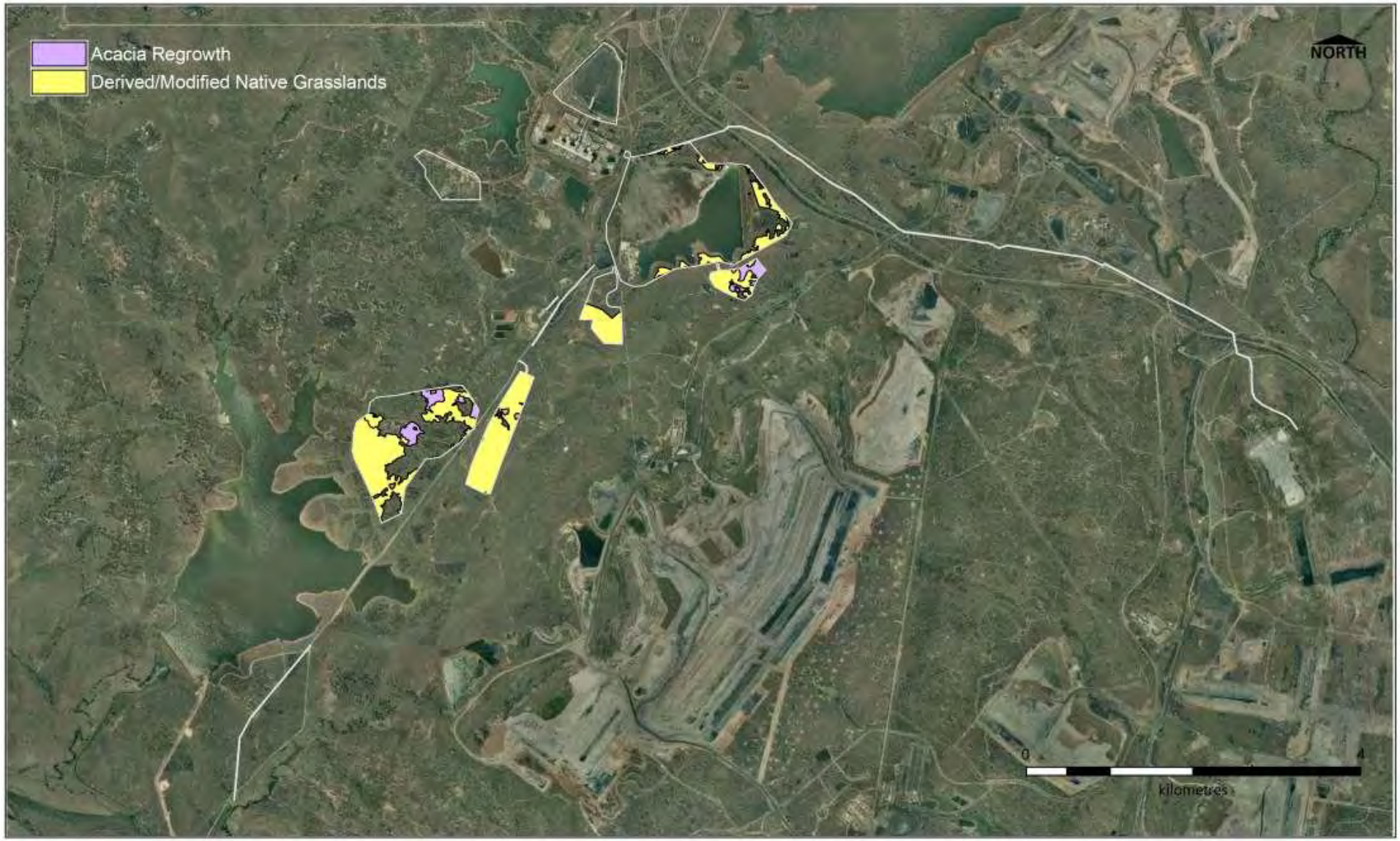

Figure 19 Habitat considered suitable for *Diuris tricolor* and *Prasophyllum petilum* within the Project Area.

In addition, I have searched for and monitored other populations of *Diuris tricolor* at separate sites in the Muswellbrook and Singleton local government areas, at one of these sites for seven consecutive years. Methods used for all of these studies have incorporated systematic open-ended transect surveys in appropriate habitat, using GPS devices to record tracks searched and orchids located. Separation distances between adjacent search transects vary in relation to quality of habitat and visibility. Search times have only occurred when other known reference populations have been in flower.

c. *a resume detailing projects pertaining to the survey of the relevant species (including the locations and dates of the work) over the previous 10 years*;

My full Curriculum Vitae are appended as Appendix 2 to this report. In relation to the relevant species that are the subject of this report (*Diuris tricolor, Prasophyllum petilum*), the following projects pertain to survey for these:

- Bell, S.A.J. (submitted) Floristic community diversity in derived native grasslands: a case study from the upper Hunter Valley of New South Wales. *Cunninghamia* (submitted).
- Bell, S.A.J. (submitted) Translocation of threatened terrestrial orchids into non-mined and post-mined lands in the upper Hunter Valley of New South Wales, Australia. *Restoration Ecology* (submitted).
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d. *their employer's name and period of employment (where relevant)*;

I am the principal and owner of *Eastcoast Flora Survey*, established in the Hunter Valley in October 1996, and spanning a continual period of dedicated flora consulting of over 23 years. Since 2014, I have also been a Conjoint Fellow at the University of Newcastle (School of Environmental and Life Sciences), where I am a member of two research groups: the Centre for Plant Science and the Conservation Biology Research Group.

e. *relevant peer reviewed publications*;

I have prepared two publications specifically addressing *Diuris tricolor* and *Prasophyllum petilum*: Bell (2019a, assessing translocation success in these species) and Bell (submitted, comparing translocation efforts in mined and non-mined lands). A third paper, detailing occupied habitat of these two species in the upper Hunter, is currently in preparation.

I have also published on several other threatened orchid species (e.g. *Cryptostylis hunteriana*: Bell 2001a, de Lacey et al. 2012a,b, de Lacey et al. 2013; *Thelymitra adorata*: Bell

et al. 2005; *Diuris praecox*: Yare et al. in press) and non-orchid threatened taxa (e.g. *Acacia dangarensis*: Bell & Elliott 2013; *Acacia pendula*: Bell 2018; Bell et al. 2007, Bell & Driscoll 2014, 2016; *Acacia wollarensis*: Bell & Driscoll 2017, Bell & Kodela 2018; *Angophora inopina*: Bell 2004; *Banksia conferta*: Bell 2017b; *Commersonia rosea*: Bell & Copeland 2004, Bell & Holzinger 2015; *Dracophyllum macranthum*: Bell & Sims 2018; *Eucalyptus expressa*: Bell & Nicolle 2012; *Hibbertia procumbens*: Bell 2002, Bell & Driscoll 2005; *Leionema lamprophyllum* subsp. *fractum*: Bell & Walsh 2015; *Monotaxis macrophylla*: Bell & Holzinger 2015; *Senecio linearifolius* var. *dangarensis* and *S. spathulatus* var. *attenuatus*: Mickaill et al. submitted), together with those examining a range of significant and threatened species in sandstone habitats of the Hunter Valley (23 taxa; Bell 2001b) and those present in Wollemi National Park (110 taxa; Bell 2008, 2019c). I am also the lead author of a recently published book with CSIRO Publications (Bell et al. 2019), detailing 54 of the endemic plant species of the Hunter Region, many of which are threatened species. A recent paper, of which I am co-author, examined the conservation status of 822 eucalypt taxa from across Australia (Fensham et al. 2020).

f. *evidence that the person is a well-known authority on the relevant species to which the survey relates*.

I have been surveying and monitoring the two target species for over 10 years in the Hunter Valley, and am acutely aware of their habitat requirements and variability in flowering from year to year. Additionally, Dr Lachlan Copeland (EcoLogical Australia & orchid taxonomist) has endorsed me as a recognised authority on the field ecology of *Diuris tricolor* and *Prasophyllum petilum* (see letter attached in Appendix 3).

8. Conclusion

82. The proposed Project at Bayswater Power Station will allow for the expansion and upgrading of existing facilities to improve the generation and delivery of electricity in New South Wales. Apart from four planned borrow pits, all proposed disturbances will be closely associated with existing infrastructure, and hence their impacts on the natural environment will be minimal. Planned borrow pits will extract earth from existing natural landforms to allow for upgrading, and although these areas have themselves also been subjected to c. 200 years of agricultural grazing they currently comprise predominantly native derived grasslands in good condition.

83. No known records of the threatened *Diuris tricolor* or *Prasophyllum petilum* exist for the Project Area, however after assessment I consider that approximately **166 ha of the proposed 561 ha (30%) disturbance area may provide habitat for these species**. Both species occupy extensive geographical ranges in New South Wales, and both are represented in the Hunter Valley as disjunct and isolated populations. Records for *Diuris tricolor* exist c. 5-9 km to the north-west and west of the Project Area, and also c. 50 km to the south-east at North Rothbury. The North Rothbury record (from 2016) suggests that other currently unknown populations of *Diuris tricolor* may exist between that location and Muswellbrook, including within the Project Area. There are no validated populations of *Prasophyllum petilum* outside of the Wybong (Mangoola Coal mine) locality (c. 28 km WNW).

84. Following a single day site inspection of the Project Area in February 2020, I noted observable differences in the floristic composition of grasslands to other areas where the two orchids occur, and the predominance of *Eucalyptus 'albemol'* as the main remnant canopy species within these largely cleared lands. Differences were supported by a review of ecological information prepared by Kleinfelder (2017, 2020) for the Project Area, the mapping of which I found to be accurate and acceptable. Analysis of defined vegetation communities and their component sample plots revealed clear differences to habitat elsewhere in the Hunter Valley supporting these species. Despite this, I conservatively considered that vegetation units defined by Kleinfelder (2020) as Derived/ Modified Native Grasslands (Zone 4) and Acacia Regrowth (Zone 3) provided the best potential of supporting *Diuris tricolor* and *Prasophyllum petilum* (albeit unlikely in large numbers), which with the removal of heavily disturbed portions comprise the 166 ha of potential habitat.

85. In support, a detailed assessment of the well-studied Mangoola Coal mine population of both species showed that 60% of all *Diuris tricolor* individuals (n=3089) occured within present or former *Eucalyptus crebra* woodland, 33% were within *Eucalyptus dawsonii* woodland, but only 6% were within *Eucalyptus 'albemol'* woodland. The first two communities combined supported 93% of all *Diuris* records across that site. Similarly, 59% of all individuals of *Prasophyllum petilum* (n=2413) were found to occur within present or former *Eucalyptus crebra* woodland, 20% in *Eucalyptus dawsonii* woodland, and 19% in *Eucalyptus 'albemol'* woodland. Based on this analysis, landscapes derived from former *Eucalyptus 'albemol'* woodland are therefore more likely to support populations of *Prasophyllum* than *Diuris*.

86. Observable floristic differences were also supported by mapped soil landscapes across the Project Area, which showed a poor correlation between orchid presence at Mangoola Coal mine and potential habitat within the Project Area. The clay- (rather than sand-) based soils in the Project Area argued against the presence of substantial populations of *Diuris tricolor*, given the preponderance of this species elsewhere in sandy or sandy-clay soils. These same clay soils would tend to favour *Prasophyllum petilum*, given field observations of that species occupying slightly damper situations in the landscape (Bell 2019b), however an absence of any confirmed proximate records <28 km distant suggests a low probability of occurrence.

87. The combination of landscape, floristic, condition and soil features, together with proximity to and habitat traits at known validated populations, suggest that the Project Area is unlikely to support extensive populations of *Diuris tricolor* or *Prasophyllum petilum*. The areas where I consider these may occur occupy 30% of the total disturbance footprint, predominantly within the four borrow pits (142 ha of the 166 ha, or 86%), but even here I do not expect large populations to be present.

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Appendix 1 – Floristic Composition of Grassland Habitat (Bell 2012a)

The derivation of diagnostic species for each defined floristic group has been defined using the SIMPER routine in *Primer* on available full floristic plot data. SIMPER analysis provides the relative contributions of each species to the Bray-Curtis similarity within each of the defined vegetation communities. Only those species contributing to a total cumulative contribution of 99% of the average similarity (i.e. the value shown at the top of each floristic table) for each community are listed. These species can be described of as *typical* of that community, and have a consistently large presence within the data as reflected in the ratio of their contribution to the standard deviation (the Sim/SD field in each table) across the within-group similarities (the average similarity). Key canopy species are highlighted.

In the tables:

- Average similarity — is the within-group similarity for all pairs of sample plots comprising the community. Higher average similarity indicates a better defined community.
- Av.Abund — is the average cover abundance of that species within sample plots comprising the community
- Av.Sim — is the average similarity (contribution) made by each species to the within-group similarity (the overall average similarity).
- Sim/SD — is the ratio of average similarity to standard deviation for each species across all pairs of samples. A high ratio represents a good discriminating species. At least three samples are required for this ratio to be calculated (not available for four communities).
- Contrib % — is the percentage contribution of each species to the overall average similarity for the community.
- Cum.% — is the cumulative percentage contribution of each species, up to a maximum of 99%.

