APPENDIX I REVISED BIODIVERSITY IMPACT ASSESSMENT

BIODIVERSITY IMPACT ANALYSIS

Angus Place Mine Extension Project

144414
Biodiversity Impact Analysis
V1
6 November 2019

rpsgroup.com

Document status

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EXECUTIVE SUMMARY

Angus Place Colliery is an existing underground coal mine located approximately 15 kilometres (km) to the northwest of the regional city of Lithgow and 120 km west-northwest of Sydney in New South Wales (NSW). Angus Place Colliery's Project Approval (PA_06_0021) will expire in August 2024 and a new consent is required to ensure Angus Place Colliery is operational beyond this date. A State Significant Development (SSD) application and supporting Environmental Impact Statement (EIS) was submitted to the NSW Department of Planning, Infrastructure and Environment (DPIE) in April 2014 for the Angus Place Mine Extension Project (APMEP; SSD_5602). A decision was made by Centennial Coal in March 2015 to place the Angus Place Colliery into care and maintenance. At this time, the assessment of the APMEP was placed on hold. An amended application for the APMEP is currently being prepared.

RPS has been engaged by Centennial Angus Place Pty Limited (the Applicant) to prepare a Biodiversity Impact Analysis (BIA), to support the amended application for the APMEP. This BIA considers proposed changes to the APMEP to that presented in the original EIS, which was informed by a Flora and Fauna Assessment by RPS (2014). Proposed amendments to the Project considered within this BIA were broadly grouped into surface infrastructure, subsidence-related and mine-water discharge impacts.

This BIA draws upon existing data collected during earlier biodiversity assessments and monitoring by RPS, specialist subsidence and water management reports, as well as recently collected floristic data. As well as assessing the potential impacts to biodiversity values arising from the Amended Project, this report also provides a comprehensive Swamp Monitoring Program and Biodiversity Management Plan that were designed to effectively respond to impacts to biodiversity values as mining progresses. Lastly, in the case of impacts to swamps, a Swamp Offset Strategy is presented that satisfies requirements under the NSW Biodiversity Offset Scheme and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) Environmental Offsets Policy.

Subsidence-related Impacts

As with the initial EIS, an EPBC Act listed Endangered Ecological Community (EEC) known as Temperate Highland Peat Swamp on Sandstone (THPSS).is within the amended predicted subsidence extents. Potential subsidence related impacts on THPSS may arise as a consequence of the secondary extraction of coal from mined longwalls. THPSS is also commensurate with Newnes Plateau Shrub Swamps (NPSS) which is listed as an EEC under the *Biodiversity Conservation Act* 2016 (BC Act). Additionally, THPSS is also commensurate with Newnes Plateau Hanging Swamp (NPHS) which is not listed as an EEC under the BC Act. The terms 'THPSS' and 'swamp' are used interchangeably in this document and refer collectively to the abovementioned swamp communities.

In contrast to the initial EIS, knowledge recently gained from ecological monitoring at Springvale and Angus Place and re-calibration of Subsidence models by MSEC (2019) suggest that the Angus Place Extension Project is likely to have a greater than negligible impact upon THPSS. Subsidence-related impacts are expected at named swamp including; Tri Star Swamp, Twin Gully Swamps (including North), Japan (Trail Six) Swamp, Crocodile Swamp, Birdrock Swamp, Wolgan River Swamps (including Upper) and the hanging swamps within their catchments. Although, the predicted impacts at Wolgan River, Wolgan River Upper and Crocodile Swamps are not considered to be significant (Jacobs 2019a). Impacts to THPSS may also extend up to 400 m outside the mining area (MSEC 2019). For the purposes of this BIA, the area of potential impact has been extended to a 600 m buffer from the goaf edge which is hereafter termed the Trigger Investigation Area (TIA). These impacts may include vegetation dieback, major incision and erosion (in some instances down to bedrock), associated with loss of peat layer, significant loss of ecosystem function and ecological resilience, and ecological and geomorphic threshold exceedance. As such, impacts to THPSS-associated threatened species are also likely in these locations; these species are the Blue Mountains Water Skink (*Eulamprus leuraensis*), Giant Dragonfly (*Petalura gigantea*), Deane's Boronia (*Boronia deanei*), Red Crowned Toadlet (*Pseudophryne australis*), Swamp Everlasting (*Xerochrysum palustre*) and Klaphake's Sedge (*Carex klaphakei*).

This BIA presents the maximum potential ecosystem and species credit liability given total loss of THPSS within the Amended Project Area. Nevertheless, given the current THPSS monitoring results, it is considered unlikely that the THPSS systems will be lost in entirety. Consequently, this BIA presents a monitoring program aimed at verifying the assumptions discussed in this report, and quantifying the actual loss following

mining is conducted. A Swamp Offset Strategy is also presented here to compensate for the potential impacts to THPSS and their associated threatened species for the amended APMEP.

Surface Infrastructure Impacts

To provide flexibility for the location of infrastructure throughout the life of the project, the Amended Project proposes to undertake surface disturbance activities within an Impact Envelope of 49.93 ha. This is an increase of 26.69 ha of potential surface disturbance since the initial EIS. However, the actual footprint will likely be far less as infrastructure will be designed to avoid and minimise impacts on bushland and threatened species by avoiding areas of high biodiversity value, confining construction to pre-disturbed areas and established access tracks where possible. Where impacts cannot be avoided, the actual offset liabilities will be offset in accordance with the BC Act. These actual offset requirements will be informed by extensive field surveys before construction (in accordance with the Biodiversity Assessment Method; BAM), which will include use of high-resolution (7 cm pixel resolution) aerial photography before and after construction.

Assessment of biodiversity values within the Impact Envelope found four Plant Community Types (PCTs) may be impacted; none of which are commensurate with any EECs. Given the presence of these four PCTs, sixty-two Species Credit Species were also identified as having potential to occur. This BIA presents the maximum potential ecosystem and species credit liability, given the potential loss of four PCTs and 14 species likely to occur within the Impact Envelope.

Mine-water Discharge Impacts

The EIS (Centennial Coal 2014) assessed up to 30 ML/day of mine water discharges from the Angus Place Colliery LDP001. Although the 2014 EIS concluded that this volume of discharge and expected water quality will unlikely have a significant impact on threatened entities or other MNES, the Amended Project will avoid the potential to impact downstream sensitive receivers since any excess groundwater not used for onsite operational requirements will be transferred to the Springvale Water Treatment Project (SSD_7592).

GLOSSARY

Acronyms

Acronym	Definition
AOD	Angle of draw (26.5 degrees)
APMEP	Angus Place Mine Extension Project (SSD_5602)
BACI	Before After Control Impact
BAM	Biodiversity Assessment Method
BC Act	*Biodiversity Conservation Act* 2016(supersedes TSC Act)
BIA	Biodiversity Impact Analysis
BMP	Biodiversity Management Plan
BOS	Biodiversity Offset Strategy
DPIE	NSW Department of Planning, Infrastructure and Environment
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
EP&A Act	*Environmental Planning and Assessment Act* 1979
ESA	Environmental Study Area
GBMA	Greater Blue Mountains Area
GCP	Ground Control Point
GDE	Groundwater Dependant Ecosystem
HBT	Hollow-Bearing Tree
LGA	Local Government Area
LoOA	Likelihood of Occurrence Analysis
NPSS	Newnes Plateau Shrub Swamp (EEC listed under the BC Act). Commensurate with THPSS.
NPHS	Newnes Plateau Hanging Swamp (not an EEC listed under the BC Act). Commensurate with THPSS.
PCT	Plant Community Type
RDP	Rapid Data Point
RGB	Red Green Blue colour imagery
ROM	Run of Mine coal
RTS	Response to Submissions
SAII	Serious and Irreversible Impacts
SMEP	Springvale Mine Extension Project (SSD_5594)
SMP	Swamp Monitoring Program
SSD	State Significant Development
THPSS	Temperate Highland Peat Swamp on Sandstone
TIA	Trigger Investigation Area - a 600 m buffer from the goaf edge where there is potential for impacts upon Swamps.
TSC Act	*Threatened Species Conservation Act* 1995 (now repealed and replaced by BC Act)
VIS	Vegetation Integrity Score

Terms

Term	Origin	Definition
Amended Project		Amendment to the existing development application (SSD_5602).
Environmental Study Area (ESA)	RPS F&F 2014	A focused area for intensive targeted flora and habitat surveys during the original EIS assessments. Only a proportion of an ESA will require clearing to accommodate required surface facilities, which allows flexibility in terms of mine design and avoidance of important ecological attributes, such as threatened species. Some track edges of chosen access tracks may require widening.
Initial Project	RPS F&F 2014	The previously defined 'Project' in Centennial Coal (2014) EIS
Initial Project Area	RPS F&F 2014	The 'Project Application Area' assessed during the initial EIS (Centennial Coal 2014). Approx. 10,470 ha in total
Initial Study Area	RPS F&F 2014	Approximately 10,760 ha in total – RPS surveyed additional areas outside the Project boundary, including a buffering on the AOD boundary.
Impact Envelope		An indicative area where surface infrastructure will be constructed as part of the Amended Project. Targeted surveys will focus on avoiding and minimising impacts on threatened species and their habitats by avoiding areas of high biodiversity value, confining construction to pre-disturbed areas and established access tracks where possible.
Locality		A 10 km radius of the Project Area.
Project Area		The Amended Project Application Area

1 INTRODUCTION

Angus Place Coal Pty Ltd (Angus Place) is an underground longwall mine which produces high quality thermal coal extracted from the Lithgow Seam. Angus Place Colliery is located within the western coalfield, approximately 21 kilometres (km) to the northwest of Lithgow and 125 km west-north-west of Sydney, NSW. Angus Place Colliery is bordered to the south by Springvale Colliery. Angus Place is in the Lithgow Local Government Area (LGA).

Angus Place mine is a joint venture owned in equal share by Centennial Springvale Pty Ltd (a wholly owned subsidiary of Banpu Minerals Ltd) and Springvale SK Kores Pty Limited. Angus Place is operated by Centennial Angus Place Pty Ltd.

The Angus Place mine's current project approval (Project Application 06_0021) was granted in September 2006 under Part 3A of the *Environmental Planning and Assessment Act* 1979. The current project approval has since been declared a State Significant Development (SSD) under clause 6 of Schedule 2 to the Environmental Planning and Assessment (Savings, Transitional and Other Provisions) Regulation 2017, for the purposes of the *Environmental Planning and Assessment Act* 1979 (EP&A Act). The Angus Place Colliery project approval and its subsequent modifications remain current and authorises the extraction of up to 4 million tonnes per annum (Mtpa) of run of mine (ROM) coal per annum. The current project approval will expire in August 2024 and a new development consent is required to ensure Angus Place Colliery is operational beyond this date.

A SSD application (SSD_5602) and supporting Environmental Impact Statement (EIS) was submitted to NSW Department of Planning, Infrastructure and Environment (DPIE) in April 2014 (Centennial Coal 2014) for the Angus Place Mine Extension Project (APMEP). The APMEP sought to extend the life of the Angus Place Colliery and continue the ability to extract up to 4 Mtpa ROM coal using longwall mining techniques. The initial project also sought to continue the utilisation of existing infrastructure, as well as construct and operate additional infrastructure to support the underground mining operations. The extracted coal is expected to supply domestic and export markets. Western Coal Services Project development consent (SSD_5579), authorises coal to be transported from the Angus Place Colliery pit top via private haul roads to:

- The Mount Piper Power Station;
- Wallerawang Power Stations;
- Kerosene Vale Stockpile; and
- Springvale Coal Services Site.

The exhibition period for the EIS commenced on 12 April 2014 and ended on 26 May 2014. A Response to Submissions (RTS) report was lodged with the DPIE on 1 October 2014 to respond to submissions received during the public exhibition period. A supplementary RTS was lodged with the DPIE in December 2014.

In response to a prolonged downturn in international coal markets, a decision was made by Centennial Coal to place the Angus Place Colliery into care and maintenance following the completion of secondary extraction within longwall panel 900W. Secondary extraction of longwall panel 900W was completed on 15 February 2015 and the mine was placed in care and maintenance on 28 March 2015. At this stage, the assessment of the APMEP was placed on hold.

This Biodiversity Impact Analysis (BIA) aims to support an amendment to the existing development application (SSD_5602). This report assesses the difference in potential impacts arising from the amended Project compared to that assessed within the initial EIS (Centennial Coal 2014), which was informed by a Flora and Fauna Assessment by RPS (2014). Information sources used to inform this report include this Flora and Fauna Assessment and data recently collected during the Angus Place Extension Max Offset Liability Assessment (RPS 2019). The EIS for the Initial Project was prepared in accordance with the Director General's Environmental Assessment Requirements (issued 6 November 2012), and the Supplementary Director General's Requirements (issued 30 August 2013). Specialist reports are also referred to here, including subsidence predictions and impact assessments by MSEC (2019). For the purpose of this report,

the original Project design is referred to as the “Initial Project”, whilst the amended Project design is referred to in the current report as the “Amended Project”.

2 BACKGROUND INFORMATION

This section aims to provide information regarding both the Initial Project and the Amended Project, as a collation of data from available resources.

2.1 Initial Project Description

The APMEP as proposed in the 2014 EIS included all existing and approved operations, facilities and infrastructure of the Angus Place Colliery authorised by project approval PA 06_0021 (as modified) in addition to:

- An extension and continuation of longwall mining for 25 years from the date consent is granted for the APMEP, with rehabilitation to be undertaken following this period;
- Ongoing exploration activities within the Project Application Area; and
- Modifications to existing facilities and infrastructure, and construction and operation of new facilities and infrastructure, within the Project Application Area for the APMEP that are required to support the Initial Project.

The APMEP as proposed in the Initial Project EIS (Centennial Coal 2014) excluded those previously approved activities that were subsequently authorised by the Western Coal Services Project development consent (SSD_5579). These activities comprised the ROM coal transport operations and the operational management and rehabilitation of the Kerosene Vale stockpile.

2.1.1 Mine Design and Minimisation of Impacts to Sensitive Surface Features

The mine design for the Initial Project was revised in order to minimise impacts to sensitive surface features. It is based on extensive and long-term monitoring of subsidence and related consequences to groundwater, surface water, biodiversity, cliffs and pagodas. The Initial Project design was supported by detailed geological and geotechnical monitoring and analysis at the time of the initial assessment. The mine plan sought to avoid undermining the majority of sensitive surface features and where this was not feasible, specific proven designs have been proposed to minimise environmental consequences.

2.2 Amended Project Description

The Amended Project proposes a modified Project Area to take into consideration revisions to the mine plan and to encompass the proposed new underground roadway connections between the Angus Place and Springvale Collieries. The Amended Project Area will encompass 10,551 ha; an increase of 91 ha (hereafter referred to as the 'Project Area').

All proposed surface infrastructure works are to be contained within an 'Impact Envelope'. The Impact Envelope is an indicative area where surface infrastructure will be constructed as part of the Amended Project. Targeted surveys will focus on avoiding and minimising impacts on threatened species and their habitats by avoiding areas of high biodiversity value, confining construction to pre-disturbed areas and established access tracks where possible.

2.2.1 Sensitive features

The APMEP will involve undermining of Temperate Highland Peat Swamps on Sandstone (THPSS) which is commensurate with the Plant Community Type (PCT) 657 *Baeckea linifolia - Grevillea acanthifolia* subsp. *Acanthifolia* shrub/sedge swamp on sandstone, Sydney Basin Bioregion. THPSS is listed as an Endangered Ecological Community (EEC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). THPSS is also commensurate with Newnes Plateau Shrub Swamps (NPSS) which listed as an EEC under the *Biodiversity Conservation Act* 2016 (BC Act). Additionally, THPSS is commensurate with Newnes Plateau Hanging Swamp (NPHS) which is not listed as an EEC under the BC Act. The terms

'THPSS' and 'swamp' are used interchangeably in this document and refer collectively to the abovementioned swamp communities.

Threatened species known to be associated with THPSS include:

≠ Blue Mountains Water Skink (*Eulamprus leuraensis*; BC Act = Endangered; EPBC Act = Endangered);

≠ Giant Dragonfly (*Petalura gigantea*; BC Act = Endangered; EPBC Act = Not Listed);

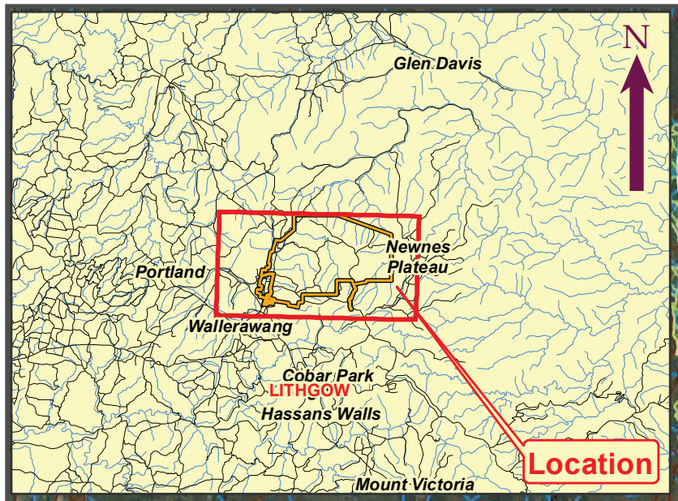
≠ Deane's Boronia (*Boronia deanei*; BC Act = Vulnerable; EPBC Act = Vulnerable);

≠ Red Crowned Toadlet (*Pseudophryne australis*; BC Act = Vulnerable);

≠ *Xerochrysum palustre* (Swamp Everlasting; EPBC Act = Vulnerable): and

≠ *Carex klaphakei* (Klaphake's Sedge; BC Act = Endangered).

Contrary to the predictions within the Initial Project, ongoing monitoring at Springvale Colliery has indicated that THPSS and associated threatened species may experience greater than negligible impacts as a result of longwall mining. In order to quantify the potential maximum offset liability for the APMEP, RPS (2019) calculated the liability using the Biodiversity Assessment Method (BAM) for ecosystem and species credits (State of NSW 2017) and it is discussed in detail in **Section 9**. The initial and Amended Project Areas are overlayed with the THPSS mapping below in **Figure 1.**



Gardens of Stone

Wollemi

BAALBONE TRAIL

THE BICENTENNIAL NATIONAL TRAIL

WOLGAN RIVER

NO 8 FIRETRAIL

NO 6 FIRETRAIL

NO 5 FIRETRAIL

BIRDS ROCK TRAIL NO 1

BIRDS ROCK TRAIL NO 2

BIRDS ROCK TRAIL

Trail Six/Japan Swamp

CARNE CREEK

DEANES CREEK

GALAH MOUNTAIN ROAD

FIRE TRAIL NO 3

FIRE TRAIL NO 4

Rocky Creek Swamp

ROCKY CREEK

FIRE TRAIL NO 2

FIRE TRAIL NO 1

Twin Gully North Swamp

Twin Gully Swamp

Wolgan River Swamp

Birdrock Swamp

NO 4 FIRETRAIL

SUNNYSIDE RIDGE ROAD

Wolgan River

Tristar Swamp

Crocodile Swamp

Wolgan River Upper Swamp

LAMBS CREEK

WOLGAN ROAD

KANGAROO CREEK

NEUBECKS CREEK

CAPS RIVER

CASTLEREAGH HIGHWAY

WANGGOL CREEK

GROVES ROAD

VIEW STREET

MADDOX LANE

IAN HOLT DRIVE

SKELLY ROAD

BRAYS LANE

PIPERS FLAT CREEK

MAIN STREET

BLACKFELLOWS HAND TRAIL

ANGUS PLACE TRAIL

KANGAROOS CREEK ROAD

BEECROFT FIRETRAIL

CAMPBELLS ROAD

OLD BELLS LINE

Narrow Swamp

West Wolgan

Sunnyside Swamp

North Sunnyside

Ampetheatre

East Wolgan

Solo

Uno Sunnyside

Sunnyside East

North Gang Gang

West Carne

West Gang Gang

Central Carne

East Gang Gang

Glow Worm

Kangaroo Creek Upper

Junction

South Wall Swamp

BOUNDARY TRAIL

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Legend

- Project area
- Initial Project Application Area
- Initial Study Area
- National Park
- THPSS Swamps
- THPSS Swamps
- Roads and Tracks
- Drainage

1 0.5 0 1 2 3 4 km

SCALE: 1:50,000 AT A3 SIZE

TITLE : FIGURE 1: THE INITIAL AND AMENDED PROJECT AREAS OVERLAYED WITH THPSS MAPPING

LOCATION : ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : **5/12/2019**

PURPOSE: **EIS**

VERSION (PLAN BY): A A3 (Natalie.Wood)

PATH: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\144414 Figure 1 The Initial and Amended Project Areas overlayed with THPSS 20191205.mxd

CLIENT: **CENTENNIAL COAL**

JOB REF: **PR144414**

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MAKING COMPLEX EASY

2.3 Summary of the Initial and Amended Projects

Changes in the potential impact of the Initial and Amended Project relevant to biodiversity values are summarised in **Table 1**.

Table 1: Summary of Initial and Amended Project changes relevant to Biodiversity values

Activity	Nature of potential impact	Initial / EIS Case	Amended Project Case
Mining Method and Mine Design	≠ Subsidence ≠ Water quality/quantity	≠ Continuous miner and longwall extraction ≠ Continued development of new roadways to enable access to the proposed 1000 panel longwall mining area ≠ Extraction of existing approved longwall 910) ≠ Development and extraction of 19 new longwalls (LW1001-1019) with void widths between 260 m and 360 m.	≠ Continuous miner and longwall extraction ≠ Continued development of new roadways to enable access to the proposed 1000 panel longwall mining area ≠ Extraction of existing approved longwall 910) ≠ Development and extraction of 15 longwalls (LW1001-1015) with void widths of 360 m. ≠ Development of underground roadway connections between the Angus Place Colliery underground mine workings and the Springvale Mine underground mine workings.
Mine Support Infrastructure	Surface disturbance	≠ Existing infrastructure at the Angus Place Colliery pit top ≠ Existing infrastructure on the Newnes Plateau ≠ Additional infrastructure on the Newnes Plateau for mine water management and ventilation	≠ Existing infrastructure at the Angus Place Colliery pit top ≠ Enlargement of the ROM coal stockpile from 90,000 t to 110,000 t capacity ≠ Existing infrastructure on the Newnes Plateau ≠ Additional infrastructure on the Newnes Plateau for mine water management and ventilation
Mine ventilation	Surface disturbance	≠ Three drifts located at the Angus Place Colliery pit top are both downcast and fresh air intake shafts. ≠ One upcast shaft with electric fan and diesel back up fan located at the Angus Place Colliery pit top. ≠ Two ventilation shafts (3.5 m and 4.5 m) approved for construction at the Angus Place Ventilation Facility (APC-VS2) on the Newnes Plateau. Ventilation fans to be installed on the upcast shaft. The 3.5 m shaft constructed. ≠ Construction and operation of one additional downcast shaft to the north mains headings in the 1000 Panel Area	≠ Continue to operate all existing mine ventilation drifts, shafts and fans. ≠ Construction of the approved but not yet constructed 4.5 m shaft at the Angus Place Ventilation Facility (APC-VS2) on the Newnes Plateau. ≠ Installation and operation of the ventilation fan at the Angus Place Ventilation Facility (APC-VS2) on the Newnes Plateau. ≠ Construction and operation of one additional downcast shaft to the north mains headings in the 1000 Panel Area
Underground Water Management	≠ Water quality/quantity ≠ Surface disturbance	≠ Transfer of up to 30 ML/day of mine water discharges from the Angus Place Colliery Licensed Discharge Point (LDP001) ≠ Construction and operation of additional dewatering facilities and associated infrastructure	≠ Continued transfer of mine water to the SDWTS via existing dewatering facilities ≠ Construction and operation of additional dewatering facilities and associated infrastructure within the 1000 panel area to facilitate the

Activity	Nature of potential impact	Initial / EIS Case	Amended Project Case
		within the 1000 panel area to facilitate the transfer of mine water into the SDWTS ≠ Operation of the Angus Place Colliery 930 Bore and associated infrastructure for raw mine water transfer from the SDWTS to the underground mining area	transfer of mine water into the SDWTS ≠ Transfer of mine water to the Angus Place pit top for subsequent transfer to the Springvale Water Treatment Project (SSD 7592) via the Angus Place Pipeline (current approved) ≠ Operation of the Angus Place Colliery 930 Bore and associated infrastructure for raw mine water transfer from the SDWTS to the underground mining area
Wastewater	Water quality/quantity	Onsite wastewater treatment system and irrigation area via LDP005	Connection to the Lithgow City Council main sewer line prior to the commencement of longwall extraction (subject to a separate development application through Lithgow City Council)
Surface Disturbance for Infrastructure	Surface disturbance	≠ Up to 23.25 ha of vegetation clearing ≠ Impacts within assessed Environmental Study Areas	≠ Up to 50.48 ha of vegetation clearing ≠ Impacts within an assessed Impact Envelope
Project Application Area	≠ Subsidence ≠ Water quality/ quantity ≠ Surface disturbance	10,460 ha	10,551 ha

3 METHODOLOGY

This section describes the desktop and field methodology undertaken for both the Initial and Amended Project.

3.1 Initial Project Desktop Assessment

Desktop investigation methods for the Initial Project involve gleaning information from a number of sources, including government databases for threatened species and endangered communities, to vegetation mapping and any associated literature regarding the Project Area and its surrounds. This data then allows for an educated assessment on the Likelihood of Occurrence (LoO) for threatened species and communities within the Project Area. RPS desktop and field works covered the entire Project Area, but also included additional land hereafter referred to as the 'Initial Study Area'.

3.1.1 Database Searches

A review of relevant information was performed to gain an understanding of the biodiversity values occurring or potentially occurring within the Project Area and may be prone to impacts by either mine-related subsidence and or installation of surface infrastructure.

Information sources reviewed for a 10 km radius of the Project Area (i.e. locality) included:

≠ Flora and Fauna records contained in the Office of Environment and Heritage (OEH) Atlas of NSW Wildlife (accessed January 2014; OEH 2019); and

≠ Flora and Fauna records contained in the Department of the Environment and Energy (DoEE) Protected Matters Search tool (accessed January 2014; DoEE 2019).

A preliminary 'likelihood of occurrence' assessment was produced from this information to provide a framework for determining investigation methods necessary for performing adequate site investigations.

3.1.2 Spatial Datasets

Desktop analysis of vegetation cover including a review of the resources listed below:

≠ The Vegetation of the Western Blue Mountains including the Capertee, Coxs, Jenolan and Gurnang Areas (DEC 2006); and

≠ Recent aerial imagery of the Project Area.

3.1.3 Literature

A review of relevant information was undertaken to provide an understanding of ecological values occurring or potentially occurring within the Project Area and locality (i.e. within 10km).

≠ Centennial Coal Springvale Fauna Monitoring fauna monitoring reports for the subsidence management plan area at Springvale Colliery (2004 - 2012);

≠ Unpublished reports to Springvale Coal Pty Limited from Mount King Ecological Surveys (MKES) (2004 - 2008) Biodiversity Monitoring Services (BMS) (2009 -2012);

≠ Fauna monitoring within the subsidence management plan area at Angus Place Colliery from 2004 to 2012. Unpublished reports to Centennial Coal by Mount King Ecological Surveys (2004-2009) and Biodiversity Monitoring Services (2010-2012); RPS (2014a). APMEP. Flora and Fauna Assessment Report;

≠ Fauna monitoring within the subsidence management plan area at Clarence Colliery from 2004 to 2012. Unpublished reports to Centennial Coal by Mount King Ecological Surveys (2008) and Biodiversity Monitoring Services (2009-2010);

≠ RPS (2010) Flora and Fauna Assessment - Proposed Longwalls 910 and 900W, Angus Place Colliery. Prepared for Centennial Angus Place Pty Limited;

≠ RPS (2012) Flora and Fauna Assessment Angus Place Colliery Ventilation Facility Project. Prepared for Centennial Angus Place Pty Limited; and

≠ Draft Temperate Highland Peat Swamps on Sandstone Monitoring and Management Plan for LWs 415 - 417, Springvale Mine, April 2013.

3.1.4 Likelihood of Occurrence

The list of threatened species, populations and ecological communities (threatened biodiversity) identified as potentially occurring within the Project Area was determined through a Likelihood of Occurrence Analysis (LoOA; **Appendix A**). A preliminary LoOA was performed prior to field surveys to guide investigation methods and efforts required to assess potential impacts arising from mine-related subsidence and installation of surface infrastructure. The LoOA was subsequently refined following the completion of field survey.

3.2 Initial Project Field Methodology

The original EIS collated flora and fauna assessments across the Initial Study Area to consider both mine-related subsidence, water quality and surface infrastructure related impacts.

3.2.1 Overview

A variety of field survey techniques were employed during the Initial Angus Place Extension Area assessment to record a representative sample of flora species and fauna guilds across the Initial Study Area. The surveys included site inspections to identify initial constraints to inform survey design, vegetation community surveys and various fauna survey methods including Elliott trapping, harp trapping, hair tube installation, bat echolocation, spotlighting, call playback, diurnal bird and herpetological surveys, opportunistic surveys and habitat assessments. Targeted searches for threatened flora and fauna species were also undertaken, with particular focus on areas hereafter referred to as Environmental Study Areas (ESAs). These ESAs represent the boundaries within which surface facilities were to be located and were therefore subject to intensive targeted flora and habitat surveys in order to inform avoidance measures.

In addition to the ecological surveys undertaken by RPS, a review of surveys undertaken for other projects within the Project Area locality have been used in consideration of adequacy of survey effort and potential for occurrence of threatened species.

3.2.2 Flora Surveys

3.2.2.1 Vegetation Mapping

Desktop analysis of regional mapping of the Project Area and its surrounds was informed by large-scale vegetation mapping projects and aerial photography, including:

≠ Aerial Photograph Interpretation (API) and consultation of topographic map (Scale1:25000) of the Project Area;

≠ review of the Vegetation of the Western Blue Mountains – including the Capertee, Coxs, Jenolan and Gurnang Areas (DEC 2006);

≠ confirmation of the community type(s) present (dominant species) via undertaking flora surveys and identification;

≠ consideration of the potential for the derived vegetation communities to constitute EECs as listed under the TSC Act (repealed and replaced by the BC Act) and/or EPBC Act; and

≠ mapping the type and general extent of the communities present into definable map units where appropriate using a combination of API and ground-truthing surveys.

Flora survey effort within the Project Area was deliberately focused on the predicted subsidence extents and ESAs. However, surveys also occurred outside of these areas. The data collected informed any revisions to DEC (2006) mapping and, where applicable, alterations to this vegetation mapping occurred using the collected floristic data and API. The final vegetation map produced utilises the original DEC (2006) mapping in areas of the Project Area where no data was collected that may otherwise have informed possible mapping revisions.

The methodology first used API to construct a map template using GIS where visible changes in the vegetation and landscape were separately mapped into definable map units. Vegetation surveys were then undertaken and consisted of Rapid Data Point (RDP) and flora quadrat surveys undertaken within the Project Area. A total of 39 full floristic quadrats and 193 RDPs were undertaken within the Project Area. Additionally, further flora inspections, vegetation delineation and threatened flora searches were undertaken while conducting diurnal fauna surveys and while otherwise traversing throughout the Project Area on foot or within a vehicle.

Due to their specific conservation value, all known shrub swamps and most hanging swamps were visited within the predicted subsidence extents and ESAs. These swamps were sampled via either RDPs or quadrats. Where swamps could not be accessed, the extents of these relied on that mapped by DEC (2006).

The vegetation surveys were undertaken to define and map vegetation communities and to search for threatened flora species.

3.2.2.2 Significant Flora Survey

A list of potentially occurring significant flora species from the locality was compiled, which included threatened species and EECs listed under the BC Act and/or EPBC Act. Opportunistic and targeted flora surveys were undertaken during all vegetation field work.

Two ecologists undertook targeted flora searches across the ESAs within the Project Area, including existing track edges in January, February, March and September 2013. Targeted flora surveys were also undertaken during all vegetation survey work. Opportunistic records were also made during all fauna survey work.

The locations of any threatened flora species recorded within the ESAs were recorded using Trimble differential GPS units with sub-metre accuracy. In some cases, threatened flora within the wider Project Area were recorded using a Garmin GPS unit. The Initial Study Area, and the ESA boundaries are overlayed with the initial vegetation survey effort below in **Figure 2**.

Legend

- Initial Study Area
- Initial Project Angle of Draw

Environmental Study Area

- Access Track
- Dewatering Bore
- Vent Facility
- National Park
- GPS Coverage within PAA
- Roads and Tracks
- RDP Cummulative 2012
- Flora Quadrats Cummulative 2012

Wollemi

Gardens of Stone

BAAL BONE TRAIL

THE BICENTENNIAL NATIONAL TRAIL

NO 6 FIRETRAIL

NO 7 FIRETRAIL

NO 6 FIRETRAIL

BIRDS ROCK TRAIL NO 1

BIRDS ROCK TRAIL NO 2

NO 5 FIRETRAIL

BIRDS ROCK TRAIL

SUNNYSIDE RIDGE ROAD

NO 4 FIRETRAIL

FIRE TRAIL NO 3

FIRE TRAIL NO 4

FIRE TRAIL NO 2

WOLGAN ROAD

ANGUS PLACE TRAIL

GROVES ROAD

NOON STREET

VIEW STREET

CREAGH HIGHWAY

MADDOX LANE

IAN HOLT DRIVE

KANGAROOS CREEK ROAD

BEECROFT FIRETRAIL

BLACKFELLOWS HAND TRAIL

CAMPBELLS ROAD

GANG GANG ROAD

NORTH RIDGE ROAD

WESTERN BOUNDARY TRAIL

CAMP ROAD

RED HILL ROAD

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500 250 0 500 1,000 1,500 2,000 2,500 3,000 m

SCALE: 1:45,779 AT A3 SIZE

TITLE : FIGURE 2: INITIAL STUDY AREA AND ESA BOUNDARIES OVERLAYED WITH VEGETATION SURVEY EFFORT

LOCATION : ANGUS PLACE

DATUM: GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : **1/11/2019**

PURPOSE: **EIS**

VERSION (PLAN BY): A A3 (Zach.Cotter)

PATH: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\144414 Figure 2 Initial Study Area and ESA boundaries overlayed with vegetation survey effort 20191031.mxd

CLIENT: **CENTENNIAL COAL**

JOB REF: **PR144414**

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3.2.3 Habitat Surveys

An assessment of the relative value of the habitat present within the Initial Study Area was conducted during all survey events. Significant fauna habitat including hollow-bearing trees, hollow logs, termite mounds, *Allocasuarina* stands and wombat burrows were recorded. This was undertaken to assist with the development of actions to minimise impacts of the proposal on resident fauna, particularly within the ESAs. Given the flexibility in the final location of ESAs within the Project Area, hollow-bearing tree quadrats were conducted across the Springvale and Angus Place lease areas to determine an overall estimation of hollow bearing tree densities within the ESAs. A total of ten hollow-bearing tree quadrats were conducted, with each quadrat totalling one hectare and occurring within the forested ridgeline habitats to represent the likely final location for ESAs within the Project Area.

Habitat assessment for threatened species, which are known or have potential to occur, was based on the specific habitat requirements of each threatened fauna species with regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements. Consideration was given to contributing factors including topography, soil, light and hydrology for threatened flora and assemblages.

3.2.4 Fauna Surveys

The presence of fauna within the Initial Study Area was determined through a variety of survey techniques including Elliot trapping, hair tube installation, cage trapping, spotlighting, call playback, harp trapping, Anabat recordings, avifauna surveys, herpetofauna surveys and opportunistic sightings.

Much of the habitats within the Initial Study Area are difficult to access, with tracks predominately occurring along the ridge lines. The location and effort of each initial survey methodology (as shown in **Figure 3**) was determined based on achieving a suitable spread across the Initial Study Area and included fauna surveys within or close to the ESA. Given that targeted fauna species are highly mobile and contiguous habitat exists across the Newnes Plateau, the likelihood of occurrence of targeted species within potential habitat is considered to be consistent across the entire Initial Study Area, including areas within and surrounding the ESA.

Additional fauna surveys have been undertaken by Mount King Ecological Surveys (MKES; 2004-2008) and Biodiversity Monitoring Services (BMS; 2009-2012) as part of annual monitoring surveys for the Angus Place lease area. The level of survey effort that has been undertaken has been considered in relation to survey requirements within relevant survey guidelines and the target species. Survey methods implemented are outlined in the subsections below.

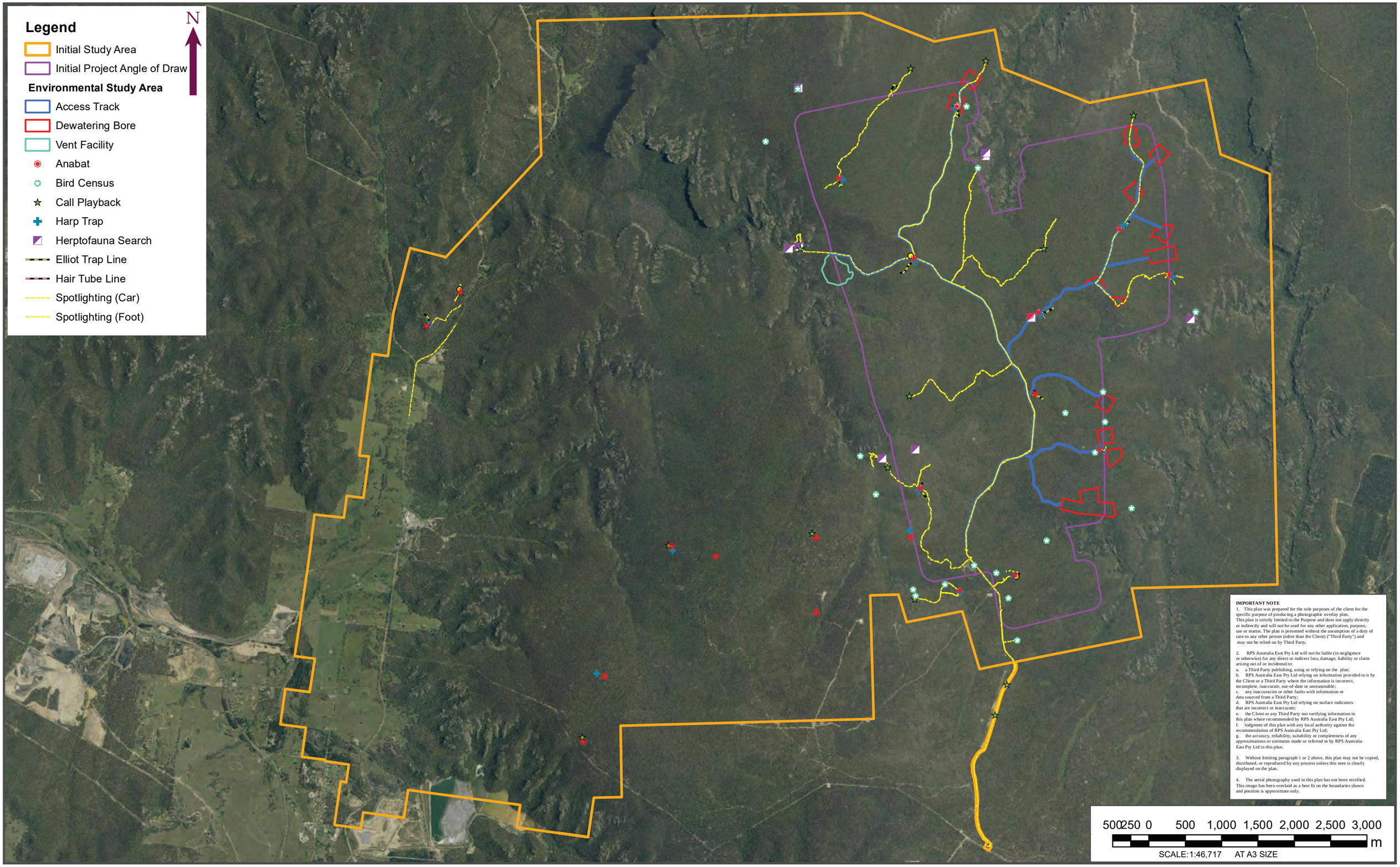
3.2.4.1 Terrestrial Mammal Trapping

Terrestrial mammal trapping was undertaken using Elliott A, Elliott B and cage traps. Elliott traps were baited with a mixture of rolled oats, peanut butter and honey, while cage traps were baited with chicken necks. A total of eleven trapping transects were undertaken containing 25 Elliott A, 25 Elliott B and six cage traps per line. This resulted in 1,100 Elliott A trap nights, 1,100 Elliott B trap nights and 264 cage trap nights.

3.2.4.2 Arboreal Mammal Trapping

3.2.4.2.1 Elliot Trapping

Arboreal trapping was undertaken using tree mounted Elliott B size traps. Traps were mounted on brackets set at approximately 2 m in height on trees with a diameter at breast height of greater than 30 cm. Traps were baited with a rolled oats, peanut butter and honey mixture and the tree trunks were sprayed liberally with a brown sugar and water mix each day in the late afternoon. A total of 11 trapping transects, containing six Elliott B size arboreal traps were installed, resulting in 264 arboreal trap nights.



TITLE : FIGURE 3: INITIAL STUDY AREA AND ESA BOUNDARIES OVERLAYED WITH FAUNA SURVEY EFFORT

LOCATION : ANGUS PLACE

DATUM: GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : **1/11/2019**

PURPOSE: **EIS**

VERSION (PLAN BY): A A3 (Zach.Cotter)

PATH: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\144414 Figure 3 Initial Study Area and ESA boundaries overlayed with fauna survey effort 20191031.mxd

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3.2.4.2.2 Hair Tubes

Hair Tubes were baited with rolled oats, peanut butter and honey. Trees in which arboreal Hair Tubes were erected were sprayed each day with a brown sugar and water mix. At each site 10 arboreal and 10 terrestrial Hair Tubes were set. A total of twelve trapping transects were undertaken, resulting in 480 arboreal trap nights and 480 terrestrial trap nights.

Hair Tubes targeted small-medium mammals such as dasyurids (e.g. Antechinus and Dunnarts), rodents (e.g. rats and mice), gliders and bandicoots. Any hair samples retrieved during the survey were sent to Barbara Triggs at 'Dead Finish' for analysis.

3.2.4.3 Avifauna Survey

The presence of avifauna within the Initial Study Area was undertaken via systematic diurnal censuses, nocturnal surveys, and by opportunistic observations during field surveys. Diurnal censuses entailed the identification of all birds occurring at one location during a 20-minute period. In total, 37 systematic bird censuses were undertaken. The potential for threatened avifauna to use the Initial Study Area was also assessed by identification of habitat attributes and their capacity to support threatened species that are known to occur in the wider locality. Nocturnal surveys were undertaken to detect nocturnal bird species within the Initial Study Area.

3.2.4.4 Herpetofauna Survey

Opportunistic and targeted herpetofauna searches were conducted during fauna surveys encompassing a diversity of habitats across the Initial Study Area. Known occurrences of threatened herpetofauna species from the region were taken into account during assessment of onsite habitat, to determine the potential for the Initial Study Area to support such species. Eight locations, where specific habitat was observed were searched and their location recorded. Amphibian surveys were conducted during Spring and Summer when climatic conditions are the most favourable for activity.

3.2.4.5 Bat Echolocation Call Recording

Microbat echolocation calls were recorded using Anabat II Detector and CF ZCAIM units set to remotely record for the entire night (6pm to 6am). Anabats were placed at 21 separate sites within the Initial Study Area with each survey location sampled for four consecutive nights. The location of each Anabat site was selected based on the likelihood that it will provide potential foraging sites and flyways for microbats.

Bat call analysis was undertaken by Dr Anna McConville who is experienced in the analysis of bat echolocation calls. Each call sequence ('pass') was assigned to one of three categories, according to the confidence with

which an identification could be made, being:

≠ Definite - Pass identified to species level and could not be confused with another species;

≠ Probable - Pass identified to species level and there is a low chance of confusion with another species; or

≠ Possible - Pass identified to species level, but short duration or poor quality of the pass increases the chance of confusion with another species.

3.3 Amended Project Desktop Methodology

Assessments in 2018 and 2019 for the Angus Place Extension Project have primarily focused on areas of greatest risk to longwall mining within the Project Area, being Groundwater Dependant Ecosystems (GDEs), specifically, THPSS. Particular focus was given to utilising the BAM (State of NSW 2017) to inform the survey effort requirements.

Given the Impact Envelope is only indicative at this stage, further targeted surveys to determine the potential for impact during the installation and operation of surface infrastructure are proposed to be completed prior to the commencement of construction for surface infrastructure.

3.3.1 Database Searches

A review of relevant information was performed to gain an understanding of the biodiversity values occurring or potentially occurring within the Project Area and may be prone to impacts by either mine-related subsidence and or installation of surface infrastructure.

Information sources reviewed for a 10 km radius of the Project Area included:

≠ BAM Calculator candidate species output (accessed July 2019);

≠ Flora and Fauna records contained in the Office of Environment and Heritage (OEH; now known as Biodiversity Conservation Division; BCD) Atlas of NSW Wildlife (accessed August 2019; BCD 2019a); and

≠ Flora and Fauna records contained in the Department of the Environment and Energy (DoEE) Protected Matters Search tool (accessed August 2019; DoEE 2019a).

A preliminary LoOA was produced from this information to provide a framework for determining investigation methods necessary for performing adequate site investigations.

3.3.2 Spatial Datasets

Desktop analysis of vegetation cover including a review of the resources listed below:

≠ The Vegetation of the Western Blue Mountains including the Capertee, Coxs, Jenolan and Gurnang Areas (DEC 2006);

≠ Mitchell Landscapes (NPWS 2003);

≠ IBRA Region and subregion mapping (IBRA7); and

≠ Recent aerial imagery of the Project Area.

3.3.3 Literature

A review of relevant information was undertaken to provide an understanding of ecological values occurring or potentially occurring within the Project Area and locality.

≠ Centennial Coal (2014). Angus Place Mine Extension Project. Environmental Impact Statement

≠ RPS (2014). Angus Place Mine Extension Project. Flora and Fauna Assessment Report;

≠ Threatened biodiversity survey and assessment: guidelines for development and activities - Working Draft (DECC 2004);

≠ Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (DECC 2009);

≠ NSW Biodiversity Assessment Methodology (State of NSW 2017), including the consideration of an operational method to assess impacts of land clearing on terrestrial biodiversity (BioMetric) (Gibbons et al. 2009);

≠ Survey guidelines for Australia's threatened mammals (DEWHA 2011a);

≠ Survey guidelines for Australia's threatened birds (DEWHA 2010a);

≠ Survey guidelines for Australia's threatened bats (DEWHA 2010b);

- Survey guidelines for Australia's threatened reptiles (DEWHA 2011b);
- Survey guidelines for Australia's threatened frogs (DEWHA 2010c);
- Simpson K. and Day N. (2010). Field Guide to the Birds of Australia. Penguin Group, Australia;
- Strahan R. (ed). (1995). The Mammals of Australia. Australian Museum/Reed Books, Chatswood;
- Tyler M. and Knight F. (2011). Field Guide to the Frogs of Australia. Revised Ed. CSIRO Publishing, Australia; and
- Wilson S. and Swan G. (2010). A Complete Guide to Reptiles of Australia. CSIRO Publishing, Australia.

A review of commercially available aerial imagery, regional mapping and literature was also undertaken to identify areas of biodiversity value in the Project Area. Information sources included:

- Aerial Photograph Interpretation (API) and literature reviews to determine the broad categorisation of vegetation within the Project Area; and
- Review of the Vegetation of the Western Blue Mountains – including the Capertee, Coxs, Jenolan and Gurnang Areas (DEC 2006).

3.3.4 Likelihood of Occurrence

The list of threatened species and ecological communities (threatened biodiversity) identified by database searches (i.e. **Section 3.3.1**) were subject to a likelihood of occurrence analysis using the key landscape and habitat parameters. Five 'likelihood of occurrence' categories have been attributed to identified threatened biodiversity; a process that had regard for:

- habitat descriptions as provided in the Threatened Species Profile Descriptions (BCD 2019b);
- the recency of threatened species observations (i.e. recent being less than five years) and proximity to the Project Area;
- landscape factors such as patch size and connectivity;
- habitat value and condition as determined through the site inspection;
- the results of targeted surveys (where performed); and
- the effect of existing key threatening process (KTPs).

The analysis starts with a preliminary desktop evaluation produced prior to field investigations for the purposes of guiding the evaluation of habitat values within the Project Area during the investigations. The preliminary analysis was revised and updated following the evaluation of findings from the field investigations, thereby focusing the assessment on species and ecological communities relevant to the Amended Project

The five LoO ratings are described in **Table 2**.

Table: 2 Likelihood of occurrence criteria

Likelihood Rating	Description
None	Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2 km (IUCN 2017)]. Species incidence is not expected and, if detected, would

Likelihood Rating	Description
	likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes.
Low	Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2 km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs.
Moderate	Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2 km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy.
High	Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2 km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy.
Known	Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2 km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs).

3.3.5 BAM Calculation Methods

As aforementioned, the Project may have a greater than negligible environmental consequence on THPSS, and possibly to the THPSS-associated threatened species as listed in **Section 3.2.1**. Consequently; offset calculations were performed in accordance with BAM. The Major Projects site assessment module of the BAM Calculator was used to calculate ecosystem and species credits for each scenario. Vegetation zone parameters were determined according to THPSS type and condition, as well as the associated longwall that may impact them. Potential impact was considered in an iterative manner, with consideration of the development plan for the longwalls. The impact scenario was assessed as Maximum Offset by assuming total loss of THPSS within the Project Area. Calculations within the BAM Calculator were undertaken using the default benchmark values (BCD 2019).

3.3.5.1 Ecosystem Credits

IBRA bioregion/subregion, Mitchell Landscape, proximity to waterways and wetlands and connectivity of habitat were determined in accordance with BAM.

The following spatial datasets were interrogated to evaluate landscape condition for each THPSS:

≠ Mitchell Landscapes (NPWS 2003);

≠ Interim Biogeographic Regionalisation of Australia (IBRA) Region and subregion mapping (IBRA7); and

≠ Vegetation of the Western Blue Mountains – including the Capertee, Coxs, Jenolan and Gurnang Areas (DEC 2006).

The Native vegetation cover was assessed on the subject land within a 1,500 m buffer area surrounding the outside edge of the boundary of the subject site using GIS.

3.3.5.1.1 Plant Community Type

The THPSS have been identified by the rule of 'best fit' as being commensurate with PCT 657 - *Baeckea linifolia - Grevillea acanthifolia* subsp. *acanthifolia* shrub/sedge swamp on sandstone, Sydney Basin Bioregion. This vegetation was associated with the Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion EEC. As such, PCT 657 was used to calculate Ecosystem Credit liability for the Amended Project and the EEC status was aligned in the calculator.

3.3.5.1.2 Vegetation Zones and BAM Plot Allocation

The outline for each THPSS located in the potential zone of influence for the Amended Project was mapped from high resolution (7 cm pixel size) colour imagery (RGB) which was captured in October 2018. Aerial photography was firstly interrogated to identify potential THPSS across the Project Area. This mapping was ground-truthed through fieldwork, which involved visiting potential areas of THPSS and undertaking RDPs noting the floristic composition and landscape position to determine if the habitat was consistent with THPSS (i.e. PCT 657). The THPSS mapping within the Project Area was refined by removing areas that were not commensurate with THPSS following fieldwork. THPSS mapping was further refined to exclude areas that were not commensurate with THPSS using PRIMER^{TM} analysis of the floristic composition of the BAM plots.

Following confirmation of the THPSS boundaries and types, vegetation zones were assigned across the Project Area. THPSS were awarded a condition status (i.e. high or low) based on interpretation of aerial photography and observations made during past RPS surveys, which are carried out routinely for Angus Place Mine as part of several ongoing monitoring programs. THPSS were also classified as Shrub Swamps or Hanging Swamps, based on their landscape position and floristic characteristics.

BAM plots were stratified by vegetation condition and THPSS type, which are collectively referred to here as vegetation zones. The field methodology for these BAM plots is provided in **Section 3.4.2** and those conducted to date are shown in **Figure 4**. Vegetation communities assessed within the Amended Project Area to date are displayed in **Figure 5**.

3.3.5.2 Species Credits

The entire area encompassed by the THPSS swamp boundary (as delineated and ground-truthed, as discussed in **Section 3.3.5.1.2**) was considered suitable habitat for Deane's Boronia (*B. deanei*), Giant Dragonfly (*P. gigantea*), Blue Mountains Water Skink (*E. leuraensis*); and Red-crowned Toadlet (*P. australis*). The condition of this habitat was then determined.

Note: the BAM plots throughout the Project Area failed to detect *B. deanei*. To better search for *B. deanei* and delineate species polygons for this species (if present), RPS could analyse aerial photography for *B. deanei* throughout the Project Area and verify the results through ground surveys in Spring 2019.

3.3.5.3 Calculating Offset Liability

Following confirmation that the surface disturbance activities can be undertaken within the Impact Envelope, detailed design of infrastructure will be undertaken to minimise impacts as far as practicable largely by relying on existing disturbance areas and access tracks as far as possible. Post clearance surveys will then be carried out to:

- Confirm surface disturbance activities remained within the approved impact envelope. This is likely to involve collecting high resolution (7 cm) imagery of the Impact Envelope prior to and after any disturbance activities being commenced; and
- Calculate the actual offset liability requirements.

Actual offset liabilities will be offset in accordance with the BC Act within 12 months of impacts being realised. Further detail regarding the calculation of the biodiversity offset liability are provided in **Section 6**.

