Appendix D
Terrestrial Ecology Assessment

WINCHESTER SOUTH PROJECT
Environmental Impact Statement

WHITEHAVEN COAL

Resource Strategies

Terrestrial Ecology Assessment

Whitehaven WS Pty Ltd
Winchester South Project

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Issue Date: 13 May 2021
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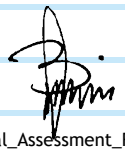
Document management

Rev.	Issue Date	Description	Author (s)	Approved	Signature
A	1/07/2019	Issued for review	P. Wagner C. Ogston L. Wickson	B. Dreis	
B	29/10/2019	Issued for review	L. Wickson	B. Dreis	
C	22/04/2020	Issued for review	P. Wagner C. Ogston L. Wickson	B. Dreis	
D	8/07/2020	Issued for review	P. Wagner C. Ogston L. Wickson	B. Dreis	
E	13/08/2020	Issued for review	P. Wagner C. Ogston L. Wickson	B. Dreis	
F	15/09/2020	Issued for review	P. Wagner C. Ogston L. Wickson	B. Dreis	
G	9/10/2020	Issued for review	P. Wagner C. Ogston L. Wickson	B. Dreis	
H	2/11/2020	Final draft report	P. Wagner C. Ogston L. Wickson	B. Dreis	
0	27/11/2020	Final report	P. Wagner C. Ogston L. Wickson	B. Dreis	
1	3/12/2020	Final report	P. Wagner C. Ogston L. Wickson	B. Dreis	
2	30/04/2021	Final report	L. Wickson	B. Dreis	
3	13/05/2021	Final report	B. Dreis	B. Dreis	

Document Reference: X:\JOBS\~2019\QEJ19011\DELIVERABLES\Terrestrial_Ecological_Assessment_Rev_3.docx

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Definitions

Term	Definition
Broad Vegetation Group	A pragmatic, higher level grouping of regional ecosystems and vegetation communities that provide an overview of the vegetation across Queensland (Neldner *et al.*, 2019). They describe major ecological patterns and relationships across Queensland, independent of bioregions and land zones, and facilitate comparisons with vegetation in other States and internationally.
Environmentally Sensitive Area	Environmentally sensitive areas as described in the Queensland *Environmental Protection Regulation 2019*.
Groundwater dependent ecosystem	Ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis for maintenance of the ecosystem (Richardson *et al.*, 2011).
Habitat type	Broad, informal groupings of habitats having equivalent structure, function, and responses to disturbance.
Mature regrowth	Vegetation that does not meet the canopy cover and/or height thresholds for remnant status, however species present are consistent with a regional ecosystem. These communities included communities that had not been cleared within the last 15 years or were degraded (e.g. dieback, selectively cleared).
Non-remnant vegetation	All vegetation that is not mapped as remnant vegetation. May include regrowth, heavily thinned or logged and significantly disturbed vegetation that fails to meet the structural and/ or floristic characteristics of remnant vegetation. It also includes urban and cropping land (Neldner *et al.*, 2019).
Regional Ecosystem	A vegetation community in a bioregion that is consistently associated with a particular combination of geology, landform and soil (Neldner *et al.*, 2019). Regional Ecosystems are described in the Regional Ecosystem Description Database, produced by the Queensland Herbarium.
Regrowth	Is non-remnant vegetation that has a significant woody component but fails to meet the structural and/or floristic characteristics of remnant vegetation. Includes vegetation that has regrown after clearing or been heavily thinned or logged (Neldner *et al.*, 2019).
Remnant vegetation	A regional ecosystem that has not undergone recent clearing. It is defined under the Queensland *Vegetation Management Act 1999* as: (b) forming the predominant canopy of the vegetation— (i) covering more than 50% of the undisturbed predominant canopy; and (ii) averaging more than 70% of the vegetation's undisturbed height; and (iii) composed of species characteristic of the vegetation's undisturbed predominant canopy.
Study Area	The area surveyed encompassing the Project area.
The Project	The Winchester South Project.
Project area	This area is defined as the area that will be impacted by the mine site, mine infrastructure, water pipeline, electricity transmission line, access road, and rail spur. It comprises a total area of 7,130 ha contained within the Study Area.