Unit 1a: Dichanthium/ Sporobolus/ Chloris Grassland - Key Diagnostic Species [based on 63 plots]:

Group 1a: Dichanthium/ Sporobolus/ Chloris Average similarity: 45.72					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Dichanthium sericeum subsp. sericeum	2.92	2.68	1.09	5.87	12.92
*Senecio madagascariensis **	1.89	2.58	3.58	5.64	18.56
Sporobulus creber	2.02	2.22	1.79	4.87	23.42
*Anagallis arvensis **	1.75	2.13	1.86	4.66	28.09
Chrysocephalum semipapposum	1.71	1.92	1.48	4.20	32.29
*Centaurium tenuiflorum **	1.67	1.88	1.40	4.10	36.39
Bothriochloa decipiens var. decipiens	2.02	1.82	1.06	3.98	40.37
Glycine tabacina	1.56	1.78	1.47	3.90	44.27
Chloris truncata	1.79	1.41	0.93	3.09	47.36

Gamochaeta americana *	1.38	1.38	1.04	3.02	50.39
Cyclospermum leptophyllum *	1.35	1.22	1.19	2.67	53.05
Fimbristylis dichotoma	1.30	1.21	0.88	2.66	55.71
Aristida ramosa var. ramosa	1.52	1.21	0.89	2.64	58.35
Vittadinia muelleri	1.41	1.20	0.84	2.63	60.99
Cheilanthes sieberi subsp. sieberi	1.27	1.12	0.86	2.44	63.43
Dichelachne micrantha	1.59	1.09	0.76	2.38	65.80
Vulpia muralis *	1.38	1.05	0.77	2.30	68.10
Hypochaeris radicata *	1.21	0.90	0.73	1.97	70.08
Trifolium arvense *	0.97	0.83	0.93	1.81	71.88
Petrorhagia dubia *	1.08	0.81	0.73	1.78	73.66
Asperula conferta	1.06	0.78	0.68	1.70	75.36
Plantago debilis	1.03	0.77	0.67	1.69	77.05
Hypochaeris microcephala var. albiflora *	1.00	0.74	0.62	1.61	78.66
Dichondra repens	0.94	0.61	0.64	1.33	80.00
Oxalis perenans	0.94	0.61	0.61	1.33	81.33
Carthamnus lanatus *	0.81	0.39	0.50	0.86	82.19
Briza minor *	0.76	0.38	0.46	0.84	83.02
Eulalia aurea	0.92	0.37	0.36	0.81	83.83
Wahlenbergia communis	0.62	0.35	0.54	0.77	84.61
Convolvulus erubescens	0.62	0.35	0.49	0.76	85.36
Cymbopogon refractus	0.63	0.31	0.46	0.68	86.04
Daucus glochidiatus	0.65	0.31	0.40	0.67	86.71
Sida corrugata	0.65	0.31	0.39	0.67	87.38
Austrodanthonia tenuior	0.65	0.30	0.36	0.65	88.03
Polycarpon tetraphyllum *	0.62	0.28	0.39	0.62	88.65
Triptilodiscus pygmaeus	0.62	0.28	0.33	0.62	89.27
Calocephalus citreus	0.78	0.27	0.33	0.58	89.85
Brunoniella australis	0.57	0.23	0.31	0.51	90.36

Unit 2: Aristida/ Cymbopogon Grassland - Key Diagnostic Species [based on 44 plots]:

Group 2: Aristida/ Cymbopogon Average similarity: 39.82					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Aristida ramosa var. ramosa	3.43	4.60	2.17	11.55	11.55
Linum trigynum *	2.18	3.01	2.04	7.56	19.11
Cheilanthes sieberi subsp. sieberi	2.07	2.84	2.01	7.14	26.25
Anagallis arvensis *	1.70	2.42	1.73	6.09	32.34
Senecio madagascariensis *	1.66	2.32	1.65	5.84	38.18
Aristida vagans	1.95	1.83	0.90	4.60	42.78
Hypochaeris radicata *	1.75	1.77	1.00	4.44	47.22
Cymbopogon refractus	1.48	1.73	1.19	4.35	51.58
Glycine tabacina	1.14	1.32	1.25	3.32	54.90
Bothriochloa decipiens var. decipiens	1.43	1.23	0.69	3.08	57.98
Vulpia muralis *	1.27	1.20	0.97	3.02	61.00
Sporobulus creber	1.14	0.99	0.68	2.48	63.48

*Briza minor **	1.07	0.96	0.79	2.41	65.89
Chrysocephalum apiculatum	1.02	0.81	0.54	2.03	67.92
Triptilodiscus pygmaeus	0.84	0.58	0.50	1.47	69.39
Vittadinia muelleri	0.93	0.58	0.44	1.45	70.83
Dichondra repens	0.77	0.54	0.53	1.35	72.18
*Gamochaeta americana **	0.80	0.53	0.52	1.34	73.52
Dichelachne micrantha	0.82	0.52	0.49	1.31	74.83
*Taraxacum officionale **	0.80	0.50	0.43	1.26	76.08
Lomandra confertifolia subsp. pallida	0.75	0.48	0.53	1.21	77.30
*Tolpis barbata **	0.77	0.46	0.44	1.16	78.46
Lachnagrostis filiformis	0.75	0.44	0.39	1.10	79.56
*Centaurium tenuiflorum **	0.70	0.41	0.41	1.03	80.59
Oxalis perenans	0.68	0.39	0.41	0.97	81.56
*Richardia stellaris **	0.66	0.38	0.41	0.94	82.51
Chrysocephalum semipapposum	0.77	0.37	0.38	0.94	83.44
Fimbristylis dichotoma	0.68	0.37	0.37	0.93	84.38
*Cyclospermum leptophyllum **	0.66	0.36	0.44	0.90	85.27
*Petrorhagia dubia **	0.68	0.35	0.37	0.88	86.15
Asperula conferta	0.59	0.31	0.35	0.77	86.93
Sida corrugata	0.57	0.30	0.39	0.75	87.67
*Linaria pelisseriana **	0.57	0.25	0.33	0.64	88.31
Glycine clandestina	0.41	0.23	0.41	0.58	88.89
Murdannia graminea	0.50	0.21	0.31	0.53	89.42
*Centaurium erythraea **	0.50	0.20	0.25	0.50	89.92

Unit 4: Bothriochloa biloba/ Carthamnus/ Danthonia Grassland - Key Diagnostic Species [based on 7 plots]:

Group 4: Bothriochloa biloba/ Carthamnus/ Danthonia Average similarity: 50.03					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Bothriochloa biloba	5.14	13.03	5.61	26.04	26.04
*Carthamnus lanatus **	2.57	6.41	2.45	12.82	38.86
Chloris truncata	1.86	4.86	4.58	9.72	48.57
Austrodanthonia tenuior	2.14	4.54	1.32	9.08	57.65
Einadia nutans subsp. linifolia	1.71	4.16	3.83	8.31	65.97
*Lolium perenne **	1.57	3.31	1.35	6.61	72.58
Austrostipa aristiglumis	1.57	2.20	0.74	4.40	76.97
Vittadinia cuneata var. cuneata	0.86	1.55	0.90	3.11	80.08
Oxalis perenans	1.14	1.34	0.62	2.68	82.76
*Senecio madagascariensis **	0.86	1.22	0.92	2.43	85.19
Sporobulus creber	1.00	1.07	0.59	2.13	87.32
*Medicago truncatula **	0.86	0.95	0.60	1.90	89.22
Carex inversa	0.86	0.92	0.58	1.84	91.05

Appendix 2 – Resume: Dr Stephen Bell

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https://www.researchgate.net/profile/Stephen_Bell10

PRÉCIS

Stephen has been involved in native vegetation survey, classification and mapping in the Greater Sydney and Hunter Regions since 1990. During this time, he has undertaken comprehensive surveys for the National Parks and Wildlife Service in over 30 conservation reserves, and has been contracted to the NSW Office of Environment & Heritage (OEH) as Senior Botanist and Team Leader for several large scale regional projects within the Sydney Basin bioregion. Under contract to local Councils, Stephen has co-ordinated and completed LGA-wide vegetation classification and mapping projects for Wyong, Gosford, Cessnock, Pittwater and Lake Macquarie LGAs, and has assisted in similar mapping projects for Blue Mountains LGA. Stephen has also completed several studies on Threatened Ecological Communities and threatened plant species, and published the results of some of these in the scientific literature.

On behalf of the Ecological Society of Australia, Stephen was the ecological expert on the Hunter Regional Vegetation Committee (2003), and from 2017 represents that organization on the NSW Threatened Species Scientific Committee (administering the *Biodiversity Conservation Act 2016*). Stephen was also a past member of the Hunter Threatened Flora Recovery Team, a founding member of the Hunter Rare Plants Committee (a sub-committee of the Hunter Region Botanic Gardens), and since 2014 has been a member of the OEH Species Technical Group which oversees management and expenditure of threatened species throughout NSW via its *Saving our Species* initiative. He is also often called upon by Government for advice regarding the significance of vegetation communities and plant species within the northern Sydney Basin bioregion, and has sat on numerous expert panels in this regard. Stephen has been called upon as an Expert Witness for several cases heard in the NSW Land and Environment Court, where his knowledge on the vegetation of the Sydney Basin bioregion has been used to argue contentious land-use decisions.

Stephen has published several scientific papers on various aspects of the vegetation of the Sydney Basin, including classifications of vegetation within conservation reserves, threatened and rare plant species, and the description of new plant taxa. Stephen has completed over 4500 standard full floristic sampling plots within the Sydney Basin, which are stored and used in vegetation classification analyses. Other skills include extensive multivariate data analysis experience, and GIS mapping. Stephen's PhD thesis, completed on a part-time basis through the University of Newcastle, presented

improvements in the recognition, identification and classification of restricted and significant vegetation communities, such as Threatened Ecological Communities (TECs).

In October 1996, Stephen established *Eastcoast Flora Survey*, a specialist botanical consultancy providing high quality services to government and the private sector. Since June 2014, Stephen has also been a Conjoint Fellow in the School of Environmental & Life Sciences at the University of Newcastle (NSW), seeking to raise the output of ecological research on plants and vegetation within the Hunter region.

ACADEMIC QUALIFICATIONS

Doctor of Philosophy (PhD), 2013	*Defining and mapping rare vegetation communities: Improving techniques to assist land-use planning and conservation* (University of Newcastle)
Bachelor of Science (Honours), 1991	*Effects of the weed Scotch Broom on bird communities in open forests on Barrington Tops* (University of Newcastle)
Bachelor of Science, 1989	*Majors in Geography and Biology* (University of Newcastle)

EMPLOYMENT HISTORY

University of Newcastle	Conjoint Fellow	June 2014 - Present
Eastcoast Flora Survey	Consultant Botanist (Principal)	Oct. 1996 - Present
Ecotone Ecological Consultants Pty Ltd	Manager - Flora Studies	Jan. 1996 - Oct. 1996
Private Ecological Consultant	Sole trader	Jan. 1991 - Dec. 1995
NSW National Parks and Wildlife Service	Project Officer	Sept. 1993 - Jan. 1994
University of Newcastle, Geography Dept.	Field Tutor (Scientific)	July 1993 - Aug. 1993
NSW National Parks and Wildlife Service	Project Officer	Jan. 1993 - June 1993
University of NSW, School of Biol. Sciences	Research Assistant (Bird ecology)	Sept. 1992 - Jan. 1993
NSW National Parks and Wildlife Service	Technical Officer (Scientific)	Jan. 1992 - June 1992
RZ Mines (Newcastle)	Environmental Research Officer	Oct. 1990 - Dec. 1991
Wayne Perry & Associates P/L	Environmental Officer (Casual)	June 1990 - Oct. 1990

RESEARCH INTERESTS

- Vegetation classification and mapping, at local and regional scales
- Definition and mapping of rare and threatened vegetation communities
- Restoration of threatened grassy woodlands from derived grasslands
- Improving data sampling methods for monitoring and classification
- Re-constructing vegetation distribution using information from historical botanical explorers
- Population ecology and habitat of rare and threatened plants
- Taxonomy and significance of Hunter Region plants

MINISTERIAL APPOINTMENTS

- Committee Member (ESA Rep.), NSW Threatened Species Scientific Committee (July 2017-present)
- Committee Member, NSW Species Technical Group, Flora (*Save Our Species Program*) (2014-present)
- Committee Member (ESA Rep.), Hunter Regional Vegetation Committee (2001-2003)

CONFERENCE & WORKSHOP PRESENTATIONS

- Australian Plant Society (NSW) Annual Conference, August 2019, Newcastle: "*Endemic Plants of the Hunter Region: Trees and Larger Shrubs*".

- Best Practice Mine Rehabilitation Conference, September 2014, Singleton, NSW; The Tom Farrell Institute for the Environment, University of Newcastle: "*Effective Biodiversity Offsets: Improving planning, valuation and monitoring practice*" (with Martin Fallding).
- Plant Identification for Flora of the Hunter Valley, 7th - 8th April 2014, Kurri Kurri, Australian Network for Plant Conservation: "*Introduction to the flora of the Hunter Valley - history, diversity and ecology*".
- HOTSPOTS Fire Project: Awabakal and Worimi Fire Forum, 27th July 2011, Williamtown, Never Never Resources: "*Vegetation of the Worimi Conservation Lands*".
- HOTSPOTS Fire Project: Wanaruah Fire Forum, 17th – 19th August 2010, Sandy Hollow, Upper Hunter Valley, Nature Conservation Council: "*Vegetation of Wanaruah Lands, Sandy Hollow*".
- Coastal Groundwater Dependent Ecosystems Workshop, 3rd – 4th September 2009, South West Rocks, NSW (Geoscience Australia): "*Surveying, classifying and mapping vegetation on the Tomago Sandbeds*".
- Vegetation Management and Biodiversity Conservation in the Hunter Region, May 2000, Singleton, NSW (Hunter Environment Lobby Inc.): "*An evaluation of vegetation survey and threatened plant species listings in the Hunter Region*"

PROFESSIONAL MEMBERSHIPS

- Ecological Society of Australia (ESA)
- Australian Network for Plant Conservation Inc. (ANPC)
- International Association for Vegetation Science (IAVS)
- International Association for Vegetation Science Vegetation Classification Working Group (IAVS VCWG)
- Australasian Systematic Botany Society (ASBS)

PUBLICATION REVIEWER

- *Diversity* (MDPI, Switzerland)
- *Forests* (MDPI, Switzerland)
- *International Journal of Environmental Research and Public Health* (MDPI, Switzerland)
- *Journal of Vegetation Science* (International Association for Vegetation Science)
- *Pacific Conservation Biology* (CSIRO Publishing)
- *Resources* (MDPI, Switzerland)
- *Sustainability* (MDPI, Switzerland)
- *Telopea* (National Herbarium of New South Wales)
- *Vegetation Classification and Survey* (International Association for Vegetation Science)

BOARD MEMBERSHIPS

- 2019 - *Vegetation Classification and Survey* (Editorial Board)
- 2019 - *Sustainability* (Review Board)
- 2019 – *Australian Network for Plant Conservation* (Committee Member)

PUBLICATIONS (PEER REVIEWED)

Bell, S.A.J. (submitted) Floristic community diversity in derived native grasslands: a case study from the upper Hunter Valley of New South Wales. *Cunninghamia* (submitted)

Bell, S.A.J. (submitted) Translocation of threatened terrestrial orchids into non-mined and post-mined lands in the upper Hunter Valley of New South Wales, Australia. *Restoration Ecology* (submitted).