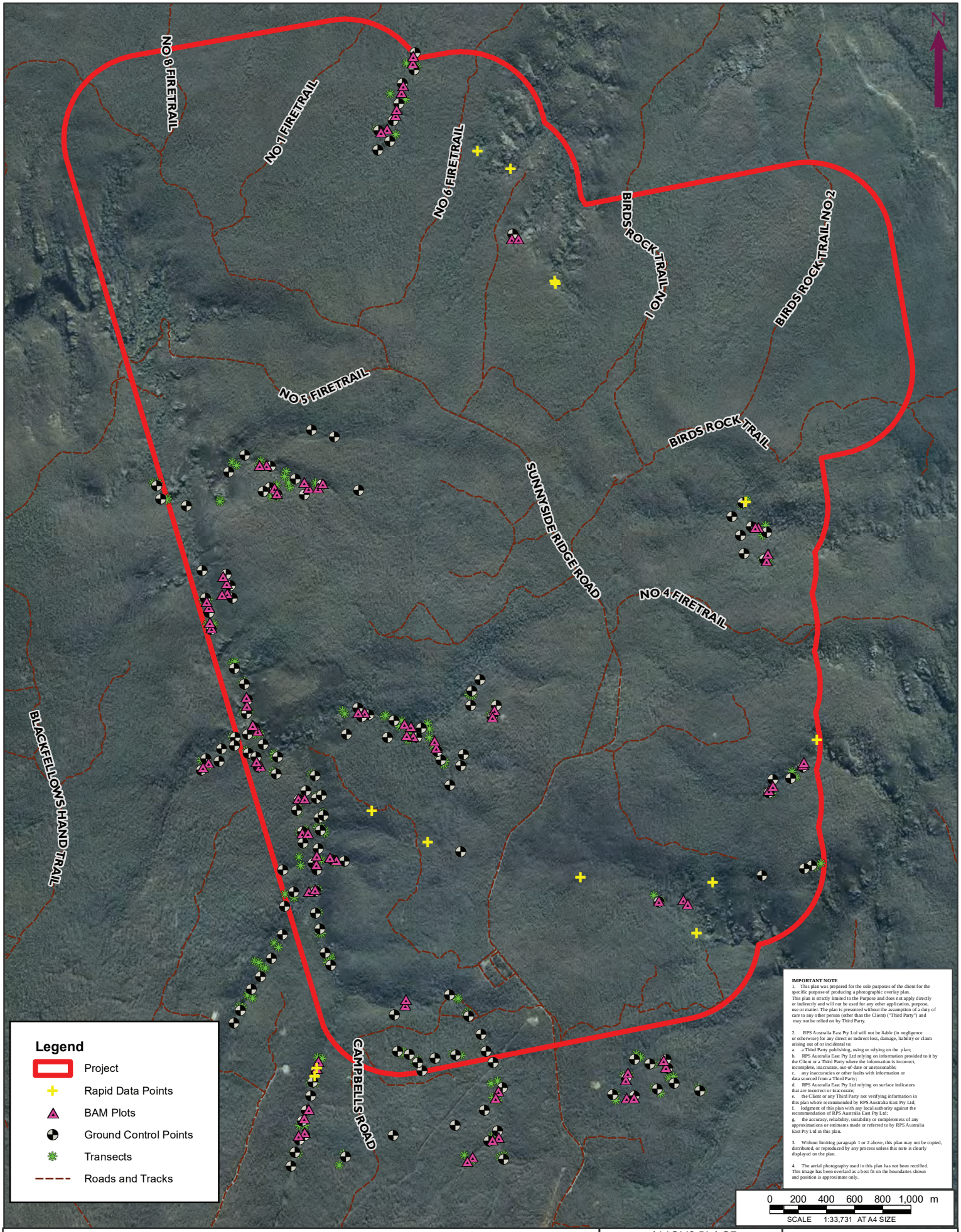

FIGURE 4: AMENDED PROJECT AREA WITH VEGETATION SURVEY EFFORT

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: PR 144414-7

PURPOSE: BMP

Technician: Zach.Cotter Date: 1/11/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\144414 Figure 4 Amended Project Area with vegetation survey effort.mxd

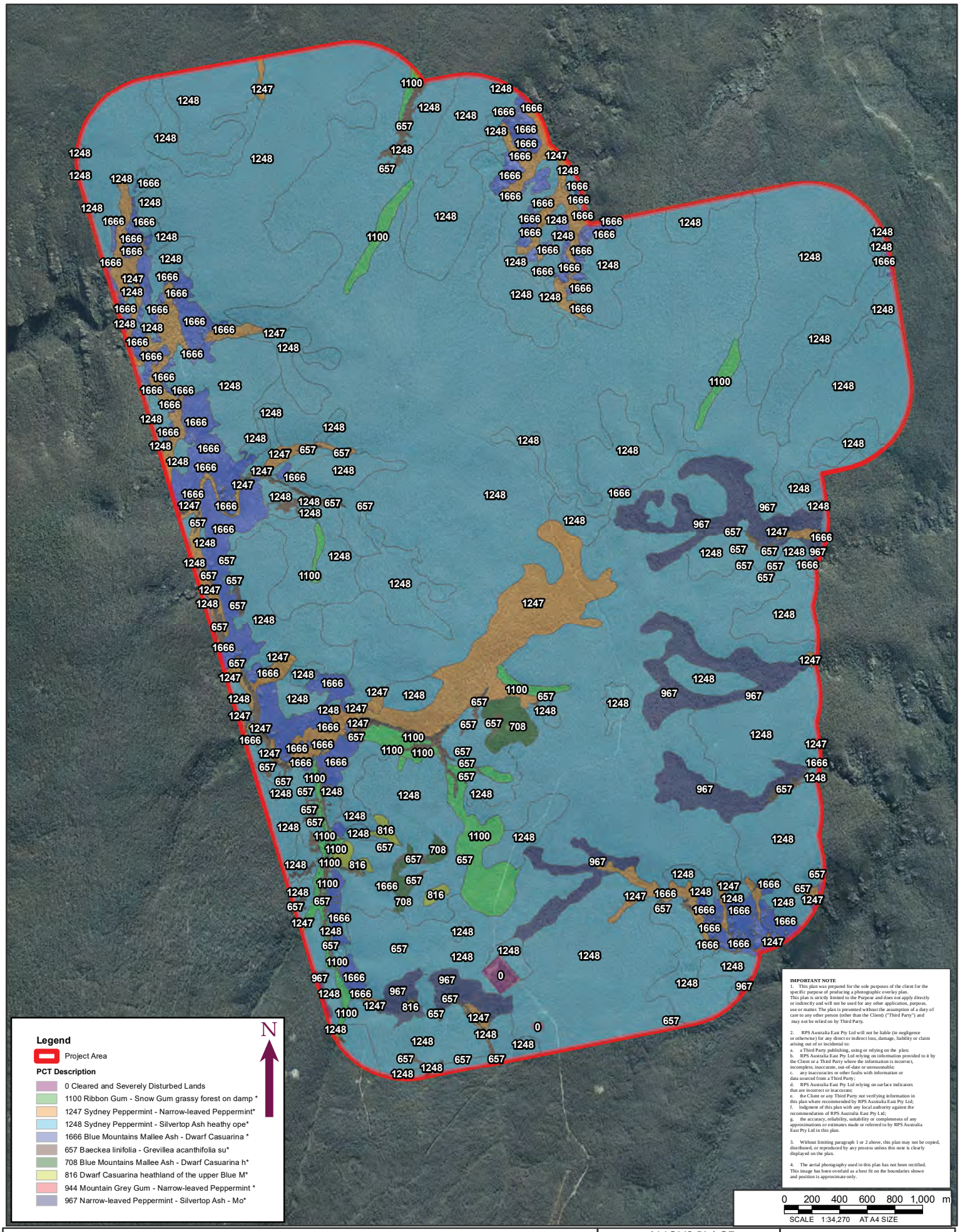

FIGURE 5: AMENDED PROJECT AREA VEGETATION MAPPING

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: **PR 144414-7**

PURPOSE: BMP

Technician: Zach.Cotter Date: 1/11/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\New figure numbering\144414 Figure 5 Amended Project Area vegetation mapping and threatened flora 20191031.mxd

3.3.6 Assessment of surface infrastructure related impacts

As the location of surface infrastructure required to support the Amended Project is dependent on the approved mine plan, and due to the potential changes to the mine plan throughout the life of the Amended Project, flexibility as to where surface infrastructure is approved to be located is required. The infrastructure required to support the Amended Project includes:

- dewatering bore facilities;
- access track upgrades;
- establishment of new access tracks;
- easement corridors for power;
- water connection pipelines;
- booster stations;
- downcast ventilation shaft facility (APC-VS3); and
- service boreholes.

To provide flexibility for the location of infrastructure throughout the life of the project, the Amended Project will seek approval to undertake all surface disturbance activities required to establish infrastructure within an Impact Envelope. The Impact Envelope for surface disturbance activities includes an assumed level of impact on certain PCTs and associated threatened species. The Impact Envelope proposed for the project has been determined using data collated from Rapid Data Points and flora quadrats undertaken by RPS in 2013 as part of the 2014 EIS.

Biodiversity surveys, in accordance with the BAM, are proposed to be undertaken prior to undertaking surface disturbance activities to ensure all surface disturbance is undertaken within the Impact Envelope. Floristic plots and threatened species surveys in accordance with BAM will be undertaken across the approximate 49.99 ha Impact Envelope, proposed for installation of surface infrastructure. Current and accurate data gained through this survey effort will also guide final design of surface infrastructure, to avoid and minimise impacts to threatened entities and higher condition bushland where possible. A summary of the proposed surveys is provided in **Section 3.4**. The approach to be used to calculate the actual impact arising from the installation of surface infrastructure is detailed in **Section 5**.

3.4 Amended Project Field Methodology

The current field methodologies for the Amended Project have focused on areas at risk of subsidence related impacts, primarily, THPSS and associated threatened species through monitoring programs which are detailed in the SMP (see **Section 9.1** for a summary and **Appendix B** for the draft SMP) and BMP (see **Section 9.2** for a summary and **Appendix C** for the draft BMP). There is an additional consideration for potential impacts to species associated with rocks, pagodas and cave habitats which will also require assessment of potential impacts and ongoing monitoring to identify any potential mining related impacts. As aforementioned, the proposed field methodologies which relate to the Impact Envelope will include targeted surveys in line with the BAM following finalisation of the detailed design for the surface infrastructure.

3.4.1 Rapid Data Points

Data collected from RDPs was used to assist vegetation classification and in determining the floristic inventory (**Figure 3**). Data collected at each RDP include:

- Dominant canopy species;
- Main associated species;

≠ Landscape position;

≠ Characteristic mid-storey species;

≠ Characteristic groundcover species; and

≠ Other diagnostic features.

3.4.2 BAM Methodology

The BAM methodology was applied to swamps within the Project Area using 20 x 50 m BioMetric plots (see **Figure 6**), as shown in **Figure 4**. This method involved estimating the vegetation composition, structure and function to determine the vegetation integrity score in accordance with the State of NSW (2017). Each plot included:

≠ One standard 20 x 20 m (400 m^2) plot, to assess the composition and structural attributes, including trees, shrubs, grasses, forbs, ferns and other growth forms;

≠ One standard 20 x 50 m (1000 m^2) plot, to assess functional attributes including: number of large trees with a diameter at breast height (DBH) > 50 cm, number of trees in stem size classes (i.e. <5, 5–9, 10–19, 20–29, 30–49, 50–79, and 80+ cm), tree regeneration, total length of fallen logs, high threat exotic vegetation cover and hollow-bearing trees (HBT); and

≠ Five 1 x 1 m (1 m^2) sub-plots to assess average litter cover for the plots.

The relevant attributes measured are summarised in **Table 3**.

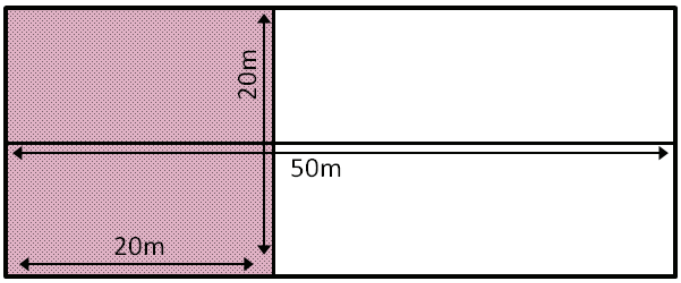

Figure 6 Biometric plot dimensions

Table 3: BAM growth forms and functional attributes

Growth form groups used to assess composition and structure (20 x 20 m plot)	Attributes used to assess function (20 x 50 m plot)[1]
a) Tree	a) Number of large trees
b) Shrub	b) Tree regeneration
c) Grass and grass like	c) Tree stem size class
d) Forb	d) Total length of fallen logs
e) Fern	e) Litter cover (Five 1 m^2 sub-plots)
f) Other	f) High threat exotic vegetation cover
	g) Hollow bearing trees

[1] Note: PCT 657 is a swamp community, with many functional attributes irrelevant for credit calculation. As such, these fields do not need to be entered within the BAM calculator to determine the Vegetation Integrity Score.

3.4.2.1.1 Sampling Effort

Data from 75 BAM plots was collected from the THPSS located within the Project Area, of which 33 were utilised to populate the credit calculator (refer to **Figure 4**). Additional BAM plots and Rapid Data Points (RDPs) were undertaken in areas identified as potential THPSS using aerial photography, however these were excluded from analysis as the floristics and/or landscape position was not commensurate with this PCT. Sampling was performed between July 2018 and March 2019.

3.4.2.1.2 BAM Calculations

The maximum offset liability was calculated individually for each vegetation zone by assigning no management zone, thereby assuming a total loss of THPSS. Results of these calculations are provided in **Section 4**.

3.4.3 Swamp Monitoring Program surveys

The APMEP Swamp Monitoring Program (SMP) provides information on the proposed approach to monitoring the swamps which have potential to be impacted by the secondary extraction of coal from longwalls as part of the Amended Project (SSD_5602). The SMP has been prepared with reference to 'Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps' (Brownstein et al. 2014).

To ensure that the requirement of two years of baseline data, the seasonal Ground Control Point (GCP) component of the 'Brownstein et al (2014) based SMP was implemented in Autumn 2019. This program is detailed within the APMEP SMP (see **Section 9.1** for a summary and **Appendix B** for the draft) and the annual component is being conducted in Spring 2019.

3.4.4 Blue Mountains Water Skink surveys

Surveys were performed in March 2019 to determine the presence/absence of Blue Mountains Water Skinks (BMWS) within the Project Area. Swamp vegetation comprising potential BMWS habitat was mapped using high resolution imagery (7 cm pixel resolution) and subsequently reviewed to identify high value habitat as described for this species in RPS (2019b). Sample sites were identified from this mapping for field investigation as shown in **Figure 7**. Each sample site comprised a linear funnel trap array comprising five traps with inter-trap distances of five metres, this being generally consistent with the method described in SEWPaC (2011). Small water containers were placed in each trap to provide a refuge for caught BMWS, thereby preventing ant attack. Trapping occurred over five consecutive days in suitable conditions (e.g. ambient daytime temperatures exceeding 20 degrees Celsius with minimal incidence of wind and rainfall). Traps were checked daily with caught animals measured and weighed. A GPS location was recorded for each BMWS caught during the sampling program. Incidental observations were also recorded.

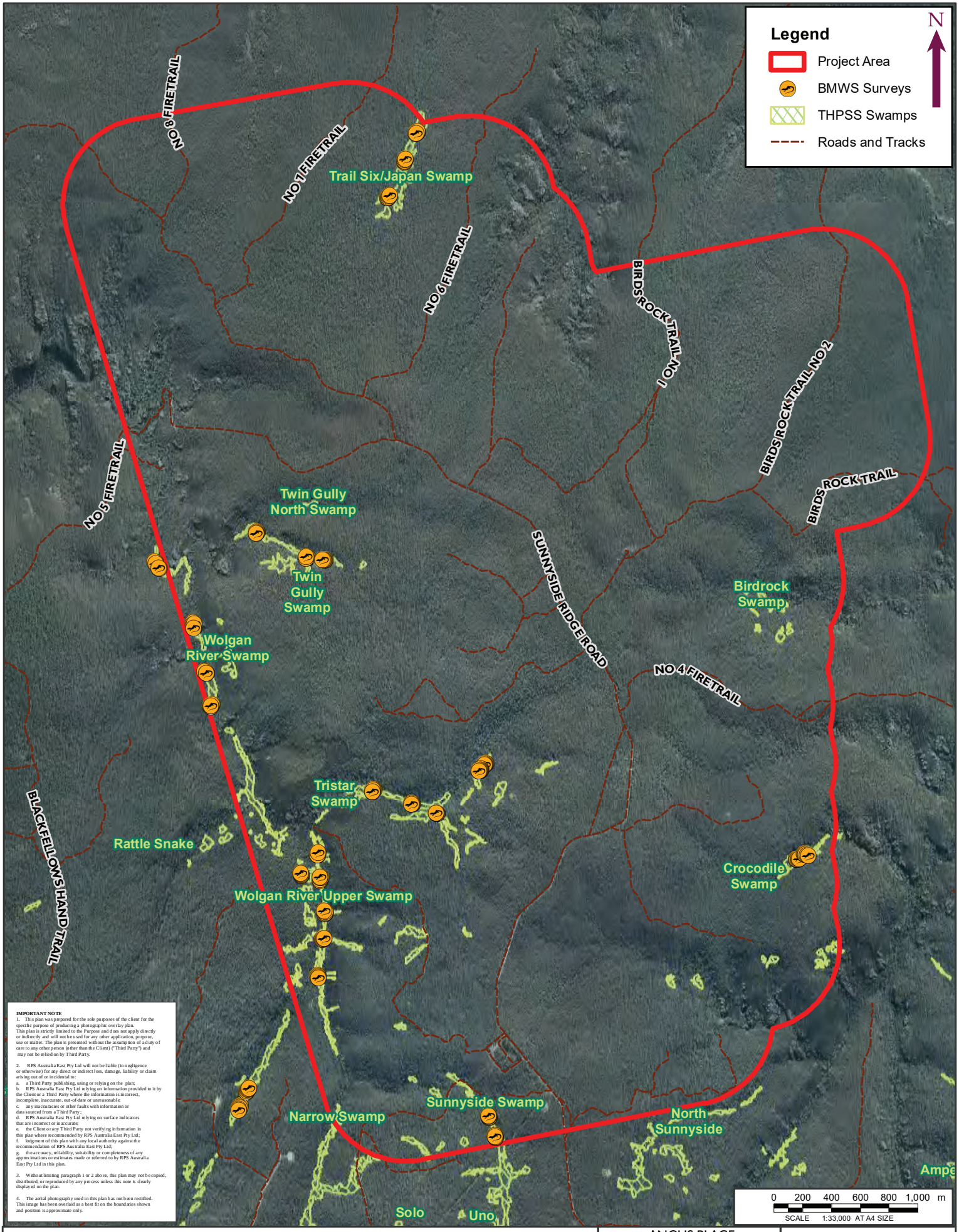

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FIGURE 7: AMENDED PROJECT AREA BMWS SURVEY EFFORT

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: PR 144414-7

PURPOSE: BMP

Technician: Natalie.Wood Date: 5/12/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
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T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\144414 Figure 7 Amended Project Area BMWS survey effort 20191205.mxd

4 RESULTS

4.1 Initial Project Surface Infrastructure

4.1.1 Endangered Ecological Communities

The Angus Place Extension Flora and Fauna Assessment by RPS (2014) identified 32 vegetation communities, as classified within the Western Blue Mountains Vegetation Survey and Mapping Project (DEC 2006) (**Figure 8**). Five of these vegetation communities are listed as EEC under the BC and or EPBC Act. However, within the areas where subsidence was predicted, the following EECs were recorded:

≠ Newnes Plateau Shrub Swamp (NPSS; listed under the BC Act);

≠ Temperate Highland Peat Swamp on Sandstone (THPSS; listed under the EPBC Act); and

≠ Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland (listed under the BC Act).

4.1.2 Threatened Flora

Four threatened flora species were recorded (see **Figure 9**), which were

≠ *Eucalyptus aggregata* (Black Gum);

≠ *Eucalyptus cannonii* (Capertee Stringybark);

≠ *Persoonia hindii*, and

≠ *Veronica blakelyi*.

Moreover, a desktop-based analysis identified the following threatened flora species as potentially occurring within the Initial Study Area:

≠ *Acacia bynoeana* (Bynoe's Wattle);

≠ *Boronia deanei* (Deane's Boronia);

≠ *Caesia parviflora* var. *minor* (Small Pale Grass-lily);

≠ *Eucalyptus pulverulenta* (Silver-leaved Gum);

≠ *Genoplesium superbum*;

≠ *Lastreopsis hispida* (Bristly Shield Fern);

≠ *Persoonia acerosa* (Needle Geebung);

≠ *Prasophyllum fuscum* (Tawny Leek Orchid);

≠ *Prostanthera cryptandroides* subsp. *cryptandroides* (Wollemi Mintbush);

≠ *Thesium australe* (Austral Toadflax).

Each of the above flora species have potential habitat within the predicted subsidence extents, except for *E. aggregata* (Black Gum) and *T. australe*. These latter species were regarded as having potential habitat along the water courses, which may be influenced by mine water discharge.

Legend

Initial Project Angle of Draw

Initial Study Area

110328 AP Master Vegetation Map 20140207_region

<all other values>

Description

- 07 Newnes Plateau Narrow - Leaved Peppermint - Mountain Gum - Brown Stringybark Layered Forest
- 08 Newnes Sheltered Peppermint - Brown Barrel Shrubby Forest
- 11 Tableland Gully Snow Gum - Ribbon Gum Montane Grassy Forest
- 14 Tableland Mountain Gum - Snow Gum - Daviesia Montane Open Forest
- 15 Tableland Hollows Black Gum - Black Sally Open Forest
- 19 Capertee Box - Narrow-leaf Ironbark - Callitris Grassy Woodland
- 20 Capertee Rough-barked Apple - Redgum - Yellow Box Grassy Woodlands
- 21 Capertee - Wolgan Slopes Red Box - Grey Gum - Stringybark Grassy Open Forest
- 26 Newnes Plateau Narrow-leaved Peppermint - Silver-top Ash Layered Open Forest
- 26a Newnes Plateau Gum Hollows varient: Brittle Gum - Mountain Gum, Scribbly Gum - Snow Gum Shrubby Open Forest
- 28 Sandstone Plateau and Ridge Scribbly Gum - Silvertop Ash Shrubby Woodland
- 29 Sandstone Slopes Sydney Peppermint Shrubby Forest
- 30 Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland
- 32 Tableland Hills Scribbly Gum - Narrow-leaved Stringybark Shrubby Open Forest
- 33 Tableland Broad-leaved Peppermint - Brittle Gum - Red Stringybark Grassy Open Forest
- 35 Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest
- 37 Coxs Permian Red Stringybark - Brittle Gum Woodland
- 43 Pagoda Rock Sparse Shrubland
- 44 Sandstone Plateaux Tea Tree - Dwarf Sheoak - Banksia Rocky Heath
- 45 Newnes Plateau Tea Tree - Banksia - Mallee Heath
- 46 Newnes Plateau Dwarf Sheoak - Banksia Heath
- 49 Rock Outcrop
- 50 Newnes Plateau Shrub Swamp
- 51 Newnes Plateau Hanging Swamp
- 53 Mountain Hollow Grassy Fen
- 54 Capertee - Wolgan Riparian Rough-barked Apple - River Oak Open Forest
- 59 Non-native Vegetation - Pine plantation / woodlot / shelter
- 60 Non-native Vegetation - Other exotics
- 61 Unclassified (<1ha patch of remnant vegetation adjacent / within cleared lands)
- 62 Cleared and Severely Disturbed Areas

N

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500 250 0 500 1,000 1,500 2,000 2,500 3,000 m

SCALE: 1:46,288 AT A3 SIZE

TITLE : FIGURE 8: INITIAL STUDY AREA VEGETATION MAPPING

LOCATION : ANGUS PLACE

DATUM: GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : **1/11/2019**

PURPOSE: **EIS**

VERSION (PLAN BY): A A3 (Zach.Cotter)

PATH: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\New figure numbering\144414 Figure 8 Initial Study Area vegetation mapping20191031.mxd

CLIENT: **CENTENNIAL COAL**

JOB REF: **PR144414**

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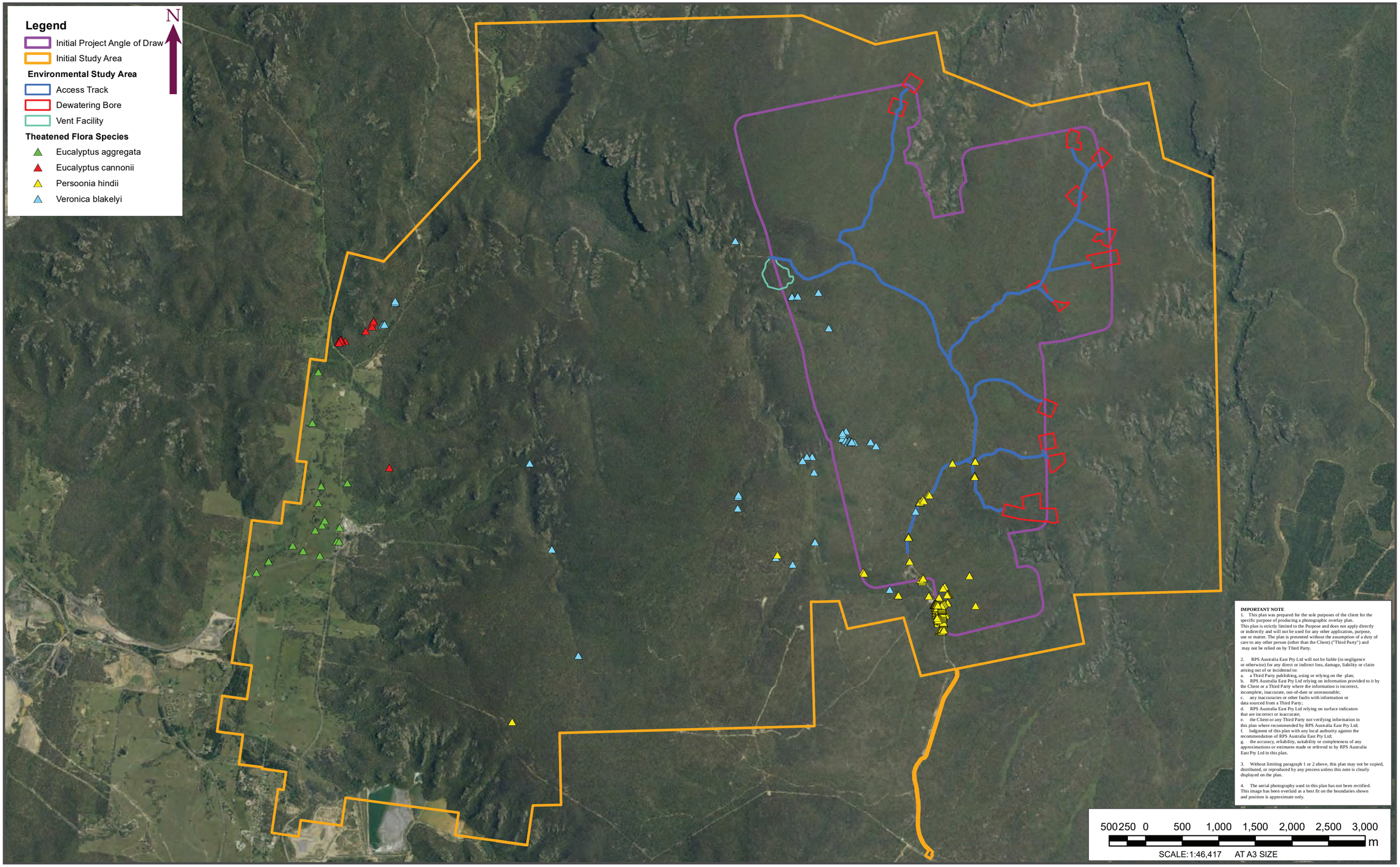

TITLE : FIGURE 9: INITIAL STUDY AREA THREATENED FLORA

LOCATION : ANGUS PLACE

DATUM: GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : **1/11/2019**

PURPOSE: **EIS**

VERSION (PLAN BY): A A3 (Zach.Cotter)

PATH: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\New figure numbering\144414 Figure 9 Initial Study Area threatened flora 20191031.mxd

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4.1.3 Threatened Fauna

Fauna habitat identified within the Initial Study Area was broadly classified as dense low shrubby swamp vegetation along the drainage lines, eucalypt forest and woodland vegetation on the slopes and ridges and dry rocky heath along cliffs. These habitats were identified as having potential to support a variety of fauna species, including threatened species.

Surveys by RPS 2014 (methods detailed in **Section 3.2**) detected 111 fauna species within the Initial Study Area, which included 23 species listed as threatened under the BC Act and/or EPBC Act (see **Figure 10**). Of these 23 species, nine were recorded within the Initial Study Area by RPS and an additional 14 have previously been recorded from fauna monitoring by BMS and/or MKES.

Threatened fauna detected were:

- *Callocephalon fimbriatum* (Gang-gang Cockatoo);
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo);
- *Cercartetus nanus* (Eastern Pygmy Possum);
- *Chalinolobus dwyeri* (Large-eared Pied Bat);
- *Chalinolobus picatus* (Little Pied Bat);
- *Chthonicola sagittata* (Speckled Warbler);
- *Climacteris picumnus victoriae* [Brown Treecreeper (eastern subsp.)];
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle);
- *Heiraaetus morphnoides* (Little Eagle);
- *Heleioporus australiacus* (Giant Burrowing Frog);
- *Melithreptus gularis gularis* (Black-chinned Honeyeater);
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat);
- *Mormopterus norfolkensis* (Eastern Freetail-bat);
- *Ninox connivens* (Barking Owl)
- *Ninox strenua* (Powerful Owl);
- *Petaurus norfolcensis* (Squirrel Glider);
- *Petroica pheonicea* (Flame Robin);
- *Petroica boodang* (Scarlet Robin);
- *Phascolarctos cinereus* (Koala);
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat); and

≠ *Tyto tenebricosa* (Sooty Owl).

Species detected adjacent the Initial Study Area during monitoring by BMS and/or MKES were:

≠ *Mixophyes balbus* (Stuttering Frog); and

≠ *Tyto novaeholladiae* (Masked Owl).

RPS (2014) identified the dense vegetation of shrub swamps and, to a lesser extent, the hanging swamps, as providing habitat for small mammals and birds, including more reserved species, which forage in the dense shrubs and undergrowth. The RPS (2014) report also noted that THPSS provides potential habitat for specialist threatened fauna species, including the Giant Dragonfly (*Petalura gigantea*) and Blue Mountains Water Skink (*Eulamprus leuraensis*). The wetter more permanent creek lines were also reported as potentially providing habitat for the. The Stuttering Frog (*Mixophyes balbus*) has been recorded within the Springvale lease area by call recognition (MKES 2004b). However, the Stuttering Frog is not known to occur at altitudes over ~610 m (Hines et al. 2004), preferred habitat of 'rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range' (BCD 2019c) is absent from the site and no observations have been recorded following the aural observation by MKES in 2004. Therefore, RPS is of the opinion that this observation may have been erroneous.

Legend

N

- Initial Project Angle of
- Initial Study

Environmental Study Area

- Access Track
- Dewatering Bore
- Vent Facility

Threatened Species

- Eastern Pygmy Possum
- Flame Robin
- Gang-Gang Cockatoo
- Gang-gang Cockatoo
- Large-eared Pied Bat
- Powerful Owl
- Scarlet Robin
- Varied Sittella

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500 250 0 500 1,000 1,500 2,000 2,500 3,000 m

SCALE: 1:46,944 AT A3 SIZE

TITLE : FIGURE 10: INITIAL STUDY AREA THREATENED FAUNA

LOCATION : ANGUS PLACE

DATUM: GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : **1/11/2019**

PURPOSE: **EIS**

VERSION (PLAN BY): A A3 (Zach.Cotter)

PATH: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\New figure numbering\144414 Figure 10 Initial Study Area threatened Fauna 20191031.mxd

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4.1.4 Impact Assessment

The assessment of impacts of the Initial Project by RPS (2014) are summarised in **Table 4**.

Table 4: Summary of impact assessment by RPS (2014)

Impact type	Predicted impacts of Initial Project
Habitat removal to accommodate surface facilities	≠ Approximately 23.24 ha of woodland vegetation was proposed to be removed for surface facilities; ≠ No areas of EEC were proposed to be cleared for the Project; and ≠ The Project was unlikely to have a significant impact on threatened species.
Subsidence related impacts	≠ Impacts to cliffs and pagoda complexes were not predicted, thus no subsequent impacts were expected to potential habitats of threatened species that may use these habitats, such as Brush-tailed Rock-wallaby, Broad-headed Snake and cave-dwelling bats; ≠ No significant impacts to the dry woodland and forest habitats were predicted as a result of subsidence. Some destabilisation of soil may have been experienced, but not to the extent it will significantly affect threatened flora and fauna; ≠ Projected changes to baseflow and maximum average standing water levels in shrub swamps were predicted to occur at varying degrees, with a decrease in baseflows and associated standing water levels within several shrub swamps with potential to occur; ≠ Most significant reductions to average standing groundwater levels were predicted in Twin Gully Swamp. This swamp has a projected drop in average standing water levels from 12.4 to 10.6 cm above the soil surface; ≠ All other monitored swamps were expected to have smaller projected decreases in average standing water levels than for Twin Gully Swamp; ≠ The Project was not expected to have a significant impact upon the hydrology of any hanging swamps; ≠ The Project was predicted to be unlikely to significantly impact upon those threatened species (e.g. *B. deanei*, Giant Dragonfly and Blue Mountains Water Skink) that rely on the swamp habitats; and ≠ Project is not expected to have a significant impact upon any shrub swamps or hanging swamps, such that their ecosystem functioning may be impaired.
Mine water discharge	≠ Potential impacts from increased mine water discharge include increases in flow and changes to water quality, particularly increases in salinity; ≠ Potential impact on geomorphology is low compared to the streambed velocity experienced in a typical large rainfall event; ≠ *E. aggregata* or the Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland EEC are unlikely to be affected by changes to salinity as a result in mine water discharge; and ≠ pH of mine water discharge was not expected to affect downstream habitats for *E. aggregata*, *T. australe* and Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland; and ≠ No impacts to water quality were anticipated to occur downstream within the Greater Blue Mountains Area (GBMA).

4.2 Amended Project Surface Infrastructure

As previously stated, field investigations have not yet commenced for areas within the Impact Envelope. All results regarding potential impact due to the installation of surface infrastructure are derived from desktop methodologies and the previous surveys conducted as part of the Initial Project. The results of the LoOA and potential offset calculations are provided in the sub-sections below.

4.2.1 Likelihood of Occurrence Analysis

The LoOA (**Appendix A**) has resulted in the identification of 66 threatened species with a moderate or higher likelihood of occurrence within the Project Area. Of these, 58 are species which are considered to be

associated with the habitats present within the Impact Envelope. The 58 species comprise 26 known to occur, 11 with a high likelihood and 21 with a moderate likelihood of occurrence as depicted in **Table 5** below.

Table 5: Threatened Species likely to occur within the Impact Envelope

Known	High Likelihood	Moderate Likelihood
Hieraaetus morphnoides (Little Eagle)	*Hoplocephalus bungaroides* (Broad-headed Snake)	*Varanus rosenbergi* (Rosenberg's Goanna)
Hirundapus caudacutus (White-throated Needletail)	*Melanodryas cucullata cucullata* (Hooded Robin *(south-eastern form))*	*Grantiella picta* (Painted Honeyeater)
Artamus cyanopterus cyanopterus (Dusky Woodswallow)	*Ninox connivens* (Barking Owl)	*Stagonopleura guttata* (Diamond Firetail)
Callocephalon fimbriatum (Gang-gang Cockatoo)	*Tyto novaehollandiae* (Masked Owl)	*Glossopsitta pusilla* (Little Lorikeet)
Calyptorhynchus lathami (Glossy Black-Cockatoo)	*Dasyurus maculatus maculatus* (Spotted-tailed Quoll)	*Neophema pulchella* (Turquoise Parrot)
Climacteris picumnus victoriae (Brown Treecreeper *(eastern subspecies))*	*Phascolarctos cinereus* (Koala)	*Petrogale penicillata* (Brush-tailed Rock-wallaby)
Anthochaera phrygia (Regent Honeyeater)	*Acacia meiantha*	*Isoodon obesulus obesulus* (Southern Brown Bandicoot (eastern))
Melithreptus gularis (Black-chinned Honeyeater (eastern subspecies))	*Pultenaea glabra*	*Petaurus australis* (Yellow-bellied Glider)
Daphoenositta chrysoptera (Varied Sittella)	*Cryptostylis hunteriana* (Leafless Tongue-orchid)	*Myotis macropus* (Southern Myotis)
Chthonicola sagittata (Speckled Warbler)	*Genoplesium superbum* (Superb Midge Orchid)	*Vespadelus troughtoni* (Eastern Cave Bat)
Petroica boodang (Scarlet Robin)	*Prasophyllum pallens*	*Acacia bynoeana* (Bynoe's Wattle)
Petroica phoenicea (Flame Robin)		*Acacia flocktoniae* (Flockton Wattle)
Ninox strenua (Powerful Owl)		*Prostanthera cryptandroides subsp. cryptandroides*
Tyto tenebricosa (Sooty Owl)		*Darwinia peduncularis*
Cercartetus nanus (Eastern Pygmy-possum)		*Isopogon fletcheri*
Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat)		*Persoonia acerosa*
Petaurus norfolcensis (Squirrel Glider)		*Pomaderris brunnea (Brown Pomaderris)*
Petauroides volans (Greater Glider)		*Leionema lachnaeoides*
Chalinolobus dwyeri (Large-eared Pied Bat)		*Leionema sympetalum (Rylstone Bell)*
Falsistrellus tasmaniensis (Eastern False Pipistrelle)		*Zieria murphyi*
Miniopterus schreibersii oceanensis (Eastern Bentwing-bat)		
Scoteanax rueppellii (Greater Broad-nosed Bat)		
Caesia parviflora var. minor (Small Pale Grass-lily)		

Known	High Likelihood	Moderate Likelihood
Kunzea cambagei		
Persoonia hindii		
Veronica blakelyi		

Of the species analysed in the LoOA, 42 threatened flora and 50 fauna will require targeted surveys within the Impact Envelope, in line with the BAM. The species requiring targeted surveys are listed below in **Section 4.2.3.**

4.2.2 Ecosystem Credits

There are four PCTs within the Impact Envelope for the Amended Project, which may be impacted by surface infrastructure. These PCTs and areas within the Impact Envelope are provided in **Table 6**. At least 10 BAM plots will be undertaken to representatively sample these vegetation communities, which occur within the Impact Envelope. These plots will be undertaken to allow calculation of the Vegetation Integrity of PCTs to be impacted, to calculate the Ecosystem Credit Offset Liability (see **Section 8.2** for further detail).

Table 6: PCTs within the Impact Envelope

PCT name	PCT Number	Potential Disturbance Area (ha)
Ribbon Gum - Snow Gum grassy forest on damp flats, eastern South Eastern Highlands Bioregion	1100	0.61
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin Bioregion	1248	47.18
Narrow-leaved Peppermint - Silvertop Ash - Mountain Grey Gum shrubby open forest of the upper Blue Mountains, Sydney Basin Bioregion	967	2.51
Narrow-leaved Stringybark - Fringe Myrtle - Scaly Phebalium heathy woodland on exposed sandstone ranges of the Sydney Basin	1666	0.18
Total		**50.48**

4.2.3 Species Credit Species

It was assumed that locally common or cryptic threatened species, as encountered on Newnes Plateau, are present within the Impact Envelope. This list was informed by regular survey efforts in the locality undertaken by RPS, BMS, MKES and BioNet records. A list of these likely threatened species and potential habitat available within the Impact Envelope, is provided in **Table 7**.

Table 7: Species Credit Species with potential to be impacted within the Impact Envelope

Species	Assumed Habitat Area (ha)
Flora	
Caesia parviflora var. minor (Small Pale Grass-lily)	49.69
Genoplesium superbum (Superb Midge Orchid)	2.51
Persoonia hindii	49.69
Prasophyllum pallens (Musty Leek Orchid)	47.18
Veronica blakelyi	50.3
Fauna	
Callocephalon fimbriatum (Gang-gang Cockatoo)	50.3
Calyptorhynchus lathami (Glossy Black-Cockatoo)	50.48

Species	Assumed Habitat Area (ha)
Cercartetus nanus (Eastern Pygmy-possum)	50.48
Miniopterus schreibersii oceanensis (Eastern Bentwing-bat)	3.3
Ninox connivens (Barking Owl)	50.48
Ninox strenua (Powerful Owl)	50.48
Petaurus norfolcensis (Squirrel Glider)	49.87
Pseudophryne australis (Red-crowned Toadlet)	49.87
Tyto novaehollandiae (Masked Owl)	50.48

To more accurately understand the occurrence and distribution of threatened species within the Impact Envelope, threatened species surveys will be undertaken in accordance with BAM prior to disturbance. According to the PCTs present in the Impact Envelope (**Table 6**), a LoOA was generated identifying the potential threatened species that may be present and the appropriate seasonal survey timing requirements to increase detectability.

The following 42 threatened flora will be surveyed for within the Impact Envelope prior to disturbance:

- *Acacia baueri subsp. aspera*;
- *Acacia bynoeana* (Bynoe's Wattle);
- *Acacia flocktoniae* (Flockton Wattle);
- *Astrotricha crassifolia* (Thick-leaf Star-hair);
- *Caesia parviflora var. minor* (Small Pale Grass-lily);
- *Cryptostylis hunteriana* (Leafless Tongue-orchid);
- *Darwinia peduncularis*;
- *Epacris hamiltonii*;
- *Veronica blakelyi*;
- *Eucalyptus cannonnii* (Capertee Stringybark);
- *Eucalyptus copulans*;
- *Eucalyptus pulverulenta* (Silver-leafed Gum);
- *Euphrasia bowdeniae*;
- *Haloragodendron lucasii*;
- *Hygrocybe anomala var. ianthinomarginata*
- *Hygrocybe aurantipes;*
- *Hygrocybe reesiae;*
- *Grevillea evansiana* (Evans Grevillea);
- *Ozothamnus tesselatus*;

- *Persoonia acerosa* (Needle Geebung);
- *Persoonia marginata* (Clandulla Geebung);
- *Prostanthera cryptandroides subsp. cryptandroides* (Wollemi Mint-bush);
- *Prostanthera discolor*;
- *Pultenaea glabra* (Smooth Bush-Pea);
- *Pultenaea sp. Olinda*;
- *Velleia perfoliata*;
- *Isopogon fletcheri* (Fletchers Drumsticks);
- *Kunzea cambagei* (Cambage Kunzea);
- *Leionema lachnaeoides*;
- *Leionema sympetalum* (Rylstone Bell);
- *Leucopogan exolasius* (Woronora Beard-heath);
- *Persoonia hindii*;
- *Persoonia hirsuta* (Hairy Geebung);
- *Genoplesium superbum* (Superb Midge Orchid);
- *Acacia meiantha*;
- *Xanthosia scopulicola*; and
- *Ziera murphyi* (Velvet Zieria).

The following 50 threatened fauna will be surveyed for within the Impact Envelope prior to disturbance:

- Anthochaera Phrygia (Regent Honeyeater);
- *Aprasia parapulchella* (Pink-tailed Legless Lizard);
- *Artamus cyanopterus cyanopterus* (Dusky Woodswallow);
- *Callocephalon fimbriatum* (Gang-gang Cockatoo);
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo);
- *Cercartetus nanus* (Eastern Pygmy-possum);
- *Chalinolobus dwyeri* (Large-eared Pied Bat);
- *Chthonicola sagittate* (Speckled Warbler);
- *Climacteris picumnus victoriae* (Brown Treecreeper (eastern subspecies));
- *Daphoenositta chrysoptera* (Varied Sittella);

- *Dasyurus maculatus maculatus* (Spotted-tailed Quoll);
- *Eulamprus leuraensis* (Water skink);
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle);
- *Glossopsitta pusilla* (Little Lorikeet);
- *Grantiella picta* (Painted Honeyeater);
- *Haliaeetus leucogaster* (White-bellied Sea-Eagle);
- *Heleioporus australiacus* (Giant Burrowing Frog);
- *Hieraaetus morphnoides* (Little Eagle);
- *Hoplocephalus bungaroides* (Broad-headed Snake);
- *Isoodon obesulus obesulus* (Southern Brown Bandicoot (eastern));
- *Lathamus discolor* (Swift Parrot);
- *Litoria booroolongensis* (Booroolong Frog);
- *Litoria littlejohni* (Littlejohn's Tree Frog);
- *Lophoictinia isura* (Square-tailed Kite);
- *Melanodryas cucullata cucullate* (Hooded Robin (south-eastern form));
- *Melithreptus gularis* (Black-chinned Honeyeater (eastern subspecies));
- *Miniopterus australis* (Little Bentwing-bat)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat);
- *Mixophyes balbus* (Stuttering Frog);
- *Myotis Macropus* (Southern Myotis);
- *Neophema pulchella* (Turquoise Parrot);
- *Ninox connivens* (Barking Owl);
- *Ninox strenua* (Powerful Owl);
- *Paralucia spinifera* (Bathurst Copper Butterfly);
- *Petalura gigantea* (Giant Dragonfly);
- *Petaurus australis* (Yellow-bellied Glider);
- *Petaurus norfolcensis* (Squirrel Glider);
- *Petrogale penicillate* (Brush-tailed Rock-wallaby);
- *Petroica boodang* (Scarlet Robin);

- *Petroica phoenicea* (Flame Robin);
- *Phascolarctos cinereus* (Koala);
- *Pseudophryne australis* (Red-crowned Toadlet);
- *Pteropus poliocephalus* (Grey-headed Flying-fox);
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat);
- *Stagonopleura guttata* (Diamond Firetail);
- *Tyto novaehollandiae* (Masked Owl);
- *Tyto tenebricosa* (Sooty Owl)';
- *Varanus rosenbergi* (Rosenberg's Goanna); and
- *Vespadelus troughtoni* (Eastern Cave Bat).

4.2.4 Surface Infrastructure Field Results

Ecological surveys to assess the impact of surface infrastructure are expected to commence following approval of the Project. These surveys will be undertaken prior to impact, to accurately determine the actual offset liability, as detailed in **Section 4.2**, **5** and **8.2**.

4.3 Initial Project Newnes Plateau Swamp Results

The previous predictions associated with the Initial Project did not expect to have a significant impact upon any THPSS, such that their ecosystem functioning may be impaired. This prediction was supported by a high level of confidence in subsidence predictions as shown by post-mining subsidence monitoring data. Additionally, ongoing ground-water, surface water and seasonal monitoring of swamp vegetation was undertaken since 2004 as an initial indicator of THPSS condition within the Initial Project Area. These previous predictions have subsequently changed as a result of the findings from contemporary best practice monitoring methods employed at neighbouring Springvale Colliery.

4.4 Amended Project Newnes Plateau Swamp Results

Field surveys since the initial Project have focussed on collecting baseline data for THPSS and the associated threatened species. BAM plots in THPSS have been conducted as part of the Maximum Offset Liability Calculations (RPS 2019), Blue Mountains Water Skink surveys commenced in March 2019 and GCPs commenced within the Project Area in Autumn 2019. In addition, Tristar and Twin Gully Swamps have been monitored using the Brownstein et al. (2014) Methodology since December 2015 for reference swamps as part of the SMEP SMPs. Opportunistic sightings of threatened flora and fauna were also documented during all recent surveys.

4.4.1 Likelihood of Occurrence Analysis

The LoOA (**Appendix A**) has resulted in the identification of 66 threatened species with a moderate or higher likelihood of occurrence within the Project Area. Of these, eight are species which are considered to be associated with the habitats present within the swamps. The eight species comprise four that are known to occur, three that have a high likelihood and one with a moderate likelihood of occurrence as depicted in **Table 8** below.

Table 8: Threatened Species likely to occur within the Swamps

Known	High Likelihood	Moderate Likelihood
Pseudophryne australis (Red-crowned Toadlet)	*Heleioporus australiacus* (Giant Burrowing Frog)	*Eucalyptus copulans*
Eulamprus leuraensis (Blue Mountains Water Skink)	*Xerochrysum palustre* (Swamp Everlasting)	
Petalura gigantea (Giant Dragonfly)*	*Boronia deanei*	
Carex klaphakei		

*Unpublished data from Marine Pollution Research. Further surveys will be undertaken by RPS in 2020.

4.4.2 Maximum Offset Liability

Surveys were conducted across THPSS in 2018 and 2019, with the results of these surveys utilised to quantify the maximum offset liability incurred should the development associated with the Amended Project have an adverse impact on THPSS (i.e. PCT 657) and any associated threatened species.

Vegetation integrity scores for THPSS located above each proposed longwall is provided in **Table 9** below. These scores were used to inform the Maximum Offset Liability for the Amended Project, as presented in **Section 8.3.1**.

Table 9: Vegetation integrity scores for the THPSS within the vicinity of each longwall.

Longwall	THPSS Type	Vegetation integrity Score
LW1001	Shrub Swamp	47.3
	Shrub Swamp	59.3
	Hanging Swamp	60.9
LW1002	Shrub Swamp	45.7
	Shrub Swamp	25.6
	Hanging Swamp	49.1
LW1003	Shrub Swamp	34.9
	Shrub Swamp	61.5
	Hanging Swamp	70.9
LW1004	Shrub Swamp	60.8
	Shrub Swamp	51.7
	Hanging Swamp	40.9
LW1005	Shrub Swamp	55.1
LW1006	Shrub Swamp	47.8
	Hanging Swamp	7.1
LW1007	Shrub Swamp	45.6
	Hanging Swamp	45.8
LW1008	Shrub Swamp	24.7
	Shrub Swamp	21.7
	Hanging Swamp	38.8
LW1009	Shrub Swamp	29.3
	Shrub Swamp	31.4
LW1013	Shrub Swamp	21.7
	Hanging Swamp	37.8

4.4.3 Swamp Monitoring Program surveys

In recent opportunistic threatened species surveys primarily associated with the Springvale SMP requirements, three species have been discovered inhabiting THPSS on the Newnes Plateau. Specifically, these species are:

≠ *Xerochrysum palustre* (Swamp Everlasting; EPBC Act = Vulnerable);

≠ *Carex klaphakei* (Klaphake's Sedge; BC Act = Endangered); and

≠ *Pseudophryne australis* (Red-crowned Toadlet; BC Act = Vulnerable)

The *X. palustre* was identified in Pine Swamp which is within the SMEP and this find is a range extension for this species. The *C. klaphakei* was discovered in Twin Gully Swamp within the Project Area. Red-crowned Toadlet was identified in Tristar Swamp. Refer to **Figures 11** and **12** for the locations of these threatened flora and fauna species respectively.

4.4.4 Blue Mountains Water Skink surveys

THPSS with potential high value habitat was identified in the following swamps: Wolgan River, South Wolgan, Narrow, Sunnyside, Twin Gullies, Tristar, Crocodile, Birdrock and Japan (Trail Six). Sampling of these sites resulted in the identification of BMWS at Sunnyside, Twin Gully, Tristar, Crocodile and Japan swamps with the location of trapped BMWS shown in **Figure 11**. Sampling design and effort expended was considered adequate for determining absence in Wolgan River, South Wolgan, Narrow and Mogul swamps. Other species such as *Eulamprus heatwolei* were trapped in these swamps instead of the target species, which provides further evidence of BMWS absence in these swamps.

4.4.5 Summary

Previous surveys for the Flora and Fauna Assessment by RPS (2014) provide a detailed understanding of the ecological communities and fauna associated with the proposed surface infrastructure for the Amended Project, specifically 32 vegetation communities and five EECs under the Western Blue Mountains Vegetation Survey and Mapping Project (DEC 2006) and nine threatened fauna species utilising these communities. Further assessments into the likely maximum offset liability for the more sensitive GDEs within the Project Area in 2018-2019 has provided a detailed review of the THPSS and their likelihood for impact as a result of the Amended Project.