Term	Definition
Threatened Ecological Community	An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. Its structure, composition and distribution are determined by environmental factors such as soil type, position in the landscape, altitude, climate and water availability. Threatened ecological communities are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
Threatened species	A threatened species is any plant or animal species that is at risk of extinction. Species listed as extinct (EX), extinct in the wild (XW), critically endangered (CE), endangered (E), vulnerable (V) or conservation dependent (CD) under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* or extinct (EX), extinct in the wild (XW), critically endangered (CE), endangered (E), vulnerable (V) under the Queensland *Nature Conservation Act 1992*.
Vegetation community	An area of vegetation which is relatively uniform with respect to structure and floristic composition (Neldner *et al.*, 2019).

Abbreviations

Abbreviation	Description
AHD	Australian Height Datum
API	Aerial Photography Interpretation
AU	Assessment Unit
Biosecurity Act	Queensland *Biosecurity Act 2014*
BOM	Bureau of Meteorology
Brigalow TEC	Brigalow (*Acacia harpohylla* dominant and co-dominant)
DAWE	Commonwealth Government Department of Agriculture, Water and the Environment
DEE	Former Commonwealth Government Department of the Environment and Energy (now DAWE)
DES	Queensland Department of Environment and Science
DEWHA	Former Commonwealth Department of Environment, Water, Heritage and the Arts (now DAWE)
DNRME	Queensland Department of Natural Resources, Mines and Energy
DotE	Former Commonwealth Department of the Environment (now DAWE)
E2M	E2M Pty Ltd
EDL	Ecologically Dominant Layer
EIS	Environmental Impact Statement
EO Act	Queensland *Environmental Offsets Act 2014*
EP Act	Queensland *Environmental Protection Act 1994*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Area
ETL	Electrical Transmission Line
EVNT	Endangered, Vulnerable or Near Threatened
GDE	Groundwater Dependent Ecosystem
MDL	Mining Development Licence
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
Natural Grasslands TEC	Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin
NC Act	Queensland *Nature Conservation Act 1992*
Poplar Box TEC	Poplar Box Grassy Woodland on Alluvial Plains
RE	Regional Ecosystem
SAT	Spot Assessment Technique

Abbreviation	Description
sp.	Singular species. For example, *Eucalyptus* sp. refers to a single species of *Eucalyptus*
spp.	Multiple species. For example, *Eucalyptus* spp. refers to multiple species of *Eucalyptus*
TEC	Threatened Ecological Community
ToR	Terms of Reference
VM Act	Queensland *Vegetation Management Act 1999*
WoNS	Weed of National Significance

Executive summary

Whitehaven WS Pty Ltd (Whitehaven WS), a wholly owned subsidiary of Whitehaven Coal Limited, proposes to develop the Winchester South Project (the Project) an open cut coal mine and associated infrastructure, within the Bowen Basin, located approximately 30 kilometres (km) south-east of Moranbah. The Project involves the development of the coal mine in an existing mining precinct for export of coal products. The coal resource would be mined by open cut mining methods, with product coal to be transported by rail to port for export.

This report documents the terrestrial ecological values in the vicinity of the Project and provides an assessment of the potential impacts and associated mitigation measures of the Project on terrestrial ecology. These ecological values include Matters of National Environmental Significance (MNES) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Matters of State Environmental Significance (MSES) outlined under the Queensland *Environmental Offsets Regulation 2014*.

E2M Pty Ltd (E2M) identified and evaluated the terrestrial ecological values within a Study Area encompassing the Project through a desktop assessment and a series of field surveys. The desktop assessment consolidated information from available environmental databases and literature reviews of environmental documents for adjacent mining operations/projects. Of particular note, the flora and fauna values of a portion of the Study Area were previously surveyed in 2011 and 2012 by Ecological Survey & Management (EcoSM).

Field surveys were undertaken by E2M in accordance with relevant Commonwealth and State guidelines for surveying flora and fauna, including threatened species and mapping vegetation communities. Four field surveys were undertaken for the Project comprising:

- two 'dry season' surveys in October 2018 and September 2019; and
- two 'wet season' surveys in May 2019 and February 2020.

The Study Area is located on approximately 13,747.5 ha of predominately gently undulating to flat landscape. It has a long history of cattle grazing and the environment has been subject to past clearance and modification. The majority of the Study Area consists of improved/disturbed pasture dominated by non-native grasses and *Acacia harpophylla* regrowth shrublands. These areas have been subject to blade ploughing, livestock impacts, pasture improvement and weed encroachment.