Bell, S.A.J. & Driscoll, C. (submitted) Data-informed Sampling and Mapping: A new approach to ensure plot-based classifications locate, classify and map rare and restricted vegetation types. *Australian Journal of Botany* (submitted)

Bell, S.A.J. & Klaphake, V. (submitted) *Eucalyptus calidissima* (Myrtaceae), a new ironbark species from the Hunter Valley of New South Wales, Australia. *Telopea* (submitted)

Mickaill, L., Bell, S., & Beranek, C. (submitted) Dispersal potential in two restricted and five wide-ranging *Senecio* (Asteraceae) taxa from central eastern New South Wales, Australia. *Australian Journal of Botany* (submitted).

Yare, B., Bell, S., & Hunter, N. (in press) Phenology of the threatened *Diuris praecox* (Orchidaceae), a range-restricted terrestrial orchid from central eastern New South Wales. *Cunninghamia* (in press)

Bell, S.A.J. (in prep) A strategy for assessing population size in threatened plant surveys using a classification of detectability based on key life-form traits, seasonality and disturbance response. *Diversity* (in prep)

Bell, S.A.J. & Nicolle, D. (in prep) Taxonomic clarification of an unusual, disjunct, mallee-form population of *Eucalyptus dealbata* (Myrtaceae) from the Hunter Valley of New South Wales, with comparative notes on other populations in the Sydney Basin bioregion. *Telopea* (in prep).

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Bell, S., Rockley, C., & Llewellyn, A. (2019) *Flora of the Hunter Region: Endemic Trees and Larger Shrubs*. CSIRO Publishing. 136 pp. ISBN: 9781486311026

DeLacey, C., Bell, S., Chamberlain, S., & Bossard, K. (in review) Prediction of and realised habitat for a cryptic plant species: the Leafless Tongue Orchid *Cryptostylis hunteriana* Nicholls. *Cunninghamia* (in review)

Bell, S.A.J. (2018) Fate of a rare flowering event in a population of the endangered *Acacia pendula* (Weeping Myall) from the Hunter Valley of New South Wales. *Cunninghamia* 18: 79-88.

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Bell, S.A.J. (2019) *A Re-assessment of Foreshore Vegetation along Tuggerah Lake, Chittaway Bay to The Entrance, Central Coast LGA*. Report to Central Coast Council. November 2019.

Bell, S.A.J. (2019) *Baseline surveys for two threatened mallees* (Eucalyptus castrensis *and* Eucalyptus pumila) *in the lower Hunter Valley of New South Wales*. Unpublished Report to NSW Office of Environment and Heritage. April 2019. Eastcoast Flora Survey.

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Appendix 3 – Endorsement: Dr Lachlan Copeland

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5th April, 2018

Reference for orchid expertise of Dr Stephen Bell

To whom it may concern

This letter serves to introduce Dr Stephen Bell of Eastcoast Flora Survey as worthy to fill the role of 'expert' for matters concerning the threatened terrestrial orchids *Diuris tricolor* and *Prasophyllum petilum*. I myself have an extensive knowledge of the orchid flora of New South Wales, Victoria and Queensland gained over several decades of field survey. With Gary Backhouse, Robert Bates and Andrew Brown, I have co-authored the "Checklist of the Orchids of Australia including its Island Territories". In separate publications I have also described 15 new orchid species. I am personally very familiar with *Diuris tricolor* and *Prasophyllum petilum* from throughout their known distributional ranges, and have worked with Stephen on these two species previously.

Stephen has a wealth of experience and professional ability in botany and threatened species management, having worked in the consultancy field since the mid 1990's. In 1996, he established Eastcoast Flora Survey, a small consultancy focusing on vegetation surveys, classification, mapping and threatened species research and management. Over a 20 year period, Stephen has shown himself to be dedicated to presenting an accurate portrayal of the distribution and abundance of native plant species, particularly threatened plant species and ecological communities. He has researched a number of threatened plant species, including several orchids, and has published regularly in the scientific literature on these. In the past, I have personally approached Stephen on numerous occasions to discuss the distribution, abundance and threats of a wide variety of threatened plant species including several orchid taxa.

I first worked with Stephen on surveys for *Diuris* and *Prasophyllum* in the upper Hunter Valley in 2009, and since that time I am aware that he has undertaken annual surveys for these species across a number of offset and development sites, including overseeing and conducting a large translocation program at one mine site requiring detailed monitoring of individual plants, and the monitoring of natural populations elsewhere. Over a nine year period of surveying and monitoring for these species, Stephen is clearly highly regarded as an expert for these taxa in the Hunter Valley. I believe that Stephen would have personally seen more individuals of these two species and know their ecology more intimately than anyone else.

Given the experience detailed above, I have no hesitation in recommending Stephen as an expert in any matters concerning *Diuris tricolor* and *Prasophyllum petilum*, particularly with regard to habitats and status within the Hunter Valley of NSW.

Yours sincerely

Dr Lachlan Copeland
Senior Botanist,
Eco Logical Australia

APPENDIX 9. ASSESSMENTS OF SIGNIFICANCE (EPBC ACT)

An assessment of whether an action is likely to have a significant impact on an EPBC Act listed threatened species has been undertaken against the *Matters of National Environmental Significant – Significant impact guidelines 1.1* (Department of the Environment [DoE], 2013).

CRITICALLY ENDANGERED AND ENDANGERED SPECIES

Prasophyllum sp. Wybong (C. Phelps ORG 5269)

An expert report has been prepared for the project which determined that *Prasophyllum* sp. Wybong, may be potentially affected by the Action due to the presence of potentially suitable habitat within the study area.

***Prasophyllum* sp. Wybong (C. Phelps ORG 5269)** is a perennial orchid, appearing as a single leaf over winter and spring. The species flowers in spring and dies back to a tuber over summer and autumn. Leek orchids are generally found in shrubby and grassy habitats in dry to wet soil (Jones, 2006). *Prasophyllum* sp. Wybong is known to occur in open eucalypt woodland and grassland (DoEE, 2019). This species is endemic to NSW, it is known from near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell, Tenterfield, Currabubula and the Pilliga area. Most populations are small, although the Wybong population contains by far the largest number of individuals (DoEE, 2019).

Significant impact criteria

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

- ***lead to a long-term decrease in the size of a population***

Prasophyllum sp. Wybong is known to occur within grassy woodlands and grasslands derived from Narrow-leaved Ironbark and Grey Box woodlands, particularly grasslands of *Dichanthium sericeum, Sporobolus creber* and *Chloris ventricosa,* or *Aristida vagans, A. ramosa* and *Cymbopogon refractus* (Bell 2019). Within the Site areas of Central Hunter Box – Ironbark Woodland were assessed as potential habitat as they generally meet the description outlined above. A more detailed assessment of each zone is provided below:

- An area of potential habitat was identified in Zone 3 (Regrowth). All of the Salt Cake Landfill portion of this vegetation zone was excluded as the ground layer has undergone heavy disturbance and is dominated by Exotic grass species. Other areas dominated by exotic species in the understorey were also excluded. A total of 18.23 ha of this Zone was assessed as moderate-low quality habitat (none along the Ravensworth Ash Line).
- Potential habitat for the species was identified in Zone 4 (Grassland). A total of 147.77 ha of this zone was assessed as moderate to low quality habitat.

Based on the above assessment, approximately 166 ha of habitat for *Prasophyllum* sp. Wybong occurs within the impact area. Due to sub-optimal conditions for the flowering season, and the lack of flowering of this species at a local reference population (Mangoola Mine Site, located approximately 25 km north-west of the study area), an expert report was undertaken to determine the habitat suitability and any

potential occurrence of this species in the study area. This expert report was prepared by Dr Stephen Bell, a recognised expert on the species. The expert report states the following:

"I consider the most likely habitat for Diuris tricolor and/or Prasophyllum petilum within the Project Area to comprise vegetation communities mapped by Kleinfelder (2020) as Derived/ Modified Native Grasslands (Zone 4) or Acacia Regrowth (Zone 3). This differs from the suggested orchid habitat contained in Kleinfelder (2020), where all areas of PCT1691 (Zones 1-6) were included with the exception of lands subjected to higher levels of historical disturbance as evidenced by higher weed occurrence. As indicated earlier, Diuris in particular is capable of persisting in moderately disturbed landscapes, and I suggest that all areas of Derived/ Modified Native Grasslands (Zone 4) and areas mapped as Acacia Regrowth (Zone 3), with the exception of the Salt Cake Landfill site, do provide orchid habitat.

Combined, 188 ha of Derived/ Modified Native Grasslands (Zone 4) and Acacia Regrowth (Zone 3) have been mapped by Kleinfelder (2020). However, after inspecting the Salt Cake Landfill site and observing the condition of habitats there, it is unlikely that a viable population of either orchid will be present there. This is also attested to by the single floristic plot positioned there by Kleinfelder (2017), showing it to support 60% cover of the weed Hyparrhenia hirta and only two native species (Aristida ramosa and Vittadinia cuneata, both at 0.1% cover). This, and the observation that there has been considerable ground disturbance in this area over many years, suggests that it is highly unlikely that orchids remain there. Consequently, the 21.85 ha of Acacia Regrowth (Zone 3) within this area can be deducted from the overall total of 188 ha, to leave 166 ha of potential orchid habitat within the Project Area.

Note that this 166 ha of potential orchid habitat is conservative, but I consider it unlikely to support large populations of Diuris, and probably no Prasophyllum. Relative to other Hunter populations of both species, the floristic composition of grasslands within the Project Area are very different and occur on different soil landscapes supporting richer soils."

Based on a lack of information regarding the known occurrence of *Prasophyllum petilum*, it is not known at this time if the action has the potential to lead to the long-term decline of a population of the species. Further surveys are proposed during the optimum period of detection of the species prior to the construction phase.

- ***reduce the area of occupancy of the species***

Based on the current data from the site it is not known if a local population occurs and if the Action will reduce the area of occupancy of the species.

- ***fragment an existing population into two or more populations***

Based on the current data from the site it is not known if a local population occurs and if the Action will fragment an existing population of the species.

- ***adversely affect habitat critical to the survival of a species***

Based on the current data from the site it is not known if a local population occurs and the site contains habitat critical to the survival of the species.

- ***disrupt the breeding cycle of a population***

Based on the current data from the site it is not known if a local population occurs and if the Action will disrupt the breeding cycle of a population of the species.

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

Based on the current data from the site it is not known if a local population occurs and if the Action will reduce the area of occupancy of the species.

- ***result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat***

A site-specific Construction Environment Management Plan (CEMP) will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Stringent management measures will prevent construction activities from introducing or spreading new

or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in invasive species becoming established in the habitat for the species.

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

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in the introduction of disease causing the species to further decline.

- ***interfere with the recovery of the species.***

A recovery plan has not been prepared for the species.

Conclusion

The species was assumed to be present within the study area based on the findings of the expert report. The expert report determined that approximately 166 ha of habitat for the species occurs within the impact area. Based on a lack of information regarding the known occurrence of *Prasophyllum petilum*, it is not known at this time if the action is likely to constitute a significant impact on this species.

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Bird Species

Two critically endangered birds would be potentially impacted by the Action:

- Regent Honeyeater (*Anthochaera phrygia*).
- Swift Parrot (*Lathamus discolor*).

The **Regent Honeyeater (*Anthochaera phrygia*)** is a nomadic feeder and can be found throughout its range where there is suitable blossom occurring (Franklin *et al*., 1989). This species is mostly recorded in box-ironbark eucalypt associations. They prefer the wettest, most fertile sites within these associations, such as along creek flats, broad river valleys and foothills. In NSW, riparian forests of River Oak (*Casuarina cunninghamiana*) with Needle-leaf Mistletoe (*Amyema cambagei*), are also important for feeding and breeding. Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Yellow Box (*E. melliodora*) and Yellow Gum (*E. leucoxylon*) are particularly important food trees. At times of food shortage the birds also use other woodland types and wet lowland coastal forest dominated by Swamp Mahogany (*E. robusta*) or Spotted Gum (*Corymbia maculata*) (Franklin *et al*., 1989; Ley and Williams, 1992; Webster and Menkhorst, 1992; Geering and French, 1998; Oliver *et al*., 1999).

The **Swift Parrot (*Lathamus discolor*)** is small parrot about 25 cm long. It is bright green with red around the bill, throat and forehead. The red on its throat is edged with yellow. Its crown is blue-purple. There are bright red patches under the wings. One of most distinctive features from a distance is its long (12 cm), thin tail, which is dark red. This species breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. 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* (Swamp Mahogany), *Corymbia maculata* (Spotted Gum), *C. gummifera* (Red Bloodwood), *E. tereticornis* (Forest Red Gum), *E. sideroxylon* (Mugga Ironbark), and

E. albens (White Box). Commonly used lerp infested trees include *E. microcarpa* (Inland Grey Box), *E. moluccana* (Grey Box), *E. pilularis* (Blackbutt), and *E. melliodora* (Yellow Box). Individuals return to some foraging sites on a cyclic basis depending on food availability (OEH, 2019).

Significant impact criteria

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

- ***lead to a long-term decrease in the size of a population***

The study area represents potential foraging habitat for both of these species, with no breeding being recorded in the region. A total of 14.68 ha of habitat for these species occurs within the impact area,. The majority of areas of habitat within the study area comprise small, isolated patches with a low-level of connectivity to surrounding habitat. Some small areas of Central Hunter Box – Ironbark Woodland (PCT 1691) (ranging from 0.7 to 1 ha) within Borrow Pit 4 are reasonably connected to larger areas of this vegetation to the north-west. However, given the small area of these patches, such loss is unlikely to contribute to the reduction in the size of a population of these species. Further, much of the habitat within the study area is highly disturbed due to current and historical agricultural practices. These species are highly mobile and any local population which may be present is likely to persist, should the Action proceed. As such, it is unlikely that the Action will decrease the size of a population of these species.