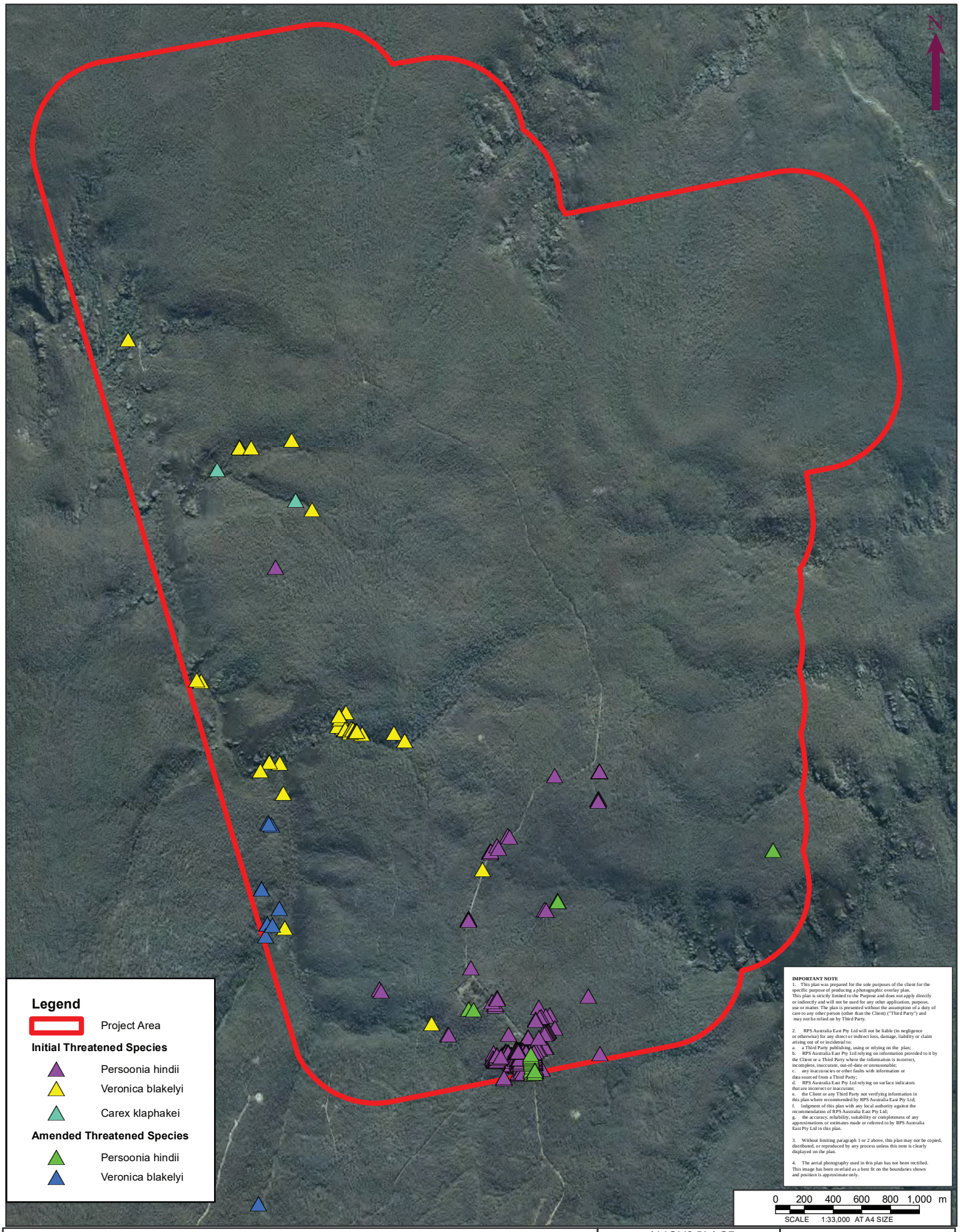

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FIGURE 11: AMENDED PROJECT AREA THREATENED FLORA

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: **PR 144414-7**

PURPOSE: BMP

Technician: Zach.Cotter Date: 1/11/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\144414 Figure 11 Amended Project Area threatened flora 20191031.mxd

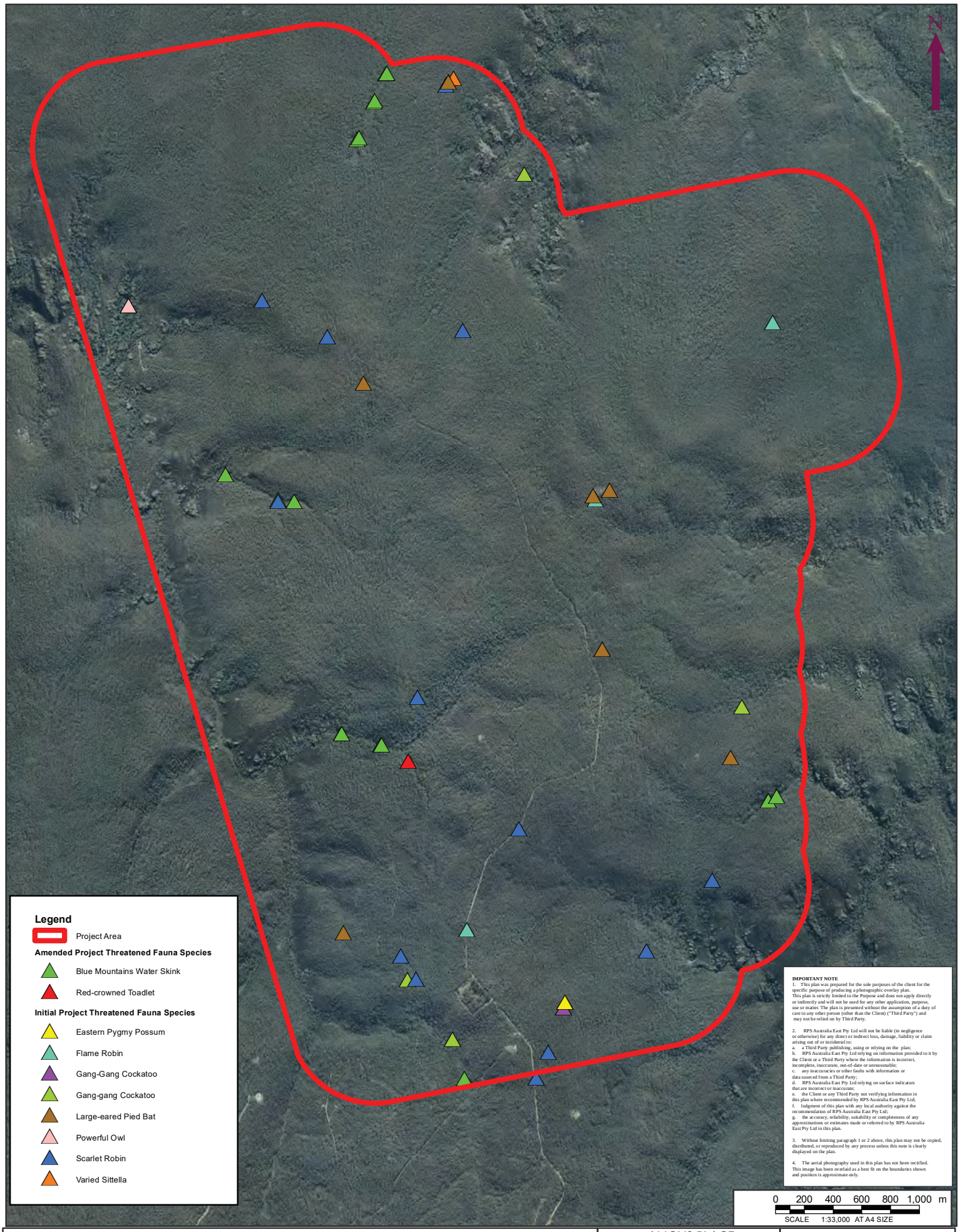

FIGURE 12: AMENDED PROJECT AREA THREATENED FAUNA

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: **PR 144414-7**

PURPOSE: BMP

Technician: Zach.Cotter Date: 1/11/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\EIS\144414 Figure 12 Amended Project Area threatened fauna 20191031.mxd

5 PREDICTED AMENDED PROJECT SURFACE INFRASTRUCTURE IMPACTS

Surface disturbance arising from surface infrastructure will be minimised where possible by using existing infrastructure on the Newnes Plateau and Angus Place Colliery pit top. Moreover, the proposed enlargement of the ROM coal stockpile from 90,000 to 110,000-ton capacity will seek to reduce impacts to bushland by extending this stockpile into pre-disturbed areas. Nevertheless, the Amended Project will impact native vegetation to allow for installation of mine water management and ventilation infrastructure on the Newnes Plateau. These impacts will be avoided or minimised as far as possible during the detailed design of infrastructure by relying on existing disturbance areas and access tracks.

The alignment and position of new surface infrastructure on the Newnes Plateau to support the Angus Place Extension will depend upon finalisation of the mine design, as well as the detection of any sensitive environmental entities in future ecological survey campaigns, including threatened species and ecological communities (see **Section 4.2**). As such, this report considers an impact envelope that will involve a maximum disturbance of up to 50.48 ha of vegetation (**Table 6**).

To ensure impacts arising the surface infrastructure are offset in accordance with the Biodiversity Offset Strategy (BOS), an adaptive management strategy will be undertaken in accordance with Section 9.4.1.1 of the BAM. This approach will determine the actual offset liability of bushland clearance arising from installation of surface infrastructure. To accurately determine the impact of the Amended Project, a liability report will be prepared, which details and calculates the actual Ecosystem and Species Credits required to offset the Amended Project.

This approach will involve:

- Prior to clearing, floristic plots in accordance with the BAM will be undertaken to understand the vegetation integrity of bushland within the Impact Envelope (as detailed **Section 4.2.4**);
- Prior to clearing, targeted threatened flora and fauna surveys will be undertaken in accordance with the BAM to identify biodiversity values within the Impact Envelope (as detailed **Section 4.2.4**);
- Emphasis will be placed on avoiding and minimising impacts to threatened species and their habitats if they are identified during pre-clearance surveys. This approach will have an aim of avoiding any significant impacts on EPBC Act listed species or communities.
- Post clearance high resolution imagery (~7 cm pixel resolution) will be consulted in order to confirm the extent of clearing within the approved Impact Envelope;
- The difference in vegetation cover before vs after construction of the surface infrastructure will be used to calculate the actual offset liabilities of the Amended Project using high resolution imagery from before and after the clearing; and
- The actual offset liability calculations will be detailed within an 'Actual Liability Report' that will be prepared and submitted to the NSW DPIE following the completion of the construction.

6 PREDICTED AMENDED PROJECT SUBSIDENCE RELATED IMPACTS

Subsidence has the potential to modify habitats through surface cracking, slope changes causing erosion and changes to hydrological regimes. Most of the Project Area is dry woodland, forest or heath. The risks of subsidence-related impacts on drier habitats are low as even significant subsidence has minimal effect on dryland plant communities. Risks of subsidence-related impacts are higher in riparian habitats and groundwater dependent ecosystems due to the potential for alterations to surface or groundwater hydrological regimes.

As a component of the Amended Project Report for the proposed LW 1001-1015, MSEC were engaged to prepare subsidence predictions for the proposed LW 1001-1015 including subsidence impacts and environmental consequences (MSEC 2019). Other habitat features that may be susceptible to high levels of subsidence include cliffs, pagodas and caves as subsidence may induce cracking or failure of these features to the extent that they become less suitable for habitation.

Table 10 provides a summary of the maximum predicted values of the total vertical subsidence, tile and curvature of LW 1001-1015.

Table 10: Maximum Predicted Total vertical subsidence, tilt and curvature after the extraction of each of the proposed longwalls (MSEC 2019)

After Longwall	Maximum Predicted Total vertical Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km-1)	Maximum Predicted Total Sagging Curvature (km-1)
LW1001	850	7	0.09	0.15
LW1002	1450	12	0.20	0.20
LW1003	1950	12	0.20	0.20
LW1004	2000	14	0.20	0.25
LW1005	2150	20	0.40	0.35
LW1006 to LW1015	2250	25	0.35	0.40

The above table exemplifies that the maximum predicted subsidence parameters, based on the Extraction Plan Layout, are different as those based on the EIS Layout. The two longwall layouts cover similar extents, however additional longwalls were previously dropped to the south and north of the current layout (MSEC 2019). Details of predicted subsidence and ecological impacts have been outlined within **Sections 6.1** and **6.2**.

6.1 Terrestrial Environment

6.1.1 Wooded Habitats

Localised changes in the soils on steeper slopes may occur from the downslope movement of soil resulting in tension cracks appearing at the tops and along the sides of the steep slopes and compression ridges forming at the bottoms of the steep slopes (MSEC 2014; MSEC 2019).

Tension cracks and soil destabilisation may cause localised disturbance of the root zone for some plants where this occurs. However, it is noted that a number of those threatened flora considered as having the potential to occur either respond positively to, or readily recover from disturbance, or naturally occur within areas where the soil surface is naturally unstable, such as mountain scree slopes. Any loss of threatened flora would be highly isolated and would not remove a significant proportion of soil seedbank such that an area would become unviable for threatened flora (RPS 2014).

As predictions to wooded habitat types have not changed since the original subsidence predictions were calculated, the conclusion relating to biodiversity impacts remains the same as per RPS (2014). RPS (2014) concluded that it is highly unlikely that subsidence-related ground movements would affect woodland or forest habitats such that they would become unsuitable for any of the threatened fauna that were recorded or likely to occur in the Project Area.

6.1.2 Riparian Habitats

The predicted post mining grades along the drainage lines are similar to the natural grades (MSEC 2019). Therefore, it is not expected that there would be any significant adverse changes in ponding, flooding or scouring resulting from the proposed mining. There may be some very minor localised areas which could experience small increases in the levels of ponding, where the natural gradients are low immediately upstream of the longwall chain pillars (MSEC 2014; MSEC 2019).

It is expected that fracturing of the bedrock would occur beneath some sections of the drainage lines which are located directly above the proposed longwalls. Fractures in bedrock underlying watercourses across the Project Area could significantly increase local hydraulic conductivity, and in some cases eliminate baseflow (Jacobs 2019a). Loss of flow can lead to the progressive drying of downstream swamps (Jacobs 2019a).

6.1.3 Cliffs, Minor Cliffs and Pagodas

The definition of a cliff provided in the NSW Department of Planning and Environment Standard of Model Conditions for Underground mining (DP&E, 2012) is a “Continuous rock face, including overhangs, having a minimum length of 20 meters, a minimum height of 10 meters and a minimum slope of 2 to 1 (>63.4°)”. Pagodas have been defined as isolated freestanding rock formations with heights greater than 5 meters.

Cliffs, caves, pagodas and rock outcrops provide potential habitat for a variety of species including the Broad-headed Snake (*Hoplocephalus bungaroides*) and the Brush-tailed Rock Wallaby (*Petrogale penicillata*); whilst caves within these features may also contain structures which provide habitat for cave-dwelling bats (RPS 2014).

The mining layout has been designed such that the majority of the cliffs and pagoda complexes are located outside the 26.5° angle of draw from the extents for the proposed longwalls (MSEC 2019). There are three cliffs that are situated within the Project Area based on the 26.5° angle of draw and no pagoda complexes, only isolated pagodas, in the Project Area (MSEC 2019).

Cliffs are predicted to experience less than 20 mm vertical subsidence and far-field horizontal movements towards the proposed mining area (MSEC 2019). It is unlikely that the cliffs would experience adverse impacts due to their distances outside of the proposed mining areas, however isolated rock falls could occur (MSEC 2019).

Minor Cliff AP-MC1 is located above LW1013 and could experience fracturing, potentially resulting in localised spalling of exposed rockface (MSEC 2019). Minor cliffs outside the Project Area are unlikely to experience adverse impacts.

Pagodas along the upper reaches of Drainage Lines 1 and 5 and the upper reaches of the Wolgan River are predicted to experience up to 150 mm vertical subsidence. Predicted strains for these pagodas is 1.4 mm/m tensile and 0.6 mm/m compressive based on the 95 % confidence intervals (MSEC 2019). Fracturing is a possibility of these pagodas due to tensile strains, which could result in rockfalls (MSEC 2019). It is unlikely that fracturing would occur in pagoda complexes that are located on or outside the 26.5° angled of draw (MSEC 2019).

6.2 Swamps

Impacts on THPSS are discussed in the following sections for swamps and drainage lines that occur within the Project Area. The following Swamps are expected to be impacted by subsidence. The predicted Groundwater and surface water related subsidence impacts are noted for each Swamp.

6.2.1.1 Tri Star Swamp

The Springvale Angus Place Swamp Water Balance Model (SAPSWBM) flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The modelled change in surface water flow at Tri Star Swamp is large and the impact of that magnitude is expected to be significant (Jacobs 2019a).

The maximum predicted water table decline beneath Tri Star Swamp is 10m for the 10th percentile drawdown and 5m for the 90th percentile drawdown. Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b)

6.2.1.2 Twin Gully Swamp

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The predicted changes range between a minor to moderate increase and a minor to moderate decrease. It is considered that the impact of the magnitude of change in flows in Twin Gully Swamp may be moderate but, is less than that predicted for Tri Star Swamp (Jacobs 2019a).

The maximum predicted water table decline beneath Twin Gully Swamp is 10m for the 10th percentile drawdown with up to 5m drawdown predicted for the 90th percentile decline (Jacobs 2019b). Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b).

6.2.1.3 Japan (Trail Six) Swamp

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The magnitude of the changes in the U90 results range from moderate to large and are expected to be significant (Jacobs 2019a).

The maximum predicted water table decline beneath Trail Six Swamp is 10m for the 10th percentile drawdown, with up only 0.5m for the 90th percentile decline (Jacobs 2019b). Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b).

6.2.1.4 Crocodile Swamp

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The predicted magnitude of decrease is negligible; therefore, the modelled impact is considered to be insignificant.

The maximum predicted water table decline beneath Crocodile Swamp is up to 5m for the 10th percentile drawdown, with the majority of the swamp predicted to be approximately 2m. For the 90th percentile decline, the predicted drawdown is mostly less than 0.5m with areas of up to 1m drawdown predicted (Jacobs 2019b). Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b).

6.2.1.5 Birdrock Swamp

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The predicted change in flow rates is a moderate to large decrease, which is considered to be significant (Jacobs 2019a).

The maximum predicted water table decline beneath Birdrock Swamp is up to 5m for the 10th percentile drawdown, with the majority of the swamp predicted to be approximately 2m. For the 90th percentile decline, the predicted drawdown is mostly less than 0.5m with areas of up to 1m drawdown predicted (Jacobs 2019b). Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b).

6.2.1.6 Wolgan River Swamp and Wolgan River Upper Swamps

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). Whilst the predicted change is of moderate magnitude, it is not considered to be significant because of the median flow rate (Jacobs 2019a).

No significant drawdown is predicted at Wolgan River Swamp or Wolgan River Upper Swamp (Jacobs 2019b).

6.2.1.7 Unnamed Drainage Lines

There are unnamed drainage lines situated directly above the proposed longwalls. Some sections of the drainage lines through and downstream of the swamps are third order (MSEC 2019). The sections downstream of the shrub swamps have small base surface water flows. Elsewhere, the drainage lines are generally ephemeral, although there are some groundwater seeps from the perched aquifers (MSEC 2019).

The predicted post-mining grades along the drainage lines are similar to the natural grades varying between 25 mm/m and 300 mm/m.

It is expected that fracturing of the bedrock would occur beneath the sections of the drainage lines that are located directly above and adjacent to the proposed longwalls. Where the bedrock is shallow or exposed, then the fracturing will be visible at the surface. Fracturing can also occur outside the extents the proposed longwalls, with fracturing possible at distances up to approximately 400 m (MSEC 2019).

Surface water flow diversions could occur along the sections of drainage lines that are located directly above and adjacent to the proposed longwalls. Further discussions on the potential impacts on surface water flows are provided by the specialist surface water consultant on the project (MSEC 2019).

It is expected that drainage lines located directly above the proposed longwalls will experience compressive strains due to valley related movements between 10 mm/m and 20 mm/m. The greatest compressive strains are expected to occur where the drainage lines are located near the centrelines of the proposed longwalls and lesser values where the drainage lines are located above or near to the chain pillars. The compressive strains for the drainage lines located outside the extents of the proposed longwalls are expected to be less again (MSEC 2019).

6.2.2 Potential Changes

The predicted post mining grades are similar to the natural grades within the drainage lines. There are no predicted significant reductions or reversals of stream grade. It is not expected, therefore, that there would be any adverse changes in ponding or scouring resulting from the mining-induced tilt.

6.2.3 Potential for Cracking in the Swamps and Fracturing of Bedrock

The maximum predicted conventional curvatures for the swamps are 0.35 km-1 hogging and 0.40 km-1 sagging, which represent minimum radii of curvature of 2.9 km and 2.5 km, respectively.

The shrub swamps are located along the alignments of drainage lines and, therefore, are likely to experience valley related movements. A summary of the maximum predicted total upsidence and closure for the shrub swamps is provided in MSEC (2019).

The predicted upsidence and closure are greatest for the parts of swamps located near the centrelines of the longwalls and less for the parts of swamps located near the chain pillars. As described in MSEC (2019), the actual valley related movements are expected to be around 60 % to 90 % of the maxima predicted near the centrelines of the longwalls, and around 30 % and 60 % of the maxima predicted near the chain pillars.

The hanging swamps are located on the sides of the valleys and, therefore, are not expected to experience significant valley related upsidence movements or compressive strains due to closure movements, which occur near the bases of the valleys.

Fracturing in bedrock has been observed due to previous longwall mining where the tensile strains have been greater than 0.5 mm/m or where the compressive strains have been greater than 2 mm/m. It is likely, therefore, that fracturing would occur beneath the swamps located directly above the proposed mining area. Fracturing can also occur outside the mining area, with minor and isolated fracturing occurring at distance up to approximately 400 m (MSEC 2019).

The estimated fracture widths in the topmost bedrock, based on the maximum predicted conventional tensile strain of 3.5 mm/m and based on a typical joint spacing of 10 m, is in the order of 35 mm. The fracture widths outside the proposed mining area are expected to be typically less than 10 mm. The crack widths are expected to be typically less than 25 mm, however localised cracking with widths greater than 50 mm can also develop (MSEC 2019). Larger surface deformations could also occur if increased scouring were to develop due to changes in swamp vegetation.

Tri Star Swamp is predicted to experience maximum predicted subsidence effects above the proposed mining area and is therefore likely to experience adverse impacts due to the proposed mining (MSEC 2019). Twin Gully is also likely to experience adverse impacts, to a lesser extent, as it is not coincident with a Type 1 or 2 geological structure and due to the lower predicted subsidence effects (MSEC 2019).

The shrub swamps have peat layers which overlie the shallow natural surface soils and underlying bedrock along the alignments of the drainage lines. In most cases, cracking would not be visible at the surface within these swamps, except where the depths of bedrock are shallow or exposed.

The mining-induced compression due to valley closure effects can also result in dilation of the strata beneath the shrub swamps and the development of bed separation in the topmost bedrock, as it is less confined. This dilation due to valley closure is expected to develop predominately within the top 10 m to 20 m of the bedrock. Compression can also result in buckling of the topmost bedrock resulting in heaving in the overlying surface soils (MSEC 2019). The dilated strata beneath the drainage lines, could result in the diversion of some surface water flows beneath parts of the shrub swamps. It is noted, however, that the drainage lines upstream of the swamps are generally ephemeral and, therefore, surface water flows occur during and shortly after rainfall events.

6.3 Learnings from Swamp Monitoring Program at Springvale

Centennial has been conducting undermining activities beneath the Newnes Plateau and surrounds using the longwall method since 1995. Previous predictions for Springvale Longwall projected that GDEs (specifically THPSS) will be ‘largely unaffected by proposed mining’ or impact will be ‘minor and short-term in duration’ (Centennial Coal 2012). However, there are now “improved understandings of interactions between significant fault zones (lineaments) and groundwater behaviour” including “recent findings (which) suggest a correlation between some identified significant fault zones (lineaments) and Newnes Plateau Shrub Swamps. According to Centennial Coal (2018), there is increasing evidence that directly undermining lineaments in the strata overlying Lithgow coal seam can cause changes to standing water levels in swamps

overlying the lineaments". This further understanding has provided more cautious predictions for Springvale's most recent Extraction Plans and associated management plans, such as the Swamp Monitoring Program for LW424 to 427.

The Extraction Plan Area for Springvale LW424-427 SMP was greater than that defined in the LW 424-427 BMP for non-swamp related biodiversity (i.e. Management Unit 1) and is otherwise referred to as the Trigger Investigation Area (TIA). It is a representation of a prior recommendation made by the Independent Monitoring Panel (IMP) to increase the investigation area for groundwater obligate biodiversity (i.e. swamps) that may be affected by far field subsidence' (Centennial Coal 2018). 'The TIA is based on the improved understanding of interactions between significant fault zones (lineaments) and groundwater behaviour. In this respect the TIA relevant to LW 424 to 427 will extend to 2,000 m along mapped lineaments when longwall mining intersects with such geological features. Where there is no fault zone interaction the TIA will remain 600m. While this part of the TIA only relates to the monitoring of the groundwater, it will extend to include additional biodiversity monitoring should a groundwater trigger eventuate (i.e. predefined response outlined in the Trigger Action Response Plan (TARP) for longwalls 424-427). It is the purpose of this extended monitoring is to monitor/ investigate the effect of altered hydrology on THPSS' (Centennial Coal 2018).

7 COMPARISON OF PREVIOUS AND AMENDED PROJECT IMPACTS

7.1 Amended Project Impact Envelope vs Initial Project Surface Infrastructure

The Impact Envelope to install surface infrastructure, as part of the Amended Project, will lead to a maximum increase in surface disturbance of 26.69 ha. **Table 11** summarises the difference in potential impact to bushland resulting from the Amended Project. Nevertheless, measures to avoid and minimise impacts to native vegetation will also be sought wherever possible in the later design phases for the surface infrastructure. Hence, the actual impact is expected to be far less than the values presented here (see **Section 6**). The amended footprint of the surface infrastructure will also seek to avoid disturbance to EECs, including THPSS.

Table 11: Comparison of Initial and Amended Project impacts

PCT	PCT No.	RPS (2014; ha)	Amended Project (Impact Envelope; ha)	Difference (ha)
Ribbon Gum - Snow Gum grassy forest on damp flats, eastern South Eastern Highlands Bioregion	1100	0.16	0.61	+0.45
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin Bioregion	1248	21.98	47.18	+25.2
Narrow-leaved Peppermint - Silvertop Ash - Mountain Grey Gum shrubby open forest of the upper Blue Mountains, Sydney Basin Bioregion	967	1.10	2.51	+1.41
Narrow-leaved Stringybark - Fringe Myrtle - Scaly Phebalium heathy woodland on exposed sandstone ranges of the Sydney Basin	1666	0	0.18	+0.18
Total		**23.24**	**50.48**	**+27.24**

Note: The Impact Envelope presented as part of the Amended Project is indicative of the maximum possible impact resulting from the surface infrastructure.

The 2014 EIS identified 23 threatened fauna and four threatened flora species within the Project Area (as reported in **Section 4.1**). These species, in addition to 47 threatened species that were identified as Candidate species according to the PCTs present, will be targeted in upcoming threatened species surveys in accordance with BAM and any impacts offset according to the BOS.

The 2014 EIS found that the impact on threatened species was negligible given the relatively small extent of bushland to be removed [i.e. 23.24 ha; constituting 0.14 % of the combined total commensurate vegetation communities mapped by the *Vegetation of the Western Blue Mountains* (DEC 2006)]. Following the surveys, final design of the surface infrastructure will seek to avoid and minimise impacts to threatened entities wherever possible by restricting the development to areas of existing disturbance and minimising clearing. As such, it is not expected that the final footprint will be considerably different to that assessed within the initial EIS. Nevertheless, impacts to surface infrastructure associated with the Amended Project will be offset in accordance with the BOS. As such, this newer scheme will capture biodiversity offsets in a more conservative manner than the previous Framework for Biodiversity Assessment (FBA: OEH, 2014) Offset Scheme. For instance, any clearing of native vegetation will require ecosystem credits that will encapsulate offset requirements for Ecosystem Credit Species; which will likely include the following Ecosystem Credit Species that associated with PCTs in the Impact Envelope: *Petroica phoenicea* (Flame Robin); *Petroica boodang* (Scarlet Robin); *Daphoenositta chrysoptera* (Varied Sittella); *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat); *Climacteris picumnus victoriae* [Brown Treecreeper (eastern subsp.)]; *Chalinolobus picatus* (Little Pied Bat); *Falsistrellus tasmaniensis* (Eastern False Pipistrelle); *Mormopterus norfolkensis* (Eastern Freetail-bat); and *Scoteanax rueppellii* (Greater Broad-nosed Bat).

7.2 Swamp-related Impacts

The key predicted swamp-related impacts, arising from the initial and Amended Project, are summarised in **Table 12**. As indicated, the potential impacts identified by MSEC (2014 and 2019), suggest a greater potential for impact to swamps arising from the Amended Project. This more conservative impact prediction arises due to learnings from mining in the area since the 2014 EIS. Notably, methods to predict subsidence by MSEC (2019) have been re-calibrated based on available ground monitoring data from Angus Place and Springvale Collieries.

Table 12: Comparison of previous and amended Project impacts

Swamp Type	Initial Project	Amended Project	Difference
Shrub Swamp	From MSEC (2014): "*Fracturing of the bedrock is expected beneath the swamps which are located directly above the proposed longwalls.*[1] *The swamps have peat layers and, in most cases, cracking will not be visible at the surface within these swamps, except where the depths of bedrock are shallow or exposed. Whilst some cracking could occur in the swamps resulting from the extraction of the proposed longwalls, the previous experience of mining beneath swamps at Angus Place, Springvale and in the Southern Coalfield indicate that the likelihoods and extents of these impacts are small.*"	From MSEC (2019): "*Fracturing and dilation of the bedrock is expected to develop beneath Tri Star Swamp, Twin Gully Swamp and the hanging swamps within their catchments, and this could result in cracking of the overlying peat layers. Fracturing and dilation of the bedrock can also occur beneath the swamps located adjacent to the mining area, within minor and isolated fracturing to occur up to 400 m outside the proposed mining area.*" For the purposes of this BIA, the area of potential impact has been extended to a 600 m buffer from the goaf edge which is termed the TIA. "*The impacts to Tri Star Swamp and Twin Gully Swamp could be similar to those previously observed at Junction Swamp, Narrow Swamp North, Narrow Swamp South and East Wolgan Swamp.*[2]"	Increased predicted impact to include Twin Gullies Swamp, and potentially adjacent swamps up to 600 m outside proposed mining area.
Hanging Swamp	From RPS (2014): "*The Project was not expected to have a significant impact upon the hydrology of any hanging swamps*."	From MSEC (2019): *Fracturing and dilation of the bedrock is expected to develop beneath Tri Star Swamp, Twin Gully Swamp and the hanging swamps within their catchments, and this could result in cracking of the overlying peat layers.*[2]"	Increased predicted impact to hanging swamps.

1 For the initial Project: "Tri Star Swamp and Trail 6 Swamp were located directly above the proposed longwalls and Twin Gully Swamp is located immediately adjacent to the proposed longwalls" (MSEC 2014).

2 Impacts at Junction Swamp, Narrow Swamp North, Narrow Swamp South and East Wolgan Swamp include:" Vegetation dieback, major incision and erosion (in some instances down to bedrock), associated with loss of peat layer, significant loss of ecosystem function and ecological resilience, and ecological and geomorphic threshold exceedance" (MSEC 2019).

8 OFFSET LIABILITIES

8.1 Measures to Minimise and Avoid Impacts

8.1.1 Surface Infrastructure

Following confirmation that the surface disturbance activities can be undertaken within the Impact Envelope, detailed design of infrastructure will be undertaken to minimise impacts as far as practicable largely by relying on existing disturbance areas and access tracks as far as possible. Post clearance surveys will then be carried out to:

≠ Confirm surface disturbance activities remained within the approved impact envelope; and

≠ Calculate the actual offset liability requirements.

8.1.2 Swamps

The APMEP has been designed where possible to avoid directly undermining THPSS and NPHS. Specifically, the mine design has been modified to minimise impacts on swamps by:

≠ Shortening longwalls to provide a minimum setback from the Gardens of Stone National Park of 1,000 m to reduce the risks of subsidence related impacts on the National Park; and

≠ Shortening longwalls to avoid directly undermining the Japan (Trail 6) NPSS.

To ensure the mine remains economically viable, an increase in the void widths to some longwalls has been proposed to provide a consistent 360 m wide longwall void width across the entire 1000 panel longwall mining area.

These mine plan changes have resulted in the number of longwalls being reduced from 19 to 15 with an overall reduction in the mine plan footprint when compared to what was presented in the 2014 EIS.

8.2 Biodiversity Offset Requirements

In accordance with the BC Act and EPBC Act, any impacts which are deemed to be related to the APMEP, will be required to be offset in accordance with the NSW Biodiversity Offset Scheme and the Commonwealth Environmental Offsets Policy.

8.3 Surface Infrastructure

Although the actual offset liability will be determined following approval, to allow for updates to the mine design, a maximum offset liability was calculated for the Impact Envelope, where this infrastructure will be located within. The indicative Ecosystem credit liability, considering total impact of the Impact Envelope and BAM-C (as of October 2019) is provided in **Table 13.**

Table 13: Indicative Ecosystem Credit Liability

Species/PCT	Notional Credit Liability	Area	PCT
Ribbon Gum - Snow Gum grassy forest on damp flats, eastern South Eastern Highlands Bioregion	31	0.61	1100
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin Bioregion	1769	47.18	1248
Narrow-leaved Peppermint - Silvertop Ash - Mountain Grey Gum shrubby open forest of the upper Blue Mountains, Sydney Basin Bioregion	94	2.51	967

Narrow-leaved Stringybark - Fringe Myrtle - Scaly Phebalium heathy woodland on exposed sandstone ranges of the Sydney Basin	7	0.18	1666

8.4 Swamp Offset Strategy

The Springvale Mine and Angus Place Colliery Swamp Offset Strategy (Centennial Coal 2019) details the multi-layered swamp offset strategy developed by Centennial Coal to compensate for the current and potential impacts to THPSS and their associated threatened species for both the SMEP and APMEP. The strategy has been designed to satisfy the various State and Commonwealth offset policy requirements where possible and takes into consideration the specific conditions of consent issued for the SMEP. This report is included within **Appendix D** and sections relevant to Amended Project THPSS offset liabilities are summarised below.

8.4.1 Maximum Offset Liability – Swamps (BC Act)

This maximum offset liability for the Amended Project was calculated using the BAM for ecosystem and species credits (State of NSW 2017). This maximum offset liability calculation assumed that there will be a total loss of swamps, rather than a reduction in condition, functionality and size. In this calculation, the potential impact on THPSS were identified throughout the Project Area. Prior to calculations, THPSS were grouped into vegetation zones based on the position related to the longwall plan, THPSS type and vegetation condition. The vegetation integrity scores used to inform this calculation are shown in **Table 9**.

8.4.1.1 Ecosystem Credits

The total number of ecosystem credits that Centennial may be liable for is 880 for PCT 657.

8.4.1.2 Species Credits

The maximum offset liability for species credits for THPSS-associated threatened species, as at May 2019, are presented in **Table 14**. For the purposes of this maximum offset liability calculation, the entire area encompassed by the THPSS swamp boundary was considered suitable habitat.

Table 14: Species Credit Liabilities

Credit Type	Credits Required
Blue Mountains Water Skink (*E. leuraensis*)	844
Giant Dragonfly (*P. gigantea*)	1276
B. deanei	844
Red-crowned Toadlet	639

8.4.2 EPBC Act - Swamp Offset Calculations

RPS assessed the EPBC Act offset liability for THPSS and associated threatened species, located above the potential zone of influence (i.e. within 600 m of the goaf edge) for the Amended Project and the SMEP.

EPBC Act listed species known to be associated with the THPSS include:

≠ Blue Mountains Water Skink [(BMWS) *Eulamprus leuraensis*; EPBC Act = Endangered];

≠ Deane's Boronia (*Boronia deanei*; EPBC Act = Vulnerable); and

≠ Recent surveys have identified *Xerochrysum palustre* (Swamp Everlasting; EPBC Act = Vulnerable).

Although the calculations in the Swamp Offset Strategy does not include the recent identification of Swamp Everlasting within THPSS at nearby Pine Swamp, the offset calculations would be the same as that for the *B. deanei* because it has the same listing status of Vulnerable. Furthermore, *B. deanei* has not been recorded with the Project area during comprehensive swamp surveys which commenced in Autumn 2019.

The proposed mining may have a greater than negligible environmental consequence on THPSS and the above associated EPBC Act listed species. The aim of this assessment was to indicatively quantify the EPBC Act offset liability incurred should the Amended Project adversely impact on THPSS and the two associated EPBC Act listed species.

Table 15: THPSS Impact and Offset Summary

Impact Site	Impact Area (ha)	Offset Area (ha)	% of Offset achieved
Angus Place THPSS within Extension Area	39.24	67.4*	9.86 (7.8 averaged)
Springvale THPSS within Extension Area	91.85	91.85*	5.74 (7.8 averaged)
AP/SV Combined impacts Vs State Forest potential Offsets	131.1*	354.41	102.95
TOTAL = Average of all low condition + AP/SV combined			**110.75**

NOTE: The Department of Environment and Energy (DoEE) has not endorsed the assumptions used to conduct these calculations and they may be subject to change following review by the DoEE.

*Reduced condition post-mining related impacts

Table 16: Species Impact and Offset Summary

Impact Site	Impact Area (ha)	Offset Area (ha)	% of Offset achieved
Angus Place Extension Area - *B. deanei*	39.24	67.4*	12.02 (9.51 averaged)
Angus Place Extension Area - BMWS	39.24	67.4*	9.86 (7.8 averaged)
Springvale Extension Area – *B. deanei*	91.85	91.85*	7.00 (9.51 averaged)
Springvale Extension Area - BMWS	91.85	91.85*	5.74 (7.8 averaged)
Angus Place and Springvale Combined - *B. deanei*	131.1*	354.41	125.57
Angus Place and Springvale Combined - BMWS	131.1*	354.41	102.95
BMWS TOTAL **=** Average of all low condition + AP/SV combined			**110.75**
***B. deanei* TOTAL** **=** Average of all low condition + AP/SV combined			**135.08**

NOTE: *Reduced condition post-mining related impacts

The Commonwealth EPBC Act 1999 Offsets Policy states that 90 per cent of offset liabilities must be met with direct offsets. As can be deduced from **Table 15** and **Table 16**, by combining the entire area of the Newnes State Forest swamps with the impacted swamps within Angus Place and Springvale Extension Areas, this 90% requirement can be met.

9 MONITORING PROGRAMS

9.1 Swamp Monitoring Program

The APMEP SMP (**Appendix B**), provides information on the proposed approach to monitoring the swamps which have potential to be impacted by the secondary extraction of coal from longwalls as part of the Amended Project (SSD_5602).

The SMP has been developed prior to the issuing of Conditions of Consent with the aim of streamlining the approval process for the APMEP by demonstrating an in depth understanding of the potential impacts and best practice monitoring methods. The Conditions of Consent released for the approved adjacent SMEP (SSD_5594) have been consulted to inform the content of the SMP. The SMP has been prepared with reference to 'Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps' (Brownstein et al. 2014). Additionally, the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) have been used to guide the report.

The SMP has the purpose of outlining the swamp monitoring measures required to comply with regulatory approvals (when available) for the secondary extraction of all longwalls within the Project Area. Monitoring, actions and responsibilities are defined to ensure the early detection and potential remedying of any adverse impacts arising from the secondary extraction of coal from longwalls.

9.1.1 Current Monitoring

To ensure that the requirement to obtain two years of baseline data occurred, the seasonal and annual 'Brownstein et al (2014) based SMP was implemented in Autumn 2019. This program is detailed within the APMEP SMP (**Appendix B**), however; a summary of this program is provided below.

9.1.1.1 Annual Monitoring

The sampling design involves a series of three or more randomly selected and permanently marked transects spanning from edge to edge of the swamp community, perpendicular to the direction that water would travel for any given swamp. Transects were randomly located within the swamps for every 200 m of linear swamp length with a minimum of three transects per surveyed swamp. A 1 m x 1 m^2 floristic quadrat was conducted every four metres along each transect. Quadrats were placed off the transect using a 50 cm offset downstream (i.e. in the direction that water would travel for any given swamp) to minimise influence from trampling damage. Transects are resampled in an identical fashion for each monitoring event.

9.1.1.1.1 Measured Attributes

Percentage cover was estimated to the nearest 1%, when the cover is < 10%, and to the nearest 5% otherwise, hierarchically for the measured attributes: live green, course debris, fine debris, standing water and bare ground. Where multiple attributes co-occur at a single point only the value for the highest on the list is to be included (e.g. where 5% of live green cover intersects with an identical amount of course debris for that area the 5% will be attributed to live green cover and 0% to the course debris category). Combined, these percentages are to sum to 100%. Percentage cover for each species is calculated independently of these and can sum to > 100% or the calculated live green cover.

Transects are sampled at the same time of year to minimise the potential for inter-seasonal variance (i.e. October-November).

9.1.1.2 Seasonal Monitoring

Remote sensing in combination with ground control monitoring methods are ideally suited to the monitoring of sensitive environments and/or large areas. A description of the methods employed is provided in the following sections.

9.1.1.2.1 Remote Sensing

An airborne platform (i.e. light aircraft) was used to collect digital imagery of the impact and control swamps with the following specifications:

≠ Spatial resolution of 7 cm (i.e. each pixel covers a 7 cm x 7 cm horizontal area); and

≠ Spectral resolution including visual light [i.e. RGB and near-infrared (NIR) at an average bandwidth of 720 nm].

Remote sensing surveys were conducted conjointly with field observations (i.e. ground control points) to allow for confirmation of aerial imagery. Imagery was collected within each season during days of no cloud cover and roughly within two hours of solar noon to reduce canopy shadow effects.

9.1.1.2.2 Ground Control Points

The purpose of GCPs is to provide a field-based validation of information generated from the analysis of remotely sensed imagery (i.e. presence of live plant material) and collect additional information on flora species (e.g. percent weed cover). A minimum of three GCPs were permanently established in each swamp, with each comprising a plot measuring 1 m^2 in area to directly measure the variables listed below:

≠ Percentage live vegetation (i.e. photosynthetically active plant material);

≠ Percentage non-vegetated area (i.e. bare ground, water, litter and standing dead biomass);

≠ Percentage cover of each exotic plant species; and

≠ Dominant and co-dominant species in the overstorey, mid-storey and groundcover strata.

Each plot was randomly selected using a minimum distance between points function prior to surveys being conducted. Plots were adjusted on the ground where required to fit within the correct THPSS boundary mapping and ensure aerial visibility of the plot markers.

The plot was permanently marked by using the combination of a star picket and 30 cm x 30 cm metal plate affixed horizontally to the top of the star picket. A white cross was painted on the upper surface of the metal plate to allow for GCP recognition in each of the remotely sensed images. This white cross was periodically re-marked to ensure ongoing visibility.

9.2 Biodiversity Management Plan

The APMEP BMP (**Appendix C**) provides information on the proposed approach to monitoring terrestrial environments and areas of THPSS which have potential to be impacted as part of the Amended Project (SSD_5602).

The APMEP BMP has been developed prior to the issuing of Conditions of Consent with the aim of streamlining the approval process for the Project by demonstrating an in depth understanding of the potential impacts and best practice monitoring methods. The Conditions of Consent released for the approved adjacent SMEP (SSD_5594) have been consulted to inform the content of the BMP. Additionally, the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) have been used to guide the report.

The BMP has the purpose of outlining the biodiversity management and monitoring measures required to comply with regulatory approvals (when available) for the secondary extraction of all longwalls within the Project Area. Monitoring, actions and responsibilities are defined with the aim of early detection and remedying of any potential adverse biodiversity impacts arising from the secondary extraction of coal from the longwalls.

9.2.1 Proposed Monitoring

Threatened species known to be associated with THPSS include:

≠ Blue Mountains Water Skink (*Eulamprus leuraensis*), listed as Endangered under the BC Act and EPBC Act;

≠ Giant Dragonfly (*Petalura gigantea*), listed as Endangered under the BC Act;

≠ Deane's Boronia (*Boronia deanei*), listed as Vulnerable under the BC Act and EPBC Act;

≠ Red Crowned Toadlet (*Pseudophryne australis*; BC Act = Vulnerable);

≠ *Xerochrysum palustre* (Swamp Everlasting; EPBC Act = Vulnerable): and

≠ *Carex klaphakei* (Klaphake's Sedge; BC Act = Endangered)

The proposed mining may have a greater than negligible environmental consequence on THPSS, and possibly to the above THPSS-associated threatened species. Research and monitoring programs for Blue Mountains Water Skink, Giant Dragonfly and *Boronia deanei* have been conducted for Springvale Mine and are recommended for the APMEP to detect any potential mining related impacts to these species.

9.2.2 BMWS

The Blue Mountains Water Skink (BMWS) Research and Management Program (the 'Program') is based on a monitoring program designed for the purpose of detecting mining related impact on this species. This Program has already been implemented across the SMEP in order to detect any mining related impacts to the species and its habitat. This Program will also be utilised for the Amended Project.

The BMWS is listed as endangered under the EPBC Act and the BC Act. State and Commonwealth Recovery Plans prepared for the species have been considered in the development of the Program.

9.2.2.1 Objectives

Under the existing Consolidated Consent for Springvale (SSD_5594), the Program is required to determine if a greater than negligible impact has occurred as a consequence of mining (e.g. 'negligible change to the composition or distribution of species within the swamp'). As a function of this regulatory context, draft objectives for the Program and the proposed program for the Amended Project are listed below:

≠ Implementation of an efficient monitoring program for the BMWS with the principle aim being the detection of subsidence related pre-harm change in a BMWS population;

≠ Characterise a baseline dataset for impact and control sites, thus define the natural pre-impact variation within BMWS populations;

≠ Define meaningful quantitative triggers that sequentially delineate a trajectory towards a 'negligible impact' harm threshold;

≠ Support the development of an adaptive management framework by matching trigger levels with targeted restoration focused management actions, thereby minimising the potential incidence of a harm outcome exceeds a 'negligible' impact performance measure;

≠ Define restorative management actions linked to pre-harm trigger levels (i.e. adaptive management framework) to minimise the incidence of harm on the BMWS and its habitat; and

≠ Quantitatively show through the monitoring program that subsidence impacts have had a negligible impact on the BMWS and its habitat.

Considerable research opportunities also exist in the course of performing works for the above objectives. Potential to add to the scientific knowledge published on this species is outlined below:

≠ Identification of a cost effective and efficient sampling method suitable for detecting and monitoring the elusive and cryptic BMWS within a remote setting;

≠ Quantify the contribution made by key environmental variables that defines important habitat for the BMWS; and

≠ Investigate population demographics within impact and reference sampling area for the purposes of establishing population viability models.

9.2.3 Giant Dragonfly

The Giant Dragonfly Research and Management Program (the 'Program') is based on a monitoring program designed for the purpose of detecting mining related impacts on this species. This Program has already been implemented across the SMEP in order to detect any mining related impacts to the species and its habitat. This Program will also be utilised for the Amended Project.

The Giant Dragonfly (*Petalura gigantea*) is listed as an endangered species under the BC Act, and relies on the EPBC Act listed EEC THPSS for its survival.

9.2.3.1 Objectives

Under the existing Consolidated Consent for Springvale (SSD_5594), the Program aims to determine if a greater than negligible impact has occurred as a consequence of mining (e.g. 'negligible change to the composition or distribution of species within the swamp'). As a function of this regulatory context, draft objectives for the Program and the proposed program for the Amended Project are listed below:

≠ to identify current distributions, potential habitat preferences and other critical insights in Giant Dragonfly population dynamics across Newnes Plateau THPSS with consideration to the performance measures stated in Schedule 3 Condition 1 of SSD_5594.

≠ design a "Before and After Control Impact" (BACI) (Underwood 1992), due to its dual utility (i.e. BACI provides both effective monitoring framework and the capacity to deliver research outcomes).

≠ characterise a baseline dataset for impact and control sites thus defining the natural pre-impact variation within Giant Dragonfly populations;

≠ define meaningful quantitative triggers that sequentially delineate increasing levels of harm, such that a trajectory towards a breach in the 'negligible impact' harm threshold can be pre-emptively detected; and

≠ support an adaptive management framework that matches targeted restoration focused management actions with pre-emptive harm thresholds, thereby minimising the potential incidence of harm outcome exceeding the subsidence impact performance measures.

9.2.4 Boronia deanei

The *Boronia deanei* Research and Management Program (the 'Program') is based on a monitoring program designed for the purpose of detecting mining related impact on this species. This Program has already been implemented across the SMEP in order to detect any mining related impacts to the species and its habitat. This Program will also be utilised for the Amended Project.

B. deanei is listed as a vulnerable species under the BC Act and the EPBC Act. It is a swamp obligate shrub species, distributed in heath at the margins of open forest adjoining swamps or alongside streams. It is currently known to be distributed in scattered populations between the far south-east of NSW and the Blue Mountains, mainly in conservation reserves (OEH, 2017).

9.2.4.1 Objectives

Under the existing Consolidated Consent for Springvale (SSD_5594), the Program is required to determine if a greater than negligible impact has occurred as a consequence of mining (e.g. 'negligible change to the composition or distribution of species within the swamp'). As a function of this regulatory context, draft objectives for the Program and the proposed program for the Amended Project are listed below:

≠ obtain data capable of detecting change in *B. deanei* populations, over time, between treatments (i.e. impact and control habitat);

- ≠ adopt a Before-After-Control-Impact (BACI) monitoring framework (*sensu* Underwood 1992) as the basis for developing the monitoring design;
- ≠ develop an efficient monitoring program for *B. deanei* with the principal aim being the detection of subsidence-related change in populations;
- ≠ determine meaningful and measurable trigger values compatible with the monitoring program that define a preliminary threshold for 'negligible impact';
- ≠ inform potential restorative management actions linked to pre-harm trigger levels (i.e. adaptive management framework) to minimise the incidence of harm on *B. deanei* and its habitat; and
- ≠ quantitatively show through the monitoring program whether subsidence impacts have had a negligible impact on *B. deanei* and its habitat.

10 DISCUSSIONS

The following sections aim to analyse the potential for any impacts to threatened species, EECs or their habitats that may result from the APMEP. The analysis considers the differences between the Initial and Amended Project LoO assessments. In addressing the potential for impacts, the following causes of potential direct and indirect impacts have been considered:

≠ direct habitat removal within the Impact Envelope to accommodate surface facilities; and

≠ subsidence related impacts (for the area of predicted subsidence, which is referred to in **Table 10**, see MSEC (2019)); Those species/communities that have been identified as having potential to be impacted upon have been subject to further assessment and comment below with regards to where relevant.

A comparison between the Initial Project LoO and the Amended Project LoO has identified 40 additional threatened species that require being surveyed for within the Project Area. Of these, three are likely to occur within the Project Area in Swamps and 13 are likely to occur within the Impact Envelope (**Appendix A**). Of the 115 species analysed in the Amended Project LoO, 42 threatened flora and 50 fauna will require targeted surveys within the Impact Envelope, in line with the BAM because they are either likely to occur or are BAM Candidate Species. Of the species analysed in the Amened Project LoO, 35 are listed as Serious and Irreversible Impact (SAII) species, nine are known to occur, three are highly likely to occur and five have a moderate likelihood of occurring. SAII species require extra consideration by the determining authorities with regards to whether there should be any additional and appropriate measures to minimise impacts.

10.1 Potential surface infrastructure related impacts

The LoO analysis (**Appendix A**) has resulted in the identification of 66 threatened species with a moderate or higher likelihood of occurrence within the Project Area. Of these, 58 are species considered to be associated with habitats present within the Impact Envelope. The 58 species comprise 26 known to occur, 11 with a high likelihood and 21 with a moderate likelihood of occurrence. Species that are considered as known (2 species), or with a high (5 species) or moderate (6 species) likelihood of occurrence in the Impact Envelope that were not considered in the Initial project are listed in **Table 17**.

Table 17: Additional Threatened Species likely to occur within the Impact Envelope that were not considered in the Initial Project

Known	High Likelihood	Moderate Likelihood
Artamus cyanopterus cyanopterus (Dusky Woodswallow)	*Acacia meiantha*	*Acacia flocktoniae* (Flockton Wattle)
Petauroides volans (Greater Glider)	*Cryptostylis hunteriana** (Leafless Tongue-orchid)	*Darwinia peduncularis*
	*Pultenaea glabra**	*Isopogon fletcheri*
	Prasophyllum pallens	*Leionema lachnaeoides*
	Kunzea cambagei	*Leionema sympetalum* (Rylstone Bell)
		Zieria murphyi

*Note: In the Initial Project, these species were previously thought to be unlikely to occur within the Project Area, however, recent surveys in the region have identified them in similar habitats to that of the Project Area within the locality. Consequently, they are now considered likely to occur.

The following species were listed after the lodgement of the 2014 EIS and therefore were not considered:

≠ The Dusky Woodswallow was listed as Vulnerable under the BC Act on 5 August 2016;

≠ The Greater Glider was listed as Vulnerable under the EPBC Act on 25 May 2016; and

≠ *Acacia meiantha* was listed as Endangered under the EPBC Act on the 11 May 2018 and BC Act on 2 October 2015.

The *Prasophyllum pallens* and *Kunzea cambagei* have both been recorded in similar habitats to that of the Poject Area within close proximity to the Project Area since the Initial Project.

The remaining species with a moderate likelihood of occurrence are additional species from the recent database searches which were not previously considered to occur within the locality or the habitats of the Project Area. The above listed species in **Table 17** have been included for brevity. As aforementioned, comprehensive surveys in line with the BAM are to be conducted for these species which are a subset of the 42 threatened flora and 50 fauna in the Impact Envelope prior to construction activities. Verification of species presence or absence will then be used to inform the actual impact and associated credit liability analysis.

10.2 Potential Swamp related impacts

10.2.1 THPSS

As part of the offset calculations which underpin the Swamp Offset Strategy (**Appendix D**), BioBanking Assessment Methodology (BBAM 2014) plot data collected in Gang Gang and Carne West Swamps before and after mining was used to calculate the average Vegetation Integrity Score (VIS). The VIS was approximately 71.46 pre-mining and approximately 44.7 post mining. The difference between these two numbers is 37.5% (i.e. 44.7/71.46x100), which is calculated as the loss of VIS post mining.

Gang Gang and Carne West Swamps were selected as representative of the expected change in THSS condition in the long-term post mining since:

≠ Vegetation condition was measured prior to and after mining using the same survey method and effort [six BBAM plots total both before and after mining (April 2019); three plots in both Gang Gang and Carne West on both occasions];

≠ Habitat condition was of high condition in both swamps (comparable to other unimpacted swamps across Newnes Plateau) prior to mining impacts by SEMP LW418-419, so was representative of the extent of impact attributed to mining;

≠ A considerable period had lapsed since mining (i.e. mining of SEMP LW418 was between 22/11/2015 and 27/05/2016), suggesting that the extent of the impact of longwall mining on THPSS is at least close to stabilising; and

≠ Gang Gang and Carne West still provide habitat for BMWS and *B. deanei* post mining (as evidenced by annual monitoring programs), suggesting that the degraded condition of these swamps post mining still constitutes habitat for these two species.