A total of 13 remnant Regional Ecosystems (RE) were identified within the Study Area, comprising four 'Endangered' REs (i.e. REs 11.3.1, 11.4.8, 11.4.9 and 11.9.5) and three 'of concern' REs (i.e. REs 11.3.2, 11.3.3c and 11.3.4) under the Queensland *Vegetation Management Act 1999*. Three Threatened Ecological Communities (TECs) under the EPBC Act were also identified within the Study Area:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (Brigalow TEC)
- Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin TEC (Natural Grasslands TEC); and
- Poplar Box Grassy Woodland on Alluvial Plains TEC (Poplar Box TEC).

The above TECs were found in small patches comprising less than 1 percent (%) of the Study Area.

Five threatened species were recorded within the Study Area:

- *Solanum adenophorum* (a perennial herbaceous plant listed as Endangered under the *Nature Conservation Act 1992* [NC Act])
- ornamental snake (*Denisonia maculata*) (Vulnerable under the EPBC Act and NC Act)
- koala (*Phascolarctos cinereus*) (Vulnerable under the EPBC Act and NC Act)
- greater glider (*Petauroides volans volans*) (Vulnerable under the EPBC Act and NC Act); and
- squatter pigeon (southern subspecies) (*Geophaps scripta scripta*) (Vulnerable under the EPBC Act and NC Act).

There was also a previously recorded detection of the Australian painted snipe (*Rostratula australis*) (Endangered under the EPBC Act and Vulnerable under the NC Act) within the Study Area. Additional conservation significant fauna identified during the field surveys included migratory species under the EPBC Act.

The majority (90%; 6,408.6 ha) of the Project area (7,130 ha) has been historically cleared and is characterised as non-remnant. The Project would require the progressive removal of a total of 719.9 ha of remnant vegetation over 30 years.

Where possible, the Project would avoid, mitigate and manage environmental impacts associated with the construction and operation of the Project by implementing and maintaining environmental management plans. Mitigation measures within these plans would include but are not limited to:

- vegetation clearing mitigation measures, including pre-clearance surveys
- rehabilitation of post-mine landforms; and
- weed/animal pest monitoring and management.

The Project has been designed to avoid or minimise impacts to terrestrial environmental values, however some residual impacts are likely to occur. The Project would adversely impact MNES as follows:

- clearance of two TECs listed under the EPBC Act (Natural Grasslands TEC [80.9 ha] and Poplar Box TEC [9.6 ha]); and
- clearance of habitat for four threatened fauna species listed under the EPBC Act (ornamental snake, koala, greater glider and squatter pigeon [southern sub-species]).

There is considerable overlap between the MNES and MSES of relevance to the Project. MSES impacted by the Project are:

- Regulated Vegetation including:
  - 'Endangered' and 'Of Concern' REs
  - Essential habitat (for the ornamental snake); and
  - within the defined distance of a vegetation management watercourse.
- Protected Wildlife Habitat for five species (*Solanum adenophorum*, ornamental snake, koala, greater glider and squatter pigeon [southern subspecies]); and
- Connectivity areas.

Residual impacts on MNES and MSES would be offset in accordance the *EPBC Act Environmental Offsets Policy* and *Queensland Environmental Offsets Policy*.

1 Introduction

This terrestrial ecology assessment report has been prepared by E2M Pty Ltd (E2M) for Whitehaven WS Pty Ltd (Whitehaven WS), a wholly owned subsidiary of Whitehaven Coal Limited, and forms part of the Environmental Impact Statement (EIS) for the Winchester South Project (the Project).

1.1 Project background

Whitehaven WS proposes to develop the Project, within the Bowen Basin, located approximately 30 km south-east of Moranbah, within the Isaac Regional Council (IRC) Local Government Area (LGA) (Figure 1). The Project involves the development of an open cut coal mine in an existing mining precinct for export of coal products. The Project would include construction and operation of a mine infrastructure area (MIA), including a Coal Handling and Preparation Plant (CHPP), train load-out facility and rail spur, which would be used for the handling, processing and transport of coal. An infrastructure corridor would also form part of the Project, including a raw water supply pipeline connecting to the Eungella pipeline network, an electricity transmission line (ETL) and a mine access road.