- ***reduce the area of occupancy of the species***

The Action will result in a relatively small reduction in the potential habitat for these species in the local area. Due to the large amount of similar and higher quality habitat occurring within the Bayswater Power Station Site, it is unlikely that the removal of the 14.68 ha of suitable foraging habitat for this species within the Site will reduce the area of occupancy of these species.

- ***fragment an existing population into two or more populations***

The species is highly mobile, and a local population will be nomadic using a wide range of food resources depending on the availability flowering eucalypts and lerp infestations. Within a 5 km radius of the study area. Due to the highly mobile nature of these species, and the distribution of similar suitable habitat within the Baywater Site, the Action is unlikely to fragment an existing population into two or more populations.

- ***adversely affect habitat critical to the survival of a species***

Habitat critical to the survival of the Regent Honeyeater includes; any breeding or foraging areas where the species is likely to occur, and any newly discovered breeding or foraging locations (DoE, 2016). While the study area has been assessed as having a moderate to low likelihood of occurrence for the Regen Honeyeater, it is unlikely to contain habitat critical to the survival of the Regent Honeyeater. This is as the site contains a relatively low density of key feed species (Yellow Box recorded in one location within Borrow Pit 4). Additionally, there is only one record of the species in the locality in 1999 and there are no records on breeding in the locality.

Habitat critical to the survival of the Swift Parrot includes; those areas of priority habitat for which the Swift Parrot has a level of site fidelity or possess phenological characteristics likely to be of importance to the Swift Parrot, or are otherwise identified by the recovery team (Saunders and Tzaros, 2011). As there are only 9 records of the species in the locality (from 2005, 2012 and 2014) it is unlikely that the study area contains habitat critical to the survival of the Swift Parrot.

- ***disrupt the breeding cycle of a population***

Breeding of the Regent Honeyeater is not known from the locality. The Swift Parrot does not breed within mainland Australia (DoEE, 2019). As such, it is unlikely that the Action will disrupt the breeding cycle of these species.

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

The majority of the habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches that are at the extremities of larger patches. The loss of any potential habitat for these species within the study area would not isolate remaining habitat from other patches

and it is unlikely that the Action would significantly reduce the area of habitat occupied by these species relative to their regional distribution.

- ***result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat***

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Stringent management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in invasive species becoming established in the habitat for the species.

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

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the proposed action will result in the introduction of disease causing the species to further decline.

- ***interfere with the recovery of the species.***

National recovery plans for the Regent Honeyeater, Swift Parrot are currently in place (DoE, 2016; Saunders and Tzaros, 2011). The activities which comprise the Action are not inconsistent with the made recovery plans, and the Action would not interfere substantially with the recovery of these species given habitat resources for the Regent Honeyeater and Swift Parrot would remain outside of the study area, such that the species are likely to persist in the landscape.

Conclusion

- **Regent Honeyeater (*Anthochaera phrygia*)** – Moderate to low likelihood of occurrence within the study area. Approximately 14.68 ha of suitable foraging habitat present within the impact areaOne record occurs within the locality. The Action is unlikely to result in a significant impact to this species given:
  - Only foraging habitat for this species would be impacted.
  - The majority of areas of habitat within the study area comprise small, isolated patches with a low-level of connectivity to surrounding habitat, or small patches at the extremity of larger patches.
  - Habitat resources for this species would remain outside of the study area within the surrounding Bayswater Power Station Site.
  - The species is highly mobile and any local population which may be present is likely to persist, should the Action proceed.
  - The Action is unlikely to introduce or increase number of invasive pest species or a disease that may cause the species to decline.
  - The Action would not interfere substantially with the recovery of this species.
- **Swift Parrot (*Lathamus discolor*)** – Moderate to low likelihood of occurrence within the study area. Approximately 14.68 ha of suitable foraging habitat present within the impact area. Nine records occur within the locality. The Action is unlikely to result in a significant impact to this species given:
  - Only foraging habitat for this species would be impacted.

- The majority of areas of habitat within the study area comprise small, isolated patches with a low-level of connectivity to surrounding habitat, or small patches at the extremity of larger patches.
- Habitat resources for this species would remain outside of the study area.
- The species is highly mobile and any local population which may be present is likely to persist, should the Action proceed.
- The Action is unlikely to introduce or increase number of invasive pest species or a disease that may cause the species to decline.
- the Action would not interfere substantially with the recovery of this species.

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Spotted-tailed Quoll (Dasyurus maculatus)

The **Spotted-tailed Quoll (*Dasyurus maculatus*)** is listed as endangered under the EPBC Act. Although this species was not detected within the study area during the assessment, based on the availability of habitat and the occurrence of local species records, this species has a low to moderate likelihood of occurrence within the study area.

This species is about the size of a domestic cat; however, it has shorter legs and a more pointed face than a cat. Its fur is rich red to dark brown and covered with white spots on the back which continue down the tail. The spotted tail distinguishes it from all other Australian mammals, including other quoll species. The Spotted-tailed Quoll is found along both sides of the Great Dividing Range from the Victorian to the Queensland borders. Scattered, unconfirmed records of the species have also been reported in the western parts of NSW. Spotted-tailed Quolls live in various environments including forests, woodlands, coastal heathlands and rainforests. They are sometimes seen in open country, or on grazed areas and rocky outcrops. They are mainly solitary animals, and will make their dens in rock shelters, small caves, hollow logs and tree hollows. They use these dens for shelter and to raise young.

These animals are highly mobile. They can move up to several kilometres in a night and may have quite large territories. Within their territories, they will have latrine sites where they defecate. These are often in exposed areas, such as on rocky outcrops (OEH, 2019).

Significant impact criteria

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

- ***lead to a long-term decrease in the size of a population***

Targeted surveys for the species were conducted using remote sensor cameras baited with chicken wings and fish sauce. No individuals were detected during the field surveys (camera established for 14-consecutive nights from 3/12/2019 to 17/12/2019). Additionally, the study area does not contain large areas of suitable denning habitat. Hollow bearing trees are present within the study area; however, patches of vegetation are typically small. The largest patch of vegetation, within Borrow Pit 4 primarily consists of Bull Oak Woodland which does not contain a high density of hollows or hollows large enough for the species. As such, it is unlikely that the study area forms part of the breeding habitat/range for a local population of the species. However, the study area could still provide foraging habitat and/or dispersal habitat for the species. Suitable habitat for the species was assessed as occurring within the majority of the vegetation types, with the exception of the Grasslands and Acacia Regrowth, due to the lack of woodland habitat features. The species may still disperse and move through the open areas of the site. Approximately 82.60 ha of habitat for this species occurs within the Impact Area.

The majority of areas of habitat within the study area comprise small, isolated patches with a low-level of connectivity to surrounding habitat, with the exception of Borrow Pit 4 which contains a large patch of vegetation and is connected to vegetation off-site to the north/north-west. While the Action will impact on habitat for this species, due to the large amount of surrounding, higher quality, habitat within the Bayswater Power Station Site, it is unlikely that the Action will lead to the long-term decrease of any potentially occurring local population of the species.

- ***reduce the area of occupancy of the species***

Due to the large home range sizes of the species, and availability of higher quality suitable habitat within the Bayswater Power Station Site, it is unlikely that the Action would reduce the area of occupancy of any potentially occurring local population.

- ***fragment an existing population into two or more populations***

The majority of habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches located at the extremities of larger patches. The species is mobile and due to the availability of suitable habitat in the surrounding area, predominantly to the west of the impact area, it is unlikely that the Action will fragment any potentially occurring local population.

- ***adversely affect habitat critical to the survival of a species***

Habitat critical to the survival of the Spotted-tailed Quoll includes large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey (Department of Environment, Land, Water and Planning, 2016). Given mammal trapping and targeted surveys for Spotted-tailed Quoll did not reveal a high density of medium sized mammals species and the site does not contain large patches of forest with adequate denning resources. As such, it is unlikely that the study area contains habitat critical to the survival of the species.

- ***disrupt the breeding cycle of a population***

No individuals were identified during targeted surveys of the species, and high quality denning habitat was not identified within the study area. As such, it has been assumed that the study area does not form part of the breeding range of a local population (foraging and dispersal habitat only). As such, it is unlikely that the Action will disrupt the breeding cycle of a locally occurring population.

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

The majority of the habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches that are at the extremities of larger patches. The loss of any potential habitat for these species within the study area would not isolate remaining habitat from other patches

and it is unlikely that the Action would significantly reduce the area of habitat occupied by the species relative to its regional distribution.

- ***result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat***

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Stringent management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in invasive species becoming established in the habitat for the species.

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

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in the introduction of disease causing the species to further decline.

- ***interfere with the recovery of the species.***

The Action does not contravene the objectives of the National recovery plan (DELWP 2016).

Conclusion

The species was assessed as having a moderate-low likelihood of occurrence within the study area. Approximately 82.60 ha of habitat for this species occurs within the Impact Area. Sixty-five records occur within the locality. Targeted surveys for this species did not identify the species. The study area was assessed as providing potential foraging and dispersal habitat of the Spotted-tailed Quoll; however, it was not assessed as providing breeding habitat for the species. As there is a large amount of higher quality habitat within the surrounding areas of the Bayswater Power Station Site, the removal of the habitat within the Impact Area is unlikely to have a significant impact on any potentially occurring local population of the species.

References

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Department of the Environment and Energy (2019). *Species Profile and Threats Database*. Available: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. Accessed: September 2019.

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VULNERABLE SPECIES

Ozothamnus tesselatus

Ozothamnus tesselatus is listed as vulnerable under the EPBC Act. This species was not detected within the study area during the assessment and was determined to have a low likelihood of occurrence. However, the species has been identified for further assessment in the supplementary assessment requirements; therefore, an assessment of potential impacts is presented here.

Ozothamnus tesselatus is a dense shrub growing to 1 m high with woolly branches. Leaves are spreading, oblong, 4–5 mm long, less than 1 mm wide, with leaf margins rolled backwards. The upper leaf surface is green, the lower leaf surface white and woolly, and the leaf base extends downwards on a stem 4 to 5 mm long. Floral heads grow in dense hemispherical corymbs, with the heads spherical,

about 4 mm long, with obovate bracts surrounding the inflorescence. Floral heads consist of about 60 bisexual florets (Everett, 1992; DECC, 2005a).

Significant impact criteria

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

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

Ozothamnus tesselatus is restricted to a few locations north of Rylstone, NSW, and is conserved within the Goulburn River National Park and Munghorn Gap Nature Reserve (NSW NWPS, 2003; DECC, 2005a). This species has been collected at eight sites in a restricted area over a range of 300 km2 (AVH, 2008). The preferred habitat of *Ozothamnus tesselatus* is eucalypt woodland (Everett, 1992) and occurs within the Hunter–Central Rivers (NSW) Natural Resource Management Region.

There is one historical record of the species in the locality (Bionet 2020). Suitable habitat is present within the better-quality woodland habitats in the impact area (PCT 1690 - 13.62 ha). It is noted that the flora surveys within the site were not conducted under 'ideal' weather conditions for the detection of many plant species; however, given that *Ozothamnus tesselatus* is a shrub species that is not known to "die off" during dry conditions, it is unlikely that the adverse weather would have reduced the detectability of a resident population of the species within the site.

No population of *Ozothamnus tesselatus* was detected within the Study Area during field surveys. As such, the proposed Action is unlikely to lead to a long-term decrease in the size of an important population of the species.

- ***reduce the area of occupancy of an important population***

As the species was not detected during field surveys, it is unlikely that the proposed Action will reduce the area of occupancy of an important population.

- ***fragment an existing important population into two or more populations***

As the species was not detected during field surveys, it is unlikely that the proposed Action will fragment an existing important population.

- ***adversely affect habitat critical to the survival of a species***

No habitat critical to the survival of the *Ozothamnus tesselatus* is mapped at this point in time (DoEE, 2019). However, it can be assumed that due to the decline of the species and restricted nature of the known populations in NSW, any occupied habitat would be critical to the survival of the species. As the species was not detected during field surveys, it is unlikely to affect habitat critical to the survival of the species.

- ***disrupt the breeding cycle of an important population***

As the species was not detected during field surveys, it is unlikely that the proposed Action will disrupt the breeding cycle of an important population.

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

Better-quality woodland habitat occurs for this species in adjacent areas outside the development site. As the species was not detected during field surveys, it is unlikely that the proposed Action will impact on habitat to the extent that the species is likely to decline.

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

The existing weed and feral animal threat levels are unlikely to change significantly due to the Action given the current agricultural use of the surrounding area. A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised.

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

As the species was not detected during field surveys, it is unlikely that the proposed Action will introduce a disease that may cause the species to decline.

- ***interfere substantially with the recovery of the species.***

A recovery plan for the species has not been prepared. As the species was not identified during surveys, it is unlikely to interfere with the recovery of the species.

Conclusion

Surveys conducted within the Study Area for the proposed Action did not identify the species. As such, no location population of the species was detected and the proposed Action is unlikely to have a significant impact on the species.

References

Department of Environment & Climate Change (DECC) New South Wales 2005b, Ozothamnus tesselatus – Priority actions (New South Wales Threatened Species Priority Action Statement).

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2008, Species Profile and Threats Database for Ozothamnus tesselatus.

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Green and Golden Bell Frog (Litoria aurea)

The **Green and Golden Bell Frog (*Litoria aurea*)** is listed as vulnerable under the EPBC Act. Although this species was not detected within the study area during the assessment, based on the availability of habitat and the occurrence of local species records, this species has a moderate likelihood of occurrence within the study area.

The Green and Golden Bell Frog occurs mainly along coastal lowland areas of eastern NSW and Victoria. Large populations are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. Green and Golden Bell Frogs need various habitats for different aspects of their life cycle including foraging, breeding, over-wintering and dispersal. They will also use different habitats or habitat components on a temporal or seasonal basis (Department of the Environment, Water, Heritage and the Arts, 2009). The species is active by day and usually breeds in summer when conditions are warm and wet (OEH, 2019).