The evidence to date shows that the condition of Impacted THPSSs has only declined, and not completely died off.

10.2.2 Associated species

The LoO analysis (**Appendix A**) has resulted in the identification of 66 threatened species with a moderate or higher likelihood of occurrence within the Project Area. Of these, eight are considered to be associated with habitats present within the swamps. The eight species comprise four that are known to occur, three that have a high likelihood and one with a moderate likelihood of occurrence. Species that are considered as known (1 species), or with a high (1 species) or moderate (1 species) likelihood of occurrence in the swamps that were not considered in the Initial project are listed in **Table 18**.

Table 18: Additional Threatened Species likely to occur within the Swamps that were not considered in the Initial Project

Known	High Likelihood	Moderate Likelihood
Carex klaphakei	*Xerochrysum palustre* (Swamp Everlasting)	*Eucalyptus copulans*

As aforementioned, recent surveys identified *C. klaphakei* during monitoring within the Project Area in Twin Gully Swamp which is a range extension for this species. '*C. klaphakei* is found in only three locations, from the Blue Mountains (at Blackheath and Mt Werong) to the Southern Highlands (at Penrose;' BCD 2019). The *X. palustre* was identified in Pine Swamp which is within the SMEP and this is also a range extension for this species. '*X. palustre* in Kosciuszko National Park and the eastern escarpment south of Badja. Also found in eastern Victoria' (BCD 2019). Although the Threatened Species Profile (BCD 2019) states that no *E. copulans* original trees remain extant. RPS is of the opinion that the habitat within the swamp margins has the potential to support the species.

The THPSS and associated threatened species will continue to be surveyed and monitored through ongoing baseline surveys in the swamps as part of the draft SMP and BMP to confirm the presence or absence of the above listed species.

11 CONCLUSION

This BIA draws upon existing data collected during earlier biodiversity assessments and monitoring by RPS, specialist subsidence and water management reports, as well as recently collected floristic data. As well as assessing the potential impacts to biodiversity values arising from the amended Project, this report also provides a comprehensive SMP and BMP that were designed to effectively respond to impacts to biodiversity values as mining progresses. Lastly, in the case of impacts to swamps, a Swamp Offset Strategy is presented that satisfies requirements under the BOS and the Commonwealth EPBC Act Environmental Offsets Policy.

11.1 Surface Infrastructure Impacts

To provide flexibility for the location of infrastructure throughout the life of the project, the amended project proposes to undertake surface disturbance activities within an Impact Envelope of 49.93 ha. This is an increase of 26.69 ha of potential surface disturbance since the initial EIS. However, the actual footprint will likely be far less as infrastructure will be designed to avoid and minimise impacts on bushland and threatened species by avoiding areas of high biodiversity value, confining construction to pre-disturbed areas and established access tracks where possible. Where impacts cannot be avoided, the actual offset liabilities will be offset in accordance with the BC Act. These actual offset requirements will be informed by extensive field surveys before construction (in accordance with the Biodiversity Assessment Method; BAM), which will include use of high-resolution (7 cm pixel resolution) aerial photography before and after construction.

11.2 Subsidence-related Impacts

In contrast to the initial EIS, knowledge recently gained from ecological monitoring at Springvale and Angus Place and re-calibration of Subsidence models by MSEC (2019) suggest that the Angus Place Extension Project is likely to be a greater than negligible impact upon THPSS. Subsidence-related impacts are expected at Tri Star Swamp, Twin Gully Swamp and the hanging swamps within their catchments. These impacts may include vegetation dieback, major incision and erosion (in some instances down to bedrock), associated with loss of peat layer, significant loss of ecosystem function and ecological resilience, and ecological and geomorphic threshold exceedance. As such, impacts to THPSS-associated threatened species are also likely in these locations; these species are the Blue Mountains Water Skink (*Eulamprus leuraensis*), Giant Dragonfly (*Petalura gigantea*), Deane's Boronia (*Boronia deanei*), Red Crowned Toadlet (*Pseudophryne australis*), Swamp Everlasting (*Xerochrysum palustre*) and Klaphake's Sedge (*Carex klaphakei*).

11.3 Mine-water Discharge Impacts

The EIS (Centennial Coal 2014) assessed up to 30 ML/day of mine water discharges from the Angus Place Colliery LDP001. Although the 2014 EIS concluded that this volume of discharge and expected water quality will unlikely have a significant impact on threatened entities or other MNES, the Amended Project will avoid the potential to impact downstream sensitive receivers since any excess groundwater not used for onsite operational requirements will be transferred to the Springvale Water Treatment Project (SSD_7592).

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Appendix A

Amended Project - Likelihood of Occurrence

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Litoria booroolongensis (Booroolong Frog)	E	E	The Booroolong Frog is found along permanent western flowing streams of the Great Dividing Range through most of NSW and down into northern Victoria. Streams range from small slow-flowing creeks to large rivers and the adults are found on or near cobble banks and other rock structures within stream margins and shelter under rocks or amongst vegetation near the ground on the stream edge. The species occurs along streams in both forested areas and open pasture but has been affected by the presence of the introduced willow tree. Booroolong Frogs sometimes basks in the sun on exposed rocks near flowing water during summer.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Litoria littlejohni (Littlejohn's Tree Frog)	V	V	Occurs in wet and dry sclerophyll forests and heathland associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range from the Central Coast down into Victoria. Individuals have been collected from a wide range of water bodies that includes semi-permanent dams, permanent ponds, temporary pools and permanent streams, with calling occurring from fringing vegetation or on the banks. Individuals have been observed sheltering under rocks on high exposed ridges during summer and within deep leaf litter adjacent to the breeding site. Calling occurs in all months of the year, often in association with heavy rains. The tadpoles are distinctive, being large and very dark in colouration.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).
Heleioporus australiacus (Giant Burrowing Frog)	V	V	The Giant Burrowing Frog has been recorded breeding in a range of water bodies associated with more sandy environments of the coast and adjacent ranges from the Sydney Basin south the eastern Victoria. It breeds in hanging swamps, perennial non-flooding creeks and occasionally permanent pools, but permanent water must be present to allow its large tadpoles time to reach metamorphosis.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Mixophyes balbus (Stuttering Frog)	E	V	Associated with streams in dry sclerophyll and wet sclerophyll forests and rainforests of more upland areas of the Great Dividing Range of NSW and down into Victoria. Breeding occurs along forest streams with permanent water where eggs are deposited within nests excavated in riffle zones by the females and the tadpoles swim free into the stream when large enough to do so. Outside of breeding, individuals range widely across the forest floor and can be found hundreds of metres from water	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.
Pseudophryne australis (Red-crowned Toadlet)	V	-	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. After rain these creeks are characterised by a series of shallow pools lined by dense grasses, ferns and low shrubs and usually contain leaf litter for shelter. Eggs are terrestrial and laid under litter, vegetation or rocks where the tadpoles inside will reach a relatively late stage of development before waiting for flooding waters before hatching will occur.	0	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Hoplocephalus bungaroides (Broad-headed Snake)	E	V	Occurs almost exclusively in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they spend most of the year sheltering in and under rock crevices and exfoliating rock. However, some individuals will migrate to tree hollows to find shelter during hotter parts of summer.	1	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records).
Aprasia parapulchella (Pink-tailed Legless Lizard)	V	V	Inhabits sloping, open woodland areas with predominantly native grassy ground layers, particularly those dominated by kangaroo grass. Sites are typically well-drained, with rocky outcrops or scattered, partially buried rocks.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Eulamprus leuraensis (Water skink)	E	E	The species is restricted to isolated and naturally fragmented habitats of permanent sedge and hanging swamps (these develop at moderate to high altitudes on sloping rock faces composed of Narrabeen sandstone which are subject to a constant supply of water), in open forest and open scrub or heath.	68	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Varanus rosenbergi (Rosenberg's Goanna)	V	-	This species is a Hawkesbury-Narrabeen sandstone outcrop specialist. Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests.	1	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Haliaeetus leucogaster (White-bellied Sea-Eagle)	V	M	Inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.
Hieraaetus morphnoides (Little Eagle)	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees.	1	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Lophoictinia isura (Square-tailed Kite)	V	-	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by Eucalyptus longifolia, Corymbia maculata, E. elata or E. smithii. Individuals appear to occupy large hunting ranges of more than 100km2. They require large living trees for breeding, particularly near water with surrounding woodland -forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Hirundapus caudacutus (White-throated Needletail)	-	V, MAR, MIG	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges.	0	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Not recently observed in the locality (NSW BioNet records).
Botaurus poiciloptilus (Australasian Bittern)	E	E	The Australasian Bitterns is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Artamus cyanopterus cyanopterus (Dusky Woodswallow)	V	-	The Dusky Woodswallow is widespread in eastern, southern and southwestern Australia. In New South Wales it is widespread from coast to inland, including the western slopes of the Great Dividing Range and farther west. It is sparsely scattered in, or largely absent from, much of the Upper Western region. The Dusky Woodswallow is often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests. At sites where Dusky Woodswallows are recorded the understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, including heath. The ground cover may consist of grasses, sedges or open ground, often with coarse woody debris (Higgins and Peter 2002). Birds are also often observed in farmland, usually at the edges of forest or woodland or in roadside remnants or wind breaks with dead timber.	5	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Callocephalon fimbriatum (Gang-gang Cockatoo)	V	-	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Also occur in subalpine snow gum woodland and occasionally in temperate or regenerating forest. In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. It requires tree hollows in which to breed.	86	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Calyptorhynchus lathami (Glossy Black-Cockatoo)	V	-	Inhabits forest with low nutrients, characteristically with key Allocasuarina spp. Tends to prefer drier forest types with a middle stratum of Allocasuarina below Eucalyptus or Angophora. Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead. Endangered population in the Riverina.	6	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Climacteris picumnus victoriae (Brown Treecreeper (eastern subspecies))	V	-	Found in eucalypt woodlands (including box-gum woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and river red gum forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	2	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Anthochaera phrygia (Regent Honeyeater)	CE	E,M	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. The distribution of the species has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests.	2	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Grantiella picta (Painted Honeyeater)	V	-	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits boree, brigalow and box-gum woodlands and box-ironbark forests.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).
Melithreptus gularis (Black-chinned Honeyeater (eastern subspecies))	V	-	Eucalypt woodlands within an approximate annual rainfall range of 400-700mm	0	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Daphoenositta chrysoptera (Varied Sittella)	V	-	Inhabits wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy ground cover or both, in all climatic zones of Australia. Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows.	15	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Chthonicola sagittata (Speckled Warbler)	V	-	The Speckled Warbler lives in a wide range of eucalypt 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.	1	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

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Stagonopleura guttata (Diamond Firetail)	V	-	Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Found in grassy eucalypt woodlands, including box-gum woodlands and snow gum woodlands. Also occurs in open forest, mallee, natural temperate grassland, and in secondary grassland derived from other communities.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).
Melanodryas cucullata cucullata (Hooded Robin (south-eastern form))	V	-	Occupy a wide range of eucalypt woodlands, Acacia shrublands and open forests.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Petroica boodang (Scarlet Robin)	V	-	The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs.	126	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Petroica phoenicea (Flame Robin)	V	-	Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January.	183	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Pomatostomus temporalis (Grey-crowned Babbler (eastern subspecies))	V	-	In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. Inhabits open box-gum woodlands on the slopes, and box-cypress-pine and open box woodlands on alluvial plains.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Glossopsitta pusilla (Little Lorikeet)	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.	5	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records).
Lathamus discolor (Swift Parrot)	E	CE	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects

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					of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).
Neophema pulchella (Turquoise Parrot)	V	-	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).

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Rostratula australis (Australian Painted Snipe)	E	E, M	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).
Calidris ferruginea (Curlew Sandpiper)	E	CE	The Curlew Sandpiper is distributed around most of the coastline of Australia. It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Numenius madagascariensis (Eastern Curlew)	-	CE	The Eastern curlew spends its breeding season in northeastern Asia, including Siberia to Kamchatka, and Mongolia. Its breeding habitat is composed of marshy and swampy wetlands and lakeshores. Most individuals winter in coastal Australia, with a few heading to South Korea, Thailand, Philippines and New Zealand, where they stay at estuaries, beaches, and salt marshes. It uses its long, decurved bill to probe for invertebrates in the mud. It may feed in solitary but it generally congregates in large flocks to migrate or roost. Its call is a sharp, clear whistle, cuuue-reee, often repeated.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.
Ninox connivens (Barking Owl)	V	-	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).

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Ninox strenua (Powerful Owl)	V	-	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within red turpentine in tall open forests and black she-oak within open forests. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm.	14	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Tyto novaehollandiae (Masked Owl)	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. Nest hollows are usually located within dense forests or woodlands. Masked owls' prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).

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Tyto tenebricosa (Sooty Owl)	V	-	Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude less than 500 metres. Nests and roosts in hollows of tall emergent trees, mainly eucalypts often located in gullies. Nests have been located in trees 125 to 161 centimetres in diameter.	0	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Not recently observed in the locality (NSW BioNet records).
Cercartetus nanus (Eastern Pygmy-possum)	V	-	Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows but can also construct its own nest. Because of its small size it is able to utilise a range of hollow sizes including very small hollows. Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5ha area over a 5-month period.	14	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

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Dasyurus maculatus maculatus (Spotted-tailed Quoll)	V	E	Spotted-tailed Quoll are found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. 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.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).
Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat)	V	-	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	9	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

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Petrogale penicillata (Brush-tailed Rock-wallaby)	E	V	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).
Pseudomys novaehollandiae (New Holland Mouse)	-	V	The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects

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					of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).
Isoodon obesulus obesulus (Southern Brown Bandicoot (eastern))	E	-	Prefers sandy soils with scrubby vegetation and-or areas with low ground cover that are burn from time to time. A mosaic of post fire vegetation is important for this species.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).

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Petaurus australis (Yellow-bellied Glider)	V	-	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).
Petaurus norfolcensis (Squirrel Glider)	V	-	Generally, occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias. There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked. Endangered population in the Wagga Wagga LGA.	1	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

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Phascolarctos cinereus (Koala)	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).
Petauroides volans (Greater Glider)	-	V	The Greater Glider occurs in eucalypt forests and woodlands. Utilise tree hollows	290	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Pteropus poliocephalus	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in

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(Grey-headed Flying-fox)			of the day roost although some individuals may travel up to 70 km.		low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).
Chalinolobus dwyeri (Large-eared Pied Bat)	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Can also be found on the edges of rainforests and in wet sclerophyll forests. This species roosts in caves and mines in groups of between 3 and 37 individuals.	24	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).

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Falsistrellus tasmaniensis (Eastern False Pipistrelle)	V	-	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high. Two observations have been made of roosts in stem holes of living eucalypts. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor. This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites.	30	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Miniopterus australis (Little Bentwing-bat)	V	-	Coastal north-eastern NSW and eastern Queensland. Little Bent-wing Bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel 100s km from feeding home ranges to breeding sites. Little Bent-wing Bat has a preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).

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Miniopterus schreibersii oceanensis (Eastern Bentwing-bat)	V	-	Eastern Bent-wing Bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.	36	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Myotis macropus (Southern Myotis)	V	-	The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).

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Nyctophilus corbeni (South-eastern Long-eared Bat)	V	V	The South-eastern Long-eared Bat has a limited distribution that is restricted around the Murray-Darling Basin in south-eastern Australia. Even in this region its distribution is scattered and it is rarely recorded. It occurs in far eastern South Australia, in areas north of the Murray River, east of Canegrass Station and south of the Barrier Highway. These areas include the Riverland Biosphere Reserve, Danggali Conservation Park and the Birds Australia Gluepot Reserve. It is distributed throughout inland NSW except in the north-west area which is dominated by treeless plains. It can be found in the Hunter Valley, extending from central NSW to the eastern Hunter Valley coast. Considered Nyctophilus timorensis south eastern form under TSC Act.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.
Scoteanax rueppellii (Greater Broad-nosed Bat)	V	-	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m. In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat. This species roosts in hollow tree trunks and branches.	0	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Not recently observed in the locality (NSW BioNet records).

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Vespadelus troughtoni (Eastern Cave Bat)	V	-	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT. 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.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records).
Paralucia spinifera (Bathurst Copper Butterfly)	E	V	The Copper Butterfly is only found in the Central Tablelands of NSW. Its habitat is restricted to elevations above 900 m where it feeds exclusively on a form of blackthorn. The butterfly's life cycle relies on a 'mutualistic' relationship with the ant Anonychomyrma itinerans, and on the presence of blackthorn (Bursaria spinosa subsp. lasiophylla).	7	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

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Petalura gigantea (Giant Dragonfly)	E	-	The Giant Dragonfly is found along the east coast of NSW from the Victorian border to northern NSW. It is not found west of the Great Dividing Range. There are known occurrences in the Blue Mountains and Southern Highlands, in the Clarence River catchment, and on a few coastal swamps from north of Coffs Harbour to Nadgee in the south. Live in permanent swamps and bogs with some free water and open vegetation. Adults emerge from late October and are short-lived, surviving for one summer after emergence.	19	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Caesia parviflora var. minor (Small Pale Grass-lily)	E	-	Found in damp places in open forest on sandstone.	72	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Xanthosia scopulicola	V	-	Known only from scattered locations between Kings Tableland (Wentworth Falls) and Boars Head rock (west of Katoomba) in the Blue Mountains. Grows in	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types

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			cracks and crevices of sandstone cliff faces or on rocky outcrops above the cliffs.		(i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).
Astrotricha crassifolia	V	V	Occurs near Patonga (Gosford LGA), and in Royal NP and on the Woronora Plateau (Sutherland and Campbelltown LGAs). There is also a record from near Glen Davis (Lithgow LGA). Also, in Victoria. Occurs in dry sclerophyll woodland on sandstone.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of

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					supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).
Wollemia nobilis (Wollemi Pine)	E	E	The Wollemi Pine occurs in the warm temperate rainforest and rainforest margins in a eucalypt forest-woodland complex within the Sydney Sandstone Biome of the eastern coast of NSW. Topography controls vegetation associations where Wollemi Pine occurs. Within the canyon's rainforest occurs and the surrounding ridges have dry sclerophyll woodland. Associated species of these communities include Ceratopetalum apetalum, Doryphora sassafras, Acmena smithii, Backhousea myrtifolia, Quintinia sieberi, Angophora floribunda, Dicksonia antarctica, Cyathea australis, Eupomatia laurina, Lepidosperma urophorum, Sticherus flabellatus, Todea barbara, Cissus hypoglauca, Clematis aristata, Pandorea pandorana and Parsonsia straminea.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).
Cynanchum elegans (White-flowered Wax Plant)	E	E	Recorded from rainforest gullies scrub and scree slopes from the Gloucester district to the Wollongong area and inland to Mt Dangar.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

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Leucochrysum albicans var. tricolor (Hoary Sunray)	Not listed	V	Hoary Sunray occurs in a wide variety of grassland, woodland and forest habitats, generally on relatively heavy soils. Plants can be found in natural or semi-natural vegetation and grazed or un-grazed habitat. Bare ground is required for germination. In NSW, the species is often found in association with yellow box, Blakely's red gum and red box.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.
Ozothamnus tesselatus	V	V	Grows in eucalypt woodland. Upper Hunter from Ravensworth to Bylong and west of Divide at Bunnan.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

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Xerochrysum palustre (Swamp Everlasting)	-	V	Grows in swamps and bogs which are often dominated by heaths. Also grows at the edges of bog margins on peaty soils with a cover of shrubs or grasses. Sometimes grows in bogs with Sphagnum. Re-sprouts after fires.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Carex klaphakei	E	-	Found in only three locations, from the Blue Mountains (at Blackheath and Mt Werong) to the Southern Highlands (at Penrose). Grows with other native sedges and rushes in swamps on sandstone at altitudes of greater than 600 metres.	0	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species not recently observed in the locality (NSW BioNet records).
Lastreopsis hispida (Bristly Shield Fern)	E	-	Grows in moist humus-rich soils in wet forest and rainforest gullies.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types

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					(i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).
Epacris hamiltonii	E	E	Occurs in the Blue Mountains, west of Sydney. Found at 72 sites within three creek catchments. The creeks occur in an altitude range of 810-940 metres a.s.l. and are all located on the northern side of the escarpment and flow into the Grose Valley. All known sites occur within a radius of approximately 5 km. Has a very specific habitat, being found on or adjacent to Narrabeen sandstone cliffs alongside perennial creeks, often below plateau hanging swamps. The soil generally has a spongy-peat-like consistency, with a very high moisture content. Sites are found at the sheltered base of cliffs adjacent to wet gully or swamp vegetation, usually where a perennial or virtually perennial source of water, such as cliff seepages, is present.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of

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					supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).
Leucopogon exolasius (Woronora Beard-heath)	V	V	Grows in woodland on sandstone. Restricted to the Woronora and Grose Rivers and Stokes Creek, Royal National Park.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

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Acacia baueri subsp. aspera	V	-	Occurs in low, damp heathlands, often on exposed rocky outcrops over a wide range of climatic and topographical conditions. Appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development; and many of the observations of this species have been made following fire, suggesting the species prefers early successional habitats. Restricted to the Sydney region, occurring on the Kings Tableland in the central Blue Mountains and with sporadic occurrences on the Woronora Plateau in the Royal National Park, Mt. Keira district and at Wedderburn. May also occur on the escarpment-Woronora Plateau in the Flat Rock Junction and Stanwell Tops area of the Illawarra.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

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Acacia bynoeana (Bynoe's Wattle)	E	V	Grows mainly in heath and dry sclerophyll forest in sandy soils. Mainly south of Dora Creek-Morisset area to Berrima and the Illawarra region, west to the Blue Mountains, also recorded from near Kurri Kurri in the Hunter Valley and from Morton National Park.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Acacia flocktoniae (Flockton Wattle)	V	V	Grows in dry sclerophyll forest on sandstone.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Acacia meiantha	E	E	The Clarence population occurs in open eucalypt forest in association with E. dives and E. sieberi and in an adjacent area of mostly shrubs where the tree overstorey was cleared for powerlines; it is found on sandy soil over sandstone at approx. 1000 m elevation.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Dillwynia tenuifolia	V	-	The core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in western Sydney are recorded from Voyager Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. Disjunct localities include: the Bulga Mountains at Yengo in the north, Kurrajong Heights and Woodford in the Lower Blue Mountains. In western Sydney, may be locally abundant particularly within scrubby-dry heath areas within Castlereagh Ironbark forest and Shale Gravel Transition forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
			woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone.		
Pultenaea glabra	V	V	Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone. Restricted to the higher Blue Mountains.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Pultenaea sp. Olinda	E	-	Has been found only in a very limited area of pagoda rock formation east of Rylstone.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Velleia perfoliata	V	V	The species is only known from the Hawkesbury District and Upper Hunter Valley in the Central Coast botanical subdivision of NSW. *Velleia perfoliata* grows in heath on shallow sandy soil over Sandstone. It is currently known to exist in 9 populations. Five of these populations are reserved whilst a further population is partly reserved. Four of the reserved sites are situated adjacent to fire trails.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).
Haloragodendron lucasii	E	E	Occurs on Hawkesbury Sandstone in moist sandy loam soil. The species prefers sheltered aspects and inhabits gentle slopes below cliff lines near creeks in low open woodland or open forest. Its distribution is correlated with high soil moisture and phosphorus levels.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Prostanthera cryptandroides subsp. *cryptandroides*	V	-	At Glen Davis, occurs in open forest dominated by Eucalyptus fibrosa. Other eucalypt species may be present as sub-dominants. In the Denman-Gungal and Widden-Baerami Valley areas, occurs on rocky ridgelines on Narrabeen Group Sandstones in association with a range of communities.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Prostanthera discolor	V	V	Grows in dry sclerophyll forest in the side gullies of main creek lines, often on rocky or well-drained alluvial substrates. Does not appear to reproduce vegetatively.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Darwinia peduncularis	V	-	Occurs as local disjunct populations in coastal NSW with a couple of isolated populations in the Blue Mountains. It has been recorded from Brooklyn, Berowra, Galston Gorge, Hornsby, Bargo River, Glen Davis, Mount Boonbourwa and Kings Tableland. Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Eucalyptus aggregata (Black Gum)	V	-	Found in the NSW Central and Southern Tablelands, with small isolated populations in Victoria and the ACT. Has a moderately narrow distribution, occurring mainly in the wetter, cooler and higher parts of the tablelands in the lowest parts of the landscape, on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. Also occurs as isolated paddock trees in modified native or exotic pastures.	186	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.
Eucalyptus cannonii	V	-	Restricted to an area of about 100 by 60 km in the central tablelands of NSW. The western border is approximately marked by a line between Bathurst and Mudgee, while the eastern locations occur approximately on a line between Lithgow and the town	5	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
			of Bylong. Within this area the species is often locally frequent. Recorded from Tablelands Grassy woodland Complex communities and Talus Slope woodland, and in Winburndale Nature Reserve within woodland dominated by Eucalyptus macrorhyncha and Eucalyptus goniocalyx.		investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species recently observed in the locality (NSW BioNet records).
Eucalyptus copulans	E	E	Only one individual tree is currently known, on Council Reserve along Jamison Creek at Wentworth Falls in the Blue Mountains, NSW. A second tree nearby may also be E. copulans although it has not been formally identified as such. A larger population is thought to have occurred historically in the locality.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Eucalyptus pulverulenta (Silver-leaved Mountain Gum)	V	V	Found in two quite separate areas, the Lithgow to Bathurst area and the Monaro (Bredbo to Bombala). Grows in shallow soils as an understorey plant in open forest, typically dominated by brittle gum, red stringybark, broad-leaved peppermint, silvertop ash and apple box.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Homoranthus darwinioides	V	V	Grows in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Landforms the species has been recorded growing on include flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes, and a slight depression on a roadside with loamy sand.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Kunzea cambagei	V	V	Occurs in wet heath and woodland on coarse sandy soil on sandstone and quartzite.	0	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species not recently observed in the locality (NSW BioNet records).
Cryptostylis hunteriana (Leafless Tongue-orchid)	V	V	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (Eucalyptus sclerophylla), Silvertop Ash (E. sieberi), Red Bloodwood (Corymbia gummifera) and Black Sheoak (Allocasuarina littoralis); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (C. subulata) and the Tartan Tongue Orchid (C. erecta).	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Genoplesium superbum (Superb Midge Orchid)	E	-	The Superb Midge Orchid occurs predominantly in wet heathland on shallow soils above a sandstone cap but has also been found in open woodland interspersed with heath and dry open shrubby woodland.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Prasophyllum fuscum (Tawny Leek-orchid)	CE	V	Prasophyllum fuscum is endemic to New South Wales where it is currently known only from the upper catchment of the Georges River, south-west of Sydney. The only recent collection of the species is from a roadside in the Wilton district. The species is very similar to Prasophyllum uroglossum but occurs further north and differs by having a much shorter midlobe on the labellum and by having the callus extending well onto the midlobe. Prasophyllum pallens, which has also been confused with Prasophyllum fuscum, is known only from the Blue Mountains and can be distinguished by having paler-coloured flowers with a musty smell.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Prasophyllum pallens	V	-	Prasophyllum pallens is a terrestrial herb of the Leek Orchid genus. Plants are up to 40 cm high and up to 30 flowers are crowded on an inflorescence up to 50 mm tall. Flowers are a pale tawny green to whitish with a 'rather unpleasant musty fragrance' that is very noticeable in warm to hot weather. Flowering is from November to December. P. pallens was first described from a specimen from Mount Banks in Blue Mountains National Park. P. pallens grows in dense low heath, often along seepage lines, in moist to wet shallow sandy soils over sandstone, mostly at altitudes greater than 900 m above sea level. The species is presently known from four distinct populations: Mt Banks and Mt Hay in Blue Mountains National Park, and near the townships of Blackheath and Wentworth Falls. Historical records suggest that it once occurred near Leura, Bell and Mount Victoria.	0	High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Prasophyllum petilum (Tarengo Leek Orchid)	E	E	Grows in open sites within Natural Temperate Grassland at the Boorowa and Delegate sites and in grassy woodland in association with River Tussock Poa labillardieri, Black Gum Eucalyptus aggregata and tea-trees Leptospermum spp. near Queanbeyan and within the grassy groundlayer dominated by Kanagroo Grass under Box-Gum Woodland at Ilford (and Hall, ACT)	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

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Prasophyllum sp. Wybong (A leek orchid)	-	CE	Endemic to NSW. It is known from seven populations in eastern NSW near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Grevillea evansiana (Evans Grevillea)	V	V	Grows in dry sclerophyll forest or woodland, occasionally in swampy heath, in sandy soils, usually over Hawkesbury sandstone.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Grevillea obtusiflora	E	E	Occurs as scattered groups in the understorey of low open eucalypt forest at an altitude of 730 metres above sea level. Subspecies fecunda occurs in clusters within low, open scrub beneath open, dry sclerophyll forest, on orange, sandy loam soils with sandstone boulders, at an altitude of 570 metres.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Isopogon fletcheri	V	V	Grows in dry sclerophyll forest and heath on sandstone; confined to sheltered moist positions on the escarpment in the Blackheath district of the Blue Mtns, rare.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Persoonia acerosa	V	V	Occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils. Recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba, Wentworth Falls, Springwood area.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Persoonia hindii	E	-	Occurs in dry sclerophyll forests and woodlands on sandy soils. Stoloniferous (has underground horizontal stems) and is thought to be clonal. Hence, each location may comprise only one to a few individuals.	98	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Persoonia hirsuta (Hairy Geebung)	E	E	Distributed from Singleton in the north, along the east coast to Bargo in the south and the Blue Mountains to the west. A large area of occurrence, but occurs in small populations, increasing the species' fragmentation in the landscape. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone. Usually present as isolated individuals or very small populations. Probably killed by fire (as other Persoonia spp. are) but will regenerate from seed.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Persoonia marginata	V	V	Grows in dry sclerophyll forest and woodland communities on sandstone. Appears to respond well to disturbance, with greater densities found along the edges of tracks and in areas disturbed by forestry activities.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records).

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Pomaderris brunnea (Brown Pomaderris)	V	V	The species is expected to live for 10 - 20 years, while the minimum time to produce seed is estimated to be 4 - 6 years. Found in a very limited area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area. It also occurs at Walcha on the New England Tableland and in far eastern Gippsland in Victoria.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Pomaderris cotoneaster	E	E	0	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Boronia deanei	V	V	Scattered populations occur between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves. Grows in wet heath, often at the margins of open forest adjoining swamps or along streams.	87	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Leionema lachnaeoides	E	E	0	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Leionema sympetalum (Rylstone Bell)	V	V	Restricted to exposed rocky sandstone formations known as pagodas. The species occurs in dry sclerophyll forest and probably also occurs in open or closed heathland communities.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Zieria murphyi	V	V	The species grows in open, dry sclerophyll forest, on sandy soils on sandstone and in sheltered sites, often just below clifflines	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Thesium australe (Austral Toadflax)	V	V	Grows in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland. Grows on kangaroo grass tussocks but has also been recorded within the exotic coolatai grass.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.
Euphrasia arguta	CE	CE	Occur in eucalypt forest with a mixed grass and shrub understorey within Nundle State forest. Sites have either been logged in the last few decades or appear to have regrown from past clearing.	0	None. Suitable 'vegetation formation level' habitat surrogates are absent from the study area. Species incidence is not expected and, if present, would represent atypical habitat usage.

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
Euphrasia bowdeniae	V	V	This species in known to occur at 750 m asl but is likely to occur up to 1000-1100 m asl. It is found on vertical sandstone cliffs, in very shallow soil on rocky ledges, or trailing over steep exposed rocks.	0	Moderate. Species specific (i.e. important habitat features) and vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Species not recently observed in the locality (NSW BioNet records).
Veronica blakelyi	V	-	Restricted to the western Blue Mountains, near Clarence, near Mt Horrible, on Nullo Mountain and in the Coricudgy Range. Occurs at fewer than 20 locations, none of which is in a conservation reserve. Occurs in eucalypt forest, often in moist areas.	6	Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records).
Hygrocybe anomala var. *ianthinomarginata*	V	-	Occurs in gallery warm temperate forests dominated by lilly pilly, grey myrtle, cheese tree and sweet pittosporum. Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
			fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.		low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).
Hygrocybe aurantipes	V	-	Occurs in gallery warm temperate forests dominated by lilly pilly, grey myrtle, cheese tree and sweet pittosporum. Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects

Scientific Name (Common Name)	BC Act status	EPBC Act status	Habitat	Recent Records (BCD 2019)	Likelihood of Occurrence
					of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).
Hygrocybe reesiae	V	-	Occurs in gallery warm temperate forests dominated by lilly pilly, grey myrtle, cheese tree and sweet pittosporum. Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	0	Low. Vegetation classification-based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, habitat utilisation is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Not recently observed in the locality (NSW BioNet records).

Appendix B

Swamp Monitoring Program

Centennial Coal

Draft Swamp Monitoring Program

Angus Place Mine Extension Project

November 2019

TABLE OF CONTENTS

List of Figures

List of Tables

DOCUMENT CONTROL

DOCUMENT DETAILS	Name:	Swamp Monitoring Program for Angus Place Extension
	Author:	RPS Australia East Pty Ltd
	Revision No.:	2
	Document Status	Final

1. INTRODUCTION

The intention of this draft Swamp Monitoring Program (SMP) is to provide a proposed framework and approach to the monitoring of impacts on the NSW listed Newnes Plateau Shrub Swamps (NPSS) and Commonwealth listed Temperate Highland Peat Swamp on Sandstone (THPSS) where there is potential for these to be impacted by the proposed Angus Place Mine Extension Project (APMEP; SSD_5602).

This draft SMP has the objective of framing the future monitoring and management program needed to evaluate impacts on NPSS and THPSS as a consequence of secondary coal extraction from longwall panels. NPSS and THPSS are both listed as an endangered ecological community (EEC) under the NSW *Biodiversity Conservation Act* 2016 (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) respectively. Additionally, the definition for THPSS also includes vegetation described as Newnes Plateau Hanging Swamp (NPHS), which does not form part of NPSS. NPSS and NPHS can be distinguished by the following features:

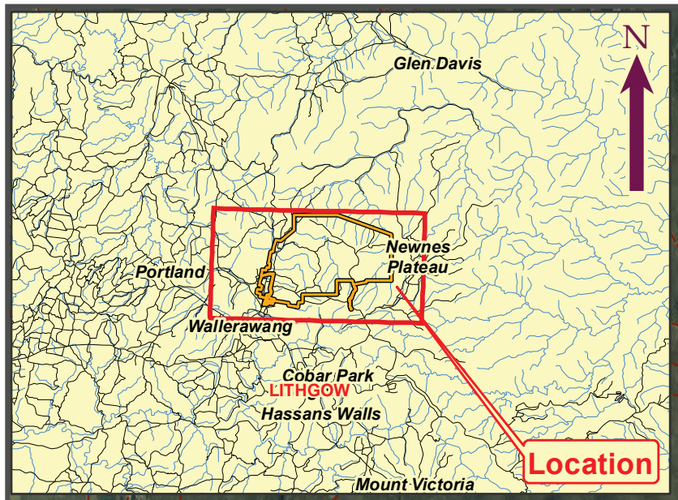
- **Hydrological regimes**. NPSS are more likely to be permanently waterlogged due to a more reliable groundwater source and relatively low sloping swamp base. NPHS are less likely to be waterlogged due to smaller more localised perched groundwater systems and steeper slope angles on the base of the swamps.
- **Flora assemblages**. Floral assemblages within the two swamp systems vary due to the physical setting and hydrological regimes.
- **Location**. NPSS occupy the bases of valleys whereas NPHS develop higher up on the flanks of valleys.

The terms ‘THPSS’ and ‘swamp’ used interchangeably in this document refer collectively to the abovementioned swamp communities.

This SMP has been prepared with reference to ‘Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps’ (Brownstein et al 2014; also referred to as the UQ Handbook.

1.1. Background

Angus Place is an underground coal mine producing thermal coal supplying both domestic and international markets. Angus Place is located 15 km northwest of Lithgow and 120 km west-north-west of Sydney in New South Wales (NSW). Angus Place is bordered by Springvale Colliery to the south-east. The regional setting for the Angus Place mining operation is shown on **Figure 1**.



Gardens of Stone

Wollemi

SECRET CRAG ROAD

GALAH MOUNTAIN ROAD

BAAL BONE TRAIL

THE BICENTENNIAL NATIONAL TRAIL

NO 8 FIRE TRAIL

NO 7 FIRE TRAIL

NO 6 FIRE TRAIL

NO 5 FIRE TRAIL

BIRDS ROCK TRAIL NO 1

BIRDS ROCK TRAIL NO 2

BIRDS ROCK TRAIL

SUNNYSIDE RIDGE ROAD

NO 4 FIRE TRAIL

FIRE TRAIL NO 3

FIRE TRAIL NO 4

FIRE TRAIL NO 2

FIRE TRAIL NO 1

WOLGAN ROAD

BLACKFELLOWS HAND TRAIL

ANGUS PLACE TRAIL

GROVES ROAD

KANGAROOS CREEK ROAD

CAMPBELLS ROAD

WESTERN BOUNDARY TRAIL

CAMP ROAD

NORTH RIDGE ROAD

GANG GANG ROAD

VIEW STREET

MADDOX LANE

BEECROFT FIRETRAIL

IAN HOLT DRIVE

SKELLY ROAD

BRAYS LANE

MAIN STREET

OLD BELLS LINE OF ROAD

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Legend

- Study area
- Project Application Area (EIS 2014)
- National Park
- Roads and Tracks

1 0.5 0 1 2 3 4 km

SCALE: 1:53,000 AT A3 SIZE

TITLE : FIGURE 1: LOCATION OF ANGUS PLACE MINE

LOCATION : ANGUS PLACE

DATUM: GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : **5/12/2019**

PURPOSE: **EIS**

VERSION (PLAN BY): A A3 (Natalie.Wood)

PATH: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\SMP\144414 Figure 1 Location of Angus Place Mine A A3 20191205.mxd

CLIENT: **CENTENNIAL COAL**

JOB REF: **PR144414**

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MAKING COMPLEX EASY

1.2. Study Area

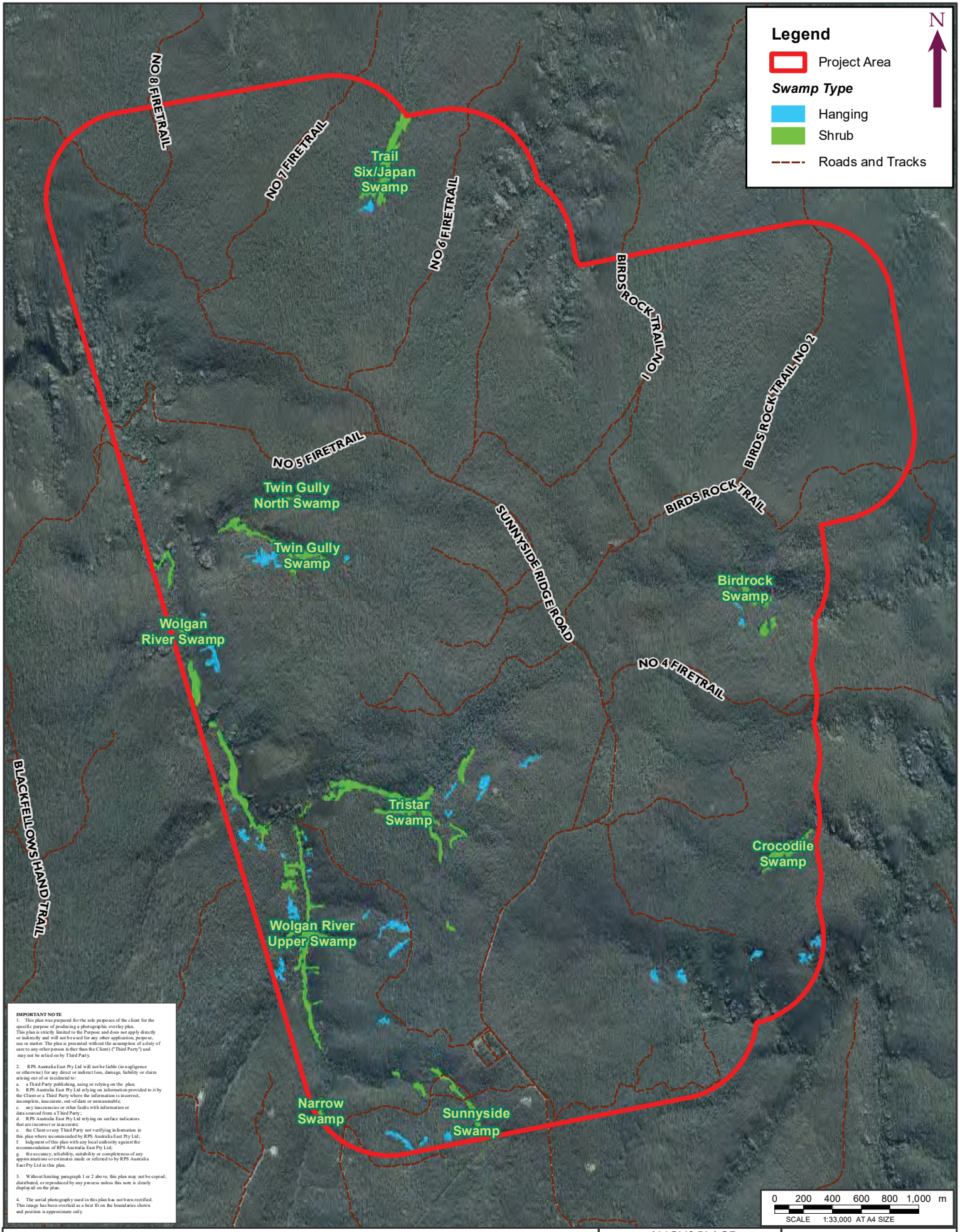
The Study Area applied to this draft SMP is defined by the combined areas arising from the following mine related impacts (see **Figure 2**):

- A 26.5° Angle of Draw (AOD) line from the limit of proposed extraction in Longwalls (LW) 1001 - 1015.
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour resulting from the extraction of LW 1001-1015.
- A 600 m boundary from extraction which specifically relates to the potential area of influence on groundwater systems from far-field subsidence impacts.

This Study Area is greater than that defined in the LW 1001-1015 Biodiversity Management Plan for non-swamp related biodiversity and is otherwise referred to as the Trigger Investigation Area (TIA). The delineation of the TIA reflects prior recommendations made by the Springvale Independent Monitoring Panel (IMP) to increase the investigation area for groundwater obligate biodiversity (i.e. swamps) that may be affected by far field subsidence.

The TIA is based on an improved understanding of interactions between significant geological fault zones (lineaments) and groundwater behaviour. Broadly, the TIA is defined as a 600 m buffer from the outer edge of the longwalls. The TIA is extended to include a 2,000 m reach along a lineament where such geological features intersect with longwall mining, with this monitoring focused solely on the detection of change in hydrological conditions. While this part of the TIA only relates to the monitoring of the groundwater, additional biodiversity monitoring would be performed should a groundwater trigger eventuate (i.e. predefined response outlined in the Trigger Action Response Plan (TARP).

The design of the monitoring program is established on the principles of comparing predicted impact swamps with those that are not expected to be affected (i.e. reference swamps). The boundary of the TIA has been used to define the likely extant of mining related impacts (i.e. no reference swamps to be located within this area). Further, reference swamps are not to be located in areas where prior and/ or future longwall mining impacts are possible. Lineaments of up to 2,000 m from their intersect within longwall mining are also excluded from the pool of possible reference swamp.



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4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

FIGURE 2: ANGUS PLACE MINE AND THPSS

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: PR 144414-7

PURPOSE: BMP

Technician: Natalie.Wood Date: 4/12/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\SMP\144414 Figure 2 Angus Place Mine and THPSS_A4_B 20191204.mxd

1.3. Purpose

This draft SMP is to demonstrate an in depth understanding of the potential impacts of longwall mining on THPSS and best practice monitoring methods and is provided as part of the assessment documentation for the APMEP for the purposes of informing the approvals process. The draft SMP is based on experience obtained from the implementation of programs implemented for the approved Springvale Mine Extension Project (SMEP) (SSD_5594).

This draft SMP has the purpose of defining the expected monitoring and management program required for compliance with regulatory approvals (when available) for the secondary extraction of longwalls that form part of the APMEP. Monitoring, actions and responsibilities are defined to ensure the early detection of adverse impacts arising from the secondary extraction of coal from longwalls and the management response in such circumstances.

1.4. Scope and Structure

This draft SMP draws on information and associated data collected by Centennial Coal since 2003. In lieu of project specific conditions of consent, the scope for preparing this draft SMP is defined by:

- Analysis of monitoring data and previous studies collected in the THPSS since 2003;
- Evaluation of current monitoring programs and the capacity of the monitoring programs to deliver the outcomes requested in approval 2011/5952;
- Use the monitoring data to determine the likelihood of mining related impacts on the Newnes Plateau THPSS within the controlled action area;
- Provide an ongoing monitoring program to determine whether mining causes impacts on the THPSS;
- Provide a series of response triggers to determine whether any mining related impacts occur, and to address any mining related impacts should any occur;
- Provide a series of management actions should any mining related impacts occur;
- Provide an overview of remediation strategies to be used on the THPSS if any mining related impacts occur; and
- Provide a framework for reporting on the performance of the strategies set out in this document (Schedule 4 Sect.32g – DP&E, 2015).

2. EXISTING ENVIRONMENT

2.1. Climate

The climate in the region is typical of a cool temperate mountain climate, characterised by cold winters and warm summers. The highest temperatures occur throughout December, January and February, with the coolest temperatures occurring in July. Snow and/or sleet are common in winter.

2.1.1. Rainfall

Rainfall throughout the year is relatively uniform; however, rainfall is higher during the months of October through to March. Summer months are generally the wettest months. It is noted that the intensity of the rainfall is locally affected by the orographic influence of the Great Dividing Range.

Two weather stations established by the Bureau of Meteorology (BoM) are located in the vicinity of Angus Place. The closed Newnes Forest Centre weather station 63062 (1938 to 1999) (BoM 2019a) represents the most complete historical rainfall dataset for elevations characteristic of the Newnes Plateau (1,000 m AHD), with the lower elevation Lidsdale (Maddox Lane) Station 63132 (890 m AHD) being closer to proposed operation. A new continuous rainfall monitoring station established in 2003 by Centennial nearby the decommissioned Newnes Forest Centre Station provides ongoing rainfall data for the Newnes Plateau and is known as the New Prison Farm gauge. Average monthly rainfalls for each of these weather stations is provided in **Table 1**.

Table 1 – Mean Monthly Rainfall for Lidsdale (63132), Newnes Forest Centre (63062) and New Prison Farm

Statistic	Monthly Rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Lidsdale (Maddox Lane) Station 63132 (1959 to July 2019)													
Mean	85.8	75.9	66.6	42.4	47.9	49.8	49.3	62.4	53.0	68.0	72.4	73.9	758.3
Lowest	8	5.6	3.8	1.	2.6	2.6	2.7	1.8	3.4	2.4	7.6	0	329.8
Highest	213.6	270.4	270.4	202.6	131.2	228.3	214	363.8	123	228.4	164.7	217	1260.3
Lithgow (Newnes Forest Centre) Station 63062 (1938 to 1999)													
Mean	121	114.1	102.9	79.9	81.3	83	68.3	83.5	67.9	91.5	89	90.4	1091.9
Lowest	18.8	5.6	5.1	6.2	11	0	2	4.6	0	6.4	4.7	2.6	495.5
Highest	280.8	338.6	519.4	299.1	286.9	320	240.7	412.4	207.2	267.2	209.3	303.2	1889.1
Springvale New Prison Farm (2002 to February 2018)													
Mean	85.9	109.5	82.1	49.8	44.0	83.2	43.3	51.4	47.4	67.0	99.8	97.5	886.2
Lowest	27.6	35.8	26.6	0.8	15.8	19.7	13.4	23.5	12.9	26.6	39.5	40.8	693.4
Highest	144.2	183.1	137.6	98.8	72.3	146.6	73.2	79.3	82.0	107.5	160.0	154.3	1176

2.1.2. Evaporation

Daily Pan A evaporation has been assessed using data from the Bathurst Agricultural Station (BOM Station No. 63005) (1966 to 2019), which is located 47 km to the west of Angus Place. The annual

average daily Pan A evaporation rate is 3.7 mm/day (BOM 2019b) with mean monthly evaporation rate is presented in **Table 2**.

Table 2 – Average Daily Pan A Evaporation (mm) from Bathurst Agricultural Station and Average Daily Calculated Evapotranspiration from Angus Place (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pan Evap (Bathurst Agricultural Station)	6.8	5.8	4.5	2.9	1.7	1.1	1.2	1.9	2.8	4.1	5.3	6.5	3.7

Pan A evaporation is usually used for estimating evaporation losses from open water surfaces of sediment ponds and dams. In forested areas, evaporation tends to be low compared to Pan A evaporation, but this is offset by increased transpiration. Analysis of flow gauging at Sunnyside Swamp on the Newnes Plateau suggest actual evapotranspiration may be of the order of 35% of Pan A evaporation.

Evapotranspiration

Evapotranspiration is calculated for the climate station at the Springvale Pit Top using the ASCE Standardized Reference Evapotranspiration Equation (ASCE, 2005), with data available from 2011 to present. The average daily Evapotranspiration (ET) for Angus Place is presented in **Table 2**.

2.2. Topography

Topography within the Newnes Plateau comprises narrow gorges with high undulating ridgelines and sandstone cliffs, which range between 10 m and 40 m in height. Elevations within the Study Area range from 900 m to greater than 1,175 m AHD, with the majority of the Study Area being plateau like and consistently above 1,050 m AHD. Lower elevations are aligned with creeks and rivers such as the Wolgan River.

2.3. Geological Setting

2.3.1. Regional Geology and Stratigraphy

The Lithgow area is located towards the western edge of the NSW Western Coalfields. The Illawarra Coal Measures are relatively thin in this area with an average thickness of 110 m from the Katoomba to the Lithgow seam at Angus Place. Above the coal measures, the Narrabeen Group is the only member of the Triassic sequence present in the area, having a maximum thickness of 340 m. Depth of cover to the Lithgow seam generally ranges between 350 m and 420 m, hence, the upper Narrabeen Group will usually comprise the surface strata above the proposed workings at Angus Place.

The sedimentary strata (Illawarra Coal Measures and Narrabeen Group) lies above older Silurian and Devonian Proterozoic rocks of the Lachlan fold belt. The Lithgow Coal Seam at Angus Place Colliery and Springvale Mine is stratigraphically the lowest economic seam with the depth to the older basement strata beneath this seam being shallow, up to 100 m, compared to other parts of the Sydney Basin, which can be many hundreds of metres. The Lithgow Seam ranges in thickness from less than one metre (where only the lower ply of the Lithgow Seam is present) to up to 9 m (where it coalesces with the overlying Lidsdale Seam) with some thin carbonaceous or tuffaceous claystone

layers present in the upper half of the seam. The seam generally dips at 1 - 2 degrees to the east northeast. The Katoomba and other seams at Angus Place are too thin to be viably extracted.

Structure in the Western Coalfield is relatively undeformed, with seams generally dipping at one to two degrees towards the northeast. The dominant structures are north-south trending regional scale monoclines and associated sub-parallel faults that can have throws of up to 200 m. Small scale faults, generally with throws of less than 5 m are also found. Igneous intrusions are only present in the centre and north east of the coalfield, (Palaris, 2013a, b).

The regional stratigraphy is summarised in **Table 3**, which also shows the average vertical distance to the base of each unit above the roof of the Lithgow seam at Angus Place. These formations comprise interbedded siltstone, sandstone and conglomeratic sandstone, with occasional claystone bands, as observed in the characteristic cliffs that occur throughout the area.

Within the Narrabeen Group of rocks, the Burralow Formation and the Mount York Claystone are key stratigraphic horizons in terms of their hydrogeological significance.

Burralow Formation

The Burralow Formation consists of medium to coarse-grained sandstones interbedded with fine-grained sandstone/siltstone/claystone units, the latter of which can be several metres thick. The base of the Burralow Formation is defined as the first significant fine-grained unit above the Banks Wall Sandstone. Palaris (2013a), reports that a recent study of the upper stratigraphy indicates that there is a lithographic and topographic link between the outcrop of the Burralow Formation claystones and the location of hanging swamps.

Within the Burralow Formation a number of continuous fine grained units have been identified that act as aquitards, limiting the vertical infiltration of groundwater and resulting in a sequence of perched aquifers. These low permeability units are designated YS1 to YS6 (McHugh, 2013).

Mount York Claystone

The Mount York Claystone is a sequence of interbedded claystone and sandstone. The average thickness of the unit is 22 m. Typically, the unit comprises two or three discrete claystone bands, up to 4 m thick separated by sandstone / siltstone bands up to 8 m thick. The top of the unit is generally 100 m to 120 m above the Katoomba seam. The MYC is generally difficult to identify from open hole drill cuttings, but geophysical gamma logging can be used to identify the unit more accurately. The top of the unit is identified as the first significant claystone band below Banks Wall Sandstone. The base of the MYC is less distinct as additional thick claystone bands occasionally occur within the underlying Burra-Moko Head Sandstone.