The species has previously been identified within the Sewage Treatment Plant Polishing Ponds within the Bayswater Site (last recorded in early 2000's) and Lake Liddell (last confirmed in late 1970's) (DECC, 2007).

Significant impact criteria

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

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

This species prefers open water bodies, fringed by reeds and other aquatic vegetation for breeding and foraging. Needs fallen logs and debris for shelter and over-wintering purposes.

There are historical records of the species in the locality, and the last confirmed record of the species in the Upper Hunter was from the Bayswater Sewage Treatment Plant Polishing Ponds in the early 2000's (DECC, 2007). At this time, 4-5 adults, a number of juveniles and tadpoles were observed. There have not been any confirmed records of the species in the Upper Hunter since.

Suitable habitat is present within the impact area and consists of constructed Dams which contain permanent water and suitable wetland vegetation (primarily *Thypha* and *Juncus acutus*). A total of eight Dams were identified within the Study Area (total of 4.99 ha). One area occurs within the exiting Ash Dam (3.90 ha; within the approved disturbance area of the Dam), two occur within the Study Area outside the disturbance area (0.35 ha, and 5 occur within the Impact Area (total of 0.74 ha).

While these Dams did contain suitable abiotic features, three of the eight Dams were identified as containing Plague Minnow (*Gambusia holbrooki*). While the presence of this species does not exclude the potential for presence of Green and Golden Bell Frogs, they do have the potential to impact on the population numbers.

A total of four separate one-person hour surveys have been conducted on each of the eight dams within the Study area. Additionally, four surveys have also been conducted within the six Sewage Treatment Plant Polishing Ponds located to the west of the Ash Dam. One round of targeted survey was conducted on 5-7/11/2019, with each dam being surveyed once. Three rounds of survey were then conducted on 20 – 22 January (survey methodology provided within the BDAR (Kleinfelder 2020)). The species was not detected within the Study Area during the surveys.

The targeted surveys for the Green and Golden Bell Frog conducted in November, occurred after 21.6 mm of rain over three days (3 – 5 November; data from Liddell). The surveys conducted in January were following 36.8 mm of rain over five days (16 – 20 January; data from Liddell). Personal communication with the Conservation Biology Research Group at the University of Newcastle confirmed that Green and Golden Bell Frogs were active at monitoring sites on Kooragang Island prior to the November and January surveys.

It is noted that the surveys within the site have not been conducted under 'ideal' weather conditions as recommended by the *Survey guidelines for Australia's threatened frogs* (DEWHA 2010; within one week of heavy rainfall, which is defined as >50 mm in seven days). Due to drought conditions, there has been limited rainfall during the seasonal survey period for the species (September to March). It should also be noted that high rainfall events (>50mm) are rarer in the locality than on the coast. Surveys were conducted after the most significant rain events during the October to January period (monthly rainfall data from 2019 from the Liddell Site is shown in the BDAR (Kleinfelder 2020)), and when the species was known to be active at Kooragang Island. While this known population of Green and Golden Bell Frogs at Kooragang Island is over 80 km to the south-east of the Study Area, it is the closest known population to the Study Area and received moderate rainfall in November and high rainfall in the January period (based on rainfall data from weather Stations located at Newcastle University (Station 061390) and Newcastle Nobbys Signal Station (Station 061055); see **Table 3**).

While heavy rainfall is preferred to encourage breeding activity, the presence of permanent water is sufficient to provide habitat. All of the identified dams within the Study Area and the six Sewage Treatment Plant Polishing Ponds contained standing water at the time of survey, and are likely to contain standing water all year round. Additionally, surveys were conducted on warm and calm (low wind) nights during the survey period (September to March). As such, surveys within the Study Area were conducted when the species was active and detectable.

Table 20: Rainfall comparison

Month	Liddell	Newcastle University	Newcastle Nobbys
November 2019	21.6 mm	27.2 mm	38.4 mm
December 2019	0.2 mm	0.0 mm	5.2 mm
January 2020	46.6 mm Total 36.8 mm prior to 20/01	39.8 mm Total 24.2 mm prior to 20/01	31.0 mm Total 29.4 prior to 20/01

No population of Green and Golden Bell Frog was detected within the Study Area during field surveys. As such, the proposed Action is unlikely to lead to a long-term decrease in the size of an important population of the species.

- ***reduce the area of occupancy of an important population***

As the species was not detected during field surveys, it is unlikely that the proposed Action will reduce the area of occupancy of an important population.

- ***fragment an existing important population into two or more populations***

As the species was not detected during field surveys, and the closest known population occurs approximately 80 km to the south-east of the Study Area, it is unlikely that the proposed Action will fragment an existing important population.

- ***adversely affect habitat critical to the survival of a species***

No habitat critical to the survival of the Green and Golden Bell Frog is mapped at this point in time (DoEE, 2019). However, it can be assumed that due to the decline of the species and restricted nature of the known populations in NSW, any occupied habitat would be critical to the survival of the species. As the species was not detected during field surveys, it is unlikely to affect habitat critical to the survival of the species.

- ***disrupt the breeding cycle of an important population***

As the species was not detected during field surveys, it is unlikely that the proposed Action will disrupt the breeding cycle of an important population.

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

Suitable habitat is present within the impact area consisting of constructed dams which contain permanent water and suitable wetland vegetation (primarily *Typha* sp. and *Juncus* sp.). A total of eight Dams were identified within the Study Area (total of 4.99 ha). One area occurs within the exiting Ash Dam (3.90 ha; within the approved disturbance area of the Dam), two occur within the Study Area outside the disturbance area (0.35 ha, and 5 occur within the Impact Area (total of 0.74 ha).

While these Dams did contain suitable abiotic features, three of the eight dams were identified as containing Plague Minnow (*Gambusia holbrooki*). While the presence of this species does not exclude the potential for presence of Green and Golden Bell Frogs, they do have the potential to impact on the population numbers.

As the species was not detected during field surveys, it is unlikely that the proposed Action will impact on habitat to the extent that the species is likely to decline.

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

The existing weed and feral animal threat levels are unlikely to change significantly due to the Action given the current agricultural use of the surrounding area. A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised.

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

Infection of amphibians with chytrid fungus resulting in chytridiomycosis is a key threatening process to the Green and Golden Bell Frog.

As the species was not detected during field surveys, it is unlikely that the proposed Action will introduce a disease that may cause the species to decline.

- ***interfere substantially with the recovery of the species.***

There is a draft recovery plan for the species (DEC 2005). As the species was not identified during surveys, it is unlikely to interfere with the recovery of the species.

Conclusion

The Green and Golden Bell Frog has previously been recorded within the Sewage Treatment Plant Polishing Ponds within the Bayswater Site (directly to the west of the Study Area), approximately 20 years ago. Surveys conducted within the Study Area for the proposed Action did not identify the species.

As such, no location population of the species was detected and the proposed Action is unlikely to have a significant impact on the species.

References

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Department of the Environment, Water, Heritage and the Arts (2009). *EPBC Act Policy Statement 3.19. Significant Impact Guidelines for the vulnerable green and golden bell frog Litoria aurea.* Canberra, ACT: DEWHA. Available from: http://www.environment.gov.au/epbc/publications/litoria-aurea.html.

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Microchiropteran Bats

Two Microchiropteran Bats listed as Vulnerable under the EPBC Act would be potentially impacted by the Action, namely:

- Large-eared Pied Bat (*Chalinolobus dwyeri*); and
- Corben's Long-eared Bat (*Nyctophilus corbeni*).

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. This species is Found in well-timbered areas containing gullies. It roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Sandstone cliffs and fertile woodland valley habitat within close proximity of each other is habitat of importance to the Large-eared Pied Bat (Department of Environment and Climate Change, 2007). Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. This species likely forages for small, flying insects below the forest canopy (OEH, 2019).

Corben's Long-eared Bat (*Nyctophilus corbeni*) is a relatively large, solid bat. Overall, the distribution of this species coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. Corben's Long-eared Bat is found in a wide range of inland woodland vegetation types. These include box/ironbark/cypress pine woodlands, Buloke woodlands, Brigalow woodland, Belah woodland, Smooth-barked Apple Woodland, River Red Gum Forest, Black Box Woodland, and various types of tree mallee (Duncan *et al*., 1999; Schulz and Lumsden, 2010; Woinarski *et al*., 2014). The species is more abundant in extensive stands of vegetation in comparison to smaller woodland patches (Turbill and Ellis, 2006), suggesting its home range is probably large (Lumsden *et al*., 2008). This species is an insectivorous bat that hunts by taking flying prey or by foliage-gleaning in flight or by foraging on the ground (Lumsden and Bennett, 2000; Schulz and Lumsden, 2010). Foraging appears to be concentrated around patches of trees in the landscape, with many individuals from different species of bat sharing the same foraging area (DoEE, 2019). Studies have found that this species roosts solitarily, mainly in dead trees or dead spouts of live trees (Lumsden *et al*., 2008).

Significant impact criteria

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

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

Suitable foraging habitat for both these species within the Study Area consists of Central Hunter Box – Ironbark Woodland, Rehabilitation, Plantation, Central Hunter Bull Oak Forest, Swamp Oak Forest. Within the impact area there is a total of 82.60 ha of habitat.

No suitable roosting or breeding habitat for the Long-eared Pied Bat occurs within the Study Area (foraging habitat only). There are 18 records of this species in the locality.

The Study Area represents potential roosting and foraging habitat for the Corben's Long-eared Bat. There is only one record of the species in the locality, with its main area of occurrence being further west.

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

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

It is unlikely that any potentially occurring population of either of these species within the site would be considered an important population as they do not meet any of the criteria listed above.

- ***reduce the area of occupancy of an important population***

It is unlikely that any potentially occurring local populations would be important population, as such the Action would not impact on the area of occupancy of an important population. However, given the highly mobile nature of these species and large area of surrounding suitable habitat, it is unlikely that the Action would impact on the area of occupancy of any locally occurring populations.

- ***fragment an existing important population into two or more populations***

The habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches at the extremities of larger patches. Therefore, the loss of any potential habitat for these species within the study area would not isolate remaining habitat from other patches and it is unlikely that the Action would fragment an existing population into two or more populations.

- ***adversely affect habitat critical to the survival of a species***

Sandstone cliffs and fertile wooded valley habitat within close proximity of each other, and any maternity roosts, should be considered habitat critical to the survival of the Large-eared Pied Bat (Department of Environment and Resource Management, 2011). No sandstone cliffs have been observed within the study area or within its close proximity. The structure of maternity roosts appears to be very specific (arch caves with dome roofs). Caves need to be high and deep enough to allow juvenile bats to learn to fly safely inside and have indentations in the roof (Department of Environment and Resource Management, 2011). Such structures are not present within the study area. On this basis, no habitat critical for the survival of the Large-eared Pied Bat occurs within the study area, and therefore the Action is unlikely to have a significant adverse impact on a local population of these species such that their local occurrence would be placed at risk.

The listing advice for the Corben's Long-eared Bat states that old-growth forest are critical habitat in its Victorian extent (DoEE, 2019). No areas of old-growth forests were identified within the Study Area as such, there is no impact on critical habitat for the Corben's Long-eared Bat.

- ***disrupt the breeding cycle of an important population***

It is unlikely that any potentially occurring local populations would be important population, as such the Action would not impact on the breeding cycle of these species, furthermore there no breeding habitat for the Long-eared Pied Bat present within the Study Area. Given the highly mobile nature of Corban's

Long-eared Bat and large area of surrounding suitable habitat, it is unlikely that the Action would impact on a locally occurring population of this species.

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

The habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches at the extremities of larger patches. Therefore, the loss of any potential habitat for these species within the study area would not isolate remaining habitat from other patches and it is unlikely that the Action would significantly reduce the area of available habitat such that it would lead to the decline of these species.

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

The existing weed and feral animal threat levels are unlikely to change significantly due to the Action given the current agricultural use of the surrounding area. A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised.

Disturbance and damage to primary nursery roosts of the Large-eared Pied Bat by feral goats (*Capra hircus*) is a recognised threat for this species (Department of Environment and Resource Management, 2011). No breeding or roosting habitat for the Large-eared Pied Bat is present within the Study Area.

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

The Action is unlikely to include activities that area likely to introduce any disease to the Large-eared Pied Bat or Corben's Long-eared Bat. A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised.

- ***interfere substantially with the recovery of the species.***

A National Recovery Plan for the Large-eared Pied Bat is currently in place (Department of Environment and Resource Management, 2011; Smith and Robertson, 1999). No recovery plan is currently in place for Corben's Long-eared Bat.

The activities which comprise the Action are not inconsistent with the National Recovery Plans. The Action would not interfere substantially with the recovery of these species given habitat resources for these species would remain outside of the study area, such that the species are likely to persist in the landscape.

Conclusion

Large-eared Pied Bat (*Chalinolobus dwyeri*) has a high likelihood of occurrence within the study area. Eighteen records occur within the locality (OEH, 2019). Targeted surveys for this species within the study area have not yet been conducted. The recommended survey timing for this species is between November and January. Surveys in December detected no suitable roost sites. The Action is unlikely to have a significant impact on this species given:

- The lack of breeding habitat for this species within the study area.
- Evidence of this species within the locality indicates this species has the potential to occur in the adjacent habitat.
- No habitat critical to the survival of this species occurs within the study area.
- The habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches at the extremities of larger patches.
- The Action is unlikely to introduce or increase number of invasive pest species or a disease that may cause the species to decline.
- The Action would not interfere substantially with the recovery of this species.

Corben's Long-eared Bat (*Nyctophilus corbeni*) has a moderate likelihood of occurrence within the study area. Approximately 122.70 ha of suitable habitat is identified within the study area. One record occurs within the locality (OEH, 2019). Targeted surveys for this species were conducted in December. These surveys detected no individuals or breeding habitat. The Action is unlikely to have a significant impact on this species, given:

- Evidence of this species within the locality indicates this species has the potential to occur in the adjacent habitat.
- No habitat critical to the survival of this species occurs within the study area.
- The habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches at the extremities of larger patches.
- The Action is unlikely to introduce or increase number of invasive pest species or a disease that may cause the species to decline.
- The Action would not interfere substantially with the recovery of this species.

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Grey-headed Flying Fox

The **Grey-headed Flying-fox (*Pteropus poliocephalus*)** occurs along the eastern seaboard of Australia roosting in large communal aggregations known as 'camps'. These camps are used permanently, annually, or occasionally, varying in size from hundreds to many thousands of individuals,

fluctuating according to food resources (Eby and Law, 2008; Parry-Jones and Augee, 1991; Tidemann, 1995). This species forages on nectar and pollen from flowers of canopy trees (particularly *Eucalyptus, Melaleuca* and *Banksia*) and fleshy fruits from rainforest trees and vines. This species is highly mobile, dispersing to sites as far as 40 km to forage and returning to the camp in one night, and seasonally they may move hundreds of kilometres in response to variation in food resource productivity which largely explains the extensive migration movement of this species (Eby and Law, 2008). Roost sites are typically located near water, such as lakes, rivers or the coast. Roost vegetation includes rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation, but colonies also use highly modified vegetation in urban and suburban areas.

Significant impact criteria

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

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

The Grey-headed Flying-fox was not detected within the study area. This species roosts communally in large, established camps which may support several thousand individuals. The Action will not affect the foraging movements of this nocturnal species. The Action would not isolate any areas of habitat or cause significant habitat fragmentation that would affect the breeding, foraging or dispersive movements of this highly mobile species.

The Action would remove up to 18.57 hectares of foraging habitat for this species.

This species has very large home range and may travel up to 50 km in a night to forage (Eby and Law 2008). The habitat to be removed would therefore make up a very small proportion of the home range of locally occurring individuals. Given the large areas of native vegetation in the locality, it is considered that the removal of habitats would be unlikely to lead to a long-term decrease in the size of the population.

- ***reduce the area of occupancy of an important population***

The habitat to be removed does not represent breeding habitat (no camps identified) for the species and therefore any individuals utilising this habitat do not represent an important population. Additionally, the area of potential foraging habitat to be removed would constitute a very small proportion of the available habitat within the locality.

- ***fragment an existing important population into two or more populations***

The Grey-headed Flying Fox is a highly mobile species. The Action will not introduce physical barriers that would fragment an existing important population into two or more populations.

- ***adversely affect habitat critical to the survival of a species***

The draft national recovery plan (DECCW 2009) states that foraging habitat that meets at least one of the following criteria qualifies as critical habitat:

- productive during winter and spring, when food bottlenecks have been identified;
- known to support populations of > 30 000 individuals within an area of 50 km radius (the maximum foraging distance of an adult)
- 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 proposal and ripening in commercial crops affected by Grey-headed Flying-foxes (months vary between regions)
- known to support a continuously occupied camp.

The habitat within the study area does not support a continuously occupied roost camp and is unlikely to support a population of more than 30,000 individuals.

Habitats within the study area contain winter and spring-flowering eucalypts and may therefore qualify as critical foraging habitat as they would be productive during identified food bottlenecks. The resources present in the study area, however, are limited in comparison to available foraging resources in nearby

areas. In this context the removal of 18.57 ha of foraging habitat is unlikely to threaten the survival of local populations of this species.

- ***disrupt the breeding cycle of an important population***

No camps of the Grey-headed Flying Fox were detected within the study area. The Action is unlikely to disrupt the breeding cycle of an important population of the Grey-headed Flying-fox.

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

The habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches at the extremities of larger patches. Therefore, the loss of any potential habitat for these species within the study area would not isolate remaining habitat from other patches and it is unlikely that the Action would significantly reduce the area of available habitat such that it would lead to a decline of this species.

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

The existing weed and feral animal threat levels are unlikely to change significantly due to the Action given the current agricultural use of the surrounding area. A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised.

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

Australian bat Lyssavirus (ABL), Bat Paramyxovirus and Menangle Pig virus are recognised threats to the Grey-headed flying fox; however, the Action would not include activities that are likely to introduce these diseases.

- ***interfere substantially with the recovery of the species.***

As discussed above, foraging habitat within the study area is consistent with the definition of habitat critical to the survival of the Grey-headed Flying-fox. The Action is therefore inconsistent with one of the stated objectives of the draft recovery plan (DEWHA 2009), which is to "identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range". As discussed above, however, the 18.57 ha of foraging habitat to be removed represents a very small proportion of available foraging habitat for this highly mobile species. It is considered unlikely, therefore, that the Action would substantially interfere with the recovery of the species.

Conclusion

The Grey-headed Flying-fox (*Pteropus poliocephalus*) has a moderate to high likelihood of occurrence within the study area. The Action is unlikely to have a significant impact on this species, given:

- the lack of breeding habitat for this species within the study area;
- evidence of this species within the locality indicates this species has the potential to occur in the adjacent habitat;
- the habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches at the extremities of larger patches;
- the Action is unlikely to introduce or increase number of invasive pest species or a disease that may cause the species to decline; and
- the Action would not interfere substantially with the recovery of this species.

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Koala (*Phascolarctos cinereus*)

The **Koala (*Phascolarctos cinereus*)** is listed as vulnerable under the EPBC Act. This species was not detected within the study area during the assessment, based on the availability of habitat and the occurrence of local species records, this species has a low likelihood of occurrence within the study area.

The Koala is an arboreal marsupial with fur ranging from grey to brown above, and is white below. It has large furry ears, a prominent black nose and no tail. It spends most of its time in trees and has long, sharp claws, adapted for climbing. Adult males weigh 6 - 12 kg and adult females weigh 5 - 8 kg. During breeding, males advertise with loud snarling coughs and bellows. The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In New South Wales, koala populations are found on the central and north coasts, southern highlands, southern and northern tablelands, Blue Mountains, southern coastal forests, with some smaller populations on the plains west of the Great Dividing Range.

Significant impact criteria

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

- ***lead to a long-term decrease in the size of a population***

Two tree species listed under SEPP for Koala Habitat Protection (2019) occur within the study area: *Eucalyptus tereticornis* and *Eucalyptus punctata*. Within the Study Area, these two tree species only constitute >15% of the canopy cover within small portions of the site (within Vegetation Zone 1 – PCT 1691: Moderate-Good-CEEC, and Vegetation Zone 6 – PCT 1691: Plantation).

No evidence of Koala activity was identified during surveys conducted within the Study Area. Due to the limited extent of habitat and the patchy occurrence of feed trees within the Study Area, it is unlikely that the Study Area represents Core Koala Habitat.

Due to a lack of Core Koala Habitat or evidence of a resident population of Koalas, it is unlikely that the Action will lead to the long-term decrease of any potentially occurring local population of the species.

- ***reduce the area of occupancy of the species***

Due to the large home range sizes of the species, and availability of higher quality suitable habitat within the Bayswater Power Station Site, it is unlikely that the Action would reduce the area of occupancy of any potentially occurring local population.

- ***fragment an existing population into two or more populations***

The majority of habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches located at the extremities of larger patches. The species is mobile and due to the availability of suitable habitat in the surrounding area, predominantly to the west of the impact area, it is unlikely that the Action will fragment any potentially occurring local population.

- ***adversely affect habitat critical to the survival of a species***

Targeted surveys for the Koala did not reveal evidence of a resident population. Additionally, the habitat to be removed does not constitute Core Koala Habitat. As such, it is unlikely that the study area contains habitat critical to the survival of the species.

- ***disrupt the breeding cycle of a population***

No individuals were identified during targeted surveys of the species. As such, it has been assumed that the study area does not form part of the breeding range of a local population (foraging and dispersal habitat only). As such, it is unlikely that the Action will disrupt the breeding cycle of a locally occurring population.

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

The majority of the habitat onsite comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches that are at the extremities of larger patches. The loss of any potential habitat for these species within the study area would not isolate remaining habitat from other patches and it is unlikely that the Action would significantly reduce the area of habitat occupied by the species relative to its regional distribution.

- ***result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat***

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Stringent management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in invasive species becoming established in the habitat for the species.

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

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in the introduction of disease causing the species to further decline.

- ***interfere with the recovery of the species.***

A recovery plan has not been prepared for the species.

Conclusion

The species was assessed as having a low likelihood of occurrence within the study area. Targeted surveys for this species did not identify the species. The study area was assessed as providing mainly dispersal habitat of the Koala, however, it was not assessed as providing breeding habitat for the species. As there is a large amount of higher quality habitat within the surrounding areas of the Bayswater Power Station Site, the removal of the habitat within the Impact Area is unlikely to have a significant impact on any potentially occurring local population of the species.

References

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Brush-tailed Rock Wallaby (Petrogale penicillata)

The **Brush-tailed Rock Wallaby (*Petrogale penicillata*)** is listed as vulnerable under the EPBC Act. This species was not detected within the study area and due to the lack of suitable habitat, the species has a low likelihood of occurrence.

The Brush-tailed Rock-wallaby has a characteristic, long and bushy, dark rufous-brown tail that is bushier towards its tip. It has long, thick, brown body-fur that tends to be rufous on the rump and greyer on the shoulders. The fur on its chest and belly are paler, and some individuals have a white blaze on their chest. It also has a characteristic white cheek-stripe and a black stripe from its forehead to the back of its head. The Brush-tailed Rock-wallaby is highly agile and can move swiftly and confidently through rugged and precipitous areas. This agility is attributed to their compact, muscular build, their long and flexible tail that is used for balance and their well-padded and rough textured feet that provide excellent traction. The average weight of this species is about 8 kg for males and 6 kg for females.

Habitat for the species includes rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north.

Significant impact criteria

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

- ***lead to a long-term decrease in the size of a population***

The species was not detected within the study area during the targeted surveys. The study area does not contain rocky escarpments, outcrops, cliffs or other habitat features consistent with the preferred habitat of this species. Therefore, it is unlikely that the Action will lead to the long-term decrease of any potentially occurring local population of the species.

- ***reduce the area of occupancy of the species***

Due to the lack of habitat for the species within the study area and lack of evidence of a known resident population, it is unlikely that the Action would reduce the area of occupancy of any potentially occurring local population.

- ***fragment an existing population into two or more populations***

Due to the lack of habitat for the species within the study area and lack of evidence of a known resident population, it is unlikely that the Action will fragment any potentially occurring local population.

- ***adversely affect habitat critical to the survival of a species***

The study area does not contain rocky escarpments, outcrops, cliffs or other habitat features consistent with the preferred habitat of this species. As such, it is unlikely that the study area contains habitat critical to the survival of the species.

- ***disrupt the breeding cycle of a population***

No individuals were identified during targeted surveys of the species. As such, it has been assumed that the study area does not form part of the breeding range of a local population (foraging and dispersal habitat only). As such, it is unlikely that the Action will disrupt the breeding cycle of a locally occurring population.

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

The study area does not contain rocky escarpments, outcrops, cliffs or other habitat features consistent with the preferred habitat of this species. It is unlikely that the Action would significantly reduce the area of habitat occupied by the species relative to its regional distribution.

- ***result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat***

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Stringent management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in invasive species becoming established in the habitat for the species.

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

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in the introduction of disease causing the species to further decline.

- ***interfere with the recovery of the species.***

The Action does not contravene the objectives of the National recovery plan (Menkhorst and Hynes (2010).

Conclusion

The species was assessed as having a low likelihood of occurrence within the study area due to the lack of suitable habitat present. The Activity is unlikely to have a significant impact on any potentially occurring local population of the species.

References

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Striped Legless Lizard (Delma impar)

The Striped Legless Lizard (*Delma impar*) is listed as vulnerable under the EPBC Act. This species was detected within the study area during the assessment at Borrow Pit 4.

The **Striped Legless Lizard (*Delma impar*)** occurs in the Southern Tablelands, the South West Slopes, the Upper Hunter and possibly on the Riverina. Populations are known in the Goulburn, Yass, Queanbeyan, Cooma, Muswellbrook and Tumut areas. Also occurs in the ACT, Victoria and south-eastern South Australia. The species is found mainly in Natural Temperate Grassland but has also been captured in grasslands that have a high exotic component, and in secondary grassland near Natural Temperate Grassland and occasionally in open Box-Gum Woodland. Habitat is where grassland is dominated by perennial, tussock-forming grasses such as *Themeda australis* (Kangaroo Grass), spear-grasses (*Austrostipa* spp.) and tussock grasses (*Poa* spp.), and occasionally wallaby grasses (*Rytidosperma* spp.). It is sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter. This species actively hunts for spiders, crickets, moth larvae and cockroaches, and goes below ground or under rocks or logs over winter (OEH, 2019).

Significant impact criteria

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

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

The Striped Legless Lizard occurs in the Southern Tablelands, the South West Slopes, the Upper Hunter and possibly on the Riverina. Populations are known in the Goulburn, Yass, Queanbeyan, Cooma, Muswellbrook and Tumut areas. Also occurs in the ACT, Victoria and south-eastern South Australia (OEH 2019). Occurrence of the species in the Muswellbrook area is a range extension for the species, with the first being recorded at the Muswellbrook Common in 2013 (approximately 15 km north-west of the Study Area). Additionally, the species was recorded approximately 5 km to the west of the site in 2018, as part of surveys for the Maxwell Coal Project.

Targeted surveys identified evidence of a population within the study area. The species was detected twice at the same location within Borrow Pit 4, where a large patch of woodland vegetation occurs (on the edge of Bull Oak Woodland under an old fence post). It could not be clarified if two individuals were detected, or the same individual was captured twice (second individual captured had a dropped tail).

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

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

The Referral Guidelines for the species (DSEWPaC 2011) state that an important population of the Striped Legless Lizard is one that meets at least one of the above criteria and is likely to be a viable over the long-term.

Based on the distribution of the species in NSW, this population is near the northern limit of the species range. As only one to two individuals were identified during targeted surveys (tile arrays and active searches), an assessment of the viability of the population is difficult to assess, while the species can be cryptic and hard to detect, it would be anticipated that if a viable population of the species occurs within the Study Area additional individuals would have been recorded. Surveys conducted for the Maxwell Coal Project to the west of the Study Area identified a total of 26 specimens (16 living individuals and 10 sloughs (shed skins)).