Table 3 – Regional Stratigraphic Summary

Period/Age	Group	Subgroup	Formation	Aquifer Unit	Lithology	Average Height Above Lithgow Seam Roof at Angus Place
Triassic	Wiannamatta		Narrabeen Sandstone	AQ6 / Weathered		
	Hawkesbury Sandstone					
	Narrabeen Group	Grose Subgroup	Burralow Formation	SP4/AQ5/YS6		
			Banks Wall Sandstone	AQ4		200 m
			Mt York Claystone	SP3		195 m
			Burra – Moko Head Sandstone	AQ3		
			Caley Formation	AQ3		106 m
Permian	Illawarra Coal Measures	Wallerawang Subgroup	Farmers Creek Formation	AQ2/SP2/ Katoomba Seam	Katoomba coal Member, Middle River Coal Member	
			Gap Sandstone	AQ2	Sandstone	
		Charbon Subgroup	State Mine Creek Formation	AQ2	Coal, mudstone, claystone	
			Watts Sandstone	AQ2	Sandstone	
			Denman Formation	SP1	Interbedded mudstone / sandstone, claystone, mudstone	
			Glen Davis Formation	AQ1	Coal, claystone	
			Newnes Formation	AQ1	Coal, claystone	
			Irondale seam	AQ1	Coal	25 m
			Long Swamp Formation	AQ1	Interbedded sandstone and siltstone	4 m
		Cullen Bullen subgroup	Lidsdale Coal	AQ1	Coal and claystone bands	0 m
			Blackmans Flat Formation	Lithgow Seam Roof	Sandstone, conglomerate	
			Lithgow seam	AQ1	Coal, claystone	3 m
			Marrangaroo Formation	Lithgow Seam Floor	Sandstone, conglomerate	
		Nile subgroup	Gundangaroo Formation	Basement	Coal, sandstone, claystone	
			Coorongooba Creek Sandstone		sandstone	
			Mount Marsden Claystone		Claystone	
	Shoalhaven Group		Berry Siltstone			
			Snapper Point Formation			

Adapted from Adhikary & Wilkins, 2013 and Palaris, 2013.

2.4. Hydrogeology

The hydrogeology at Angus Place is relatively complex and comprises a number of groundwater systems, which range from perched water tables to layered, semi confined and leaky horizons. Groundwater flow is primarily through fracture systems with some minor primary porosity and permeability. The fracture system is the major control on groundwater flow paths, as the rocks themselves generally have low primary permeability. Regional groundwater flow is typically towards the northeast, coincident with the dip of the main strata. Key elements of the hydrogeological system are described as follows and depicted on **Figures 3** and **4**.

- Stacked and segregated groundwater systems can be broadly grouped into three groundwater systems, a Perched Groundwater System, and Shallow Groundwater System, and a Deep Groundwater System.
- Groundwater is recharged by rainfall – locally in the case of shallow and perched systems and regionally in the case of the deeper systems.
- Deep regional flow essentially isolated from the shallow and perched groundwater systems.
- Perched water systems supported on low permeability aquitard layers.
- Shrub swamps fed partially by groundwater originating from the perched groundwater systems and partially from surface water run-off.
- The Mount York Claystone acting as a significant regional aquitard isolating the shallow and perched groundwater systems from the deep groundwater system.
- The deep interbedded and banded aquitard (mudstones) and aquifer (sandstone and coal) units present beneath the Mount York Claystone strongly influence the deep regional groundwater flow pattern at depth.
- Groundwater flow is dominated by both porous media flow (dominantly horizontal) and to a much lesser extent, fracture flow associated with the joint, fracture and fault conduits.
- Variably enhanced groundwater flow through the lithological pile affected by subsidence induced permeability zones.
- Extensive aquifer interference in the deep regional groundwater system aquifers due to subsidence induced goaf formation, collapse and fracturing affects. These observed aquifer impacts do not extend above the Mount York Claystone.
- Shallow formation sagging, induced by subsidence, gives rise to enhanced horizontal permeability in the shallow groundwater system (permeability enhancements decreasing closer to the ground surface).
- Disconnected vertical permeability enhancements are inferred in the shallow surface zones.

A brief summary of the identified aquifers and interbedded aquitards within the groundwater systems (termed SP or semi-permeable) are provided as follows:

- Perched Groundwater System
    - Weathered section – this is a 10 m thick layer of weathered material which is assumed to cover the top surface of the study area.
    - AQ6 – This aquifer is located in the upper part of the Burralow Formation. This is a group of largely unconfined perched aquifers and only appears near the top of the Newnes Plateau. AQ6 includes a number of discrete aquitard units (YS1 to YS3) that sustain the perched aquifers.
    - SP4 - A thin semi-permeable layer located in the Burralow Formation and comprises claystone (YS4) and sandstone/ siltstone.

  - AQ5 – This aquifer is located in the lower Burralow Formation. AQ5 is separated from AQ4 by YS6 and also includes a continuous low permeability unit (YS5) that can result in perched conditions within the aquifer.
  - YS6 – A thin semi-permeable claystone layer separates AQ4 and AQ5.

- Shallow Groundwater System
  - AQ4 – This aquifer is located in the Banks Wall Sandstone (Narrabeen Group).
  - SP3 - A semi-permeable claystone layer (Mt York Claystone) separates aquifers AQ3 and AQ4. The Mt York Claystone forms an effective barrier between the deep and shallow groundwater systems; it averages over 20 m in thickness and is continuous throughout the Angus Place area.

- Deep Groundwater System
  - AQ3 - Aquifer AQ3 can be identified in the sandstone of the Burra Moko Head Formation and the Caley Formation and located below the Mt York Claystone. It is hydraulically connected with the Katoomba Seam.
  - SP2 - A semi-permeable layer with coal, siltstone and mudstone is the boundary between aquifers AQ2 and AQ3. This semi-permeable layer is assumed to occur just below the Katoomba Seam.
  - AQ2 – This aquifer contains sandstone with laminated siltstone and Middle River Coal Member.
  - SP1 - Aquifer AQ1 is separated from aquifer AQ2 by a semi-permeable layer (SP1) located within the Baal Bone/Denman Formation and comprises mudstone, siltstone and claystone.
  - AQ1 – This aquifer is found to include Lidsdale / Lithgow Coal Seam which is hydraulically connected with the laminated siltstone (Berry Siltstone) and sandstone of the Marrangaroo Formation underneath, and the sandstone and siltstone of the Long Swamp Formation and Irondale Coal Seam above.

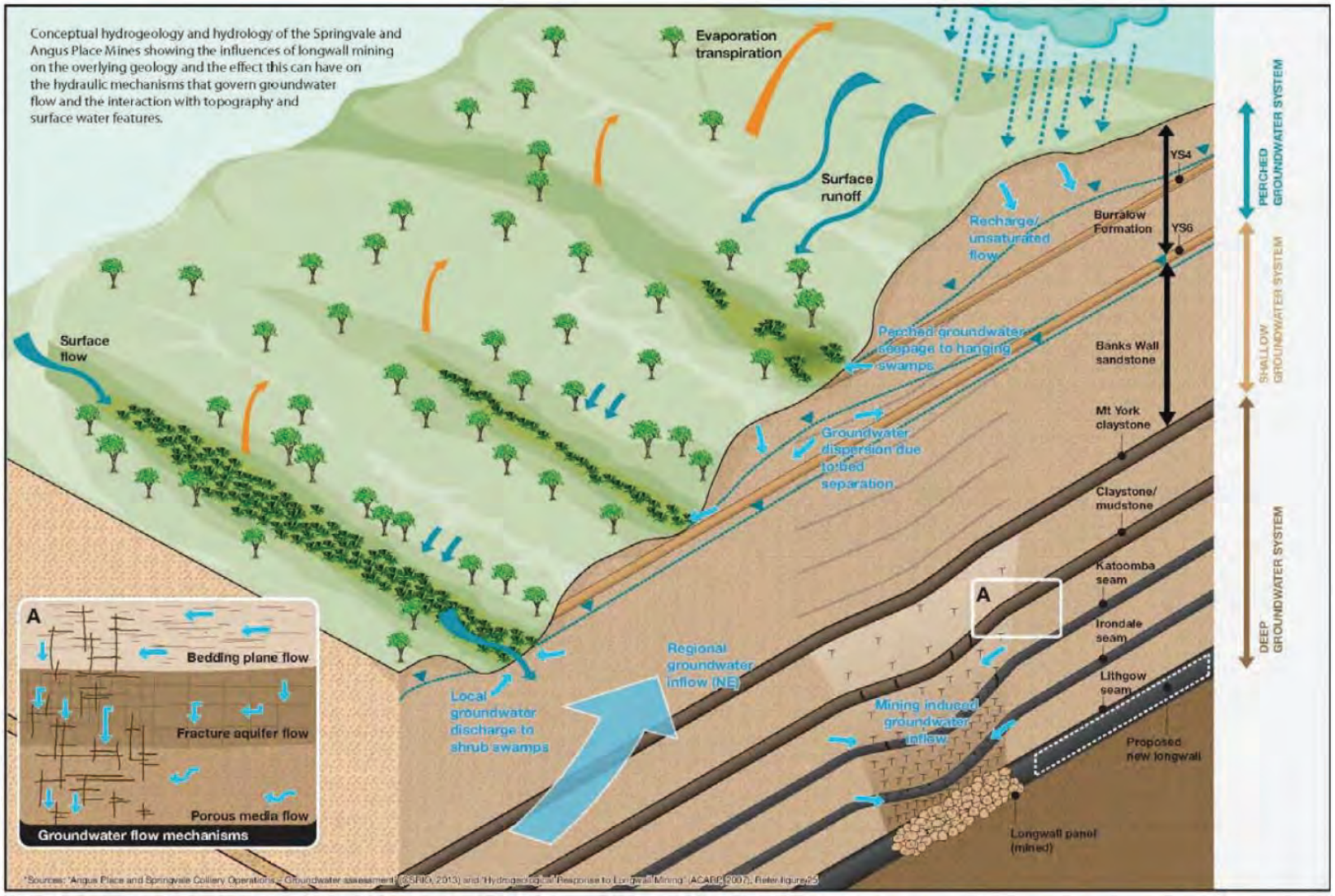

Figure 3: Angus Place Conceptual Hydrogeology (A)

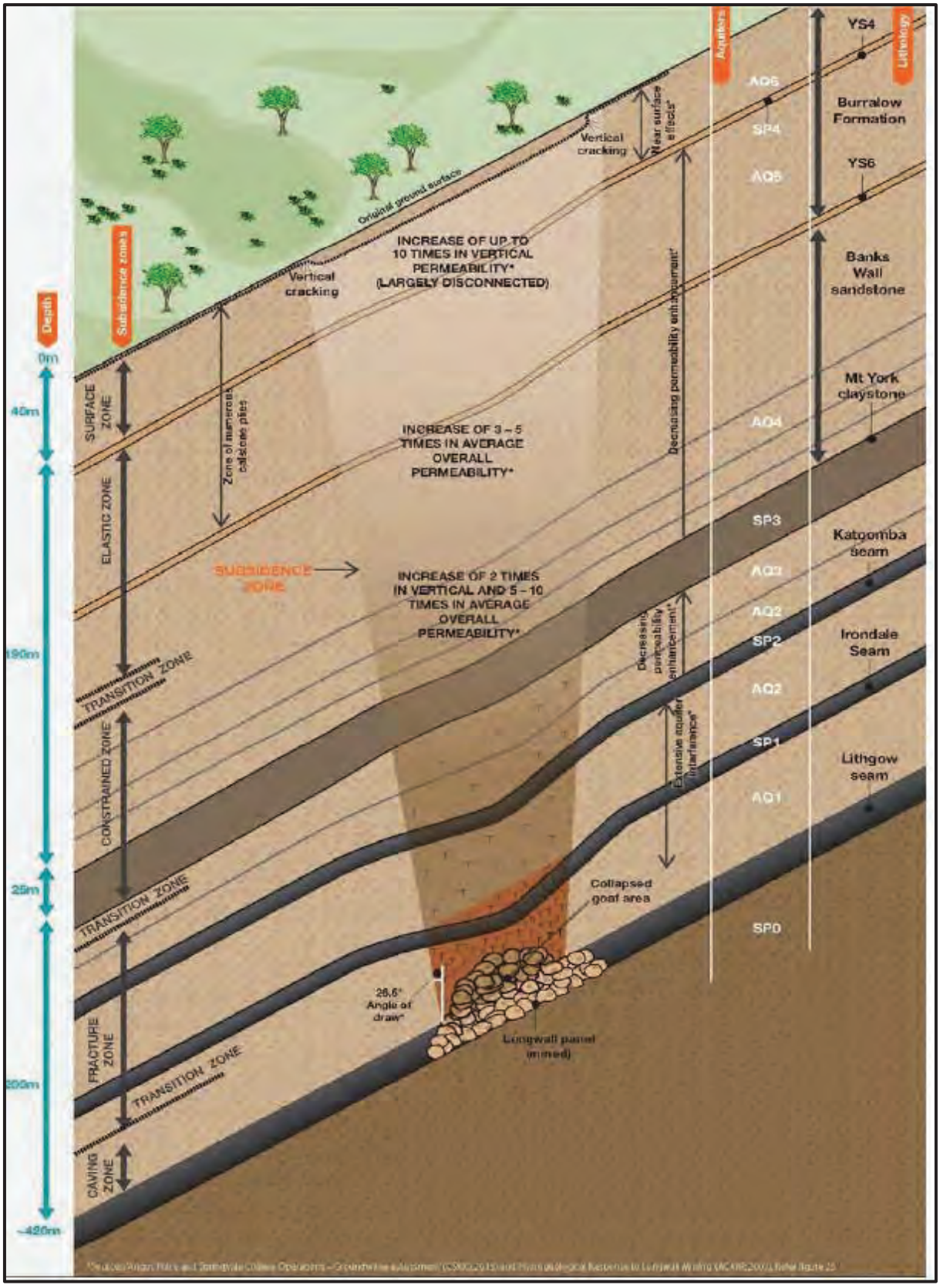

Figure 4: Angus Place Conceptual Hydrogeology (B)

2.5. Hydrology

The Angus Place mining operations lie within two sub-catchments of the greater Hawkesbury-Nepean catchment, known as, the Coxs River catchment and the Wolgan-Colo River catchment. The catchment divide between these catchments runs in a north-west to south-east direction through Angus Place's operations.

The aquatic habitats associated with the Study Area include Wolgan River, Twin Gully Swamp, Carne Creek, Tri-Star Swamp and Bird Rock Swamp and associated unnamed tributaries. Where swamps were assessed, flowing water within a channel was surveyed. These creeks and tributaries vary in their base surface water flows (Cardno 2019).

The Wolgan River feeds into the Colo River and then to the Hawkesbury River. Carne Creek is a tributary of the Wolgan River. The Coxs River is one of the tributaries of Lake Burragong, which discharges to the Nepean River and then the Hawkesbury River. Lake Burragong is the main drinking water supply catchment of the Sydney Drinking Water Catchment.

2.6. High Priority Groundwater Dependent Ecosystems and Springs

The THPSS are listed in Schedule 4 of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* with respect to the Sydney Basin Richmond Groundwater Source. There are no springs listed in the Water Sharing Plan for the Richmond Groundwater Source in the vicinity of Angus Place Mine.

THPSS also reside within the Sydney Basin Coxs River Groundwater Source. There is a potential karst environment listed in the schedule of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* with respect to the Sydney Basin Coxs River Groundwater Source, however, this is located a significant distance from Angus Place and is not considered further. There are no springs listed in the Water Sharing Plan with respect to the Coxs River Groundwater Source in the vicinity of the Angus Place Mine.

2.7. Temperate Highland Peat Swamp on Sandstone (THPSS)

2.7.1. Overview

THPSS systems are dynamic evolving systems similar to all other water courses. These systems experience natural perturbations such as erosion, slumping and piping and damage from wildfires and have an inherent ability to "self-repair" following these events (Goldney et al. 2010). The peat/sand substrate is flexible and mobile and can to an extent adjust to these dynamic perturbations.

Two forms of THPSS occur within the Angus Place mining area these being NPSS and NPHS. NPSS occupies the bases of valleys whereas NPHS develop on the adjacent flanks in association with groundwater expressions. The SPRAT database (DoEE 2019) generically describes the floristics of THPSS for lower slope headwater valley swamps on the Newnes Plateau as follows:

Shrublands and heathlands associated with low slope headwater valleys are generally dominated by the shrubs *Baeckea linifolia* (Swamp Baeckea), *B. utilis* (Mountain Baeckea), *Boronia deanei* (Deane's Boronia), *Epacris paludosa* (Swamp Heath), *E. microphylla* (Coral Heath), *E. pulchella* (Wallum Heath), *Grevillea acanthifolia* subsp. *acanthifolia* (Spiny-leaved Grevillea) and *Leptospermum grandifolium* (Woolly Tea-tree). The understorey is generally dominated by the sedges *Empodisma minus* (Spreading Rope Rush), *Lepidosperma limicola* (Razor Sedge), *Lepyrodia scariosa* (Scale Rush), *L. anarthria* and *Baloskion australe* (Cordrush; previously called *Restio australis*) and graminoids such as *Patersonia fragilis* (Swamp Iris), *P. sericea* (Silky Purple-flag) and *Xyris ustulata* (Yellow-eye, Yellow Flag).

Species of *Leptospermum* (*L. polygalifolium*, *L. myrtifolium*, *L. continentale*, *L. obovatum*) and *Callistemon sieberi* (River Bottlebrush) are more common in swamps with a higher soil clay content, with ground covers including the sedges *Baloskion australe* (Cordrush) and *Juncus continuus*.

Scattered trees up to about 3 m in height may be present above the shrub layer in some swamps and include the mallee *Eucalyptus gregsoniana* (Wolgan Snow Gum), *Leptospermum juniperunum* and *Banksia marginata* (Silver Banksia) or *Eucalyptus pauciflora* (White Sally, Snow Gum) and *E. dalrympleana* (Mountain Gum). Dominant lower shrub species in such areas include *Baeckia linifolia* (Swamp Baeckea), *Hakea* spp, *Epacris paludosa* (Swamp Heath), *E. microphylla* (Coral Heath), *Grevillea acanthifolia* subsp. *acanthifolia* (Spiny-leaved Grevillea) and species of *Leptospermum* (including *L. continentale*, *L. lanigerum* (Woolly Tea-tree), *L. parvifolium* and *L. sphaerocarpum*, or *Leptospermum obovatum* and *L. trinervium* (Slender Tea-tree)). The ground layer is dominated by sedges such as *Empodisma minus* (Spreading Rope Rush), *Gahnia sieberiana* (Red-fruit Saw-sedge), *Lepidosperma limicola* (Razor Sedge) and *L. tortuosum* and the ferns *Gleichenia dicarpa* (Coral Fern) and *Sticherus* sp. (Umbrella Fern) with graminoids such as *Xyris* spp also present.

Drainage lines and permanent water channels on low slope headwater valleys support sedgeland dominated by *Gleichenia dicarpa* (Coral Fern) and *Gymnoschoenus sphaerocephalus* (Button Grass).

2.7.2. Impact and Reference Swamps

For the purposes of this report, impact and reference swamps have been delineated on the basis of the TIA boundary. The 2,000 m fault line investigation area will not be used to select impact and reference swamps for flora monitoring unless a greater than negligible impact has been identified and is deemed to be mining related. Monitoring has also been implemented at a number of swamps that will not be encroached upon by the AOD or occur within the TIA. These are designated as Reference Swamps.

Recent surveys using the Brownstein et al (2014) method have resulted in the seasonal acquisition of high resolution imagery at approximately 7cm pixel resolution, which has enabled refinement of the existing mapping of THPSS through aerial photograph interpretation (API). This process has resulted in the boundaries of THPSS being altered and the identification of some investigation areas which may comprise vegetation which is commensurate with NPHS. For the purposes of this SMP the additional NPHS investigation areas which have been identified using API will be included in the monitoring program unless verified through field observations as vegetation not fulfilling the description of THPSS.

Impact and References Swamps are shown in **Figure 5** and as listed below. NPSS located within the area of potential impact and reference sites for the APMEP comprise:

- Potential Impact Sites
    - Wolgan River (including upper)
    - Tristar
    - Twin Gully
    - Japan (Trail 6)
    - Sunnyside (northern extent)
    - Narrow (northern extent)
    - Birdrock
    - Crocodile

- Reference Sites
  - Barrier Swamp
  - Best Swamp
  - Firetail Swamp

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4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

N

Legend

- Project Area
- Potential Impact Swamp
- Reference Swamp
- Roads and Tracks

NO 8 FIRETRAIL
NO 7 FIRETRAIL
NO 6 FIRETRAIL
NO 5 FIRETRAIL
Trail Six/Japan Swamp
Twin Gully North Swamp
Twin Gully Swamp
Wolgan River Swamp
Wolgan River Upper Swamp
Tristar Swamp
Narrow Swamp
Sunnyside Swamp
Birdrock Swamp
Crocodile Swamp
BIRDS ROCK TRAIL NO 1
BIRDS ROCK TRAIL NO 2
BIRDS ROCK TRAIL
SUNNYSIDE RIDGE ROAD
NO 4 FIRETRAIL
GALAH MOUNTAIN ROAD
FIRE TRAIL NO 3
FIRE TRAIL NO 4
FIRE TRAIL NO 2
FIRE TRAIL NO 1
Best Swamp
MOUNT CAMERON TRAIL
Firetail
DEEP PASS TRAIL
WESTERN BOUNDARY TRAIL
CAMP ROAD
GLOWWORM TUNNEL ROAD
Ampetheatre
Barrier
Murrays
RED HILL ROAD
NORTH RIDGE ROAD
GANG GANG ROAD
Central Carne
CAMPBELLS ROAD
BLACKFELLOWS HAND TRAIL
BEECROFT FIRETRAIL
KANGAROOS CREEK ROAD
ANGUS PLACE TRAIL

500 250 0 500 1,000 1,500 2,000 2,500 m

SCALE: 1:40,000 AT A3 SIZE

TITLE : FIGURE 5: THPSS POTENTIAL IMPACT AND REFERENCE SWAMPS

LOCATION : ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : **4/12/2019**

PURPOSE: **SMP**

VERSION (PLAN BY): A A3 (Natalie.Wood)

PATH: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\SMP\144414 Figure 5 THPSS Potential Impact and Ref_A3_A 20191108.mxd

CLIENT: **CENTENNIAL**
JOB REF: **PR 144414-7**

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
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T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

MAKING COMPLEX EASY

NPHS located within the area of potential impact and reference sites for the Angus Place Mine Extension Project comprise:

- Potential Impact Sites
  - Wolgan River;
  - Wolgan River Upper;
  - Tristar;
  - Twin Gullies;
  - Twin Gullies North;
  - Japan (Trail 6);
  - Sunnyside (northern extent);
  - Narrow (northern extent);
  - Crocodile; and
  - Birdrock.
- Potential Impact Sites
  - Amphitheatre

Suitable reference swamps are yet to be identified for Wolgan, Birdrock, Sunnyside, Japan TriStar and Twin Gully NPHS; however, NSW National Parks & Wildlife Service has granted approval (as at 30 October 2019) for seasonal and annual monitoring to occur in the Blue Mountains National Park where suitable THPSS is identified. This allows for baseline data to be collected from reliable Reference NPHS locations to compare against Impact Swamps at Angus Place.

2.8. Land Use

Non-mining related land uses also have the potential to impact THPSS and require an understanding when evaluating monitoring data that indicates a potential change. The Newnes Plateau above Angus Place Mine is subject to a variety of land uses. The plateau is a state forest subject to historical logging and is open to recreational use by the public. These non-mining related land uses can result in point source and diffuse source disturbance to THPSS systems. These land uses include:

- **Forestry activity**. Forestry is the most intense land use on the plateau and includes tree logging, track construction, undergrowth clearing and burning. These activities lead to significant land changes through increased run-off and sediment transport, vegetation removal, weed invasion and an altered fire regime. These impacts are experienced throughout the plateau area including the THPSS systems.
- **Four-wheel drive and motor bike activity**. The plateau is freely accessible to the public including recreational four wheel drive enthusiasts and motor bike riders. These activities are unregulated and result in the development of tracks in and adjacent to the THPSS. These tracks are unplanned and unmaintained and can result in accelerated runoff and erosion and weed invasion.
- **Feral pig activity** results in land disturbance during pig foraging activity. This results in accelerated erosion and a decrease in water quality in drainage lines.
- **Hunting** can affect native wildlife numbers and movements. New tracks are often formed which results in increased erosion and run-off.

- **General public access** can lead to an increased incidence of bushfires, introduction of weeds, introduction of feral animals and accumulation of rubbish.
- **Agriculture** A small portion of land along the western boundary of the Project Area is cleared and is used for agriculture. Agricultural practices can result in clearing, the use of fertilisers which harm native flora and fauna species, introduction of weeds and feral animals.

3. ASSESSMENT OF POTENTIAL IMPACTS

This section describes the potential impacts associated with the longwall extraction of coal on THPSS and surface water features.

It is expected that fracturing of the bedrock would occur beneath some sections of the drainage lines which are located directly above the proposed longwalls. Fractures in bedrock underlying watercourses across the Study Area could significantly increase local hydraulic conductivity, and in some cases eliminate baseflow (Jacobs 2019a). Loss of flow can lead to the progressive drying of downstream swamps (Jacobs 2019a).

The predicted post mining grades along the drainage lines are similar to the natural grades (MSEC 2019). Therefore, it is not expected that there would be any significant adverse changes in ponding, flooding or scouring resulting from the proposed mining. There may be some very minor localised areas which could experience small increases in the levels of ponding, where the natural gradients are low immediately upstream of the longwall chain pillars (MSEC 2014; MSEC 2019).

Centennial Coal (2017) indicate there is increasing evidence linking changes to standing water levels in swamps with the undermining of lineaments in the strata overlying Lithgow coal seam. This hypothesis is considered throughout the potential impacts section.

3.1. Swamp Floor Cracking and Bedrock Fracturing

Fracturing in bedrock has been observed due to previous longwall mining where the tensile strains have been greater than 0.5 mm/m or where the compressive strains have been greater than 2 mm/m. It is likely, therefore, that fracturing would occur beneath the swamps located directly above the proposed mining area. Fracturing can also occur outside the mining area, with minor and isolated fracturing occurring at distance up to approximately 400 m (MSEC 2019).

The estimated fracture widths in the topmost bedrock, based on the maximum predicted conventional tensile strain of 3.5 mm/m and based on a typical joint spacing of 10 m, is in the order of 35 mm. The fracture widths outside the proposed mining area are expected to be typically less than 10 mm. The crack widths are expected to be typically less than 25 mm, however localised cracking with widths greater than 50 mm can also develop (MSEC 2019). Larger surface deformations could also occur if increased scouring were to develop due to changes in swamp vegetation.

Tri Star Swamp is predicted to experience maximum predicted subsidence effects above the proposed mining area and is therefore likely to experience adverse impacts due to the proposed mining (MSEC 2019). Twin Gully is also likely to experience adverse impacts, to a lesser extent, as it is not coincident with a Type 1 or 2 geological structure and due to the lower predicted subsidence effects (MSEC 2019).

The NPHS are located on the sides of the valleys and, therefore, are not expected to experience significant valley related upsidence movements or compressive strains due to closure movements, which occur near the bases of the valleys.

The NPSS have peat layers which overlie the shallow natural surface soils and underlying bedrock along the alignments of the drainage lines. In most cases, cracking would not be visible at the surface within these swamps, except where the depths of bedrock are shallow or exposed.

The mining-induced compression due to valley closure effects can also result in dilation of the strata beneath the shrub swamps and the development of bed separation in the topmost bedrock, as it is less confined. This dilation due to valley closure is expected to develop predominately within the top 10 m to 20 m of the bedrock. Compression can also result in buckling of the topmost bedrock resulting in heaving in the overlying surface soils (MSEC 2019). The dilated strata beneath the drainage lines, could result in the diversion of some surface water flows beneath parts of the shrub swamps. It is noted, however, that the drainage lines upstream of the swamps are generally ephemeral and, therefore, surface water flows occur during and shortly after rainfall events.

3.2. Impact Assessment of THPSS using increased Predictions

Observations above the previously extracted longwalls at Angus Place and Springvale Collieries indicate that locally increased subsidence (of the order of 25%) can occur in the locations of the significant geological lineaments (Type 1 and Type 2 geological structure zones of Palaris, 2013b). For this reason, the subsidence predictions have been increased by 25 % in the locations of these surface lineaments which are located directly above the proposed longwalls.

The potential for subsidence impacts generally result from differential movements (i.e. curvature and strain), rather than from vertical subsidence. It is expected that the compressive strains at the lineaments above the longwall panels will be similar to those observed above the previously extracted longwalls at Angus Place and Springvale Collieries, which were typically between 5 mm/m and 15 mm/m.

If the actual conventional subsidence movements exceeded those predicted by a factor of 2 times, the predicted changes in grade along the drainage lines would generally be less than 25 mm/m, which is less than the natural grades which typically vary between 25 mm/m and 300 mm/m. There could be localised increased ponding along the drainage lines, in some locations, where the natural grades are relatively flat just upstream of the chain pillars.

If the actual curvatures, strains or valley related movements exceeded those predicted by a factor of 2 times, it would be expected that the extent of fracturing in the uppermost bedrock would increase along the drainage lines which are located directly above the approved longwalls.

While the predicted ground movements are important parameters when assessing the potential subsidence impacts on surface drainages, it is noted that the previous experience at Angus Place and Springvale Collieries indicates that the potential impacts on the drainage lines are low.

There is also potential for re-activation or dilation of the lineaments due to differential movements. This has the potential to create a conduit for groundwater flow or depressurisation that could create a connection between the perched groundwater system and shrub swamps with deeper groundwater systems.

3.3. Potential Changes in THPSS

The predicted post mining grades are similar to the natural grades within the drainages and shrub swamps. There are no predicted significant reductions or reversals of grade. It is not expected, therefore, that there would be any adverse changes in ponding or scouring resulting from the predicted mine subsidence movements. It is also not anticipated that there would be any significant changes in the distribution of the stored surface waters within the swamps as a result of the mining induced tilt or vertical subsidence.

The following THPSS have potential to be impacted by longwall mining. The expected subsidence impacts are noted for each Swamp.

3.3.1. Tri Star Swamp

Flow rates were assessed as a percent change between proposed and null case by Jacobs (2019). The modelled change in surface water flow at Tri Star Swamp is large and the impact of that magnitude is expected to be significant (Jacobs 2019a).

3.3.2. Twin Gully Swamp

Flow rates were assessed as a percent change between proposed and null case by Jacobs (2019). The predicted changes range between a minor to moderate increase and a minor to moderate decrease. It is considered that the impact of the magnitude of change in flows in Twin Gully Swamp may be moderate but is less than that predicted for Tri Star Swamp (Jacobs 2019a).

3.3.3. Japan Swamp

Flow rates were assessed as a percent change between proposed and null case by Jacobs (2019). The magnitude of the changes in the U90 results range from moderate to large and are expected to be significant (Jacobs 2019a).

4. PERFORMANCE MEASURES AND INDICATORS

4.1. Overview

Triggers will be developed to identify when observed variance exceeds the natural range of conditions expected within a healthy swamp, thus acting as an early warning signal for the potential of a mining related impact on THPSS. A trigger event provides the impetus for the consideration of mining as the causation for change, however, such conclusions can only be drawn through detailed investigation. If mining related, then management actions may be implemented to minimise impacts on THPSS.

Triggers are measurable thresholds used to determine whether changes in the physical setting and / or ecological processes are within or outside an expected range of conditions naturally occurring in a swamp. Trigger levels will be developed for subsidence, flora, groundwater and surface water. The triggers will be designed to detect change that is likely to lead to the exceedance of a 'negligible impact' if the change is related to mining operations (i.e. soon after mining has occurred below the Newnes Plateau as well as lagging triggers). Early warning triggers will be developed for subsidence and groundwater levels which are designed to quickly determine whether any mining induced changes in swamp systems have occurred or likely to occur.

Triggers will be developed through statistical analysis of pre-mining monitoring data (data observed before a monitoring point is within the TIA or before a lineament is intercepted) with post-mining monitoring data (data observed after monitoring point was within the TIA or after a lineament was intercepted) used to determine whether these triggers have been exceeded.

As with ecological diversity, the assessment of long term changes in swamp water levels, surface water and shallow aquifer groundwater are also considered. Typically, this involves the prolonged absence of water and/or base flows or changes in observed water heights as a result of subsidence (the separation of bedding planes and dilation of fractures and lineaments, increasing secondary porosity of the formation and subsequently lowering groundwater levels). Impacted swamps and shallow aquifers are monitored for several years into the post-mining period.

The exceedance of a trigger level threshold does not necessarily mean that a severe impact on THPSS has occurred, nor does it mean that mining operations are the sole causation for observable change. For example, with the collection of more data, the climactic influences on swamp water levels and shallow aquifer groundwater levels have become apparent with strong correlations to Cumulative Rainfall Deviation (CRD) found in both impact and reference swamp piezometers and ridge piezometers (monitoring the shallow aquifer system) indicating regional scale influences. However, if a trigger level has been exceeded, an investigation into the potential causation of the exceedance will be completed. The investigation considers likely causes such as climatic variability and anthropogenic interactions to help discern potential mining impacts. This detailed investigation into the short-term change at impact swamps and impact ridge piezometers is required as a causation of factors often compounds the responses observed in THPSS and the shallow aquifer, making it difficult to isolate the cause of the exceedance. Assessing ecology, swamp water levels, surface water and shallow aquifer groundwater levels for long term change is a more readily usable method of assessing overall mining impacts.

Trigger levels will be developed following receipt of the Development Consent conditions to ensure they are responding to the performance measures therein.

There are also a series of lagging triggers which are used to indicate whether any mining impacts are detected after mining has moved on from any point in space and time. These triggers have been set to determine effects on flora and surface water quality. Any mining related impacts on flora or surface water quality would be expected to manifest months or possibly years following mining. All triggers have been developed through statistical analysis of pre-mining monitoring data with post mining monitoring data used to determine whether trigger thresholds have been exceeded.

4.2. Response Triggers

Baseline data will be used to develop a series of triggers that will be used to determine whether any mining related impacts have occurred during and following mining in LW 1001-1015. Triggers will be developed following receipt of the Development Consent for environmental factors most likely to indicate the incidence of a mining related impact, these being:

- Subsidence,
- Flora,
- Groundwater Level and Quality, and
- Surface Water Quality.

With the following exceptions, baseline data will be collected over a minimum 2 year period:

- The UQ Handbook (based on Brownstein et al (2014)) requires a baseline data gathering period of one year,
- Any new monitoring sites established in the context of the State Development Consent (SSD_5602) or Federal EPBC approval (2011/5952).

Time series analysis processes will be built into the development of trigger values. For example, triggers will be developed to identify short and long-term mining related impacts should any occur.

5. PROPOSED MONITORING PROGRAMS

5.1. Overview

The monitoring programs aim to detect change in the existing environment beyond expected natural variance and, if detected, assign causation for this change (i.e. determine if change is the result of mining operations performed by Centennial Coal). In this respect, the monitoring programs meet this purpose by measuring parameters meaningful to the biological functioning of THPSS such as flora, groundwater and surface water. Direct mining related change is also coincidently measured (i.e. subsidence) to assist in assigning causation for change, if detected. Monitoring is applied to shrub swamps and hanging swamps in this SMP.

There is increasing evidence that swamps well outside the footprint of the longwalls are experiencing hydrological changes as a result of mining. Lineaments that fall underneath swamps that are undermined are more likely to be susceptible to impacts resulting in hydrological changes such as altered groundwater and surface water flows.

The monitoring program is designed using a before-after-control-impact (BACI) monitoring model. A BACI monitoring design involves data collection before and after an impact event at monitoring sites where impacts are expected and corresponding control/ reference sites (Underwood 1991). The sampling of BACI monitoring sites over time has the purpose of detecting and quantifying change in addition to determining the likely causation for change. Management actions and corresponding effectiveness of management activity can be evaluated through the BACI analysis, thus provide insight into how adaptive management can be used to minimise the impacts of mining operations.

Brownstein et al. (2014) recommend the use of at least three (3) reference sites for each impact site to provide a reasonable basis for statistical comparison. However, the selection of reference sites is restricted by the finite number of THPSS available within and adjacent to the controlled action area. Details of all monitoring programs including monitoring sites are outlined including details on methods and data analysis.

5.1.1. Shrub Swamps

Impact and reference shrub swamps monitored during the development of LW 1001-1015, as shown in **Figure 5**, include:

- Potential Impact Sites
  - Wolgan River;
  - Wolgan River Upper;
  - Tristar;
  - Twin Gullies;
  - Japan (Trail 6);
  - Sunnyside (northern extent);
  - Narrow (northern extent);
  - Crocodile; and
  - Birdrock.
- Reference Sites
  - Barrier Swamp;
  - Best Swamp; and

- Firetail Swamp.

5.1.2. Hanging swamps

A different approach to the monitoring of hanging swamps relative to shrub swamps is outlined in this SMP for the following reasons:

- Possible mining-related effects that could impact on hanging swamps are surface cracking, or excessive tilt that could interfere with swamp hydrology. While cracking is theoretically possible, no cracking has ever been observed in soft soil or peat-covered areas due to the relatively low strains that are normally experienced in this area. In addition, the predicted and previously measured tilts are well below the surface tilt required to reverse the hydraulic gradient in these systems.
- Numerous hanging swamps have been previously undermined by longwall panels by both Angus Place and Springvale Mines and no report of cracking within a hanging swamp vegetation has been identified.
- Hanging swamps generally do not have a thick peat base or a consistent free groundwater surface or surface water that can be measured. As a result, the conditions are not suited to the installation of piezometers or surface water monitoring points.
- The base of hanging swamps is significantly steeper than in the shrub swamps so any seepage drains away relatively quickly.
- Hanging swamps are often much smaller than shrub swamps and are therefore much more susceptible to monitoring related damage. Damage can result from the initial installation of monitoring instrumentation, maintenance of the instrumentation as well as the regular visits required to carry out monitoring activities. This would likely result in a lot more damage than is likely to occur from mining. Therefore, low impact visual inspections, UQ Handbook and LiDAR will be used to monitor Hanging Swamps.

NPHS located within the area of potential impact sites for the Angus Place Mine Extension Project comprise:

- Potential Impact Sites
  - Wolgan River;
  - Wolgan River Upper;
  - Tristar;
  - Twin Gullies;
  - Japan (Trail 6);
  - Sunnyside (northern extent); and
  - Birdrock.

No current Reference NPHS have been identified; however, NSW National Parks & Wildlife Service has granted approval (as at 30 October 2019) for seasonal and annual monitoring to occur in THPSS in the Kanangra Area of the Newnes Plateau National Park. This allows for baseline data to be collected from reliable Reference NPHS locations to compare against Impact Swamps at Angus Place.

5.2. Shrub Swamps

The monitoring activities performed within these swamps are further discussed in the following sections.

5.2.1. Subsidence Monitoring

Swamps and drainages within the Study Area will be monitored during and post mining for evidence of any subsidence related impacts. **Table 4** provides a summary of the subsidence monitoring program that will be undertaken to manage these features. Additional detail pertaining to subsidence monitoring methodology relevant to the Study Area can be found in the LW 1001-1015 Subsidence Monitoring Program.

Table 4 – Relevant Subsidence Monitoring Program Targets

Monitoring Method	Parameter	Frequency
Subsidence survey line	Subsidence, tilt, strain and angle of draw	During and post mining
Visual inspections (including photo monitoring) of rock outcrops, steep slopes, swamps and tracks within the Study Area	Presence or absence of damage	Monthly during secondary extraction of LW1001-1015. Inspections will continue for four months following the completion of secondary extraction of longwalls. A final inspection will be undertaken within 12 months of secondary extraction of each longwall.

5.2.2. Soil Moisture Monitoring

Soil moisture monitoring will be used to compliment ecological investigations. Additional soil moisture probes are still to be installed.

5.2.3. Groundwater Monitoring

A program of works will be designed to address the Development Consent conditions (when available) and to further understand the key groundwater interactions within the swamps. The program will likely include the following monitoring:

- ≠ Additional Swamp Piezometers and Soil Moisture Probes;
- ≠ Correlation of water levels to rainfall and evapotranspiration;
- ≠ Water Balance Review; and
- ≠ Routine Groundwater Level Monitoring

5.2.4. Flora

Brownstein et al. (2014) describes the design principles and methods for the monitoring of flora in THPSS. It outlines the datasets, analyses, and reporting required to conduct a statistically rigorous and sensitive flora monitoring program to detect change at an individual swamp community scale. Brownstein et al. (2014) provides guidance on the following:

- ≠ Monitoring design principles consistent with a BACI monitoring model;

≠ Sufficient replication at the swamp scale to allow for a reliable analysis of key indicators of community composition and health in a statistically rigorous manner;

≠ Updated trigger levels; and

≠ A clear framework outlining required management actions.

Monitoring programs performed include those prescribed by Brownstein et al. (2014), species specific (*Boronia deanei*, Blue Mountains Water Skink and Giant Dragonfly) and complimentary methods for trigger investigations and offset calculations (RPS 2019).

Monitoring design

Underwood (1992) outlined the key elements critical to the design of a monitoring program based on the principles of before-after-control-impact (BACI). Key factors considered in such a monitoring design are:

- Singularity of the impact site: 'Impact area' is defined by the swamp boundary and as such within swamp sampling is classed as subsampling. Sample replication is therefore defined by the number of swamps sampled, not the number of within swamp samples.
- Variance in space: Most natural populations oscillate in ways that are not concordant from one place to another. Thus, abundances of most species will fluctuate from time to time independently in any two sites (one potentially impacted and one control). As such, comparisons between one impact and one control site are not capable of demonstrating differences in temporal patterns should the only detectable/ measurable change in the environment be the consequence of longwall mining. As such multiple independent sampling sites are required to increase the power of any analysis that attempts to isolate subsidence as the causation of change.
- Variance in time: The numbers of organisms in a population are likely to vary over time, with the assumption that the population will remain constant generally unfounded. Monitoring timing and confounding factors need to be considered to minimise unrelated sources of variance.

A balanced experimental design comprising at least three impact and three control sites independent of each other is considered the minimum for developing a robust statistically based monitoring program. The experimental design would need to carefully consider the following potentially confounding factors to reduce sources of 'noise' (i.e. unrelated data variance) in such a program:

- Swamp type;
- Past, present and future mining impacts;
- Past fire regimes;
- Proximity of non-natural land uses (e.g. forestry); and
- Elevation (i.e. minimise any confounding factors potentially related to climate change).

Site selection

It is neither possible nor practical to design an on ground flora monitoring program that provides 100% coverage of any swamp system without causing significant impacts to vegetation and other swamp processes (Centennial Coal 2013). Within this context, and the requirements for designing a BACI compliant monitoring design, consideration has been afforded to the following criteria when selecting a monitoring site:

≠ Impacts sites must occur within the angle of draw for each longwall;

- ≠ Reference sites need to be located outside of the angle of draw and TIA;
- ≠ Reference sites need to be relatively close, but independent of, impact sites so that the reference sites experience similar climatic and hydrogeological conditions;
- ≠ Where possible, reference sites should share similarity in vegetation composition and structure to impacts sites;
- ≠ A minimum of three sampling sites is required for impact and reference swamps;
- ≠ A minimum of three reference swamps is to be sampled;
- ≠ All sites need to have reasonable access to allow for on ground monitoring and investigation activities to be carried out; and
- ≠ OH&S issues such as access and communications also need to be considered.

Monitoring locations – Ground Control Points

Ground control survey points are to be randomly located within mapped THPSS boundaries prior to going into the field to ensure an unbiased sampling design. Initially, the THPSS boundaries should be delineated in VISMap2231 to randomly locate the plots, which may be revised following future THPPS boundary remapping using higher resolution imagery. The location of ground control survey points may need to be adjusted once in the field to correct for THPSS boundary mapping and/or GPS location inaccuracies. Where random points are on or outside the boundary of the THPSS, plots should be moved the minimum distance required to fall 3 m inside the boundary of swamp vegetation.

Minimum distance between plots should never exceed 100 m to retain coverage. Plots are 1 m^2 centred on a star picket, which should have post top markers to identify them in the aerial imagery. This approach allows direct correlation of field observations with RGBI imagery and also ensures on-ground observations are conducted at the extents of the community in all seasons.

Monitoring sites for the Ground control point monitoring method is provided in **Table 5** and **6** for 'Reference' and 'TIA' swamps respectively and are shown in **Figure 6**.

Table 5 – Ground Control Point Monitoring locations - Reference

Swamp	Site Name	Easting	Northing
Barrier	BS01-001	241798	6302512
Barrier	BS02-002	241697	6302519
Barrier	BS03-003	241864	6302624
Barrier	BS04-004	242126	6302729
Barrier	BS05-005	242044	6302765
Barrier	BS06-006	241921	6302820
Barrier	BS07-007	242192	6302805
Barrier	BS08-008	242288	6302905
Barrier	BS09-009	242108	6302967
Barrier	BS10-010	242051	6302994
Barrier	BS11-011	242103	6303260
Barrier	BS12-012	242143	6303366
Barrier	BS13-013	242155	6303479
Barrier	BS14-014	242030	6303432
Barrier	BS15-015	242088	6303474

Swamp	Site Name	Easting	Northing
Barrier	BS16-016	242171	6303575
Barrier	BS17-017	242088	6303770
Barrier	BS18-018	241676	6303690
Barrier	BS19-019	241628	6303757
Barrier	BS20-021	241889	6303825
Barrier	BS21-021	242025	6303913
Barrier	BS22-022	242084	6303946
Barrier	BS23-023	242007	6304198
Barrier	BS24-024	242025	6304312
Barrier	BS25-025	241956	6304294
Barrier	BS26-026	241872	6304257
Barrier	BS27-027	241725	6304243
Barrier	BS28-028	241568	6304276
Barrier	BS29-029	241760	6302664
Barrier	BS30-030	242325	6303273
Barrier	BS31-031	242022	6304004
Firetail	FT01-32	247329	6306957
Firetail	FT02-033	247120	6306975
Firetail	FT03-034	247073	6306755
Firetail	FT04-035	247139	6306663
Firetail	FT05-036	246911	6306535
Firetail	FT06-037	246802	6306699
Firetail	FT07-038	246588	6306665
Firetail	FT08-039	246392	6306632
Firetail	FT09-040	246243	6306648
Firetail	FT10-031	246870	6306431
Firetail	FT11-032	246678	6306325
Firetail	FT12-043	246555	6306222
Firetail	FT13-044	246385	6306287
Best	BEST01-109	247312	6309347
Best	BEST02-110	247204	6309250
Best	BEST03-111	247030	6309216
Best	BEST04-112	246974	6309008
Best	BEST05-113	246777	6308784
Best	BEST06-114	246885	6308617
Best	BEST07-115	246753	6308392
Best	BEST08-116	246582	6308290
Best	BEST09-117	246461	6308189
Best	BEST10-118	246301	6308068
Best	BEST11-119	246201	6307925
Best	BEST12-120	246013	6307824
Best	BEST13-121	245869	6307676
Best	BEST14-122	245685	6307483
Best	BEST15-123	245574	6307377
Best	BEST16-124	245474	6307248
Best	BEST17-125	245455	6307132

Swamp	Site Name	Easting	Northing
Amphitheatre	AMP01-103	241074	6304638
Amphitheatre	AMP02-104	241121	6304518
Amphitheatre	AMP03-105	241099	6304426
Amphitheatre	AMP04-106	240981	6304410
Amphitheatre	AMP05-107	240914	6304545
Amphitheatre	AMP06-108	241047	6304330

Table 6 – Ground Control Point Monitoring locations - TIA

Swamp	Site Name	Easting	Northing
Twin Gully	TG01-064	236561	6308767
Twin Gully	TG02-065	236437	6308702
Twin Gully	TG03-066	236376	6308813
Twin Gully	TG04-067	236201	6308902
Twin Gully	TG05-068	236018	6308986
Twin Gully	TG06-069	235901	6308865
Twin Gully Hanging	TGHS01-070	236243	6308706
Twin Gully Hanging	TGHS02-071	236194	6308757
Twin Gully Hanging	TGHS03-072	236147	6308722
Tristar	TRI01-73	237474	6306636
Tristar	TRI02-074	237411	6306810
Tristar	TRI03-075	237385	6306868
Tristar	TRI05-077	237239	6306967
Tristar	TRI04-076	237270	6307039
Tristar	TRI06-078	237079	6307090
Tristar	TRI07-079	237032	6306971
Tristar	TRI08-080	236902	6307133
Tristar	TRI09-081	236847	6307122
Tristar	TRI10-82	236823	6307188
Tristar	TRI11-083	236742	6307011

Note: Additional monitoring locations will be confirmed following installation in Spring 2019.

Monitoring locations – Flora Transects

To determine the required sampling intensity, an initial site set-up and pilot study should be undertaken. When setting up new sites the sampling design should follow the general principles:

- To detect changes in vegetation at specific swamps between surveys, or to compare vegetation between different swamps, a minimum of three replicate transects are necessary per swamp.
- The initial number of transects set up per swamp to collect baseline data should be proportional to swamp area to ensure representative sampling of vegetation across the whole swamp, where Brownstein et al. (2014) determined that one randomly positioned transect for every 200m of swamp length was found to be sufficient for the pilot study.
- Transect start points should be positioned at the swamp edge using a stratified random sampling approach (e.g. after dividing the length of the swamp into sections, transect start positions should be located at a random point along the swamp edge, within each section).

- Transect start points are determined before entering the field to avoid sampling bias.
- During the initial baseline survey, 1 m x 1 m quadrats should be positioned at a sampling interval of approximately one quadrat per 4 m.

The location of flora transects for reference and TIA swamps is provided in

Table 7 and **Table 8** respectively and shown in **Figure 6**.

Table 7 – Flora Transect Monitoring locations - Reference

Swamp	Transect Number	Transect Start		Transect End	
		Easting	Northing	Easting	Northing
Best Swamp	1	246599	6308247	246603	6308246
Best Swamp	2	246308	6308017	246253	6308050
Best Swamp	3	246027	6307788	245995	6307820
Best Swamp	4	245720	6307504	245698	6307521
Best Swamp	5	246704	6308414	246694	6308413
Firetail	1	246431	6306676	246441	6306634
Firetail	2	246695	6306690	246691	6306661
Firetail	3	246728	6306390	246785	6306306
Firetail	4	246784	6306739	246946	6306515
Firetail	6	247105	6306653	247132	6306686
Firetail	7	247104	6306923	247207	6306830
Firetail	8	247124	6306956	247166	6306984
Firetail	9	247465	6307088	247495	6307044
Barrier	1	241755	6302479	241795	6302603
Barrier	2	241779	6302583	241727	6302612
Barrier	3	241897	6302665	241811	6302745
Barrier	4	242210	6302978	242137	6302910
Barrier	5	242167	6303420	242108	6303419
Barrier	6	242179	6303541	242126	6303543
Barrier	7	241943	6303851	241933	6303868
Barrier	8	241698	6303727	241697	6303756
Barrier	9	241896	6304254	241886	6304288
Barrier	10	241593	6304262	241595	6304288

Table 8 – Flora Transect Monitoring locations - TIA

Swamp	Transect Number	Transect Start		Transect End	
		Easting	Northing	Easting	Northing
Twin Gully	1	236526	6308756	236519	6308784
Twin Gully	2	236270	6308824	236270	6308857
Twin Gully	3	236117	6308907	236129	6308942
Twin Gully	4	235958	6308909	235927	6308933
Twin Gully	5	235890	6308801	235870	6308798
Twin Gully Hanging	1	236323	6308741	236309	6308768
Twin Gully Hanging	2	236250	6308681	236245	6308768

Swamp	Transect Number	Transect Start		Transect End	
		Easting	Northing	Easting	Northing
Twin Gully Hanging	3	236205	6308688	236208	6308735
Tristar	1	237429	6306778	237447	6306812
Tristar	2	237339	6306916	237377	6306925
Tristar	3	237369	6307065	237350	6307093
Tristar	4	237002	6307119	237015	6307138
Tristar	5	236906	6307127	236911	6307146
Tristar	6	236783	6307129	236772	6307152
Tristar	7	236738	6307110	236720	6307127

*Note: Additional transects will be confirmed following installation in Spring 2019.

Methods: Seasonal Monitoring

Seasonal monitoring comprises the following two methods:

- Remote sensing of red-green-blue-near infrared (RGBI) imagery; and
- Low-impact ground-truthing survey (ground control points).

The direct comparison of ground based observation and remotely sensed imagery provides a report that can be interpreted with a high level of confidence (Brownstein et al. 2014).

Remote Sensing

Red-Green-Blue-Infrared (RGBI) imagery at a spatial resolution of 7cm is to be collected seasonally for impact and reference swamps shown in **Figure 5**. Imagery analysis is to use an objective computerised classification technique to minimise observer bias. In this program, each image is to be classified using the Soil Adjusted Normalised Difference Vegetation Index (SANDVI) to quantitatively define plant health (i.e. a measure of active chlorophyll within the captured scene). The analysis of this classification is to be based on biologically meaningful units (e.g. areas of shrub vegetation, sedge, water bodies, bare ground/dead vegetation etc). Baseline data is to be collected seasonally for impact and reference swamps for a two year period. The range of conditions apparent during this baseline period will form the basis for future 'net change' analysis.

Ground Control Surveys

Ground control surveys supplement the remote sensing monitoring method by providing field verified point based information on the following variables:

- Percentage live green vegetation (i.e. a visual measure of photosynthetically active plant material);
- Percentage non-vegetated area (bare ground, water, litter and standing dead biomass); and
- Percentage cover of each exotic plant species.

The percentages of live green and non-vegetated area may not sum to 100% (i.e. presence of live vegetation that is not green such as branches). The plot data should be collected each time, and within a few days of collecting the aerial imagery.