The Conservation Advice for the species identifies the Muswellbrook population as an important population. The individuals identified within the Study Area are approximately 15 km from the Muswellbrook population, and approximately 5 km from another identified population to the west, and are as such likely to form a separate population of sub-population of the species. However, as the Study Area is at the northern extent of the species range, the precautionary principal has been applied and the individuals have been assessed as forming part of an important population.

Within the Study Area it is estimated that of the 184.43 ha of available habitat occurs, approximately 122.97 ha will be removed for the Action. All areas of vegetation, with the exception of the grasslands, were assessed as suitable habitat for the species. Grassland areas were excluded due to the lack of grass cover, and/or other refugia (i.e. logs, fence posts, rocky area) within these areas.

Due to the low number of individuals identified within the Study Area, and as the distribution of the species in the surrounding area is unknown, long-term impacts on the local population are uncertain. Within the Study Area and the surrounding vegetation large areas of similar habitat occur, if occupied the long-term impacts on the species are unlikely to be significant.

- ***reduce the area of occupancy of an important population***

It is estimated that of the 184.43 ha of available habitat within the study area, approximately 122.97 ha will be removed for the Action. While there is a large area of surrounding potentially suitable habitat in the area, the proposal has the potential to reduce the area of occupancy of the population. However, mitigation measure will be implemented as part of the Action to limit impacts on the species during works

(pre-clearing and clearing protocols, and translocation protocols if individuals identified), and all Borrow Pit areas will be rehabilitated upon the completion of works.

- ***fragment an existing important population into two or more populations***

The habitat onsite primarily comprises small, isolated patches with a low-level of connectivity to surrounding habitat, or patches at the extremities of larger patches. With the exception of Borrow Pit 4, where an expanse of Bull Oak Woodland occurs. However, this vegetation is commenced to habitat to the west/ north-west, but has limited connectivity to the east/south-east. Therefore, the loss of any potential habitat for these species within the study area would not isolate remaining habitat from other patches and it is unlikely that the Action would fragment an existing population into two or more populations.

- ***adversely affect habitat critical to the survival of a species***

Habitat critical to the survival of the Striped Legless Lizard is likely to include sites that possess more than one of the following characteristics (from Conservation Advice):

- **Provides breeding habitat:** The presence of two or more adult individuals or juveniles (lizards <70 mm snout to vent length) is confirmed on site and a habitat assessment confirms that the site contains complex grass structures including areas of tussocks with high biomass, surface rocks or invertebrate burrows necessary as sites for oviposition and which provide protection for eggs from disturbance. This may include sites with exotic grasses.
- **Provides foraging habitat:** the site is floristically diverse with little to no disturbance and is connected to other nearby grasslands or grassy woodlands.
- **Provides refuge from disturbance events:** within the Likely to occur modelled distribution and contains surface rocks arthropod burrows or suitable cracks in soil.
- **Provides for long term protection from development:** the site is currently covenanted for conservation management or has existing sympathetic management practices.
- **Has connectivity value and contributes to the evolutionary potential of the species in the wild across its natural geographical range:** The site is or forms part of a large area of habitat that is not in an urban area or zoning, and contains and is connected to breeding habitat or to a site subject to conservation management.

The site is unlikely to meet the majority of the above criteria; however, breeding habitat cannot be ruled out. Of the individuals identified within the Impact Area, one was identified as being approximately 50 – 60 mm in length (snout to vent length). As such, a juvenile lizard was possibly identified.

Habitat assessment of the Study Area for the species identified that the site contains marginal habitat across the majority of the site due to historical disturbance from cattle grazing lack of substantiable areas of tussock forming grasses and low grass density. There are some grassy areas which contain higher density of groundcover and increased sheltering opportunities for the species. The site also contains some scattered debris (logs, fence posts, metal sheets) and cow pats.

Due to the habitat not being assessed as optimal for the species and as surveys conducted during peak activity period (November – December) only identified a low number of individuals (one to two) it is unlikely that the Study Area contains habitat critical to the survival of the species. However, if a larger population is present, the habitat could be important for the species. There is a larger area of similar habitat in the areas surrounding the impact area that will be retained.

- ***disrupt the breeding cycle of an important population***

Clearing activities of the proposal within habitat for the species will be avoided, where possible, during breeding and through to egg hatching periods for the species, November to February (November to December mating, December to January egg laying, and January to February hatching). As such, impacts on the breeding cycle of the species will be minimised.

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

There is a large area of potentially suitable habitat for the species present within the Bayswater Site, to the west/north-west of the Study Area. Therefore, the loss of any potential habitat for this species within

the Impact Area would not isolate remaining habitat from other patches and it is unlikely that the Action would significantly reduce the area of available habitat such that it would lead to the decline of these species.

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

The existing weed and feral animal threat levels are unlikely to change significantly due to the Action given the current agricultural use of the surrounding area. A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised.

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

The Action would not include activities that area likely to introduce any disease, fungus or virus to the local populations of the species.

- ***interfere substantially with the recovery of the species.***

The activities which comprise the Action are not inconsistent with the recovery plan for the species (Smith and Robertson 1999), and the Action would not interfere substantially with the recovery of the species given habitat resources for these species would remain outside of the study area, such that the species are likely to persist in the landscape.

Conclusion

Striped Legless Lizard (*Delma impar*) – Approximately 187.43 ha of suitable habitat for this species within the study area, approximately 122.97 ha will be removed for the Action. Twenty-three records occur within the locality (OEH, 2019). Targeted surveys for this species within the study area identified one to two individuals at the same location (on different days) within Borrow Pit 4. Due to the uncertainty around the status of the population within the Study Area (size, importance, breeding potential), the potential for the proposal to have a significant impact on the species is uncertain. As such, the proposal has the potential to significantly impact on the species in the locality.

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Pink-tailed Worm-lizard (Aprasia parapulchella)

The Pink-tailed Worm-lizard (*Aprasia parapulchella*) is listed as vulnerable under the EPBC Act. This species was not detected within the study area during the assessment and there are no records of the species within the locality.

The pink-tailed worm-lizard is a member of the family Pygopodidae. It is a small, legless and very slender lizard that lives underground, growing to about 25 cm in length, nearly half of which is tail. The snout and the tail are rounded and blunt. The presence of small hind-limb flaps distinguishes it from a juvenile snake. Colouration is predominantly grey-brown to pale grey, with a slightly darker head and nape and a paler underside. The end part of the tail is pinkish to reddish-brown. Each dorsal scale has a short dark mark, forming indistinct, broken, longitudinal stripes that often come together on the tail. There are no external ear openings.

The pink-tailed worm-lizard's habitat includes primary and secondary grassland, grassy woodland and woodland communities, and the species usually inhabits sloping sites that contain rocky outcrops or scattered, partially buried rocks (Robertson and Heard 2008; Wong et al. 2011).

Significant impact criteria

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

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

The pink-tailed worm-lizard occurs in New South Wales (NSW), Victoria and the Australian Capital Territory (ACT) where it is widely but patchily distributed along the foothills of the western slopes of the Great Dividing Range between Bendigo in Victoria and Gunnedah in NSW (Wong et al. 2011). The species' distribution is highly fragmented across this range (Department of the Environment 2013) and occurs on a variety of land tenures. In Victoria its distribution is not fully known, but it is centered around Bendigo and thought to encompass Big Hill Range to the south, Marong to the west and Sugarloaf Range to the east (Robertson and Heard 2008; Wong et al. 2011). In NSW the species is only known from the Central and Southern Tablelands and the South Western Slopes, where sites are widespread, but highly isolated from each other (Wong et al. 2011; NSW OEH 2014). The species is known from many sites in the ACT, mainly distributed along the Murrumbidgee and Molonglo River corridors as well as some of the hills within Canberra Nature Park (Osborne and Jones 1995; Wong et al. 2011). The species has a wide altitudinal range, from 180 m near Bendigo to 815 m in the ACT (Wong et al. 2011)

Targeted surveys identified no evidence of a population within the study area. Very few areas occur within the study area that support rocky outcrops or scattered, partially buried rocks. Due to a lack of evidence of occurrence of resident population and the unsuitability of the habitat, impacts on the species are unlikely to be significant.

- ***reduce the area of occupancy of an important population***

A resident population of the species was not identified within the study area; hence, an important population has not been identified for which the area of occupancy will be reduced.

- ***fragment an existing important population into two or more populations***

A resident population of the species was not identified within the study area; hence, it is unlikely that an existing important population would be fragmented into two or more populations.

- ***adversely affect habitat critical to the survival of a species***

No individuals of the species were identified within the study area. Additionally, very few areas of suitable habitat were identified, hence, it is unlikely that the activity will adversely affect habitat that is critical to the survival of the species.

- ***disrupt the breeding cycle of an important population***

No individuals of the species were identified within the study area; hence, there is no evidence of breeding of an important population. It is unlikely that the activity would disrupt the breeding cycle of an important population of this species.

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

The loss of small areas of habitat for this species within the Impact Area would not isolate remaining habitat to be retained outside the study area. It is unlikely that the Action would significantly reduce the area of available habitat such that it would lead to the decline of these species.

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

The existing weed and feral animal threat levels are unlikely to change significantly due to the Action given the current agricultural use of the surrounding area. A site- CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised.

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

The Action would not include activities that area likely to introduce any disease, fungus or virus to the local populations of the species.

- ***interfere substantially with the recovery of the species.***

No recovery plan has been developed for the species. The Action would not interfere substantially with the recovery of the species given habitat resources for these species would remain outside of the study area, such that the species are likely to persist in the landscape.

Conclusion

No records of the Pink-tailed Worm-lizard (*Aprasia parapulchella*) occur within the locality. Targeted surveys for this species within the study area identified no individuals. As such, the proposal is unlikely to significantly impact the species in the locality.

References

Department of the Environment and Energy (2019). *Species Profile and Threats Database*. Available: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. Accessed: September 2019.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2011). Environment Protection and Biodiversity Conservation Act 199 *Referral Guidelines for the Vulnerable Striped Legless Lizard,* Delma impar. Commonwealth of Australia.

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CRITICALLY ENDANGERED AND ENDANGERED ECOLOGICAL COMMUNITIES

Central Hunter Valley Eucalypt Forest and Woodland

Approximately 32.39 ha of Central Hunter Valley eucalypt forest and woodland CEEC was identified within the study area.

The CEEC comprises eucalypt woodlands and open forests, typically with a shrub layer of variable density and/or a grassy ground layer. Across its range, one or more of a complex of four eucalypt tree species typically dominate the canopy, namely *Eucalyptus crebra* (Narrow-leaved Ironbark), *Corymbia maculata* (Spotted Gum), *E. dawsonii* (Slaty Gum) and *E. moluccana* (Grey Box). Under certain circumstances a fifth species, *Allocasuarina luehmannii* (Bulloak), may be part of the mix of dominants, in sites previously dominated by one or more of the above four eucalypt species. The composition of the ecological community at a particular site is influenced by the size of the site, recent rainfall, and drought conditions and by its disturbance history (including clearing, grazing and fire) (DoE, 2015).

Note an additional approximately 11.17 ha of woodland vegetation of PCT 1691 - Central Hunter Box - Ironbark Woodland (Vegetation Zone 2) has been mapped within the study area; however, these areas were not assessed as meeting the condition thresholds outlined in the listing advice for Central Hunter Valley eucalypt forest and woodland (DoE, 2015).

Significant impact criteria

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:

- ***reduce the extent of an ecological community***

The area of CEEC mapped within the study area comprises part of a larger extent of the CEEC in the locality. Within the Study area, the majority of the CEEC occurs around the Salt Cake Landfill, within Borrow Pit 4 and along the Northern HP area, with smaller or more isolated patches occurring around

the Ash Dam, along the western portion of the Ash Line, within Borrow Pits 2 and 3, adjacent to Borrow Pit 1, and along the Southern HP area. Approximately 32.39 ha was mapped within the study area (see Habitat Map). Within the surrounding Bayswater Power Station and Liddell Sites, a much larger extent of the community occurs (previously mapped by Kleinfelder 2017). Primarily within the vicinity of the current Study Area, the occurrence of the community is from the Plashett Dam north, on the western side of the Freshwater Dam and Bayswater Power Station, through to the southern extent of the Liddell Ash Dam. Within this area adjoining the current study area, there is over 700 ha of the CEEC.

Approximately 13.62 ha of the CEEC would be removed for the Action. This total removal equates to approximately 42% within the Study Area, and 1.9% within the broader Bayswater Site. As such, while the proposal will reduce the extent of the CEEC within, it is unlikely to significantly impact on the occurrence of the CEEC in the locality.

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

The CEEC exists within the study area in a fragmented state due to historical vegetation clearing activities for agricultural development and the construction of roads and other infrastructure. Areas of the CEEC to be removed for the Action are comprised of isolated woodland patches and edges of larger woodland patches, which are subject to edge effects. Within the Study area, the majority of the CEEC occurs around the Salt Cake Landfill, within Borrow Pit 4 and along the Northern HP area, with smaller or more isolated patches occurring around the Ash Dam, along the western portion of the Ash Line, within Borrow Pits 2 and 3, adjacent to Borrow Pit 1, and along the Southern HP area.

The majority of the woodland vegetation removal will occur from within Borrow Bit 4. Within Borrow Pit 4 the CEEC predominately occurs in the northern portion of the Borrow Pit, with a small patch in the south. This vegetation is connected to the south-east (patchy) and to the north and north-west (more continuous patches) of the Borrow Pit. The removal of the vegetation within Borrow Pit 4 would increase fragmentation of areas of the CEEC occurring to the north-west and south-east of the Borrow Pit. However, the vegetation occurring to the south-east is already highly fragmented (consists of scattered patches of the CEEC.

Impact on the CEEC within the Salt Cake Landfill is unlikely to contribute to fragmentation as it will occur at the edge of a patch of the community. Due to the limited width of the clearing proposed along the HP Pipe clearing areas and the Ash Line (maximum 10 m wide), and as these portions of the impact area already contain pipeline easements, any impacts on vegetation within these portions of the Site is unlikely to significantly increase fragmentation. Additionally, clearing of the isolated patches within Borrow Pits 2 and 3, and around the Ash Dam is also unlikely to significantly contribute to fragmentation of the CEEC as these patches are either already isolated, or occur on the edge of larger patches of the community.