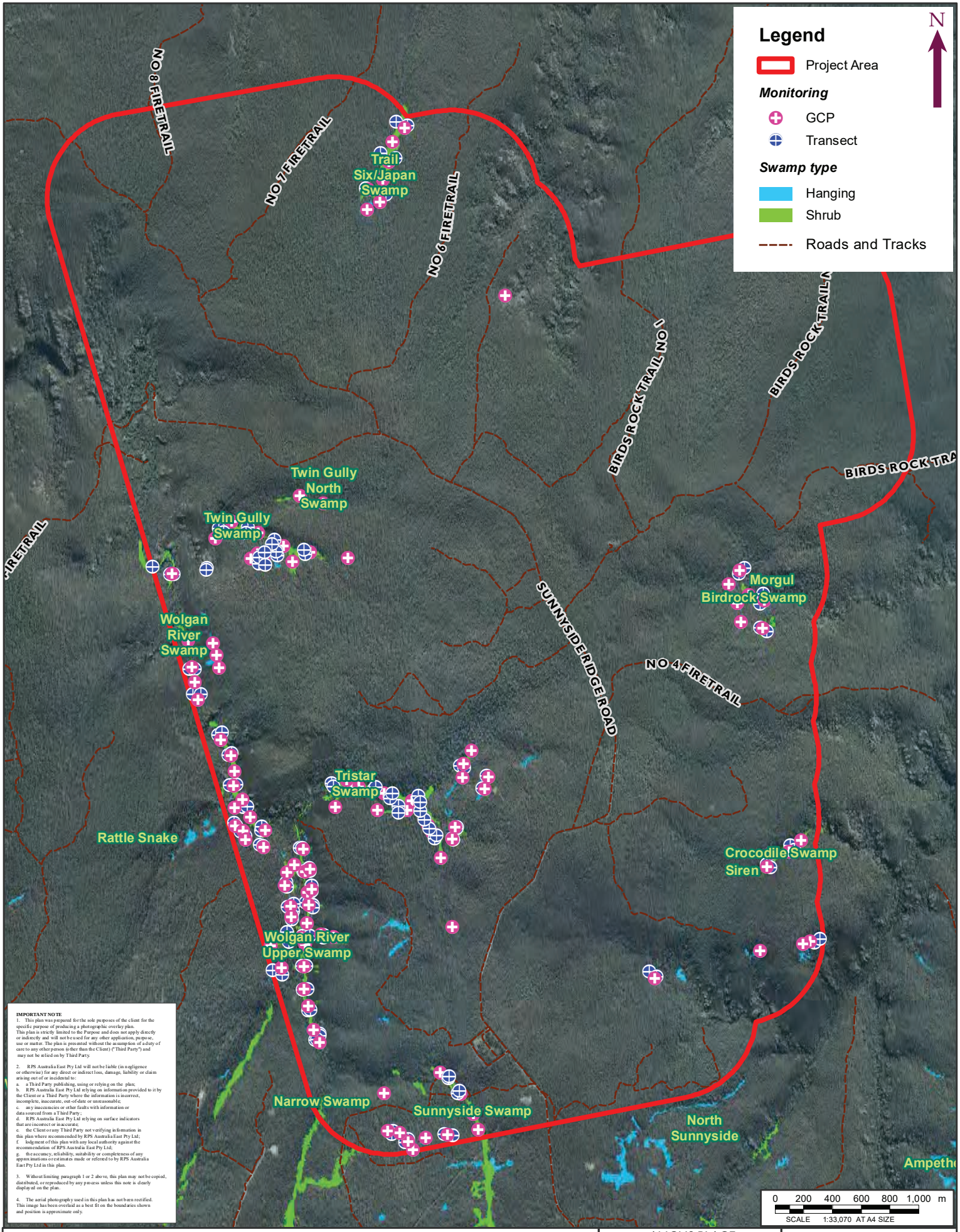

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FIGURE 6: FLORA MONITORING LOCATIONS

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: PR 144414-7

PURPOSE: BMP

Technician: Natalie.Wood Date: 4/12/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\SMP\144414 Figure 6 Flora Monitoring Locations_A4_B 20191031.mxd

In addition, soil moisture content is to be measured at each GCP. Additional information should be collected where other possible changes are observed throughout the community.

Data Analysis and Reporting

Seasonal imagery is to be compared to the baseline data to calculate net change. Areas of net change will be defined as either within or outside the range of conditions observed during the baseline survey period (i.e. two years). Change is to consider the naturally seasonal variation and the effects of standing water. Change outside baseline condition will be analysed to determine if a trigger event has occurred. Trigger investigations would consider the use of existing monitoring data from the ground control points and transect sampling methods.

The exotic species trigger should be calculated using the exotic species cover from the ground control pilot. For each trigger level variable, a single sample t-test comparing baseline with current data should conducted, where any significant differences ($P<0.10$) will be reported.

In reporting the analysis and determining management actions, the following should be considered:

- Change in values relating to trigger levels should be reported,
- Values from impacted and control swamp need to be reported to determine if the magnitude of change in the impacted swamps is outside the natural range,
- Following a trigger value exceedance, a review of potential issues is required prior to initiating a management action, including:
    - Has bare ground occurred due to a tree falling or development of 4x4 tracks?
    - Issues with aerial imagery (e.g. ground sampling distance, flight conditions, prevalence of shadows and camera equipment).
- Finally, intensive sampling should be conducted to ensure plant health change has occurred.

Methods: Annual Monitoring

Transect Sampling

The sampling design of the annual monitoring is a series of three or more permanently marked transects spanning the width of each impact/ reference swamp. Each transect will comprise a series of 1 m^2 plots are placed at 4 m intervals. Within each plot, the percentage cover of each species is recorded along with the percentage cover of bare ground. In addition, soil moisture content is to be measured at each 1 m^2 plot. The collected data is then used to calculate changes in the indicator values to assess if triggers have been exceeded.

Transect setup:

- In the field transect start points should be field verified, where the start and end points should be located at or just inside the swamp edge.
- Transect start and endpoints should be marked with both stakes and waypoints during the site set-up, to ensure comparable data are collected.
- A compass bearing should be recorded from the start point and used for future reference.
- Quadrats should be placed slightly offset of the walked transect to avoid disturbance.

Threatened Species

Impact and control monitoring sites will be established at locations known to harbour threatened species associated with THPSS prior to the impacts of mining.

Threatened species known to be associated with THPSS include:

- Blue Mountains Water Skink (*Eulamprus leuraensis*; BC Act = Endangered; EPBC Act = Endangered);
- Giant Dragonfly (*Petalura gigantea*; BC Act = Endangered; EPBC Act = Not Listed);
- Red Crowned Toadlet (*Pseudophryne australis*; BC Act = Vulnerable);
- Boronia deanei (*Deane's Boronia*; BC Act = Vulnerable; EPBC Act = Vulnerable);
- Xerochrysum palustre (Swamp Everlasting; EPBC Act = Vulnerable): and
- Carex klaphakei (Klaphake's Sedge; BC Act = Endangered).

Contrary to the predictions within the Initial 2014 EIS, ongoing ecological monitoring at Springvale Colliery has indicated that THPSS and associated threatened species may experience greater than negligible impacts as a result of longwall mining. In addition, re-calibration of Subsidence models by MSEC (2019) suggest that the Angus Place Extension Project is likely to be a greater than negligible impact upon THPSS. Subsidence-related impacts are expected at Tri Star Swamp, Twin Gully Swamp and the hanging swamps within their catchments. These impacts may include vegetation dieback, major incision and erosion (in some instances down to bedrock), associated with loss of peat layer, significant loss of ecosystem function and ecological resilience, and ecological and geomorphic threshold exceedance. As such, impacts to THPSS-associated threatened species are also likely in these locations.

Given the current THPSS monitoring results, it is considered unlikely that the THPSS and associated threatened species will be lost in entirety. Consequently, a BACI monitoring program will be designed with the aim of verifying the assumptions discussed in the Biodiversity Impact Analysis, and quantifying the actual impacts following mining. *Carex klaphakei*, Blue Mountains Water Skink, Giant Dragonfly and the Red-crowned Toadlet have all been confirmed present within the Project Area. However, *Xerochrysum palustre* and *Boronia deanei* have not yet been confirmed within the Project Area, consequently; further targeted surveys will focus on presence/absence of these species.

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Appendix C

Biodiversity Management Plan

Centennial Coal

Draft Biodiversity Management Plan

Angus Place Mine Extension Project

December 2019

TABLE OF CONTENTS

List of Figures

List of Tables

DOCUMENT CONTROL

DOCUMENT DETAILS	Name:	Draft Biodiversity Management Plan for Angus Place Mine Extension Project
	Author:	RPS Australia East Pty Ltd
	Revision No.:	2
	Document Status	Final

1. INTRODUCTION

This Biodiversity Management Plan (BMP) has the purpose of guiding the management and monitoring biodiversity values that may be impacted by the Angus Place Mine Extension Project (APMEP; SSD_5602). It mainly relates to the management of terrestrial environments associated with mine surface infrastructure. The biodiversity values in the wetland areas (i.e. Temperate Highland Peat Swamp on Sandstone (THPSS) and associated swamp obligate species) are being addressed more comprehensively in the Swamp Monitoring Program (SMP).

The conditions of consent issued for the approved Springvale Mine Extension Project (SMEP; SSD_5594) have been used as the guiding framework for the preparation of this draft BMP. These conditions of consent are of relevance as both the approved and proposed mining operations share similarities in geography and geology (i.e. Newnes Plateau), mining methods (i.e. longwall mining) and biodiversity values that are likely to be affected.

1.1. Background

Angus Place is an underground coal mine producing thermal coal supplying both domestic and international markets. Angus Place is located 15 km northwest of Lithgow and 120 km west-north-west of Sydney in New South Wales (NSW). Angus Place is bordered by Springvale Colliery to the south-east. The regional setting for the Angus Place mining operation is shown on **Figure 1**.

1.2. Purpose

This draft BMP is to demonstrate an in depth understanding of the potential impacts of longwall mining on biodiversity impacted by longwall mining and is provided as part of the assessment documentation for the APMEP for the purposes of informing the approvals process. The draft BMP is based on experience obtained from the implementation of programs implemented for the approved BMP (SSD_5594). Additionally, the Guidelines for the Preparation of Extraction Plans (DP&E and DRE, 2015) have been used to guide the preparation of this draft BMP.

This draft BMP has the purpose of defining the expected monitoring and management program required for compliance with regulatory approvals (when available) for the secondary extraction of longwalls that form part of the APMEP. Monitoring, actions and responsibilities are defined to ensure the early detection of adverse impacts arising from the secondary extraction of coal from longwalls and the management response in such circumstances.

1.3. Scope

Angus Place will operate in accordance with various future BMPs as listed below:

≠ Angus Place Site Specific BMP; and

≠ Extraction Plan BMPs (longwall specific plans).

In broad terms, Angus Place has been partitioned into two separate biodiversity management units, as listed below:

≠ Terrestrial environments; and

≠ Swamps (i.e. THPSS).

Both these management units are addressed in this BMP; although it should be noted that a more detailed consideration of the swamp management unit is provided in a separate document referred to

as the APMEP SMP. Further details on the scope for each of these biodiversity management units are provided in the following sections.

1.3.1. Management Unit 1: Terrestrial Environment

This BMP addresses the monitoring and management requirements for biodiversity impacts resulting from the secondary extraction of all longwalls within the Management Area. More specifically, this BMP has focused on threatened species and/ or their habitats, endangered ecological communities (EECs) and aquatic ecosystems where not occurring in swamps [1]. It applies to the management of biodiversity across the surface area likely to be affected by subsidence arising from the extraction of coal from Longwalls (LW) 1001 to LW 1015 (herein referred to as the Management Area). This Management Area is defined by the areas bound by the following parameters (see **Figure 2**):

≠ A 26.5° angle of draw line from the limit of proposed extraction in LW 1001-1015.

≠ The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour resulting from the extraction of LW 1001-1015.

≠ A 600 m boundary from extraction which specifically relates to the potential area of influence on groundwater systems from far-field subsidence impacts.

1.3.2. Management Unit 2: Swamps

THPSS is a term collectively describing swamps formed on peat overlaying sandstone. For the purposes of this plan, swamp types that may be impacted by longwall mining include vegetation referred to as Newnes Plateau Shrub Swamps (NPSS) and Newnes Plateau Hanging Swamps (NPHS). Examples of these swamp types can be found in the following named swamp systems, as shown in **Figure 3**:

≠ Wolgan River;

≠ Wolgan River Upper;

≠ Tristar;

≠ Twin Gullies;

≠ Japan (Trail 6);

≠ Sunnyside (northern extent);

≠ Narrow (northern extent);

≠ Crocodile; and

≠ Birdrock.

This BMP and the related SMP have been prepared for swamps occurring within the LW 1001-1015 (i.e. Management Area as defined in **Section 1.3.1**).

[1] Excludes threatened species and endangered ecological communities associated with THPSS. See Section 1.3.2 for guidance on these matters.

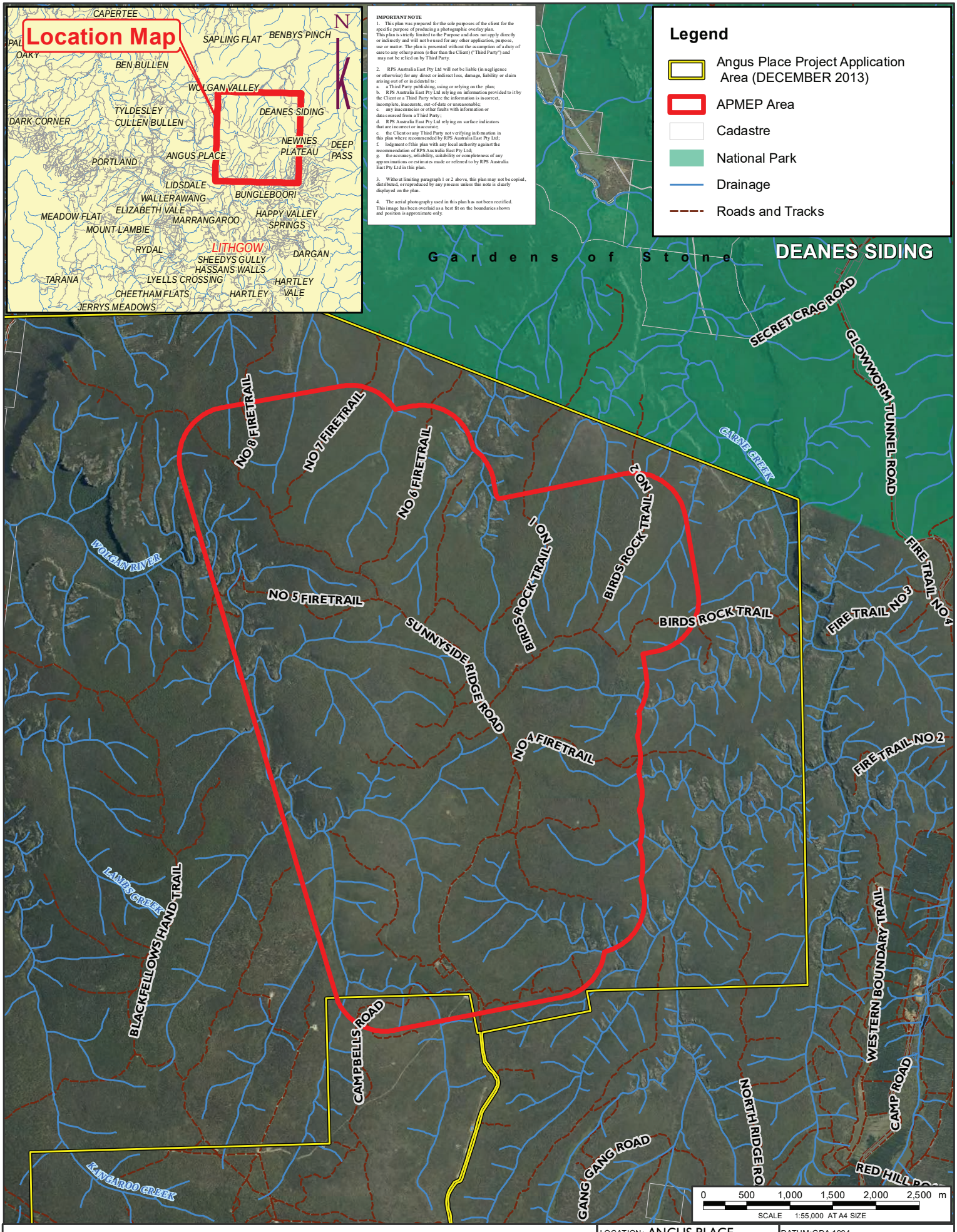

FIGURE 1: LOCALITY PLAN

LOCATION: ANGUS PLACE	DATUM:GDA 1994 PROJECTION: GDA 1994 MGA Zone 56
JOB NO.: PR 144414-7 PURPOSE: BMP Technician: Natalie.Wood Date: 11/10/2019	Data Sources: RPS, Client © Department of Finance, Services & Innovation 2017

CLIENT: CENTENNIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\BMP\144414-7 Figure 1 BMP Locality Map A A4 20191011.mxd

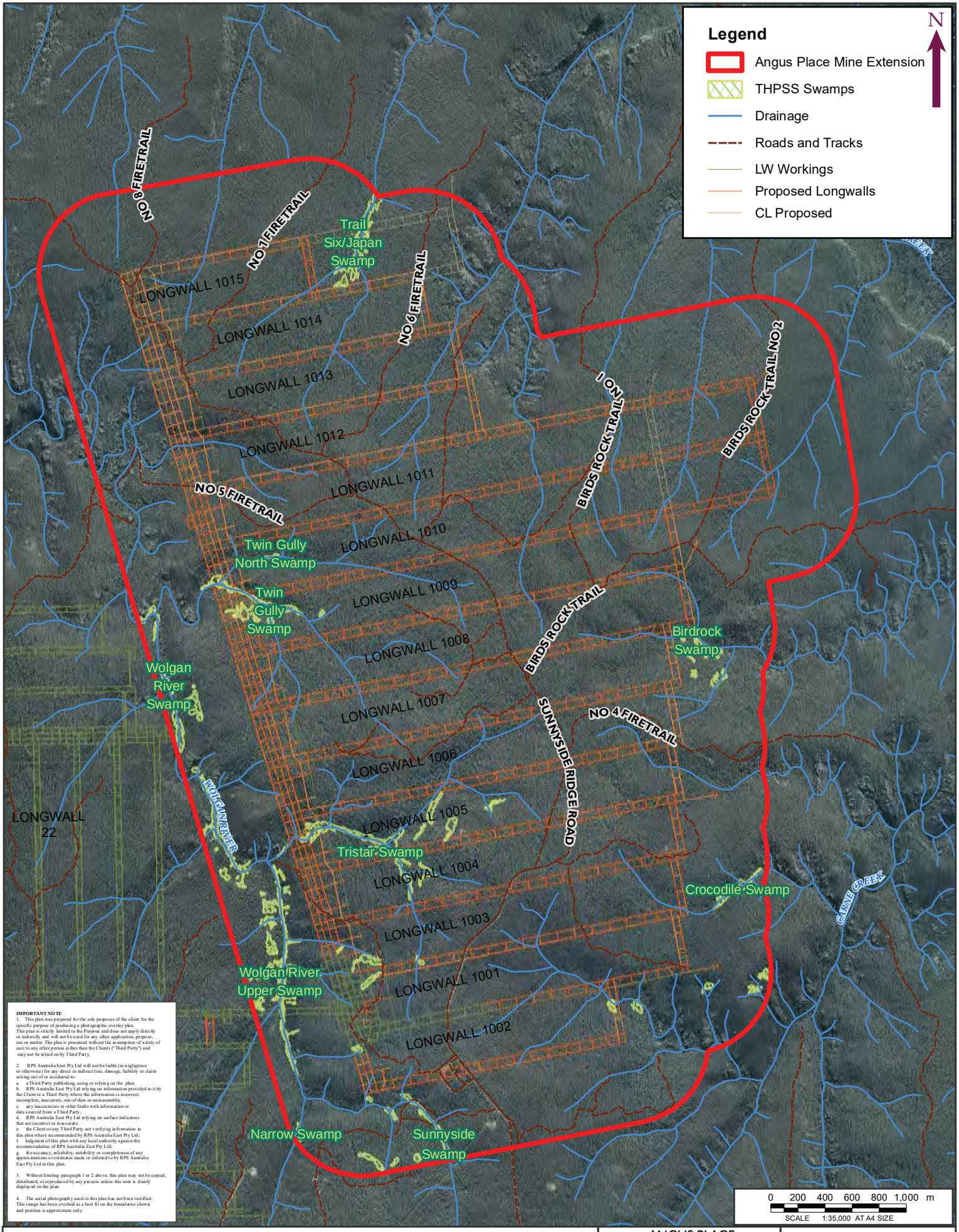

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FIGURE 2: STUDY AREA

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: PR 144414-7

PURPOSE: BMP

Technician: Natalie.Wood Date: 3/12/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\BMP\144414-7 Figure 2 BMP Study Area AA4 20191011.mxd

2. BIODIVERSITY FEATURES AND PREDICTED IMPACTS

This section provides an overview of biodiversity features of the Management Area requiring management and monitoring under this BMP. A description of the relevant features including habitats, threatened flora and fauna, groundwater dependent ecosystems and aquatic ecology has been provided in **Section 2.1**. **Section 2.2** describes all predicted subsidence-related impacts and environmental consequences relevant to this BMP.

2.1. BIODIVERSITY FEATURES

2.1.1. Overview

The Management Area forms part of a larger tract of native vegetation within the Newnes State Forest, which lies adjacent to the World Heritage listed Greater Blue Mountains National Park. The broader landscape comprises a number of habitat types such as characterised by open forest, heath, cliffs, pagodas and exposed rocky areas, riparian zones and swamps. Of these, open forest, heath, riparian zones and swamps are apparent in the Management Area.

Two management units which are representative of the contrasting biodiversity values are recognised in this BMP. A terrestrial environment management unit reflects the majority of the Management Area and comprises mostly sclerophyllous montane forest and heath. This management unit is generally not regarded as sensitive to longwall mining. The second management unit comprises groundwater dependant ecosystems (i.e. THPSS). This management unit is sensitive to longwall mining as there is potential for the alteration of groundwater resources connected with these systems. Both these management units are further described in the following sections.

2.1.2. Management Unit 1: Terrestrial Environment

2.1.2.1 Vegetation

The vegetation cover of this Management Area was mapped by RPS (2014) in Map Units (MU), which have been converted to current vegetation naming conventions [i.e. Plant Community Types (PCT)]. **Table 1** lists the MU and corresponding PCTs occurring within this Management Area.

Table 1 MU (DEC 2006) and corresponding PCTs (BCD 2019) within the Management Area

MU (DEC 2006)	PCT (BCD 2019)
MU 3 Hillslope Talus Mountain Gum - Brown Stringybark - Grey Gum - Broad-leaved Hickory Moist Forest	944 Mountain Grey Gum - Narrow-leaved Peppermint grassy woodland on shales of the Southern Highlands, southern Sydney Basin
MU 7 Newnes Plateau Narrow-Leaved Peppermint – Mountain Gum – Brown Stringybark Layered Forest	967 Narrow-leaved Peppermint - Silvertop Ash - Mountain Grey Gum shrubby open forest of the upper Blue Mountains, Sydney Basin Bioregion (Narrow-leaved Peppermint - Mountain Gum - Brown Barrel moist open forest on high altitude ranges, northern South Eastern Highlands)
MU 8 Newnes Sheltered Peppermint - Brown Barrel Shrubby Forest	1247 Sydney Peppermint - Narrow-leaved Peppermint shrubby open forest on sheltered slopes of the Newnes Plateau, Sydney Basin (Narrow-leaved Peppermint - Mountain Gum - Brown Barrel moist open forest on high altitude ranges, northern South Eastern Highlands)
MU 14 Tableland Mountain Gum - Snow Gum - Daviesia Montane Open Forest	1100 Ribbon Gum - Snow Gum grassy forest on damp flats, eastern South Eastern Highlands (Snow Gum - Mountain Gum tussock grass-herb forest of the South Eastern Highlands)

MU (DEC 2006)	PCT (BCD 2019)
MU 26 Newnes Plateau Narrow-leaved Peppermint - Silver-top Ash Layered Open Forest	1248 Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin
MU 26a Newnes Plateau Gum Hollows variant: Brittle Gum - Mountain Gum, Scribbly Gum - Snow Gum Shrubby Open Forest	
MU 28 Sandstone Plateau and Ridge Scribbly Gum - Silvertop Ash Shrubby Woodland	
MU 29 Sandstone Slopes Sydney Peppermint Shrubby Forest	
MU 30 Exposed Blue Mountains Sydney Peppermint - Silver-top Ash Shrubby Woodland	
MU 43 Pagoda Rock Sparse Shrubland	1666 Narrow-leaved Stringybark - Fringe Myrtle - Scaly Phebalium heathy woodland on exposed sandstone ranges of the Sydney Basin
MU 44 Sandstone Plateaux tea Tree – Dwarf Sheoak – Banksia Rocky Heath	708 Blue Mountains Mallee Ash - Dwarf Casuarina heath of the upper Blue Mountains, Sydney Basin
MU 45 Newnes Plateau Tea Tree - Banksia - Mallee Heath	
MU 46 Newnes Plateau Dwarf Sheoak - Banksia Heath	816 Dwarf Casuarina heathland of the upper Blue Mountains
MU 50 Newnes Plateau Shrub Swamp	657 Baeckea linifolia – Grevillea acanthifolia subsp. acanthifolia shrub/sedge swamp on sandstone, Sydney Basin Bioregion
MU 51 Newnes Plateau Hanging Swamp	

Monitoring design and analysis will be referenced against the corresponding PCT as benchmark datasets have been published for these vegetation classifications.

2.1.2.2 Habitat

Land uses evident within the Management Area include the selective harvesting of hardwood timber and clear felling of pine plantation by the Forestry Corporation of NSW (FCNSW). Vegetation within the Management Area and overall Newnes Plateau is subject to periodic fires throughout the high fire season, some of which are intense enough to alter vegetation structure. The combined effect of these influences has resulted in large areas of even aged young forest with a low to moderate density of hollow bearing trees. Short to medium term impacts on fallen timber, groundcover and leaf litter providing shelter and foraging habitat for fauna has also been observed although recovery is underway.

2.1.2.3 Threatened Species

Threatened flora and fauna species listed under the *Biodiversity Conservation Act 2016* (BC Act) and/or the EPBC Act identified as occurring (RPS 2014, RPS unpublished data) within the Management Area are listed in **Table 2**. Mapped occurrences are provided in **Figures 3** and **4** for threatened flora and fauna respectively.

Table 2 Threatened Species in the Management Area

Life Form	Scientific Name	Common Name	Management Unit
Flora	*Veronica blakelyi*	*Veronica blakelyi*	1 and 2
	Persoonia hindii	*Persoonia hindii*	1
Fauna	*Eulamprus leuraensis*	Blue Mountains Water Skink	2
	Petroica phoenicea	Flame Robin	1
	Callocephalon fimbriatum	Gang-gang Cockatoo	1
	Chalinolobus dwyeri	Large-eared Pied Bat	1
	Petroica boodang	Scarlet Robin	1
	Daphoenositta chrysoptera	Varied Sittella	1
	Ninox strenua	Powerful Owl	1
	Cercartetus nanus	Eastern Pygmy Possum	1

2.1.3. Management Unit 2: Swamps

As shown in **Figure 2**, the swamp management unit of the Management Area is associated with Japan Swamp (formerly Trail 6 Swamp), Twin Gully Swamp, Tri Star Swamp, Sunnyside Swamp and Narrow Swamp. Japan Swamp, Tri Star Swamp and Twin Gully Swamp form part of the State listed NPSS EEC. Additionally, there are patches of NPHS located proximal to Twin Gullies, Tri Star, Birdrock and Wolgan River Swamps, which do not form part of the State listed NPSS EEC. All mapped patches of NPSS and NPHS are groundwater dependent and collectively form part of the Commonwealth listed THPSS EEC.

THPSS is known to provide habitat for threatened flora species including *B. deanei* and for threatened fauna species including Blue Mountains Water Skink (*Eulamprus leuraensis*), Giant Dragonfly (*Petalura gigantea*) and threatened frogs such as the Red-crowned Toadlet (*Pseudophryne australis*). It is due to the groundwater dependency of THPSS that both threatened species and EECs are sensitive to any alteration in groundwater resources linked to these swamps.

2.1.4. Aquatic Ecology

The aquatic habitats associated with the Management Area include Wolgan River, Twin Gully Swamp, Carne Creek, Tri-Star Swamp and Birdrock Swamp and associated unnamed tributaries. Where swamps were assessed, flowing water within a channel was surveyed. These creeks and tributaries vary in their base surface water flows (Cardno 2019).

Wolgan River, which is approximately 64 km long, has small base surface flows that are derived from shrub swamps or perched aquifers. The river channel was fairly narrow, varying in width from 1 m to 5 m with water depths ranging from 0.2 m to 1.5 m. Sites along the Wolgan River were surrounded by dense, overhanging riparian vegetation, however had been exposed to moderate amounts of disturbance (Cardno 2019).

Carne Creek is situated in a valley bordered by steep sandstone escarpments supporting native vegetation. Maximum channel width reached 5 m, and maximum depth reach 0.9 m. Boulder outcrops, fallen logs and dense vegetation were present along the banks, but no macrophytes or charophytes were observed in Carne Creek (Cardno 2019).

The swamps typically had dense heath vegetation, that were either within or surrounding the drainage channels. Channels are typically narrow and shallow, forming a series of bedrock cascades. Pool depths ranged from 0.3 m to 1 m with widths ranging from 1 m to 2 m. Aquatic habitats included trailing bank vegetation, detritus, undercut banks and logs (Cardno 2019).

Wolgan River sites supported a total of 57 aquatic macroinvertebrate fauna (Cardno 2019). Most of these consisted of insects, freshwater mites, crustaceans, and freshwater worms. Lower numbers were recorded within the swamp and Carne Creek sites. No fish or amphibians were recorded in these areas during baseline surveys. Aquatic plants recorded include Bulbous Rush, Charophytes and clubrush. No filamentous green algae were observed (Cardno 2019).

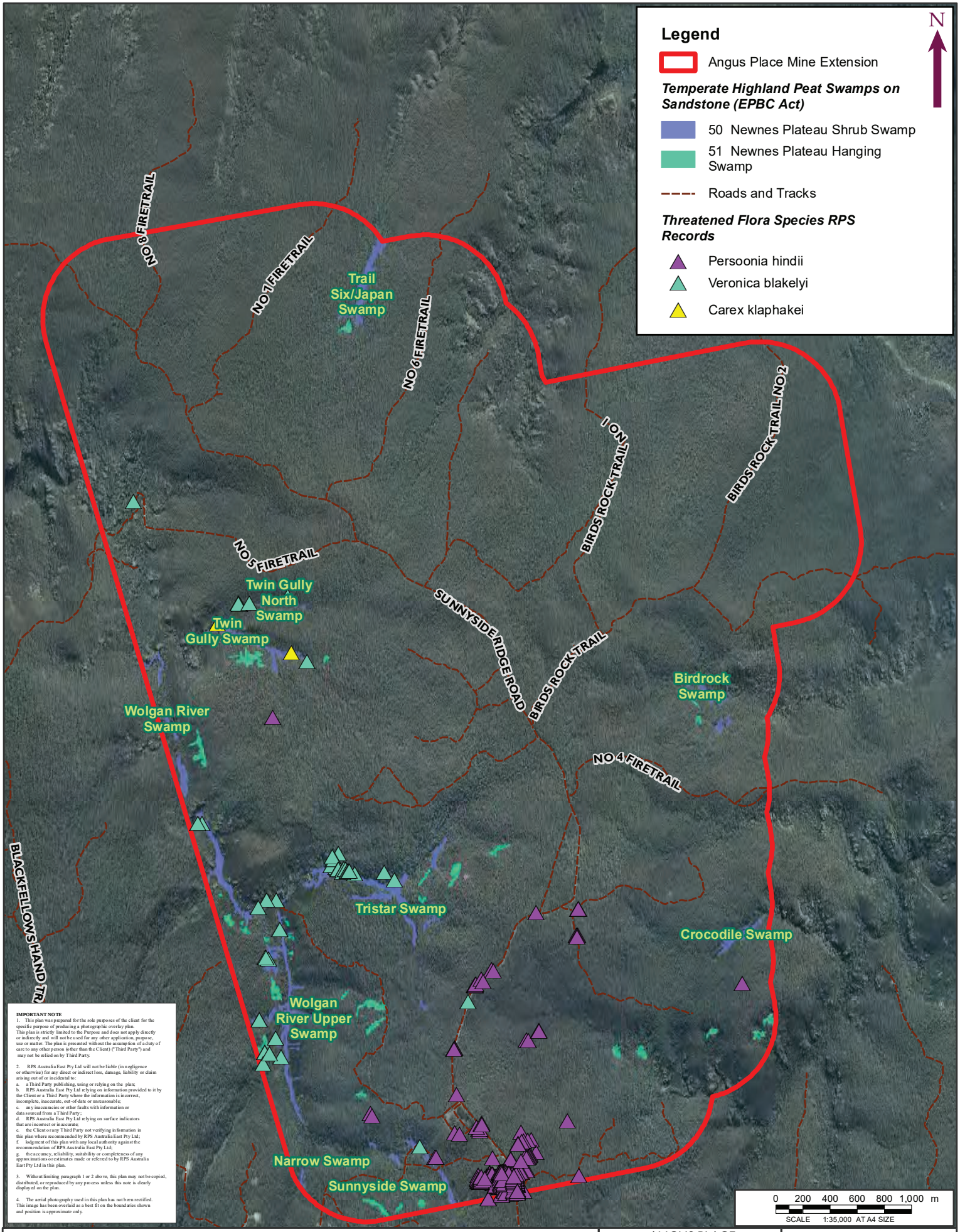

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FIGURE 3: THREATENED FLORA

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: PR 144414-7

PURPOSE: BMP

Technician: Natalie.Wood Date: 3/12/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\BMP\144414-7 Figure 3 BMP Th Flora A A4 20191014.mxd

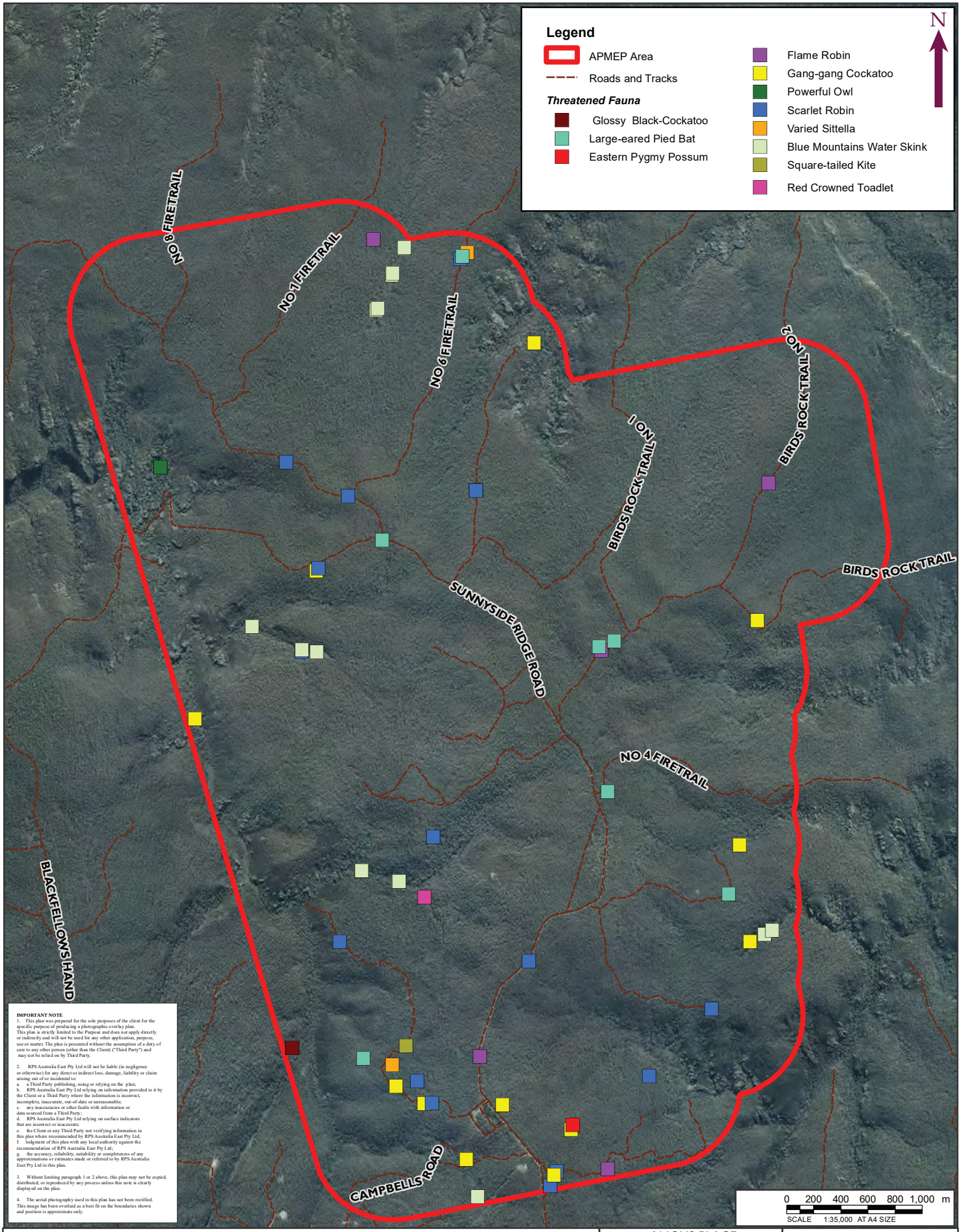

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FIGURE 4: THREATENED FAUNA

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: **PR 144414-7**

PURPOSE: BMP

Technician: Zach.Cotter Date: 1/11/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

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2.2. Predicted Impacts

Subsidence has the potential to modify habitats through surface cracking, slope changes causing erosion and changes to hydrological regimes. Most of the Management Area is dry woodland, forest or heath. The risks of subsidence-related impacts on drier habitats are low as even significant subsidence has minimal effect on dryland plant communities. Risks of subsidence-related impacts are higher in riparian habitats and groundwater dependent ecosystems due to the potential for alterations to surface or groundwater hydrological regimes.

As a component of the Amended Project Report for the proposed LW 1001-1015, MSEC were engaged to prepare subsidence predictions for the proposed LW 1001-1015 including subsidence impacts and environmental consequences (MSEC 2019). Other habitat features that may be susceptible to high levels of subsidence include cliffs, pagodas and caves as subsidence may induce cracking or failure of these features to the extent that they become less suitable for habitation.

Table 3 provides a summary of the maximum predicted values of the total vertical subsidence, tile and curvature of LW 1001-1015.

Table 3 Maximum Predicted Total vertical subsidence, tilt and curvature after the extraction of each of the proposed longwalls (MSEC 2019)

After Longwall	Maximum Predicted Total vertical Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
LW1001	850	7	0.09	0.15
LW1002	1450	12	0.20	0.20
LW1003	1950	12	0.20	0.20
LW1004	2000	14	0.20	0.25
LW1005	2150	20	0.40	0.35
LW1006 to LW1015	2250	25	0.35	0.40

The above table exemplifies that the maximum predicted subsidence parameters, based on the Extraction Plan Layout, are different as those based on the EIS Layout. The two longwall layouts cover similar extents, however additional longwalls were previously dropped to the south and north of the current layout (MSEC 2019). Details of predicted subsidence and ecological impacts have been outlined within **Sections 2.2.1** and **2.2.2**.

2.2.1. Management Unit 1: Terrestrial Environment

2.2.1.1 Wooded Habitats

Localised changes in the soils on steeper slopes may occur from the downslope movement of soil resulting in tension cracks appearing at the tops and along the sides of the steep slopes and compression ridges forming at the bottoms of the steep slopes (MSEC 2014; MSEC 2019).

Tension cracks and soil destabilisation may cause localised disturbance of the root zone for some plants where this occurs. However, it is noted that a number of those threatened flora considered as having the potential to occur either respond positively to, or readily recover from disturbance, or naturally occur within areas where the soil surface is naturally unstable, such as mountain scree slopes. Any loss of threatened flora would be highly isolated and would not remove a significant proportion of soil seedbank such that an area would become unviable for threatened flora (RPS 2014).

As predictions to wooded habitat types have not changed since the original subsidence predictions were calculated, the conclusion relating to biodiversity impacts remains the same as per RPS (2014). RPS (2014) concluded that it is highly unlikely that subsidence-related ground movements would affect woodland or forest habitats such that they would become unsuitable for any of the threatened fauna that were recorded or likely to occur in the Management Area.

2.2.1.2 Riparian Habitats

The predicted post mining grades along the drainage lines are similar to the natural grades (MSEC 2019). Therefore, it is not expected that there would be any significant adverse changes in ponding, flooding or scouring resulting from the proposed mining. There may be some very minor localised areas which could experience small increases in the levels of ponding, where the natural gradients are low immediately upstream of the longwall chain pillars (MSEC 2014; MSEC 2019).

It is expected that fracturing of the bedrock would occur beneath some sections of the drainage lines which are located directly above the proposed longwalls. Fractures in bedrock underlying watercourses across the Management Area could significantly increase local hydraulic conductivity, and in some cases eliminate baseflow (Jacobs 2019a). Loss of flow can lead to the progressive drying of downstream swamps (Jacobs 2019a).

2.2.1.3 Cliffs, Minor Cliffs and Pagodas

The definition of a cliff provided in the NSW Department of Planning and Environment Standard of Model Conditions for Underground mining (DP&E, 2012) is a “Continuous rock face, including overhangs, having a minimum length of 20 meters, a minimum height of 10 meters and a minimum slope of 2 to 1 (>63.4°)”. Pagodas have been defined as isolated freestanding rock formations with heights greater than 5 meters.

Cliffs, caves, pagodas and rock outcrops provide potential habitat for a variety of species including the Broad-headed Snake (*Hoplocephalus bungaroides*) and the Brush-tailed Rock Wallaby (*Petrogale penicillata*); whilst caves within these features may also contain structures which provide habitat for cave-dwelling bats (RPS 2014).

The mining layout has been designed such that the majority of the cliffs and pagoda complexes are located outside the 26.5° angle of draw from the extents for the proposed longwalls (MSEC 2019). There are three cliffs that are situated within the Management Area based on the 26.5° angle of draw and no pagoda complexes, only isolated pagodas, in the Management Area (MSEC 2019).

Cliffs are predicted to experience less than 20 mm vertical subsidence and far-field horizontal movements towards the proposed mining area (MSEC 2019). It is unlikely that the cliffs would experience adverse impacts due to their distances outside of the proposed mining areas, however isolated rock falls could occur (MSEC 2019).

Minor Cliff AP-MC1 is located above LW1013 and could experience fracturing, potentially resulting in localised spalling of exposed rockface (MSEC 2019). Minor cliffs outside the Management Area are unlikely to experience adverse impacts.

Pagodas along the upper reaches of Drainage Lines 1 and 5 and the upper reaches of the Wolgan River are predicted to experience up to 150 mm vertical subsidence. Predicted strains for these pagodas is 1.4 mm/m tensile and 0.6 mm/m compressive based on the 95 % confidence intervals (MSEC 2019). Fracturing is a possibility of these pagodas due to tensile strains, which could result in rockfalls (MSEC 2019). It is unlikely that fracturing would occur in pagoda complexes that are located on or outside the 26.5° angled of draw (MSEC 2019).

2.2.2. Management Unit 2: Swamps

Impacts on THPSS are discussed in the following sections for swamps and drainage lines that occur within the Project Area. The following Swamps are expected to be impacted by subsidence. The predicted Groundwater and surface water related subsidence impacts are noted for each Swamp.

Tri Star Swamp

The Springvale Angus Place Swamp Water Balance Model (SAPSWBM) flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The modelled change in surface water flow at Tri Star Swamp is large and the impact of that magnitude is expected to be significant (Jacobs 2019a).

The maximum predicted water table decline beneath Tri Star Swamp is 10m for the 10th percentile drawdown and 5m for the 90th percentile drawdown. Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b)

Twin Gully Swamp

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The predicted changes range between a minor to moderate increase and a minor to moderate decrease. It is considered that the impact of the magnitude of change in flows in Twin Gully Swamp may be moderate but, is less than that predicted for Tri Star Swamp (Jacobs 2019a).

The maximum predicted water table decline beneath Twin Gully Swamp is 10m for the 10th percentile drawdown with up to 5m drawdown predicted for the 90th percentile decline (Jacobs 2019b). Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b).

Japan (Trail Six) Swamp

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The magnitude of the changes in the U90 results range from moderate to large and are expected to be significant (Jacobs 2019a).

The maximum predicted water table decline beneath Trail Six Swamp is 10m for the 10th percentile drawdown, with up only 0.5m for the 90th percentile decline (Jacobs 2019b). Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b)

Crocodile Swamp

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The predicted magnitude of decrease is negligible, therefore, the modelled impact is considered to be insignificant.

The maximum predicted water table decline beneath Crocodile Swamp is up to 5m for the 10th percentile drawdown, with the majority of the swamp predicted to be approximately 2m. For the 90th percentile decline, the predicted drawdown is mostly less than 0.5m with areas of up to 1m drawdown predicted (Jacobs 2019b). Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b).

Birdrock Swamp

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). The predicted change in flow rates is a moderate to large decrease, which is considered to be significant (Jacobs 2019a).

The maximum predicted water table decline beneath Birdrock Swamp is up to 5m for the 10th percentile drawdown, with the majority of the swamp predicted to be approximately 2m. For the 90th percentile decline, the predicted drawdown is mostly less than 0.5m with areas of up to 1m drawdown predicted (Jacobs 2019b). Water Table drawdowns of this magnitude have potential to result in at least partial drying of the swamp (Jacobs 2019b)

Wolgan River and Wolgan River Upper Swamps

The SAPSWBM flow rates were assessed as a percent change between proposed and null case by Jacobs (2019a). Whilst the predicted change is of moderate magnitude, it is not considered to be significant because of the median flow rate (Jacobs 2019a).

No significant drawdown is predicted at Wolgan River Swamp or Wolgan River Upper Swamp (Jacobs 2019b).

Unnamed Drainage Lines

There are unnamed drainage lines situated directly above the proposed longwalls. Some sections of the drainage lines through and downstream of the swamps are third order (MSEC 2019). The sections downstream of the shrub swamps have small base surface water flows. Elsewhere, the drainage lines are generally ephemeral, although there are some groundwater seeps from the perched aquifers (MSEC 2019).

The predicted post-mining grades along the drainage lines are similar to the natural grades varying between 25 mm/m and 300 mm/m.

It is expected that fracturing of the bedrock would occur beneath the sections of the drainage lines that are located directly above and adjacent to the proposed longwalls. Where the bedrock is shallow or exposed, then the fracturing will be visible at the surface. Fracturing can also occur outside the extents the proposed longwalls, with fracturing possible at distances up to approximately 400 m (MSEC 2019).

Surface water flow diversions could occur along the sections of drainage lines that are located directly above and adjacent to the proposed longwalls. Further discussions on the potential impacts on surface water flows are provided by the specialist surface water consultant on the project (MSEC 2019).

It is expected that drainage lines located directly above the proposed longwalls will experience compressive strains due to valley related movements between 10 mm/m and 20 mm/m. The greatest compressive strains are expected to occur where the drainage lines are located near the centrelines of the proposed longwalls and lesser values where the drainage lines are located above or near to the chain pillars. The compressive strains for the drainage lines located outside the extents of the proposed longwalls are expected to be less again (MSEC 2019).

Potential Changes

The predicted post mining grades are similar to the natural grades within the drainage lines. There are no predicted significant reductions or reversals of stream grade. It is not expected, therefore, that there would be any adverse changes in ponding or scouring resulting from the mining-induced tilt.

2.2.2.2 Potential for Cracking in the Swamps and Fracturing of Bedrock

The maximum predicted conventional curvatures for the swamps are 0.35 km-1 hogging and 0.40 km-1 sagging, which represent minimum radii of curvature of 2.9 km and 2.5 km, respectively.

The shrub swamps are located along the alignments of drainage lines and, therefore, are likely to experience valley related movements. A summary of the maximum predicted total upsidence and closure for the shrub swamps is provided in MSEC (2019).

The predicted upsidence and closure are greatest for the parts of swamps located near the centrelines of the longwalls and less for the parts of swamps located near the chain pillars. As described in MSEC (2019), the actual valley related movements are expected to be around 60 % to 90 % of the maxima predicted near the centrelines of the longwalls, and around 30 % and 60 % of the maxima predicted near the chain pillars.

The hanging swamps are located on the sides of the valleys and, therefore, are not expected to experience significant valley related upsidence movements or compressive strains due to closure movements, which occur near the bases of the valleys.

Fracturing in bedrock has been observed due to previous longwall mining where the tensile strains have been greater than 0.5 mm/m or where the compressive strains have been greater than 2 mm/m. It is likely, therefore, that fracturing would occur beneath the swamps located directly above the proposed mining area. Fracturing can also occur outside the mining area, with minor and isolated fracturing occurring at distance up to approximately 400 m (MSEC 2019).

The estimated fracture widths in the topmost bedrock, based on the maximum predicted conventional tensile strain of 3.5 mm/m and based on a typical joint spacing of 10 m, is in the order of 35 mm. The fracture widths outside the proposed mining area are expected to be typically less than 10 mm. The crack widths are expected to be typically less than 25 mm, however localised cracking with widths greater than 50 mm can also develop (MSEC 2019). Larger surface deformations could also occur if increased scouring were to develop due to changes in swamp vegetation.

Tri Star Swamp is predicted to experience maximum predicted subsidence effects above the proposed mining area and is therefore likely to experience adverse impacts due to the proposed mining (MSEC 2019). Twin Gully is also likely to experience adverse impacts, to a lesser extent, as it is not coincident with a Type 1 or 2 geological structure and due to the lower predicted subsidence effects (MSEC 2019).

The shrub swamps have peat layers which overlie the shallow natural surface soils and underlying bedrock along the alignments of the drainage lines. In most cases, cracking would not be visible at the surface within these swamps, except where the depths of bedrock are shallow or exposed.

The mining-induced compression due to valley closure effects can also result in dilation of the strata beneath the shrub swamps and the development of bed separation in the topmost bedrock, as it is less confined. This dilation due to valley closure is expected to develop predominately within the top 10 m to 20 m of the bedrock. Compression can also result in buckling of the topmost bedrock resulting in heaving in the overlying surface soils (MSEC 2019). The dilated strata beneath the drainage lines, could result in the diversion of some surface water flows beneath parts of the shrub swamps. It is noted, however, that the drainage lines upstream of the swamps are generally ephemeral and, therefore, surface water flows occur during and shortly after rainfall events.

2.2.3. Aquatic Ecology

In the case of surface watercourses, subsidence may result in fracturing of the stream bed and banks, movements of joint and bedding plates in the stream bed, and uplift and buckling of strata in the stream bed (Cardno 2019). These physical impacts can cause diversions of surface and sub-surface flows, drainage desiccation of fringing vegetation, reductions in longitudinal connectivity and deterioration of water quality (Cardno 2019). Ground movements can also lead to tilting of stream beds which can in turn lead to erosion of the stream bed and banks and increased instream sediment load, changes in flow rates and migration of stream channels (Cardno 2019). Subsidence may also allow the release of gas from sub-surface strata which could reduce water quality in some cases lead to dieback of riparian vegetation (Cardno 2019).

3. MANAGEMENT MEASURES

The current mine plan and design has been selected to minimise environmental effects of underground mining operations at Angus Place. Centennial Coal has developed a reliable and detailed understanding of the environmental constraints from operating the Springvale Mine which has been in operation for over 20 years and the resulting environmental management and monitoring programs associated with operation of the site. The current mine plan for the APMEP has been proactively designed with a high regard and full consideration of the ecological constraints present within the area.

The proposed mine plan has been developed using the extensive monitoring and baseline data available for the neighbouring Springvale Mine, which will significantly reduce the risk of impacts to sensitive ecological features. Due to the unlikely event of an adverse biological response to the secondary extraction for biodiversity values contained within Management Unit 1, it is considered unnecessary to prescribe specific management measures in this draft BMP. Rather, if monitoring detects an impact that exceeds the performance indicator then an investigation would be performed and would include the development of a specific management response to the matter impacted. Performance indicators will be developed once the Development Consent conditions are received.

Conversely, there is a greater likelihood for an impact on sensitive biodiversity occurring in Management Unit 2. Due to the specific nature of this management unit and the complex interrelated factors involved in determining the incidence and extent of an impact, management measures for Management Unit 2 are not detailed in this BMP, rather, are provided in the associated SMP. Notwithstanding, the management response to an exceedance of a performance indicator would involve one or more of the following:

≠ Trigger investigation to evaluate likely causation;

≠ Implementation of adaptive management including mitigation works where considered feasible;

≠ Ongoing investigations to review efficacy of adaptive management; and

≠ Offsetting if impacts are mining related and are not regarded as negligible.

3.1. Response Triggers

Baseline data will be used to develop a series of triggers based on performance indicators that will be used to determine whether any mining related impacts have occurred during and following mining in LW 1001-1015. Triggers will be developed following receipt of the Development Consent for environmental factors most likely to indicate the incidence of a mining related impact, these being:

- Subsidence,
- Flora,
- Fauna
- Groundwater Level and Quality, and
- Surface Water Quality.

With the following exceptions, baseline data will be collected for any new monitoring sites established in the context of the State Development Consent (SSD_5602) or Federal EPBC approval (2011/5952).

Time series analysis processes will be built into the development of trigger values. For example, triggers will be developed to identify short and long-term mining related impacts should any occur.

4. BIODIVERSITY MONITORING PROGRAM

Monitoring within the Management Area is to be performed prior to commencement of secondary extraction. Baseline data is to be obtained prior to the initiation of secondary extraction with monitoring to occur with predefined frequency during and after the mining period (i.e. impact data). The monitoring of control or reference sites should also be performed to allow for a comparative evaluation with baseline and impact datasets to aid in determining causation should change be detected.

In this respect, the broader monitoring framework is listed below:

≠ Land surface or topography;

≠ Photographic;

≠ Groundwater;

≠ Surface water;

≠ Terrestrial biodiversity; and

≠ Aquatic biodiversity.

Information contained in this BMP is limited to the latter two matters (i.e. terrestrial and aquatic biodiversity). Reference to relevant components of other monitoring programs is made, where needed, to address specific parts of the conditions of consent.

Monitoring for each of management unit is outlined in the following sections. Monitoring design principles and methods are provided in this BMP and allow implementation within any monitoring event. Survey effort and location specifications for each method are deferred to the initial monitoring event. The implementation of subsequent monitoring events is to be in accordance with the methods specified in this BMP and the prescriptions determined in the initial monitoring event (i.e. assumes an ongoing repeat sampling of initial monitoring event).

4.1. Monitoring Design

4.1.1. Stratification

It is neither possible nor practical to design a monitoring program that provides 100% coverage. Within this context, it is proposed to sample the Management Area in a stratified manner that best represents the identified biodiversity values of each management unit. Stratification units identified for each of the management units are provided in **Table 4**.

Table 4 Sample Stratification for Management Units 1 and 2

Management Unit	Stratification Unit
1: Terrestrial Environment	Montane Heathlands Montane Sclerophyll Forest
2: Swamps	Shrub Swamps (NPSS) Hanging Swamps (NPHS)

4.1.2. Site Selection and Sample Size

The following criteria are to be considered when determining the location of a monitoring site:

≠ Monitoring sites having the purpose of measuring the impacts of longwall mining must occur within the Management Area;

≠ Reference or control sites need to be located outside of the Management Area;

≠ Reference sites need to be relatively close, but independent of, impact sites to maximise similarities in weather and hydrogeological conditions;

≠ Where possible, reference sites should share similarity in vegetation composition and structure to impacts sites;

≠ A minimum of three replicates are required for each treatment (i.e. impact and control are separate treatments);

≠ All sites need to have reasonable access to allow for on ground monitoring and investigation activities if required; and

≠ OH&S issues such as access and communications also need to be considered.

4.2. Methods

4.2.1. Significant Features

Significant features within and in close proximity to the Management Area (including cliffs, minor cliffs, pagodas, rock outcrops) will be monitored pre and post mining for evidence of any subsidence related impacts such as rock falls or surface cracking.

4.2.2. Flora

4.2.2.1 Vegetation Integrity

Plots performed in accordance with the Biodiversity Assessment Method Order (2017), hereafter referred to as BAM plots, were used to measure the vegetation integrity of THPSS in both impact and reference swamps. The purpose of this investigation was to calculate the maximum offset liability as outlined in **Section 4.2.2.2**. The configuration of a BAM plot is shown in **Figure 5**.

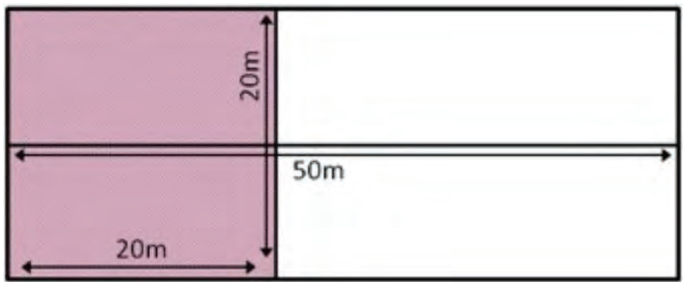

Figure 5 BAM Plot Dimensions

Each plot includes the measurement of the following variables:

≠ One standard 20 x 20 m (400 m2) plot, to assess the composition and structural attributes, including trees, shrubs, grasses, forbs, ferns and other growth forms;

≠ One standard 20 x 50 m (1000 m2) plot, to assess functional attributes including: number of large trees with a diameter at breast height (DBH) > 50 cm, number of trees in stem size

classes (i.e. <5, 5–9, 10–19, 20–29, 30–49, 50–79, and 80+ cm), tree regeneration, total length of fallen logs, high threat exotic vegetation cover and hollow-bearing trees (HBT); and

≠ Five 1 x 1 m (1 m2) sub-plots to assess average litter cover for the plots.

NPSR was recorded within a 400 m2 floristic plot nested within the 1,000 m2 BAM plot. Cover as a percentage and abundance estimate was recorded for each plant species observed in the nested 400 m2 floristic plot.

Photographs were taken of each BAM plot from a standardised point coincident with the transect origin (i.e. recorded GPS point) at an approximate height of 1.5 m. At least a 5 megapixel was used for each photograph. A horizontal field of view of approximate 40 degrees is achieved, which is within the central angle of view for human vision (i.e. 40-60 degrees).

Data procured from the BAM plots is initially analysed using an indirect gradient analysis (i.e. non-Metric Multidimensional Scaling) to identify if change is occurring between impact and control plots. If change is indicated, then separate analysis such as ANOVA would be performed to determine if the change meets a significance threshold. This analysis would be performed as part of a trigger investigation.

4.2.2.2 Maximum Offset Liability

A biodiversity offset liability is incurred if the performance measure for Management Unit 2 is exceeded and it is determined that the impact is greater than negligible. This is determined through the monitoring program established under the APMEP SMP for the Management Area.

The maximum offset liability for sensitive biodiversity located within Management Unit 2 has been calculated at the swamp scale and is provided in RPS (2019). This has been calculated in accordance with the NSW BAM (State of NSW) with specific reference to the policy framework for determining subsidence impacts on upland swamps and associated threatened species.

In the circumstances where it is predicted (supported by evidence) that a partial impact to an upland swamp is likely, then only the portion of the swamp likely to experience greater than negligible impacts should be included in the offset calculation. This situation is considered the most likely circumstance should a greater than negligible environmental consequence arise from the mining of LW 1001-1015. In this respect, the following has been documented in the Maximum Offset Liability report (RPS 2019):

≠ Pre-mining data was collected from 75 BioMetric plots across the Newnes Plateau, of which 33 were utilised to populate the BAM Credit calculator.

≠ Vegetation zones were assigned to each NPS across the Management Area and were classified as either shrub or hanging swamps based on their landscape position and floristic characteristics.

≠ NPSS was considered suitable habitat for four species credit species, being:

- Blue Mountains Water Skink (*Eulamprus leuraensis*);
- Giant Dragonfly (*Petalura gigantea*);
- Red-crowned Toadlet (*Pseudophryne australis*); and
- *Boronia deanei* (Deane's Boronia).

By longwall, Table 5 describes the type, mapped extent and number of BAM plots performed within THPSS. The location of these BAM plots is shown in **Figure 6**.

Table 5 THPSS type for each longwall panel and number of BAM Plots

Longwall	Swamp Type	Area (ha)	BAM Plots
LW1001	Shrub Swamp	2.57	61,62
	Shrub Swamp	3.78	31,33
	Hanging Swamp	5.29	30,55,56
LW1002	Shrub Swamp	0.97	39
	Shrub Swamp	0.2	35
	Hanging Swamp	0.93	74
LW1003	Shrub Swamp	5.18	25,26,27
	Shrub Swamp	1.48	29
	Hanging Swamp	1.06	23
LW1004	Shrub Swamp	0.69	70
	Shrub Swamp	2.59	19,20
	Hanging Swamp	0.72	21
LW1005	Shrub Swamp	0.53	63
LW1006	Shrub Swamp	1.05	64
	Hanging Swamp	0.06	69
LW1007	Shrub Swamp	1.21	66
	Hanging Swamp	0.92	16
LW1008	Shrub Swamp	2.4	12,13
	Shrub Swamp	0.38	76
	Hanging Swamp	1.23	14
LW1009	Shrub Swamp	0.31	67
	Shrub Swamp	1.17	68
LW1013	Shrub Swamp	4.16	8,9
	Hanging Swamp	0.36	65
Totals		**39.24**	**33**

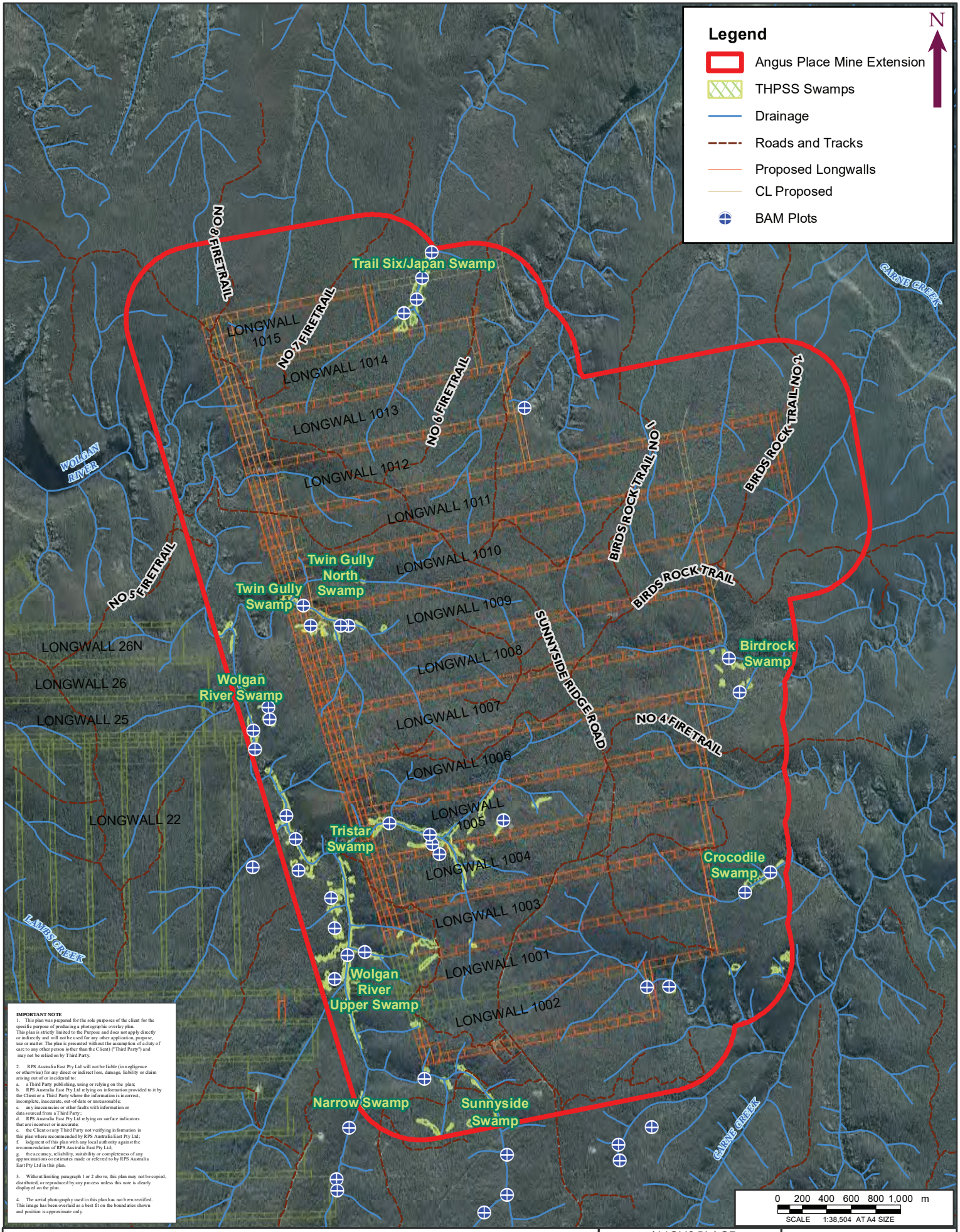

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FIGURE 6: FLORA MONITORING LOCATIONS

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: PR 144414-7

PURPOSE: BMP

Technician: Natalie.Wood Date: 3/12/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\BMP\144414-7 Figure 6 BMP Flora Monitoring Locations A A4 20191018.mxd

4.3. Fauna

Fauna monitoring will target threatened microbat, frog, invertebrate and reptile species to measure the Operations' impact on these values. Due to the subsidence and impact predictions it is proposed to primarily focus monitoring on THPSS and the associated threatened species in Management Unit 2 (Swamps). A representative sample of other biodiversity values present within Management Unit 1 (Terrestrial) will focus primarily on threatened species reliant on Cliffs and Pagodas or riparian habitats. A general description of the proposed methods used to perform fauna monitoring is provided in the following section.

4.3.1. Amphibians

Methods for amphibian census employ field techniques such manual searches, triangulation, call play back and call mimicry to identify frog species. Surveys should target riparian vegetation or damp, low-lying areas (including GDEs) and target chorus periods at dusk after rainfall events during the day and at night. Results will report species diversity (including species name and the number of individuals observed and method of detection).

4.3.2. Reptiles

Targeted reptile surveys have been performed for the Blue Mountains Water Skink and Broad-headed Snake. Surveys for the Blue Mountains Water Skink involve the use of funnel traps and/ or pitfall traps and is being performed as part of a research program for the species, as detailed in the APMEP SMP.

Sydney Broad-headed Snake surveys are generally performed in pre-clearance surveys using targeted searches of habitat (i.e. exfoliated rock). Nocturnal surveys should also be conducted to target this species. Reporting will include location, habitat context, habits and behavioural observations.

4.3.3. Mammals

Cliffs, caves, pagodas and rock outcrops which have potential to be impacted provide habitat for the cave dwelling bats and the Brush-tailed Rock Wallaby.

Brush-tailed Rock Wallaby Surveys

The Brush-tailed Rock Wallaby will surveyed for using camera traps, scat surveys and opportunistically when conducting other targeted surveys within the Management Area.

Cave Dwelling Microbat surveys

Methods for bat detection include the deployment of Echolocation call detection apparatus (e.g. Anabat express units: Titley scientific) to record microbat calls in suitable habitat such as potential foraging and flyway sites. Recordings are then analysed by an experienced ball call analyst. Microbat species richness and activity is reported.

4.3.4. Threatened Invertebrates

One threatened invertebrate species, the Giant Dragonfly (Petalura gigantea), may occur within the Management Area. It occupies habitat within the NPSS/ THPSS EEC and is an obligate groundwater dependent swamp species. A BACI design research and monitoring program for the Giant Dragonfly dedicated to assessing potential mining related impacts upon this species will be prepared.

4.3.5. Pest Fauna

Camera traps will be utilised to estimate the spatial extent of pest species incidence and activity within the Management Area. Indirect methods such as the mapping of signs and tracks is to also be performed opportunistically where possible (i.e. signs, tracks and scats). Monitoring programs are to be adjusted following implementation of control measures to measure success.

4.4. Data Analysis Methodology

Data will be analysed, and reports will be generated by a specialist consultant and provided to Centennial Angus Place. Data from the surveys will be analysed to show:

≠ Species counts;

≠ Habitat characteristics;

≠ Species diversity; and

≠ Species richness.

4.5. Aquatic Ecology

The location of aquatic ecology monitoring sites for Spring 2016 has been shown in **Figure 7**. **Table 6** outlines the physical location of aquatic ecology monitoring sites. The most recent Aquatic Ecology monitoring report is by Cardno (2019).

Table 6 Aquatic Ecology Monitoring Sites

Catchment Area	Site	Easting	Northing
Carne Creek	CCXdn	240473	6305884
Wolgan River	WRup	237495	6305114
Wolgan River	WRmd	236420	6306880
Wolgan River	WRdn	235388	6309805
Tri Swamp	TRIS	236571	6307015
Carne Creek	BRS	239961	6308489
Two Gully Swamp	TGS	235780	6308693
Twin Gully Swamp	TGSup	236661	6308723
Tri Swamp	TRISup	237321	6307047

4.5.1. Monitoring Methodology

The aquatic macroinvertebrate assemblages are determined using the standardised National River Process and Management Program River Bio-assessment Manual methods (Davies, 1994) as adapted for the National River Health Program (referred to as the AUSRIVAS method) (Turak et al 2004, Chessman 2003). The AUSRIVAS protocol provides a number of definitions of sites and habitats within sites for selection of sampling locations and recommends that, wherever possible, two habitats (riffles and edges) be sampled at each site.

The following AUSRIVAS definitions are relevant and sampling has conformed to these definitions:

≠ A site is "a stream reach with a length of 100 m or 10 times the stream width, whichever is the greater";

≠ A riffle habitat is "an area of broken water with rapid current that has some cobble or boulder substratum". However, "sampling riffles where the substratum consists predominantly of large boulders may be difficult and may not produce reliable results"; and

≠ Edge habitat is "an area along the creek with little or no current".

Ideally, a particular reach within each of the sample locations is selected on the basis of it being (i) a reach with high drought resistance (generally based on pool size, depth and riparian cover) and (ii) a reach with high aquatic habitat diversity; ideally deep pools connected by gentle riffles, abundance of stream bed litter, presence of snags, presence of aquatic vegetation and good extent of cover of overhanging riparian vegetation. Field methods for the sampling of water quality, macroinvertebrates, fish and other vertebrates are outlined within Appendix C of Cardno (2019).

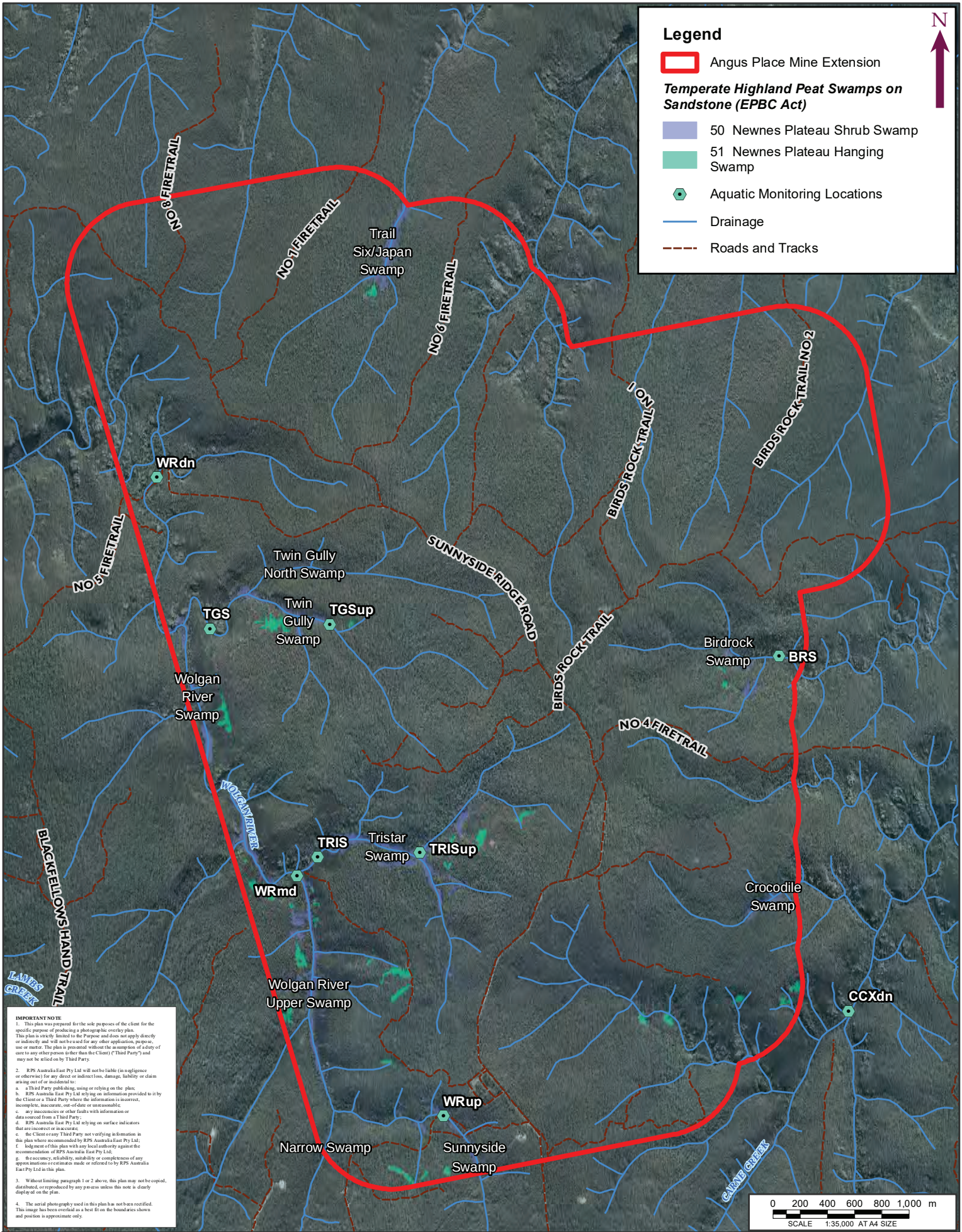

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FIGURE 7: AQUATIC MONITORING LOCATIONS

LOCATION: ANGUS PLACE

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

JOB NO.: PR 144414-7

PURPOSE: BMP

Technician: Natalie.Wood Date: 3/12/2019

Data Sources:
RPS, Client
Angus Place 20cm Ortho

CLIENT: CENTENNIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\BMP\144414-7 Figure 7 BMP Aquatic Monitoring A A4 20191017.mxd

4.5.2. Data Analysis Methodology

Aquatic Macroinvertebrate Data

The aquatic invertebrate assemblage for each sample site is described in terms of the site taxa diversity (number of individual AUSRIVAS taxa) and in terms of a site SIGNAL score. SIGNAL (Stream Invertebrate Grade Number Average Level) is a pollution tolerance index for stream macroinvertebrates.

AUSRIVAS predictive model also generated OE50Taxa scores for the ratio of the number of macroinvertebrate families with a greater than 50% predicted probability of occurrence that were actually observed at a site to the number of macroinvertebrate families expected with a greater than 50% probability of occurrence. Overall Bands derived from OE50 Taxa scores indicate the level of impairment of an assemblage and are categorised as X, A, B C and D.

Each macroinvertebrate family has been assigned a SIGNAL score ranging from 10 (very pollution intolerant) to 1 (very pollution tolerant). For the present study SIGNAL-2 scores were applied. Taxa with no published SIGNAL score were excluded from the site SIGNAL analysis. Once taxa SIGNAL indices have been applied individual site SIGNAL indices are calculated (as the mean) from all site taxa with SIGNAL scores. Creek SIGNAL scores are calculated as the mean of all taxa SIGNAL value occurrences recorded within each creek system for a survey. Site and creek SIGNAL scores are then summarised and compared across each survey and between surveys. As a general guide site SIGNAL Indices are graded into the following categories:

≠ SIGNAL Index > 6 = Healthy Unimpaired

≠ SIGNAL Index 5-6 = Mildly Impaired

≠ SIGNAL Index 4-5 = Moderately Impaired

≠ SIGNAL Index < 4 = Severely Impaired.

Fish Survey Data

Taxonomic identification of fish species are made to the levels required by AUSRIVAS.

Description of Site Condition

A standardised description of site aquatic habitat condition is used to compile a stream site condition index, based on a modified version of the River-Creek-Environment (RCE) method developed by Petersen (1992), as reported by Chessman et al (1997) for the greater Hunter River catchment. The assessment involves evaluation and scoring of the characteristics of the adjacent land, the condition of riverbanks, channel and bed of the watercourse, and degree of disturbance evident at each site. The index is compiled by giving each of the 13 RCE descriptors a score between 0 and 4, then summing the scores to reach a maximum possible score of 52. Scores are then expressed as a percentage.

5. ADAPTIVE MANAGEMENT

Angus Place has developed an adaptive management framework designed to avoid repetition of any unpredicted subsidence impacts and/or environmental consequences. Primary demonstrations of adaptive management actions occurred at the design phase of this Project. The previous mine plan for the APMEP EIS consisted of 19 longwalls ranging in void widths of between 260-300 m. The current mine plan to be proposed as part of the Amended Project Report has been developed to avoid environmental impacts by:

≠ Reducing the lengths of longwalls to provide an offset of at least 1000 m from the adjacent Gardens of Stone National Park; and

≠ Mining under two Shrub Swamps (Twin Gully and Tri-Star), as longwalls have been shortened to avoid mining under Japan (Trail 6) Swamp that was proposed to be under-mined in the EIS.

As a result of these changes, the mining footprint of the proposed mine plan is smaller then the EIS mine plan footprint, and the number of longwalls proposed to be mined reduced from the original 19 longwalls to 15 longwalls.

Minimization of impacts will include the monitoring and periodic evaluation of environmental consequences against the performance measures, performance indicators and response triggers which will all form part of a Trigger Action Response Plan (TARP). The TARP will be developed following receipt of the development consent conditions.

An adaptive management framework has been adopted for offsetting calculations whereby a Before After Control Impact (BACI) monitoring program can be designed to determine impact type, magnitude and causation. This framework provides opportunity to match operational related impacts as they are identified, with targeted management activity to minimise the future impacts of the operation. Thus, this framework would ultimately have the objective to avoid an unmanageable ‘greater than negligible impact’, thus avert the need for offsetting. The above integrated approach demonstrates commitment to the ‘avoid, minimise, offset’ hierarchy.

6. BIBLIOGRAPHY

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Appendix D

Swamp Offset Strategy

Centennial Coal

Springvale Mine
&
Angus Place Colliery

Swamp Offset Strategy

July 2019

DOCUMENT CONTROL

DOCUMENT DETAILS	**Name:**	Springvale Mine and Angus Place Colliery Swamp Offset Strategy
	Author:	James Wearne Group Approvals Manager Centennial Coal
	Date	July 2019
	Version	2
	Document Status:	Final

Table of Contents

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Executive Summary

The Springvale Mine and Angus Place Colliery are existing underground coal mines located approximately 15 kilometres (km) to the northwest of the regional city of Lithgow and 120 km west-northwest of Sydney in New South Wales (NSW).

Springvale Mine currently operates under State Significant Development consent (SSD 5594). The Springvale Mine Extension Project is a controlled action (EPBC 2013/6881) under the *Environment Protection and Biodiversity Act* 1999 (EPBC Act).

Angus Place Colliery's Project Approval PA_06_0021 will expire in August 2024 and a new consent is required to ensure Angus Place Colliery is operational beyond this date. A new SSD application and supporting Environmental Impact Statement (EIS) was submitted to the NSW Department of Planning, Infrastructure and Environment (DPIE) in April 2014 for the Angus Place Mine Extension Project (SSD 5602). A decision was made by Centennial Coal in March 2015 to place the Angus Place Colliery into care and maintenance. At this time, the assessment of the Angus Place Mine Extension Project was placed on hold. An amended application for the Angus Place Mine Extension Project is currently being prepared.

Both the proposed Angus Place Mine Extension Project and the approved Springvale Mine Extension Project will undermine Newnes Plateau Shrub Swamps (NPSS) and Newnes Plateau Hanging Swamp (NPHS). NPSS is listed as an endangered ecological community (EEC) under the NSW *Biodiversity Conservation Act* 2016 (BC Act). NPSS and NPHS are collectively commensurate with the Temperate Highland Peat Swamps on Sandstone (THPSS) community which is listed as an EEC under the EPBC Act. Threatened flora and fauna species associated with THPSS and their conservation status is listed below:

- ≠ Blue Mountains Water Skink (*Eulamprus leuraensis*) is listed as Endangered under both the BC Act and the EPBC Act;
- ≠ Giant Dragonfly (*Petalura gigantea*) is listed as Endangered under the BC Act;
- ≠ Deane's Boronia (*Boronia deanei*) is listed as Vulnerable under both the BC Act and the EPBC Act; and
- ≠ Red Crowned Toadlet (*Pseudophryne australis*) is listed as Vulnerable under the BC Act.

In accordance with the BC Act and EPBC Act, any greater than negligible environmental consequences to THPSS and their associated threatened species will be required to be offset in accordance with the NSW Biodiversity Offset Scheme and the Commonwealth EPBC Act Environmental Offsets Policy.

Centennial Coal has developed a multi-layered swamp offset strategy to compensate for the current and potential impacts to THPSS and their associated threatened species for both the Springvale Mine Extension Project and Angus Place Mine Extension Project (should it be approved). The strategy has been designed to satisfy the various State and Commonwealth offset policy requirements where possible and takes into consideration the specific conditions of consent issued for the Springvale Mine Extension Project. The Swamp Offset Strategy includes:

- ≠ Payment into the Biodiversity Conservation Trust (BCT) Fund for impacts to THPSS and their associated threatened species associated with the Angus Place Mine Extension Project (if approved).
- ≠ Support for a transfer of land (currently owned and managed by Forestry Corporation NSW (FCNSW)) into a State Conservation Area on a staged basis to satisfy the EPBC Act Environmental Offsets Policy requirements for both the Springvale Mine Extension Project and Angus Place Mine Extension Project as well as contribute to the offset liability obligations under the Springvale Mine Extension Project development consent (SSD 5594).
- ≠ A monetary contribution from Springvale Coal to the management of the land as an additional supplementary measure to meet the offset obligations under the Springvale Mine Extension Project development consent (SSD 5594).

- A commitment to ongoing monitoring of THPSS and their associated threatened species within the Springvale Mine and Angus Place Colliery mine extension areas.
- A commitment to ongoing research on the Blue Mountains Water Skink (*Eulamprus leuraensis*).

1 Introduction

1.1 Background

The Springvale Mine and Angus Place Colliery are existing underground coal mines producing high quality thermal coal which is supplied to both domestic and international markets. The two underground coal mining operations are located approximately 15 kilometres (km) to the northwest of the regional city of Lithgow and 120 km west-northwest of Sydney in New South Wales (NSW).

The Springvale Mine and Angus Place Colliery are both owned by Centennial Springvale Pty Limited (as to 50%) and Springvale SK Kores Pty Limited (as to 50%) as participants in the Springvale unincorporated joint venture. Springvale Coal Pty Limited (Springvale Coal) is the operator of Springvale Mine on behalf of the joint venture participants. Centennial Angus Place Pty Limited (Centennial Angus Place) is the operator of the Angus Place Colliery on behalf of the Springvale joint venture participants.

1.2 Springvale Mine

Springvale Mine currently operates under State Significant Development consent (SSD 5594). This consent was granted on 21 September 2015 by the Planning Assessment Commission of NSW and allows Springvale Mine to carry out mining operations until 31 December 2028.

The Springvale Mine Extension Project is a controlled action (EPBC 2013/6881) under the *Environment Protection and Biodiversity Act* 1999 (EPBC Act). The approval under the EPBC Act was granted on 13 October 2015 and has effect until 8 October 2035.

Springvale Mine's State consent and Federal approval allow extraction of coal from 20 longwalls (LW416 – LW432, LW501 – LW503) as shown in **Figure 1**.

1.3 Angus Place Colliery

Angus Place Colliery's Project Approval PA_06_0021 was granted in September 2006 under the now repealed Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The existing development consent will expire in August 2024 and a new consent is required to ensure Angus Place Colliery is operational beyond this date.

A new SSD application and supporting Environmental Impact Statement (EIS) was submitted to the NSW Department of Planning and Environment (DPE) in April 2014 for the Angus Place Mine Extension Project (SSD 5602). In response to a prolonged downturn in international coal markets, a decision was made by Centennial Coal in March 2015 to place the Angus Place Colliery into care and maintenance following the completion of secondary extraction within Longwall 900W. At this time, the assessment of the Angus Place Mine Extension Project was placed on hold.

An amended application for the Angus Place Mine Extension Project is currently being prepared to enable the recommencement of the Angus Place Mine Extension Project assessment and determination process. The proposed mine layout for the Angus Place Mine Extension project is shown in **Figure 2**.

2 Newnes Plateau Shrub Swamps and Hanging Swamps

Newnes Plateau Shrub Swamps (NPSS) develop on the Newnes Plateau at altitudes in excess of 1,000 m in the bases of valleys which are subject to periodic to permanent waterlogging from groundwater, surface water and direct rainfall. Newnes Plateau Hanging Swamps (NPHS) develop on the Newnes Plateau on the flanks of valleys which are subject to infrequent waterlogging from perched groundwater systems, surface runoff and direct rainfall. These swamps have a characteristic floral assemblage which is largely a result of the physical location on the flanks of valleys and the hydrological regime and typically occur at altitudes in excess of 1,000 m.

NPSS are listed as an endangered ecological community (EEC) under the NSW *Biodiversity Conservation Act* 2016 (BC Act) and provide important habitat for a range of plants and animals.

NPSS and NPHS are collectively commensurate with the Temperate Highland Peat Swamps on Sandstone (THPSS) community which is listed as an EEC under the EPBC Act. THPSS, NPSS and NPHS are considered to be commensurate with the Plant Community Type (PCT) 657 *Baeckea linifolia - Grevillea acanthifolia subsp. acanthifolia* shrub/sedge swamp on sandstone, Sydney Basin Bioregion.

Both the Springvale Mine Extension Project and the proposed Angus Place Mine Extension Project will have the potential to impact on NPSS and NPHS that are located within 600m of the goaf edge of the approved/proposed longwall mining areas. Consequently, the potential exists for there to be impacts to associated threatened species associated with NPSS and NPSS due to changes to or loss of habitat.

2.1 Springvale Mine NPSS and NPHS

NPSS located within the area of potential impact of the Springvale Mine Extension Project comprise:

- Sunnyside East Swamp;
- Carne West Swamp;
- Gang Gang South West Swamp;
- Gang Gang East Swamp;
- Nine Mile Swamp;
- Pine Swamp;
- Pine Upper Swamp;
- Paddys Creek Swamp;
- Marrangaroo Creek Swamp; and
- Marrangaroo Creek Upper Swamp.

NPHS located within the area of potential impact for the Springvale Mine Extension Project comprise:

- Hanging swamp on western slope above Gang Gang Swamp East;
- Hanging swamp on south western slope above Pine Swamp Upper Swamp; and
- Hanging swamps above Marrangaroo Creek Swamp.

The location of NPSS and NPHS in relation to the Springvale Mine Extension Project area is shown on **Figure 1**.

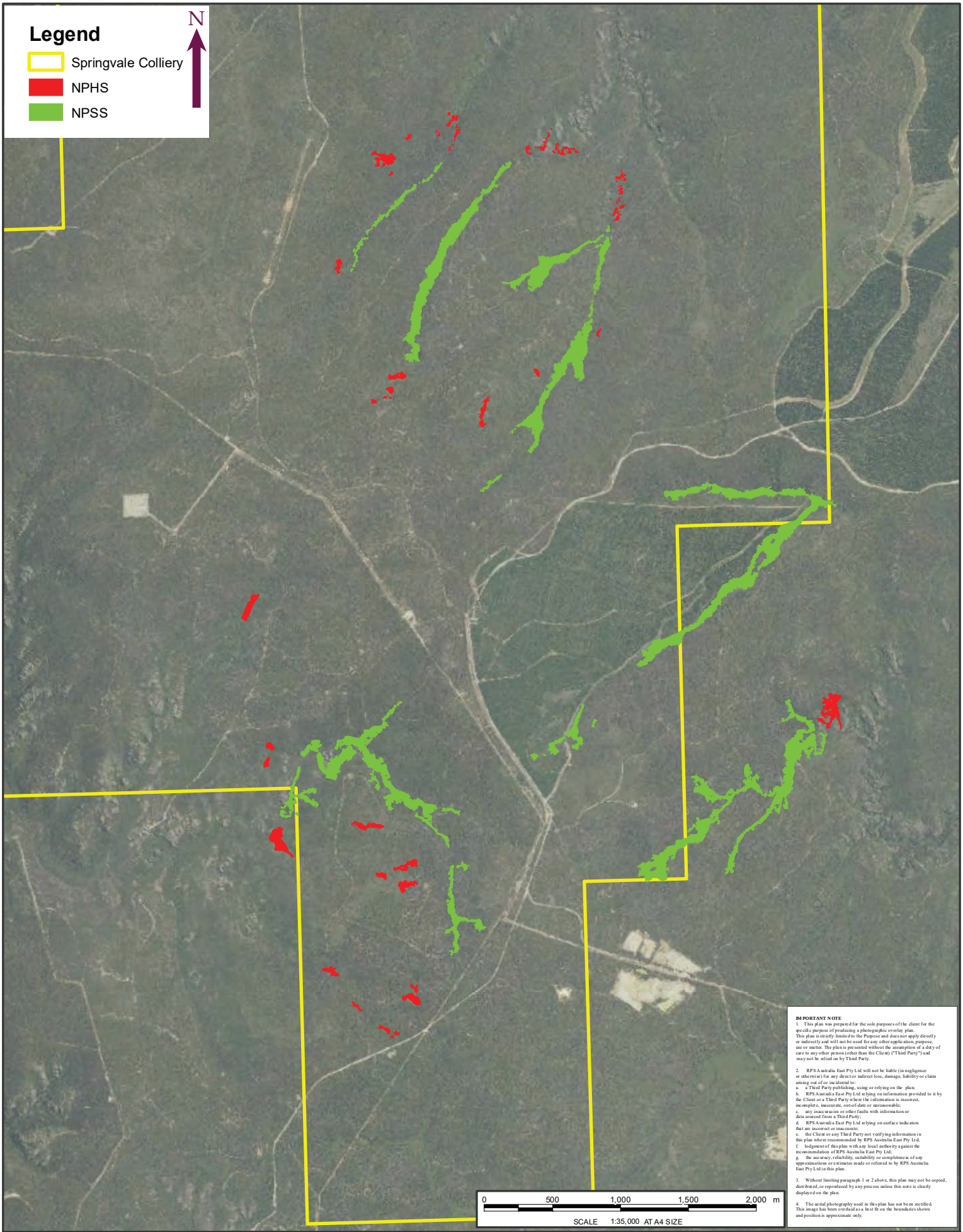

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FIGURE 1: SPRINGVALE MINE EXTENSION PROJECT MINING AREA, THPSS

LOCATION: NEWNES PLATEAU
DATUM: GDA94
PROJECTION: MGA Zone 56
JOB NO.: **PR 144414**
PURPOSE: ECOLOGY
Technician: mark.aitkens Date: 15/07/2019
Data Sources:
RPS, Client
Land and Property 2017

CLIENT: NOT SPECIFIED

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\1. Swamp Offset Strategy\144414 Figure 1 THPSS Springvale C A3 20190715.mxd

NEW_A4_Portrait 2018 Rev: B Produced:NW Reviewed: NW Date: 10/05/2018

2.2 Angus Place NPSS and NPHS

NPSS located within the area of potential impact for the Angus Place Mine Extension Project comprise:

- ≠ Wolgan River (upper, central and lower)
- ≠ Tristar
- ≠ Twin Gullies
- ≠ Japan (Trail 6)
- ≠ Sunnyside (northern extent)
- ≠ Narrow (northern extent)
- ≠ Rattle Snake

NPHS located within the area of potential impact for the Angus Place Mine Extension Project comprise unnamed swamps associated with the areas of NPSS outlined above.

The location of NPSS and NPHS in relation to the Angus Place Mine Extension Project mining area is shown on **Figure 2**.

2.3 NPSS and NPHS Threatened Species

Threatened flora and fauna species associated with NPSS and their conservation status is provided in **Table 1** below.

Table 1 – NPSS Threatened Species and Conservation Status

Species	Listing Status	
	BC Act	**EPBC Act**
Blue Mountains Water Skink (*Eulamprus leuraensis)*	Endangered	Endangered
Giant Dragonfly (*Petalura gigantea)*	Endangered	Not Listed
Deane's Boronia (*Boronia deanei)*	Vulnerable	Vulnerable
Red Crowned Toadlet (*Pseudophryne australis)*	Vulnerable	Not Listed

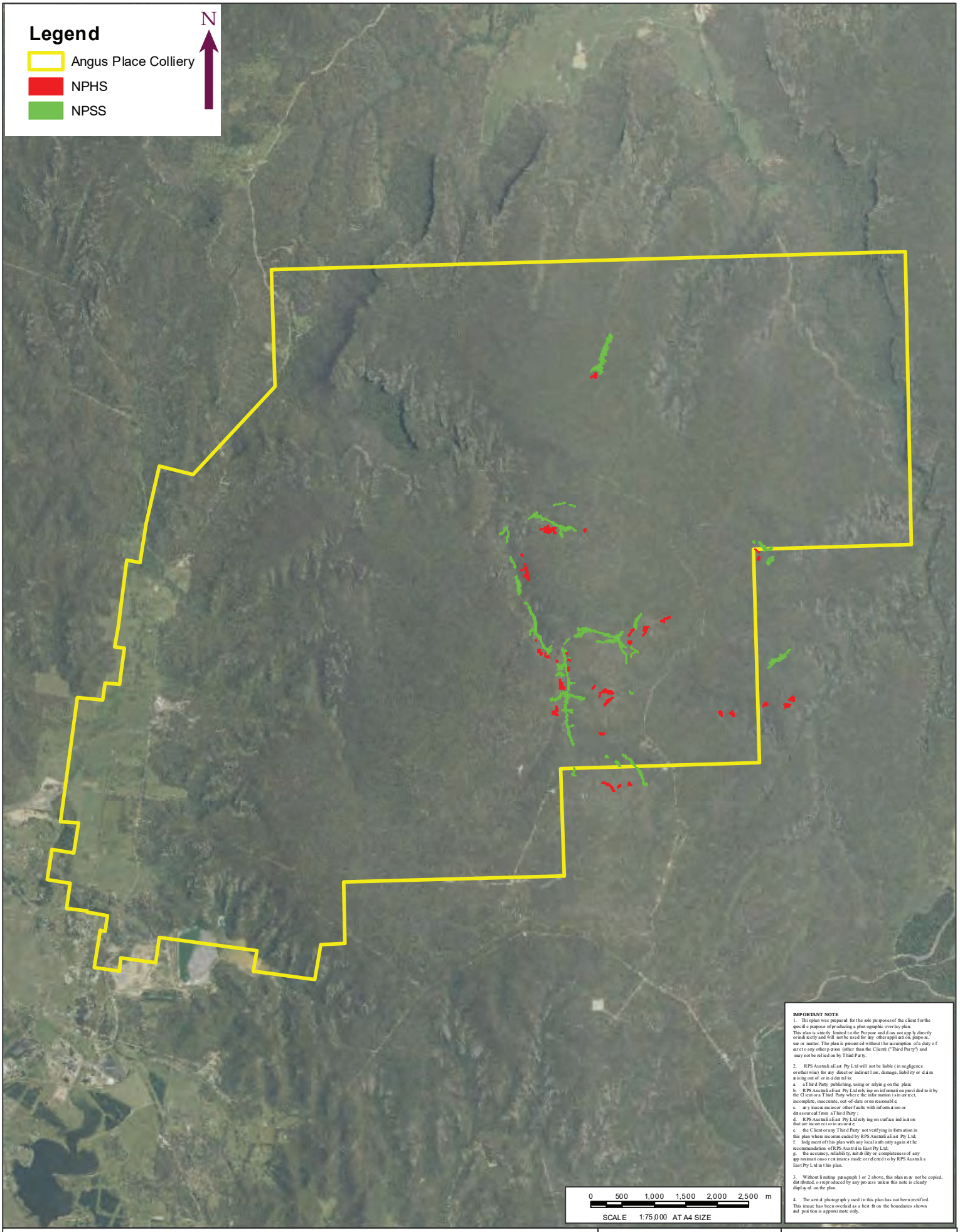

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FIGURE 2: ANGUS PLACE MINE EXTENSION PROJECT MINING AREA, THPSS

LOCATION: NEWNES PLATEAU

DATUM: GDA94

PROJECTION: MGA Zone 56

JOB NO.: **PR 144414**

PURPOSE: ECOLOGY

Technician: Natalie.Wood Date: 28/06/2019

Data Sources:
RPS, Client
Land and Property 2017

CLIENT: CENTENNIAL COAL

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T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\1. Swamp Offset Strategy\144414 Figure 2 THPSS Anugus Place B A3 20190402.mxd

NEW_A4_Portrait 2018 Rev:B Produced:NW Reviewed:NW Date: 10/05/2018

3 Biodiversity Offset Policies

3.1 NSW Biodiversity Offsets Policy for Major Projects

The NSW Biodiversity Offsets Policy for Major Projects commenced on 1 October 2014 (the 'Policy') and applies to state significant development and state significant infrastructure projects under the EP&A Act. The Policy, however, does not provide guidance around certain impacts of a project on biodiversity that are not associated with clearing of vegetation, particularly in relation to subsidence related impacts.

As the Policy was not designed to manage subsidence related impacts to biodiversity, the NSW Office of Environment and Heritage (OEH) released the draft policy *Framework for Biodiversity Offsets for Upland Swamps and Associated Threatened Species Impacted by Longwall Mining Subsidence* in May 2015. The release of this draft policy came during the final stages of the assessment process for the Springvale Mine Extension Project. The finalised version of the *Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland swamps impacted by longwall mining subsidence* (OEH 2016) was released in December 2016 and is hereafter referred to as the Offset Policy Addendum.

The Offset Policy Addendum is to be applied to all new extraction plans for projects that have an existing development consent for longwall mining that may cause subsidence impacts on upland swamps where 'reasonable and feasible'.

The NSW Biodiversity Offsets Policy, including the Offset Policy Addendum, is relevant to the Springvale Mine Extension Project.

3.2 NSW Biodiversity Offset Scheme

The Biodiversity Offsets Scheme was established in 2016 under the BC Act and came into effect on 25 August 2017. The Biodiversity Offsets Scheme was designed to create a transparent, consistent and scientific based approach to biodiversity assessment and offsetting for all types of development that are likely to have a significant impact on biodiversity.

The NSW Government established transitional arrangements related to biodiversity assessment and offsetting for the various categories of development consent or approval that are underway or have already been made. These are set out in the *Biodiversity Conservation (Savings and Transitional) Regulation* 2017; hereafter referred to as the Transitional Arrangements. The Transitional Arrangements apply to the Angus Place Mine Extension Project pursuant to Clause 28(1) of the *Biodiversity Conservation (Savings and Transitional) Regulation* 2017.

Regardless of the application of the Transitional Arrangements to the Angus Place Mine Extension Project, the Maximum Offset Liability potentially incurred as a result of mine related impacts to NPSS and NPHS has been calculated in accordance with the Biodiversity Assessment Method Order 2017 (BAM). This is further detailed in **Section 6** below.

3.3 EPBC Act Environmental Offsets Policy

The EPBC Act Environmental Offsets Policy was released on 20 September 2012. The EPBC Act Environmental Offsets Policy details the considerations for providing biodiversity offsets for residual impacts to matters of national environmental significance. Where offsets to residual impacts of matters of national environmental significance are required, the EPBC Act Environmental Offsets Policy states that 90 per cent of offset liabilities must be met with direct offsets. The remaining 10 per cent of the offset liability may be met by outcomes obtained from research programs related to impacted matters.

Biodiversity offsets under EPBC Act Environmental Offsets Policy must:

- ≠ Deliver an overall conservation outcome that improves or maintains the viability of the protected matter;
- ≠ Be built around direct offsets but may include other compensatory measures;

- ≠ Be in proportion to the level of statutory protection that applies to the protected matter;
- ≠ Be of a size and scale proportionate to the residual impacts on the protected matter;
- ≠ Effectively account for and manage the risks of the offset not succeeding;
- ≠ Be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs;
- ≠ Be efficient, effective, timely, transparent, scientifically robust and reasonable; and
- ≠ Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

The EPBC Act Environmental Offsets Policy is applicable to both the Springvale Mine Extension Project and Angus Place Mine Extension Project.

4 Biodiversity Offset Requirements

4.1 Springvale Mine SSD 5594 Offset Requirements

The SSD 5594 development consent includes performance criteria requiring that no greater than negligible environmental consequences are experienced to NPSS or NPHS. Negligible environmental consequences to NPSS include:

- ≠ negligible change to the shallow groundwater regime when compared with control swamps;
- ≠ negligible erosion of the surface of the swamp;
- ≠ negligible change in the size of the swamp;
- ≠ negligible change in the ecosystem functionality of the swamp;
- ≠ negligible change to the composition or distribution of species within the swamp; and
- ≠ negligible change to the structural integrity of the bedrock base or any controlling rockbar/s of the swamp.

Negligible environmental consequences to NPHS include:

- ≠ negligible change in the size of the swamp;
- ≠ negligible change in the ecosystem functionality of the swamp; and
- ≠ negligible change to the composition or distribution of species within the swamp.

Where monitoring demonstrates that greater than negligible environmental consequences are caused to NPSS or NPHS, and these consequences stabilise for at least 12 months, Springvale Coal must offset those consequences in a manner and timeframe that is satisfactory to the Secretary of the Department of Planning.

The offset must give priority to like-for-like physical environmental offsets, but may also consider payment into any NSW Offset Fund established by OEH, or funding or implementation of supplementary measures such as:

- ≠ actions outlined in threatened species recovery programs;
- ≠ actions that contribute to threat abatement programs;
- ≠ biodiversity research and survey programs; and/or
- ≠ rehabilitating degraded habitat.

4.2 Springvale Mine EPBC (2013/6881) Offset Requirements

In accordance with, Condition 5 of the EPBC approval (2013/6881), greater than negligible environmental consequences on THPSS, and therefore offset liabilities, must be initially determined based on changes to the shallow groundwater aquifer as measured using piezometers.

Under the definitions in the EPBC Approval (2013/6881) THPSS include the following associated species:

• Deane's Boronia (*Boronia deanei*), listed as vulnerable under the EPBC Act

• Giant Burrowing Frog (*Heleioporus australiacus*), listed as vulnerable under the EPBC Act

• Blue Mountains Water Skink (*Eulamprus leuraensis*), listed as endangered under the EPBC Act.

Giant Burrowing Frog is deemed unlikely to occur due to the lack of; preferred habitat and records and the failure to detect the species during ongoing and extensive monitoring programs. Consequently, the EPBC Offset calculations provided in **Section 8** only consider the other two listed threatened species which have been identified to be associated with the THPSS on the Newnes Plateau.

Where monitoring identifies a change to the shallow groundwater aquifer below an undermined THPSS and that change cannot be reasonable attributed to other specific factors to the satisfaction of the Minister, the swamp will be considered to have experienced a greater than negligible environmental consequence. By area, 90 per cent of the THPSS offset liability must be met with direct offsets, within the meaning of the EPBC Act Environmental Offsets Policy. The remaining offset liability may be met by other supplementary measures such as research programs including, but not restricted to, the outcomes attained from the Blue Mountains Water Skink Research and Management Program (which is also a requirement under Section 13 of the EPBC Approval).

4.3 Angus Place Mine Extension Project Offset Requirements

In accordance with the BC Act and EPBC Act, any greater than negligible environmental consequences to NPSS, NPHS and their associated threatened species will be required to be offset in accordance with the NSW Biodiversity Offset Scheme and the Commonwealth EPBC Act Environmental Offsets Policy.

5 Measures to Minimise and Avoid Impacts

To reduce the potential for impacts to NPSS and NPHS located within and beyond the Springvale Mine Extension Project area, Springvale Coal has adaptively managed its mine design since the Springvale Mine Extension Project development consent was granted in 2015. These adaptive management measures have been specifically designed to avoid undermining significant lineaments which could subsequently lead to impacts to NPSS and NPHS. The adaptive mine plan management measures implemented to date include:

- ≠ Shortening of longwalls 421, 422, 424, 425, 426 and 427 to avoid undermining significant lineaments that may lead to interactions to NPSS and NPHS; and
- ≠ Not extracting longwall 422, 423 and 424.

The adaptive management mine plan changes represent a loss of approximately 3.56 million tonnes of coal reserves approved as part of the Springvale Mine Extension Project.

The Angus Place Mine Extension Project has been designed where possible to avoid directly undermining NPSS and NPHS by limiting the length of longwall blocks. Due to the location of NPSS and NPHS associated with the Angus Place Mine Extension Project Area, avoiding impacts to NPSS and NPHS through further mine design measures is not considered feasible.

6 Maximum Offset Liability

The maximum offset liability is a worst case representation of offset liability as it assumes a total loss of biodiversity values and does not consider partial or actual loss or the potential for future regeneration of NPSS or NPHS over time. The maximum offset liability calculations include the ecosystem credits for the swamp vegetation types present within the swamp and any associated threatened species known or predicted to occur within the swamp. These calculations were performed in with reference to the Offset Policy Addendum.

6.1 Maximum Offset Liability Calculations for the Springvale Mine Extension Project

In accordance with, the Offset Policy Addendum and the conditions of the SSD 5594 development consent, Springvale Coal is required, as part of each Extraction Plan, to calculate the maximum offset liability for any swamps predicted to experience a greater than negligible environmental consequence as a result of mining.

For each extraction plan for the Springvale Mine, a maximum offset liability must be calculated for the total area of NPSS predicted to be subject to greater than negligible environmental consequences. This includes the calculation of ecosystem and species credits using the Framework for Biodiversity Assessment (FBA).

The maximum offset liability for NPSS within the Springvale Mine Extension Project Area is summarised in **Table 2** below.