- ***adversely affect habitat critical to the survival of an ecological community***

As per the Conservation Advice for the CEEC, areas which meet the minimum condition thresholds and the associated buffer zones (30 m) are considered critical to the survival of the CEEC (DoE, 2015). The propose Action will impact on 13.62 ha of the CEEC. This total removal equates to approximately 42% within the Study Area, and 1.9% within the broader Bayswater Site to the west of the Study Area. As such, while the proposal will impact on habitat critical to survival of the species, it is unlikely to adversely effect critical habitat in the locality due to the relatively small impact.

- ***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 CEEC is unlikely to be a GDE. Due to the location of the vegetation (higher in the landscape), and dominant soil type (Clay) it is unlikely that the roots of the vegetation would be able to penetrate to the groundwater. However, where depth to the groundwater is reduced, and more penetrable soils (sandy) are present, there is the potential for this vegetation to be facultative phreatophyte (opportunistically groundwater dependant), and could potentially be impacted by modification to the groundwater. There is the potential for impacts on the groundwater due to the Action within and surrounding the Salt Cake Landfill. However, based on the modelling (see Groundwater report) it is unlikely that the salt concentrations at the top of the water table would increase above existing background levels, as such

it is not considered that there would be a significant impact on the vegetation in the vicinity of the Salt Cake Landfill due to salinity.

There is also the potential to modify surface water drainage patterns due to the Action. The various portions of the disturbance area intersect a number of Creeks and smaller drainage lines. Impacts of the Action on these drainage lines could include reduction in water quantity flowing down steam, and/or modification to water quality downsteam. The majority of the drainage lines that could be potentiallyimpacted are already modified due to historical land practices, particularly Pikes Creek and Tinkers Creek through the exiting Ash Dam and CHPP, respectively, which stream flows are already modified due to existing infrastructure. As such, impacts on drainage patterns and potential water quality are not likely to be substantial such that the Action has a significant indirect impact on occurrences of the CEEC downstream of the Action. Furthermore, works within the CHPP are being conducted improve water quality, and implementation of appropriate erosion and sedimentation control measures as part of the Project will minimise the potential for impacts to water quality.

- ***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***

A maximum of 13.62 ha of this community would be removed as part of the Action. Areas of this CEEC outside of the study area would not be subject to burning, flora or fauna harvesting, or other activities which are likely to result in the decline or loss of a functionally important species within the CEEC. Edge effects following the Action are likely to be similar to current edge effects and therefore, the species composition of retained areas is likely to be similar. Additionally, upon the completion of clay extraction works within each Borrow Pit, these areas will be rehabilitated. A rehabilitation plan for the Borrow Pits will be prepared, locally endemic species will be used for rehabilitation where available consisting of appropriate vegetation communities, using locally sourced seeds/plants.

- ***cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:***
  - ***assisting invasive species, that are harmful to the listed ecological community, to become established, or***
  - ***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***

A site-specific CEMP will be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Stringent management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in invasive species becoming established in the habitat for the CEEC.

It is not anticipated that any novel activities involving the use of fertilisers, herbicides or other chemicals will be introduced to the subject site that would pose a threat to the CEEC.

- ***interfere with the recovery of an ecological community.***

No recovery plan is currently in place, or recommended, for this CEEC (DoEE, 2019). The Action would not interfere substantially with the recovery of this community given larger areas of the CEEC would remain outside of the study area, such that the community is likely to persist in the landscape.

Conclusion

Approximately 32.39 ha of the CEEC has been mapped within the study area. A total of 13.62 ha will be removed by the Action. It is unlikely that this removal will cause a significant impact to the CEEC given that:

- The CEEC is well represented in the locality in a similar state to that represented in the study area.

- The Action will not cause significant fragmentation of the CEEC given that it already exists in the study area in a highly fragmented state.
- No indirect impacts of the Action have been identified that are likely to have a significant impact areas of the CEEC that will be retained within the study area and the adjacent areas.
- The existing weed and feral animal threat levels are unlikely to change significantly following completion of the Action.

References

Department of the Environment (2015). Approved Conservation Advice (including listing advice) for the Central Hunter Valley eucalypt forest and woodland ecological community. Canberra: Department of the Environment.

Department of the Environment and Energy (2019). Species Profile and Threats Database. Available: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. Accessed: September 2019.

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White-Box Yellow-Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland

No areas of White-Box Yellow-Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland were identified within the study area.

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland is listed as a CEECunder the EPBC Act. The ecological community can occur either as woodland or derived native grassland (i.e. grassy woodland where the tree overstorey has been removed). It is characterised by a species-rich understorey of native tussock grasses, herbs and scattered shrubs (where shrub cover comprises less than 30% cover), and a dominance or prior dominance of White Box (*Eucalyptus albens*) and/or Yellow Box (*E. melliodora*) and/or Blakely's Red Gum (*E. blakelyi*) trees. In the Nandewar bioregion, Grey Box (*E. microcarpa or E moluccana*) may also be dominant or co-dominant. In the woodland state, tree cover is generally discontinuous and of medium height with canopies that are clearly separated.

To be considered part of the listed ecological community remnant areas must also:

- have a predominantly native understorey (i.e. more than 50% of the perennial vegetative ground-layer must comprise native species), and
- be 0.1 hectare (ha) or greater in size and contain 12 or more native understorey species (excluding grasses), including one or more identified important species (see Appendix 1); or
- be 2 ha or greater in size and have either natural regeneration of the overstorey species or an average of 20 or more mature trees per ha.

Box-Gum Grassy Woodland occurs along the western slopes and tablelands of the Great Dividing Range from southern Queensland through New South Wales and the Australian Capital Territory to Victoria. The ecological community once covered several million hectares in the eastern part of the wheat-sheep belt and tablelands and some coastal regions (e.g. Bega Valley of NSW). Due to the ecological community's occurrence on fertile soils it has been extensively cleared for agriculture and intact remnants, including both trees and unmodified understorey, are now extremely rare. Very few high-quality remnants remain anywhere across its former range. Current estimates indicate that only 405,000 ha of the ecological community in various condition states remain (Australian Government 2007). Clearing and fragmentation for urban, rural residential, agricultural and infrastructure development remain on-going threats to this ecological community, while degradation resulting from

inappropriate management and weed invasion by introduced perennial grasses continues to erode the conservation value of remnant areas.

Significant impact criteria

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:

- ***reduce the extent of an ecological community***

No vegetation was identified within the study area that contained key diagnostic species of White-Box Yellow-Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland. No areas of CEEC were mapped within the study area. As such, the proposal will not reduce the extent of the CEEC and it is therefore unlikely to significantly impact on the occurrence of the CEEC in the locality.

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

No areas of CEEC were mapped within the study area; therefore, the Activity is unlikely to significantly contribute to fragmentation of the CEEC in the locality.

- ***adversely affect habitat critical to the survival of an ecological community***

No areas of CEEC were mapped within the study area. As such, the activity is unlikely to adversely effect critical habitat in the locality.

- ***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 CEEC is unlikely to be a GDE. The Action has the potential to modify surface water drainage patterns. The various portions of the disturbance area intersect several Creeks and smaller drainage lines. Impacts of the Action on these drainage lines could include reduction in water quantity flowing down steam, and/or modification to water quality downsteam. The majority of the drainage lines that may be potentially impacted are already modified due to historical land practices, particularly Pikes Creek and Tinkers Creek through the exiting Ash Dam and CHPP, respectively, which stream flows are already modified due to existing infrastructure. As such, impacts on drainage patterns and potential water quality are not likely to be substantial such that the Action has a significant indirect impact on occurrences of the CEEC downstream of the Action. Furthermore, works within the CHPP are being conducted improve water quality, and implementation of appropriate erosion and sedimentation control measures as part of the Project will minimise the potential for impacts to water quality.

- ***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***

No areas of CEEC were mapped within the study area. Areas of this CEEC outside of the study area would not be subject to burning, flora or fauna harvesting, or other activities which are likely to result in the decline or loss of a functionally important species within the CEEC. Edge effects following the Action are likely to be similar to current edge effects and therefore, the species composition of retained areas is likely to be similar. Additionally, upon the completion of clay extraction works within each Borrow Pit, these areas will be rehabilitated. A rehabilitation plan for each Borrow Pit will be prepared, only locally endemic species will be used for rehabilitation of appropriate vegetation communities, using locally sourced seeds/plants.

- ***cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:***
  - ***assisting invasive species, that are harmful to the listed ecological community, to become established, or***
  - ***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***

A site-specific CEMPwill be prepared and implemented prior to the commencement of any clearing or construction works to ensure that impacts are minimised. Stringent management measures will prevent construction activities from introducing or spreading new or existing environmental and noxious weeds or plant and animal pathogens. As such, it is unlikely that the Action will result in invasive species becoming established in the habitat for the CEEC.

It is not anticipated that any novel activities involving the use of fertilisers, herbicides or other chemicals will be introduced to the subject site that would pose a threat to the CEEC in the locality.

- ***interfere with the recovery of an ecological community.***

A recovery plan is currently in place for this CEEC (DECCW 2010). The Action would not interfere substantially with the recovery of this community given that no areas will be impacted by the Activity and areas of the CEEC would remain outside of the study area, such that the community is likely to persist in the landscape.

Conclusion

It is unlikely that the Activity will cause a significant impact to the CEEC given that:

- No areas of CEEC were mapped within the study area (no direct impacts).
- The Action will not cause significant fragmentation of the CEEC.
- No indirect impacts of the Action have been identified that are likely to have a significant impact areas of the CEEC that will be retained in adjacent areas.
- The existing weed and feral animal threat levels are unlikely to change significantly following completion of the Action.

References

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MIGRATORY SPECIES

The White-throated Needletail (*Hirundapus caudacutus*) is listed as a migratory species under the EPBC Act. This species was not identified during the assessment; however, based on habitat availability, the species has a moderate to low likelihood of occurrence in aerial habitat within the study area.

The White-throated Needletail (*Hirundapus caudacutus*) is a large swift with a thickset, cigar-shaped body, stubby tail and long pointed wings. Sexes are alike, with no seasonal variation, and juveniles are separable with good visibility (Higgins, 1999). The White-throated Needletail is generally gregarious when in Australia, sometimes occurring in large flocks, comprising hundreds or thousands of birds, though they are occasionally seen singly, and occasionally occur in mixed flocks with other aerial insectivores, including Fork-tailed Swifts (*Apus pacificus*) and Fairy Martins (*Hirundo ariel*) (Learmonth, 1950, 1951; McMicking, 1925; Wheeler, 1959). The White-throated Needletail is widespread in eastern and south-eastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent

inland plains (Barrett *et al.*, 2003; Blakers *et al*., 1984; Higgins, 1999). The White-throated Needletail breeds in Asia (Chantler, 1999; de Schauensee, 1984; Dement'ev and Gladkov, 1951; Ornithological Society of Japan, 2000). In Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground (Coventry, 1989; Tarburton, 1993; Watson, 1955).

Significant impact criteria

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

- ***substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species***

Terrestrial habitat will be disturbed for the proposed activity; however, the White-throated Needletail is almost exclusively aerial when foraging and is unlikely to utilise the terrestrial vegetation within the study area. Habitat for this migratory species will not be destroyed or isolated by the Action.

- ***result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or***

The Action is unlikely to cause an increase in pest species that are harmful to this migratory species, especially considering that the species is almost exclusively aerial and is unlikely to interact with terrestrial vertebrate species.

- ***seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.***

The species is highly mobile and can readily move between habitats. The action is therefore unlikely to disrupt or interfere with the natural behaviour of this species.

Conclusion

The action is unlikely to have a significant impact on this species, given:

- the lack of breeding habitat for this species within the study area;
- this species is almost exclusively aerial and unlikely to utilise the terrestrial habitat present onsite;
- this species highly transitory and able to move between different habitats easily; and
- the Action is unlikely to introduce or increase number of invasive pest species or a disease that may cause the species to decline.

References

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APPENDIX 10. STAFF CONTRIBUTIONS

The following staff were involved in the compilation of this report.

Name	Qualification	Title/Experience	Contribution
Ash Owen	DipSc BEnvSc (In progress)	Ecologist	Fauna and flora surveys
Ben Stewart	MMSc&Mgt	Field Assistant / Ecologist	Flora surveys
Daniel O'Brien	BEnvSc & Mgt (Hons) / PhD (in progress)	Senior Ecologist	Fauna surveys and report review
David Coleman	BSc, Grad Dip (EnvSc)	Principal Environmental Consultant	Flora surveys
David Russell	BSc Accredited BAM Assessor	Senior Ecologist	Flora surveys, vegetation mapping
Devon Raiff	BSc (Hons)	Field Assistant / Ecologist	Flora surveys
Elise Connolly	Dip Cons Lnd Mgmt, Adv Dip Env Mgmt Accredited BAM Assessor	Ecologist (Botanist)	Flora surveys
Emily Fittell	BSc (Hons)	Ecologist	Fauna surveys, flora surveys and report writing
Gayle Joyce	BSc Forestry (Hons)	GIS Specialist	GIS data management and figure preparation
Gilbert Whyte	BSc (Hons) PhD	Senior Ecologist	Report review and amendment.
Kevin Wormington	BAppSc (Hons) PhD	Senior Ecologist	Flora surveys
Luke O'Brien	BEnvSc&Mgt	Ecologist	Fauna and flora surveys
Mark Dean	BEnvSc&Mgt	Ecologist	Fauna and flora surveys, fauna reporting
Nigel Fisher	BSc (Hons) PhD	Senior Soil Microecologist / Ecologist	Flora surveys
Samara Schulz	BEnvSc & Mgt (Hons) Accredited BAM Assessor	Senior Ecologist	Flora Surveys, BAM calculations and report writing
Yann Buissiere	BEnvSc & Mgt	Ecologist	Flora surveys

APPENDIX 11. LICENSING

Kleinfelder employees involved in the current study are licensed or approved under the *Biodiversity Conservation Act 2016* (License Number: SL100730, Expiry: 31 March 2021) and the *Animal Research Act 1985* to harm/trap/release protected native fauna and to pick for identification purposes native flora and to undertake fauna surveys.