Table 2 – Springvale Mine Maximum Offset Liability Calculations for Newnes Plateau Shrub Swamps

Swamp	Maximum Offset Liability Credits			
	Ecosystem (NPSS)	Blue Mountains Water Skink	Giant Dragonfly	Deane's Boronia
Gang Gang Swamps (East and South West)	1230	1155	1155	4500
Sunnyside East Swamp	198	6	6	0
Carne Central Swamp	303	55	55	15000
Nine Mile Swamp	298	69	69	0
Carne West Swamp	605	112	112	2250
Marrangaroo Swamp (Creek and Upper)	797	1130	1130	0
Paddys Creek Swamp	1003	1421	1421	11850
Pine Swamp (Pine and Upper)	1049	1066	1066	1635
TOTAL	**5483**	**1397**	**1397**	**35235**

6.2 Maximum Offset Liability Calculations for the Angus Place Mine Extension Project

Although the Transitional Arrangements apply to the Angus Place Mine Extension Project, the maximum offset liability for all swamps (including both NPSS and NPHS) that are potentially impacted by the project have been calculated using the BAM for both ecosystem and species credits.

The total area of NPSS was considered suitable habitat for the Blue Mountains Water Skink, Giant Dragonfly, Deane's Boronia and Red Crowned Toadlet.

A summary of the ecosystem and species credits for the Angus Place Mine Extension Project, calculated in accordance with the BAM, is provided in **Table 3** below.

Table 3 – Angus Place Mine Extension Project Ecosystem and Species Credit Liabilities

Credit Type	Credits Required
PCT 657 (NPSS and NPHS)	880
BMWS	844
Giant Dragonfly	1276
Deane's Boronia	844
Red Crowned Toadlet	639

7 Satisfying State Offset Liabilities

In accordance with the NSW Biodiversity Offsets Policy for Major Projects and the NSW Biodiversity Offset Scheme, the default position is that impacts are offset in a like-for-like manner. This means:

- ≠ species must be offset with the same species; and
- ≠ plant community types must be offset with closely related plant community types.

According to the OEH website, the NPSS covers an estimated 650 hectares, of which approximately 160 hectares occurs within Blue Mountains and Wollemi National Parks. The remainder occurs within State Forest and freehold land. More recent estimates of NPSS extent obtained from mapping using high resolution aerial photography has increased the extent of NPSS within the Newnes Plateau to ~696 hectares with additional increases in extent possible following completion of additional high resolution mapping. The extent of NPSS in the Springvale Mine Extension Project and Angus Place Mine Extension Project collectively represents approximately 15% of the total extent of NPSS on the Newnes Plateau.

Due to the limited area of swamps available to secure on freehold land outside of the Newnes State Forest, it is not possible to secure the total maximum swamp offset liability as a 'like-for-like' offset in accordance with the Biodiversity Offsets Policy for Major Projects or the NSW Biodiversity Offset Scheme.

Where like-for-like offsets cannot be secured, variation rules may be applied or offsets satisfied by payment to the Biodiversity Conservation Trust Fund (BCT Fund) established under the BC Act.

7.1 Springvale Mine Extension Project State Offset Liability

As noted in **Section 3.1**, the Offset Policy Addendum is, in relation to projects that have an existing development consent such as the Springvale Mine Extension Project, only to be applied to new extraction plans where reasonable and feasible. As satisfying the maximum offset lability with the securing of like-for-like credits is not possible, the only alternative options available are to secure offsets through payment to the Biodiversity Conservation Trust Fund.

Adoption of the OEH methods for calculating the monetary contribution that would be required to be paid by Springvale Coal towards the BCT Fund result in a very substantial monetary contribution being required (estimated to be approximately 70 million as at 26 February 2018). A monetary contribution in this amount is not considered a feasible option by Springvale Coal in relation to the Springvale Mine Extension Projects requirement to compensate for mining related impacts to NPSS and NPHS.

Schedule 3 Condition 5 of the SSD 5594 development consent states that the offset liability required to be secured is to be set by the Secretary of the Department of Planning, in consultation with the NSW Office of Environment and Heritage, following consideration of:

- the estimated liability using the FBA in accordance with the 'Policy'; and
- advice from the Independent Monitoring Panel.

7.2 Angus Place Mine Extension Project State Offset Liability

Should the Angus Place Mine Extension Project be approved, Springvale Coal has calculated the maximum monetary contribution that would be required to be paid to the BCT Fund should the maximum offset liability for NPSS, NPHS and their associated threatened species be realised. As Payment into the BCT Fund for the Angus Place Mine Extension Project would be the only option available to satisfy the swamp offset liability under the NSW Biodiversity Offset Scheme in lieu of being able to secure like-for-like offsets due to similar reasons outlined above.

9 Calculating EPBC Act Offset Liabilities for Angus Place and Springvale Extension Projects

9.1 Introduction

RPS Australia East Pty Ltd (RPS) was engaged by Centennial Coal Pty Ltd to assess the EPBC Act offset liability for THPSS and associated threatened species, located above the potential zone of influence for extension of longwall mining at Angus Place and Springvale Mine (i.e. within 600 m of the goaf edge).

As aforementioned, the Angus Place and Springvale Mine Extension Projects will involve undermining the EPBC Act listed THPSS EEC.

EPBC Act listed species known to be associated with the THPSS include:

≠ Blue Mountains Water Skink [(BMWS) *Eulamprus leuraensis*; EPBC Act = Endangered];

≠ Deane's Boronia (*Boronia deanei*; EPBC Act = Vulnerable).

The proposed mining may have a greater than negligible environmental consequence on THPSS and the above associated EPBC Act listed species. The aim of this assessment was to indicatively quantify the EPBC Act offset liability incurred should the Projects adversely impact on THPSS and the two associated EPBC Act listed species.

9.2 EPBC Offset Liability

The numbers used in **Table 1** and **Table 2** below for Impact Areas for the Angus Place and Springvale Extension Projects have been assessed separately because they are impact swamps that will be used as offsets with assumed lower condition scores post-mining. The details which underpin the calculations and justifications have been provided in **Appendix 1**. The area identified as 'AP/SV Combined impacts Vs State Forest Potential Offsets' includes the remaining mapped Swamps outside of the Impact Areas and within the Newnes State Forest.

Table 1: THPSS Impact and Offset Summary

Impact Site	Impact Area (ha)	Offset Area (ha)	% of Offset achieved
Angus Place NPS within Extension Area	39.24	67.4*	9.86 (7.8 averaged)
Springvale NPS within Extension Area	91.85	91.85*	5.74 (7.8 averaged)
AP/SV Combined impacts Vs State Forest potential Offsets	131.1*	354.41	102.95
TOTAL **=** Average of all low condition + AP/SV combined			**110.75**

NOTE: *Reduced condition post-mining related impacts

Table 2: Species Impact and Offset Summary

Impact Site and Species	Impact Area (ha)	Offset Area (ha)	% of Offset achieved
Angus Place Extension Area - *B. deanei*	39.24	67.4*	12.02 (9.51 averaged)
Angus Place Extension Area - BMWS	39.24	67.4*	9.86 (7.8 averaged)
Springvale Extension Area – *B. deanei*	91.85	91.85*	7.00 (9.51 averaged)
Springvale Extension Area - BMWS	91.85	91.85*	5.74 (7.8 averaged)
Angus Place and Springvale Combined - *B. deanei*	131.1*	354.41	125.57
Angus Place and Springvale Combined - BMWS	131.1*	354.41	102.95
BMWS TOTAL **=** Average of all low condition + AP/SV combined			**110.75**
***B. deanei* TOTAL** **=** Average of all low condition + AP/SV combined			**135.08**

NOTE: *Reduced condition post-mining related impacts

The Commonwealth EPBC Act 1999 Offsets Policy states that 90 per cent of offset liabilities must be met with direct offsets. As can be deduced from **Table 1** and **Table 2**, by combining the entire area of the Newnes State Forest swamps with the impacted swamps within Angus Place and Springvale Extension Areas, this 90% requirement can be met.

10 Determining Actual Offset Liabilities

Springvale Coal has implemented a Before-After-Control-Impact (BACI) monitoring program to objectively detect ecological and ecosystem functionality changes and quantify net changes to Newnes Plateau Shrub Swamps over time. As changes to vegetation communities in response to changes in shallow groundwater aquifers may take many years to eventuate and stabilise in order to quantify actual offset liability, it is not considered reasonable to withhold the securing of offsets for impacts to swamps to allow for actual offset liabilities to be determined. This represents significant uncertainty in the offset liability incurred.

11 Proposed Offset Strategy

Centennial Coal has developed a multi-layered swamp offset strategy to compensate for the current and potential impacts to NPSS, NPHS and their associated threatened species for both the Springvale Mine Extension Project and Angus Place Mine Extension Project (should it be approved). The strategy has been designed to satisfy the various State and Commonwealth offset policy requirements where possible and takes into consideration the specific conditions of consent issued for the Springvale Mine Extension Project. The Swamp Offset Strategy includes:

- ≠ Payment into the BCT Fund for impacts to NPSS, NPHS and their associated threatened species associated with the Angus Place Mine Extension Project (if approved).
- ≠ Support for a transfer of land (currently owned and managed by Forestry Corporation NSW (FCNSW)) into a State Conservation Area on a staged basis to satisfy the EPBC Act Environmental Offsets Policy requirements for both the Springvale Mine Extension Project and Angus Place Mine Extension Project as well as contribute to the offset liability obligations under the Springvale Mine Extension Project development consent (SSD 5594).
- ≠ A monetary contribution from Springvale Coal to the management of the land as an additional supplementary measure to meet the offset obligations under the Springvale Mine Extension Project development consent (SSD 5594).
- ≠ A commitment to ongoing monitoring of NPSS, NPHS and their associated threatened species within the Springvale Mine and Angus Place Colliery mine extension areas.
- ≠ A commitment to ongoing research on the Blue Mountains Water Skin (*Eulamprus leuraensis*).

These elements of the proposed Swamp Offset Strategy are detailed further below.

11.1 Payment into the BCT Fund

As noted in **Section 9.2** above, the NSW Biodiversity Offset Strategy is applicable to the Angus Place Mine Extension Project. Due to the inability to secure like-for-like offsets in accordance with the NSW Biodiversity Offset Strategy, it is proposed that the offset liability for subsidence related impacts to NPSS, NPHS and their associated threatened species that result from the Angus Place Mine Extension project are satisfied through payment into the BCT Fund.

11.2 Land Transfer

The Newnes State Forest contains a large percentage of the total area of NPSS and NPHS outside the National Park Areas. The Newnes State Forest borders the existing Blue Mountains, Wollemi and Gardens of Stone National Parks with the extent of THPSS contained within the Newnes Plateau Mitchell Landscape shown in **Figure 3**. Springvale Coal propose to support the transfer of the Newnes State Forest land, currently owned and managed by FCNSW, into a State Conservation Area (SCA) to protect and improve the condition of NPSS, NPHS and their associated threatened species from various anthropogenic impacts. Should the transfer of land proceed, the SCA would enable Springvale Coal to meet 100% of its EPBC Act Environmental Offset Policy requirements incurred as a result of the Springvale Mine Extension Project and Angus Place Mine Extension Project. The justification and calculations to demonstrate this is provided in **Attachment 1**.

In addition to the transfer of land enabling Springvale Coal to meet the EPBC Act Environmental Offsets Policy requirements for both the Springvale Mine Extension Project and Angus Place Mine Extension Project, the land transfer would also form part of a package of commitments to satisfy the NPSS and NPHS offset liabilities for the Springvale Mine Extension Project in accordance with the requirements of its development consent conditions.

The area of land Springvale Coal has identified for potential transfer into a SCA is identified on **Figure 4** for the areas which are not impacted and **Figure 5** for the areas have been impacted. **Figure 4** and **Figure 5** include a large area of other vegetation communities that support a range of species including species listed as threatened under both the BC Act and EPBC Act. With the area of land being located adjacent to existing National Parks, the proposed land transfer would provide a continuum of habitat for the protection of these species and their associated habitats.

The transfer of proposed land into a SCA, coupled with an appropriate land management strategy, would result in the protection of the unique biodiversity and geodiversity of the Newnes Plateau into perpetuity while ensuring impacts from coal mining, future sand mining, forestry and recreational users are appropriately managed.

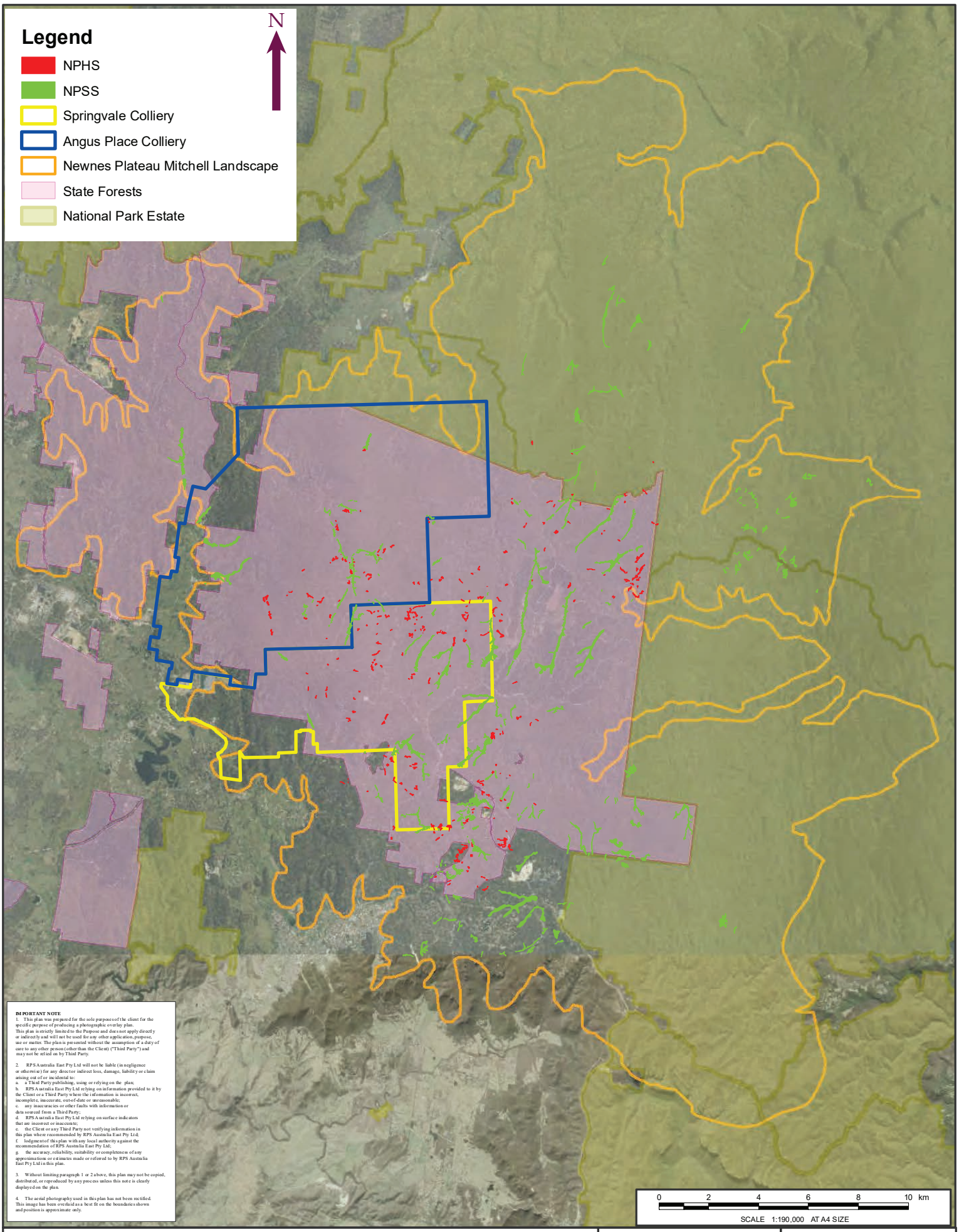

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FIGURE 3: EXTENT OF THPSS WITHIN THE NEWNES PLATEAU MITCHELL LANDSCAPE

LOCATION: NEWNES PLATEAU

DATUM: GDA94

PROJECTION: MGA Zone 56

JOB NO.: **PR 144414**

PURPOSE: ECOLOGY

Technician: mark.aitkens Date: 15/07/2019

Data Sources:
RPS, Client
Land and Property 2017

CLIENT: NOT SPECIFIED

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Path: S:\Centennial\All Jobs\144414 Angus Place Extension Project\10 - Drafting\Arcgis Map Documents\Eco\1. Swamp Offset Strategy\144414 Figure 3 THPSS Newnes B A3 20190715.mxd

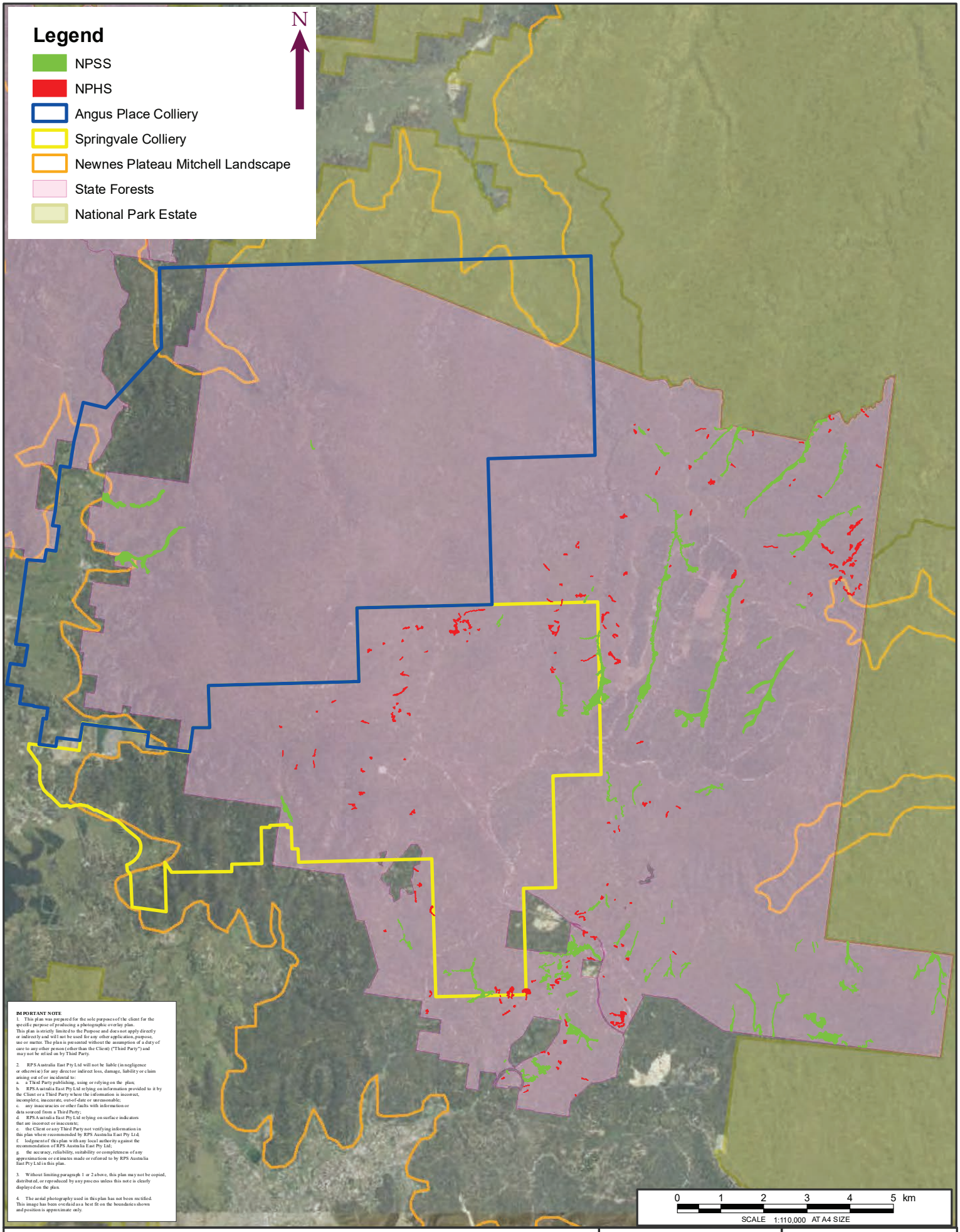

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FIGURE 4: AREA OF NEWNES STATE FOREST TO BE TRANSFERRED TO SCA (NOT IMPACTED)

LOCATION: NEWNES PLATEAU	DATUM: GDA94 PROJECTION: MGA Zone 56
JOB NO.: **PR 144414** PURPOSE: ECOLOGY Technician: mark.aitkens Date: 15/07/2019	Data Sources: RPS, Client Land and Property 2017

CLIENT: NOT SPECIFIED

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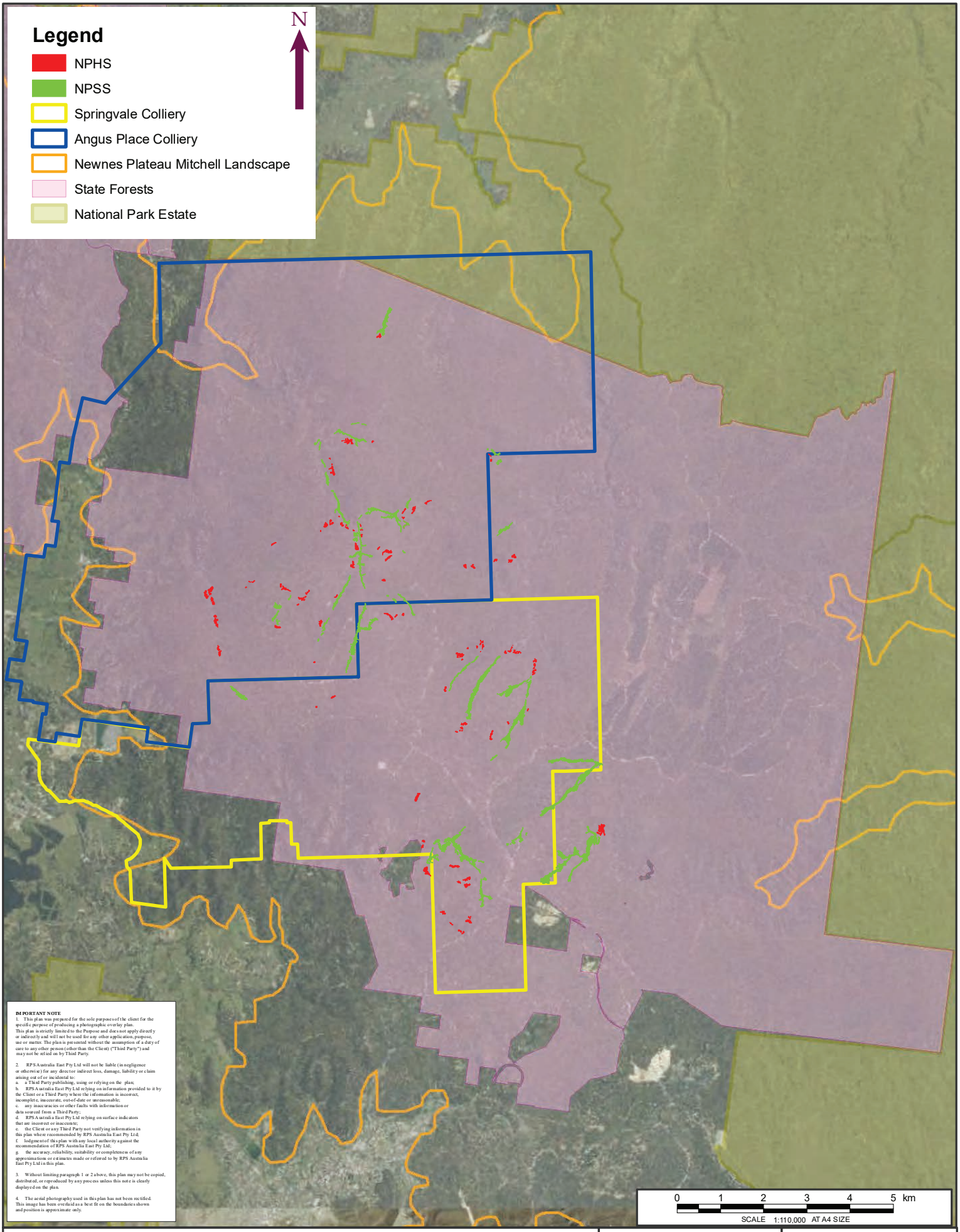

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FIGURE 5: AREA OF NEWNES STATE FOREST TO BE TRANSFERRED TO SCA (IMPACTED)

LOCATION: NEWNES PLATEAU	DATUM: GDA94 PROJECTION: MGA Zone 56
JOB NO.: **PR 144414** PURPOSE: ECOLOGY Technician: mark.aitkens Date: 15/07/2019	Data Sources: RPS, Client Land and Property 2017

CLIENT: NOT SPECIFIED

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NEW_A4_Portrait 2018 Rev: B Produced:NW Reviewed: NW Date: 10/05/2018

11.3 Monetary Contribution

Springvale Coal is proposing to provide a $2 million monetary contribution for each NPSS that experiences a greater than negligible environmental consequence, as a result of mining undertaken as part of the Springvale Mine Extension Project, with the funds to be applied towards the management of the land to be transferred into a State Conservation Area as discussed in **Section 11.2** above.

It is proposed that the $2 million for each NPSS be payable 12 months following the cessation and stabilisation of impacts from mining if monitoring has demonstrated a greater than negligible environmental consequence has occurred. The $2 million monetary contribution has been calculated based on the previous valuation of swamps by the Department of Planning and Environment through the conditions of consent and approval conditions for subsequent extraction plans. The Department of Planning and Environment currently holds $10 million as security against 5 swamps as detailed in **Section 8**. This is the valuation that has been accepted by Springvale Coal to date for the potential for impacts to NPSS.

11.4 Ongoing Monitoring Program

Springvale Coal has developed and implemented a NPSS and NPHS monitoring program. This monitoring program has been significantly expanded since 2015 and covers key areas of potential impact including:

- ≠ Subsidence monitoring
- ≠ Shallow groundwater aquifer monitoring
- ≠ Regional aquifer monitoring
- ≠ Soil moisture monitoring
- ≠ Vegetation composition monitoring
- ≠ Vegetation health monitoring
- ≠ Key threatened species monitoring (Blue Mountains Water Skink, *B. deanei* and Giant Dragonfly)

This monitoring program has assisted in the understanding of how NPSS and NPHS are influenced by underground mining operations over time and represents a significant investment by Springvale Coal to fill existing knowledge gaps in relation to mining related impacts on NPSS and NPHS.

Springvale Coal proposes to continue to invest in monitoring of NPSS and NPHS to build on and improve the understanding of how these ecosystems are impacted by mining, identify subsequent changes over time and identify any future potential regeneration of swamps following the cessation of mining. This ongoing investment by Springvale Coal in monitoring the NPSS and NPHS will be able to be used to inform policy and planning decisions in relation to mining operations that may have the potential for impact to these, or similar, vegetation communities. As such, the commitment by Springvale Coal to the ongoing monitoring of NPSS and NPHS forms an important component of the proposed Swamp Offset Strategy.

12 Security Bonds

The Department of Planning and Environment currently hold security bonds to the value of $10 million dollars against anticipated mining impacts to NPSS. Security is currently held for Sunnyside East Swamp, Carne West Swamp, Gang Gang East Swamp, Gang Gang South West Swamp, Pine Swamp and Pine Upper Swamp. A further $4 million dollar bank guarantee is required to be lodged with the Department of Planning and Environment at least three months prior to the commencement of extraction in longwall 427 to cover any potential for impacts to Marangaroo Creek Swamp and Upper Marrangaroo Creek Swamp. The security bonds have been required in lieu of not having an agreed offset strategy to offset swamp impacts to date. Any swamp Offset liabilities will continue to be held in security bonds until monetary contributions are required.

13 Justification

The time sequence for projects requiring biodiversity offsets is outlined below in **Graph 1**. The length of each red bar illustrated for Angus Place and Springvale Mine Extension Projects is a representation of the approval's timespan; from inception (i.e. first registered with the Department of Planning and onset of the environment approvals process) to acquisition of project approval (i.e. provision of conditional consent). The blue bars represent the relevant planning policies during the development approvals/consent timespans. The top green bar represents the Flora and Fauna survey and assessment guidelines (DEC 2004) which underpinned the survey effort and approach for the Angus Place (SSD_5602) and Springvale (SSD_5594) Mine Extension Projects.

Graph 1 Approvals Timeline and Regulatory Framework for Biodiversity Offsetting

The approvals timeframe for the Springvale Mine Extension Project coincided with the introduction of the NSW Biodiversity Offsets Policy for Major Projects (1 October 2014) and the associated FBA. This included a transitional period of approximately 24 months (depending on project status). Consequently, the Springvale Mine calculation of ecosystem and species credits was undertaken in line with the FBA. In addition, the draft policy *Framework for Biodiversity Offsets for Upland Swamps and Associated Threatened Species Impacted by Longwall Mining Subsidence* which was introduced in May 2015 has also been considered.

As aforementioned, Angus Place Mine Extension Project was lodged in April 2014 (SSD 5602) and subsequently, a decision was made in March 2015 to place the Angus Place Colliery into care and maintenance. An amended application for the Angus Place Mine Extension Project is currently being prepared. Although, the Transitional Arrangements still apply to the Angus Place Mine Extension Project pursuant to Clause 28(1) of the Biodiversity Conservation (Savings and Transitional) Regulation 2017. The Maximum Offset Liability potentially incurred as a result of mine related impacts to NPSS and NPHS has been calculated in accordance with the BAM. The BAM has been utilised considering the lapsed approval timeframe, in order to use the most contemporary and best practice offset calculations available for the amended project report.

13.1 EPBC Offset justifications

The Commonwealth EPBC Act 1999 Offsets Policy states that 90 per cent of offset liabilities must be met with direct offsets. As can be deduced from **Section 9** and **Appendix 1**, by combining the entire area of the Newnes State Forest swamps with the impacted swamps within Angus Place and Springvale Extension Areas, this 90% requirement can be met. **Table 1** demonstrated that the average of all low condition + AP/SV combined achieves a 110.75% offset. Furthermore, *B. deanei* and BMWS which are likely to be impacted as a result of the decline in THPSS habitat have also been directly offset to achieve a 135.08% and 110.75% respectively. Thus, the viability of the protected matters in question will be improved and maintained by this offset strategy.

Further compensatory measures in addition to direct offsets, include; a Blue Mountains Water Skink research and monitoring project and a *Boronia deanei* monitoring project which utilises remote sensing. The compensatory measures will be implemented, supporting clear conservation objectives and reducing the monitoring related impacts to the Newnes Plateau.

The proposed offsets for THPSS (Endangered under the EPBC Act), *Boronia deanei* (Vulnerable under the EPBC Act) and Blue Mountains Water Skink (Endangered under the EPBC Act) are all proposed to be met with like-for-like offsets thus meaning they will fall under the same statutory protection.

Proposed offsets as indicated in **Table 1** will either match or exceed the size and scale of the residual impact on all protected matters. This is further demonstrated by the detailed calculations and justifications presented in **Appendix 1**.

14 References

Australian Government - Department of the Environment, Water, Heritage and the Arts (2012) *Environment Protection and Biodiversity Conservation Act 1999: Environmental Offsets Policy.*

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Appendix 1- EPBC Act Offset Calculations

For the purpose of the contemporary calculation, offsets are expected to significantly reduce the risk of loss to biodiversity through securing sites for conservation in perpetuity and implementing appropriate management and monitoring strategies.

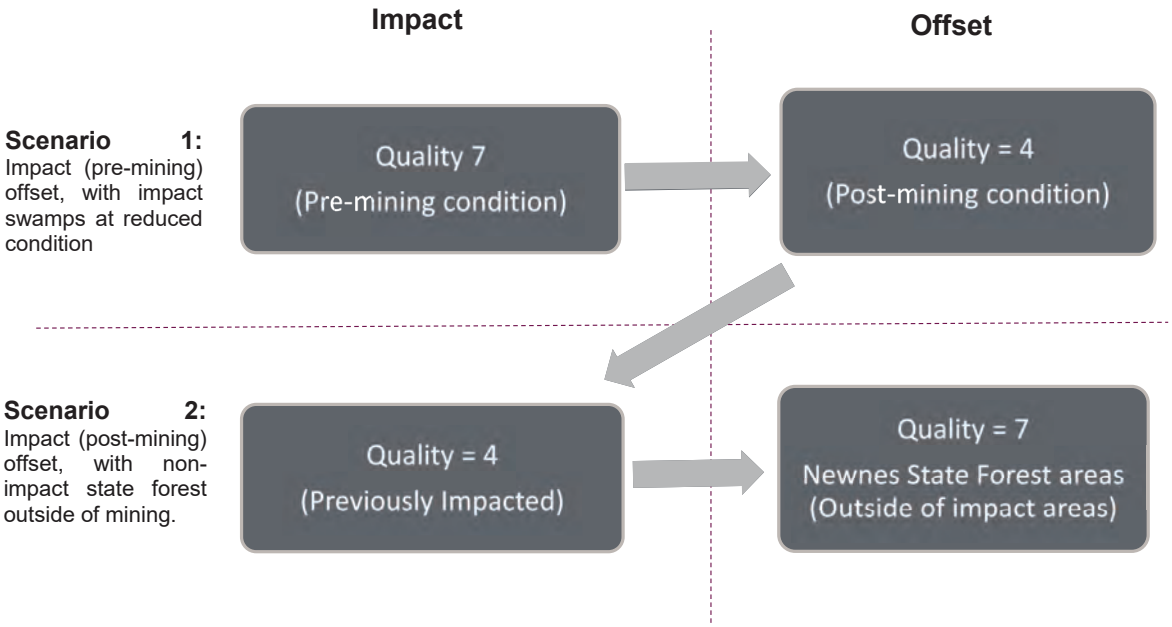
The quality and averted loss scores, which underpin the analyses herewith, have been calculated by comparing BioBanking Assessment Methodology (BBAM 2014) plot data collected in Gang Gang and Carne West Swamps before and after mining. It was calculated the average Vegetation Integrity Score (VIS) was approximately 71.46 pre-mining and approximately 44.7 post mining. The difference between these two numbers is 37.5% (44.7/71.46x100), which is calculated as the loss of VIS post mining.

Gang Gang and Carne West Swamps were selected as representative of the expected change in THSS condition in the long-term post mining since:

- ≠ Vegetation condition was measured prior to and after mining using the same suvey method and effort [six BBAM plots total both before and after mining (April 2019); three plots in both Gang Gang and Carne West on both occasions];
- ≠ Habitat condition was of high condition in both swamps (comparable to other unimpacted swamps across Newnes Plateau) prior to mining impacts by LW418-419, so was representative of the extent of impact attributed to mining;
- ≠ A considerable period had lapsed since mining (i.e. mining of LW418 was between 22/11/2015 and 27/05/2016), suggesting that the extent of the impact of longwall mining on THPSS is at least close to stabilising; and
- ≠ Gang Gang and Carne West still provide habitat for BMWS and *B. deanei* post mining (as evidenced by annual monitoring programs), suggesting that the degraded condition of these swamps post mining still constitutes habitat for these two species.

The selection of reduced Quality (VIS) scores has been two-fold. Firstly, through using impacted areas as partial offsets, which has seen quality conditions changing from scores of 7 to 4 (e.g. Scenario 1 in **Chart 1** below). Secondly, the evidence to date shows that the condition of Impacted THPSSs has only declined, and not completely died off. Therefore, this reduction in the combined calculations has used scores of 4 rather than 7 to account for the partial impacts (e.g. Scenario 2 in **Chart 1** below).

Chart 1 Partial Impact Scenarios



Calculation 1. Angus Place Mine Extension Project THPSS Impacts - offset against Impacted THPSS (Scenario 1 type assessment, see Chart 1 above).

- ≠ **Impact**
  - Area = 39.24 ha[1]
  - Quality = 7[2]
- ≠ **Proposed Offset**
  - Area = 67.4 ha[3]
  - Start area quality = 4[4]
  - Time horizon = 20 years[5]
  - Time until ecological benefit = 2 years[6]
  - Risk of loss without offset (averted loss) = 25%[7]
  - Risk of loss with offset = 10%[8]
  - Future quality with offset = 4[9]
  - Future quality without offset = 4[10]
  - Confidence in results = 85%[11]
- ≠ **Percent of Impact Offset = 9.86%**

[1] Angus Place Mine Extension Project THPSS Impact area (~39.24 ha).

[2] A local benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest which has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the state forest area rather than using the OEH Benchmark of 10 (100/100).

[3] All mapped THPSS areas known or likely to be impacted by Longwall Mining at Angus Place (including 28.16 ha previously impacted by mining).

[4] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100 respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10 it equals 4.

[5] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[6] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[7] The averted loss is calculated as the likely further reduction in quality as a result of continued degradation associated with forestry, mining and recreational use.

[8] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. However, given the already reduced VIS of the offset areas a conservative estimate of 10% has been used.

[9] The future quality with offset was estimated at 4 out of a possible 10 which is consistent with the start area quality of 4. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[10] Contributing factors include current mining related activities; forestry related activities; and recreational activities, and related impacts, such as motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[11] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures such as forestry and recreational use (primarily motorbikes and 4wd vehicles). However, given the already reduced VIS of the proposed offsets the confidence is reduced accordingly.

Calculation 2. Springvale Mine Extension Project THPSS Impacts - offset against Impacted THPSS (Scenario 1 type assessment, see Chart 1 above).

- ≠ **Impact**
  - Area = 91.85ha[12]
  - Quality = 7[13]
- ≠ **Proposed Offset**
  - Area = 91.85ha[14]
  - Start area quality = 4[15]
  - Time horizon = 20 years[16]
  - Time until ecological benefit = 2 years[17]
  - Risk of loss without offset (averted loss) = 25%[18]
  - Risk of loss with offset = 10%[19]
  - Future quality with offset = 4[20]
  - Future quality without offset = 4[21]
  - Confidence in results = 85%[22]
- ≠ **Percent of Impact Offset = 5.74%**

[12] Springvale Mine Extension Project THPSS Impact area (~91.85 ha).

[13] A local benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest which has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the state forest area rather than using the OEH Benchmark of 10 (100/100).

[14] All mapped THPSS areas likely to be impacted by Longwall Mining within the Springvale Mine Extension Project area.

[15] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100, respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10 it equals 4.

[16] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[17] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[18] The averted loss is calculated as the likely further reduction in quality as a result of continued degradation associated with forestry, mining and recreational use.

[19] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. However, given the already reduced VIS of the offset areas a conservative estimate of 10% has been used.

[20] The future quality with offset was estimated at 4 out of a possible 10 which is consistent with the start area quality of 4. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[21] Contributing factors include current mining related activities; forestry related activities; and recreational activities and related impacts, such as motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[22] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures such as forestry and recreational use (primarily motorbikes and 4wd vehicles). However, given the already reduced VIS of the proposed offsets the confidence is reduced accordingly.

Calculation 3. Angus Place and Springvale Combined - Swamp Impacts offset against all un-impacted THPSS in the Newnes State Forest (Scenario 2 type assessment, see Chart 1 above).

- ≠ **Impact**
  - Area = 131.1 ha[23]
  - Quality = 4[24]
- ≠ **Proposed Offset**
  - Area = 354.41 ha[25]
  - Start area quality = 7[26]
  - Time Horizon = 20 years[27]
  - Time until ecological benefit = 2 years[28]
  - Risk of loss without offset (averted loss) = 37.5%[29]
  - Risk of loss with offset = 5%[30]
  - Future Quality with Offset = 7[31]
  - Future Quality without Offset = 6[32]
  - Confidence in results = 85%[33]
- ≠ **Percent of Impact Offset = 102.95%**

[23] Angus Place Mine Extension Project THPSS Impact area (~39.24 ha) combined with Springvale Mine Extension Project THPSS Impact area (~91.85 ha) = ~131.1 ha.

[24] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100, respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10, it equals 4

[25] All mapped THPSS outside of areas known to be impacted by Longwall Mining within the Newnes State Forest (354.41 ha).

[26] A local Benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the state forest area rather than using the OEH Benchmark of 10 (100/100).

[27] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[28] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[29] The averted loss is calculated as the reduction in the VIS above[1] = 37.5%. It is important to note that if we assume a total loss in swamp condition (i.e. 100% loss of swamps with an impact quality score of 7 which are offset with a quality score of 7) the averted loss results in a higher score of 176.96% like for like offset liability being met. Consequently, it is more conservative and scientifically robust to use the above calculated 37.5% averted loss score.

[30] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies.

[31] The future quality with offset was estimated at 7 out of a possible 10, which is consistent with the start area quality of 7. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[32] Contributing factors include current mining related activities; forestry related activities; and recreational activities and related impacts, such as; motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[33] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures, such as forestry and recreational use (primarily motorbikes and 4wd vehicles).

Calculation 4. Angus Place and Springvale Combined THPSS Impacts - offset against all un-impacted THPSS in the Newnes State Forest (notional total loss scenario).

- ≠ **Impact**
  - Area = 131.1 ha[34]
  - Quality = 7[35]
- ≠ **Proposed Offset**
  - Area = 354.41 ha[36]
  - Start area quality = 7[37]
  - Time Horizon = 20 years[38]
  - Time until ecological benefit = 2 years[39]
  - Risk of loss without offset (averted loss) = 100%[40]
  - Risk of loss with offset = 5%[41]
  - Future Quality with Offset = 7[42]
  - Future Quality without Offset = 5[43]
  - Confidence in results = 85%[44]
- ≠ **Percent of Impact Offset = 171.96%**

[34] Angus Place Mine Extension Project THPSS Impact area (~39.24 ha) combined with Springvale Mine Extension Project THPSS Impact area (91.85 ha) = 131.1 ha.

[35] A local Benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the state forest area rather than using the OEH Benchmark of 10 (100/100).

[36] All mapped THPSS outside of areas known to be impacted by Longwall Mining within the Newnes State Forest (354.41 ha).

[37] As per 35 above

[38] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[39] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[40] The averted loss is assuming a continual decline for all THPSS if the loss is not averted. A total (100%) loss in THPSS implies that the averted loss should also be 100% if intervention is unsuccessful. This in turn results in a higher score of 176.96% like for like offset liability being met. Consequently, it is more conservative and scientifically robust to use the above calculated 37.5% averted loss score in the other Calculations.

[41] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies.

[42] The future quality with offset was estimated at 7 out of a possible 10 which is consistent with the start area quality of 7. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[43] Contributing factors include current mining related activities; forestry related activities; and recreational activities and related impacts, such as motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[44] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures such as forestry and recreational use (primarily motorbikes and 4wd vehicles).

Calculation 5. Angus Place Mine Extension Project Blue Mountains Water Skink (BMWS) Impacts - offset against Impacted BMWS habitat (Scenario 1 type assessment, see Chart 1 above).

- ≠ **Impact**
  - Area = 39.24 ha[45]
  - Quality = 7[46]
- ≠ **Proposed Offset**
  - Area = 67.4 ha[47]
  - Start area quality = 4[48]
  - Time horizon = 20 years[49]
  - Time until ecological benefit = 2 years[50]
  - Risk of loss without offset (averted loss) = 25%[51]
  - Risk of loss with offset = 10%[52]
  - Future quality with offset = 4[53]
  - Future quality without offset = 4[54]
  - Confidence in results = 85%[55]
- ≠ **Percent of Impact Offset = 9.86%**

[45] The precautionary principle has been adopted and all Angus Place Mine Extension Project THPSS Impact area is to be assumed habitat for BMWS (~39.24 ha).

[46] A local benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest which has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the state forest area rather than using the OEH Benchmark of 10 (100/100).

[47] All mapped THPSS areas known or likely to be impacted by Longwall Mining at Angus Place (including 28.16 ha previously impacted by mining).

[48] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100 respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10 it equals 4.

[49] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[50] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[51] The averted loss is calculated as the likely further reduction in quality as a result of continued degradation associated with forestry, mining and recreational use.

[52] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. However, given the already reduced VIS of the offset areas a conservative estimate of 10% has been used.

[53] The future quality with offset was estimated at 4 out of a possible 10 which is consistent with the start area quality of 4. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[54] Contributing factors include current mining related activities; forestry related activities; and recreational activities and related impacts such as motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[55] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures, such as forestry and recreational use (primarily motorbikes and 4wd vehicles). However, given the already reduced VIS of the proposed offsets the confidence is reduced accordingly.

Calculation 6. Springvale Mine Extension Project BMWS Impacts - offset against Impacted BMWS habitat (Scenario 1 type assessment, see Chart 1 above).

- ≠ **Impact**
  - Area = 91.85 ha[56]
  - Quality = 7[57]
- ≠ **Proposed Offset**
  - Area = 91.85 ha[58]
  - Start area quality = 4[59]
  - Time horizon = 20 years[60]
  - Time until ecological benefit = 2 years[61]
  - Risk of loss without offset (averted loss) = 25%[62]
  - Risk of loss with offset = 10%[63]
  - Future quality with offset = 4[64]
  - Future quality without offset = 4[65]
  - Confidence in results = 85%[66]
- ≠ **Percent of Impact Offset = 5.74%**

[56] The precautionary principle has been adopted and all Springvale Mine Extension Project THPSS impact area is to be assumed habitat for BMWS (~91.85 ha).

[57] A local benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest which has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the State Forest area rather than using the OEH Benchmark of 10 (100/100).

[58] All mapped THPSS areas likely to be impacted by Longwall Mining within the Springvale Mine Extension Project area.

[59] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100, respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10 it equals 4.

[60] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[61] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[62] The averted loss is calculated as the likely further reduction in quality as a result of continued degradation associated with forestry, mining and recreational use.

[63] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. However, given the already reduced VIS of the offset areas a conservative estimate of 10% has been used.

[64] The future quality with offset was estimated at 4 out of a possible 10 which is consistent with the start area quality of 4. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[65] Contributing factors include current mining related activities; forestry related activities; and recreational activities and related impacts, such as motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[66] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures such as forestry and recreational use (primarily motorbikes and 4wd vehicles). However, given the already reduced VIS of the proposed offsets the confidence is reduced accordingly.

Calculation 7. Angus Place and Springvale combined BMWS impacts - offset against all un-impacted BMWS habitat in the Newnes State Forest (Scenario 2 type assessment, see Chart 1 above).

- ≠ **Impact**
  - Area = 131.1 ha[67]
  - Quality = 4[68]
- ≠ **Proposed Offset**
  - Area = 354.41 ha[69]
  - Start area quality = 7[70]
  - Time Horizon = 20 years[71]
  - Time until ecological benefit = 2 years[72]
  - Risk of loss without offset (averted loss) = 37.5%[73]
  - Risk of loss with offset = 5%[74]
  - Future Quality with Offset = 7[75]
  - Future Quality without Offset = 6[76]
  - Confidence in results = 85%[77]
- ≠ **Percent of Impact Offset = 102.95%**

[67] Angus Place Mine Extension Project BMWS Impact area (~39.24 ha) combined with Springvale Mine Extension Project BMWS Impact area (~91.85 ha) = 131.1 ha.

[68] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100, respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10, it equals 4.

[69] All mapped THPSS outside of areas known to be impacted by Longwall Mining within the Newnes State Forest (354.41 ha).

[70] A local Benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the state forest area rather than using the OEH Benchmark of 10 (100/100).

[71] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[72] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[73] The averted loss is calculated as the reduction in the VIS above[1] = 37.5%.

[74] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies.

[75] The future quality with offset was estimated at 7 out of a possible 10 which is consistent with the start area quality of 7. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[76] Contributing factors include current mining related activities; forestry related activities; and recreational activities and related impacts, such as motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[77] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures such as forestry and recreational use (primarily motorbikes and 4wd vehicles).

Calculation 8. Angus Place Mine Extension Project *B. deanei* Impacts - offset against Impacted *B. deanei* habitat (Scenario 1 type assessment, see Chart 1 above).

- **Impact**
  - Area = 39.24 ha[78]
  - Quality = 7[79]
- **Proposed Offset**
  - Area = 67.4 ha[80]
  - Start area quality = 4[81]
  - Time horizon = 20 years[82]
  - Time until ecological benefit = 2 years[83]
  - Risk of loss without offset (averted loss) = 25%[84]
  - Risk of loss with offset = 10%[85]
  - Future quality with offset = 4[86]
  - Future quality without offset = 4[87]
  - Confidence in results = 85%[88]
- **Percent of Impact Offset = 12.02%**

[78] The precautionary principle has been adopted and all Angus Place Mine Extension Project THPSS Impact area is to be assumed habitat for *B. deanei* (~39.24 ha).

[79] A local benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest which has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the state forest area rather than using the OEH Benchmark of 10 (100/100).

[80] All mapped THPSS areas known to be impacted by Longwall Mining at Angus Place (including 28.16 ha previously impacted by mining).

[81] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100, respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10 it equals 4.

[82] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[83] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[84] The averted loss is calculated as the likely further reduction in quality as a result of continued degradation associated with forestry, mining and recreational use.

[85] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. However, given the already reduced VIS of the offset areas a conservative estimate of 10% has been used.

[86] The future quality with offset was estimated at 4 out of a possible 10 which is consistent with the start area quality of 4. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[87] Contributing factors include current mining related activities; forestry related activities; and recreational activities and related impacts such as motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[88] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures such as forestry and recreational use (primarily motorbikes and 4wd vehicles). However, given the already reduced VIS of the proposed offsets the confidence is reduced accordingly.

Calculation 9. Springvale Mine Extension Project *B. deanei* Impacts - offset against Impacted *B. deanei* habitat at a reduced condition (Scenario 1 type assessment, see Chart 1 above).

- ≠ **Impact**
  - Area = 91.85 ha[89]
  - Quality = 7[90]
- ≠ **Proposed Offset**
  - Area = 91.85 ha[91]
  - Start area quality = 4[92]
  - Time horizon = 20 years[93]
  - Time until ecological benefit = 2 years[94]
  - Risk of loss without offset (averted loss) = 25%[95]
  - Risk of loss with offset = 10%[96]
  - Future quality with offset = 4[97]
  - Future quality without offset = 4[98]
  - Confidence in results = 85%[99]
- ≠ **Percent of Impact Offset = 7.00%**

[89] The precautionary principle has been adopted and all Springvale Mine Extension Project THPSS impact area is to be assumed habitat for *B. deanei* (~91.85 ha).

[90] A local benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest which has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the State Forest area rather than using the OEH Benchmark of 10 (100/100).

[91] All mapped THPSS areas likely to be impacted by Longwall Mining within the Springvale Mine Extension Project Area.

[92] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100, respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10 it equals 4.

[93] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[94] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[95] The averted loss is calculated as the likely further reduction in quality as a result of continued degradation associated with forestry, mining and recreational use.

[96] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. However, given the already reduced VIS of the offset areas a conservative estimate of 10% has been used.

[97] The future quality with offset was estimated at 4 out of a possible 10 which is consistent with the start area quality of 4. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[98] Contributing factors include current mining related activities; forestry related activities; and recreational activities and related impacts, such as motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[99] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures such as forestry and recreational use (primarily motorbikes and 4wd vehicles). However, given the already reduced VIS of the proposed offsets the confidence is reduced accordingly.

Calculation 10. Angus Place and Springvale combined *B. deanei* impacts - offset against all un-impacted *B. deanei* habitat in the Newnes State Forest (Scenario 2 type assessment, see Chart 1 above).

- ≠ **Impact**
  - Area = 131.1 ha[100]
  - Quality = 4[101]
- ≠ **Proposed Offset**
  - Area = 354.41 ha[102]
  - Start area quality = 7[103]
  - Time Horizon = 20 years[104]
  - Time until ecological benefit = 2 years[105]
  - Risk of loss without offset (averted loss) = 37.5%[106]
  - Risk of loss with offset = 5%[107]
  - Future Quality with Offset = 7[108]
  - Future Quality without Offset = 6[109]
  - Confidence in results = 85%[110]
- ≠ **Percent of Impact Offset = 125.57%**

[100] Angus Place Mine Extension Project BMWS Impact area (~39.24 ha) combined with Springvale Mine Extension Project BMWS Impact area (91.85) = 131.1 ha

[101] Pre and post mining BBAM Plot data in Gang Gang and Carne West has calculated a decrease in VIS from ~71.46 to 44.7 out of 100, respectively. Consequently, when the post mining VIS is converted into a single numeral out of 10, it equals 4

[102] All mapped THPSS outside of areas known to be impacted by Longwall Mining within the Newnes State Forest (354.41 ha).

[103] A local Benchmark condition is averaged out across plots collected across the Newnes Plateau State Forest has resulted in an approximate VIS of 7. This score is conservative as it accounts for the confounding factors of forestry and recreational use being present within the state forest area rather than using the OEH Benchmark of 10 (100/100).

[104] This is a conservative estimate due to the lack of scientific certainty; the maximum of 20 years has been selected.

[105] This number is also conservative as offsets are expected to provide ecological benefit with the implementation of appropriate management which should be implemented within 1 year with benefits realised through monitoring within 2 years.

[106] The averted loss is calculated as the reduction in the VIS above[1] = 37.5%.

[107] Offsets are expected to significantly reduce the risk of loss to biodiversity through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies.

[108] The future quality with offset was estimated at 7 out of a possible 10 which is consistent with the start area quality of 7. Offsets are expected to remain in a stable condition through the securing of sites for conservation in perpetuity and implementing appropriate management and monitoring strategies. This is also a conservative estimate given the management actions may increase the quality.

[109] Contributing factors include: current mining related activities; forestry related activities; and recreational activities and related impacts including motorbikes, four-wheel drives, waste dumping, firewood harvesting etc.

[110] The Confidence in results is relatively high for the THPSS because we have been conservative by not assuming a gain in the quality with Offset to spite the removal of other anthropogenic pressures such as forestry and recreational use (primarily motorbikes and 4wd vehicles).