The Project is forecast to extract approximately 15 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal, with a forecast peak extraction of up to 17 Mtpa for approximately 30 years. The coal resource would be mined by open cut mining methods and product coal transported by rail to port for export.

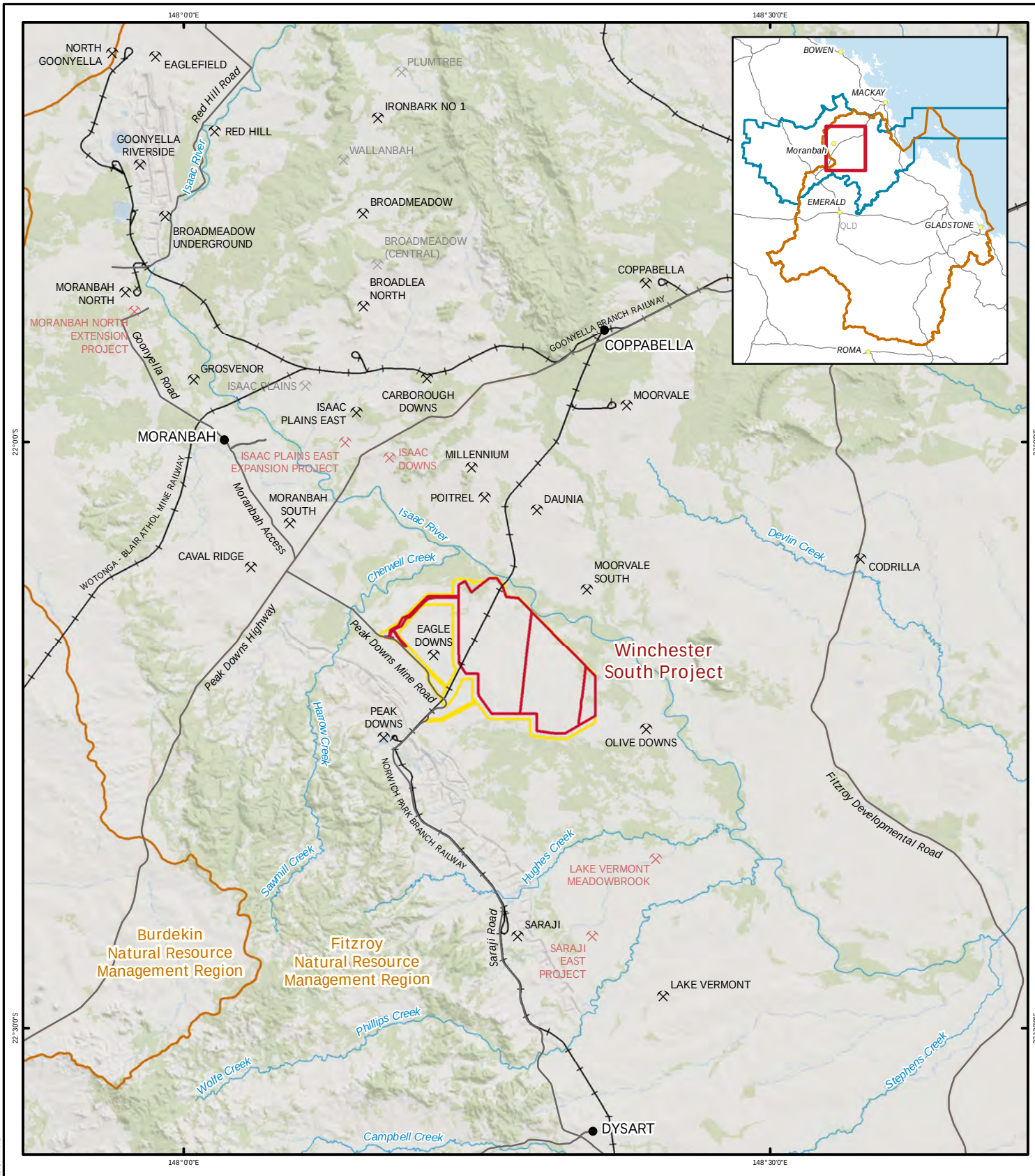
The Project would include, although not to be limited to, the following main components:

- an open cut coal mine which would primarily produce metallurgical coal for steel making (a secondary export quality thermal coal product would also be produced)
- a mine access road from the Eagle Downs Mine Access Road, off Peak Downs Mine Road
- a new rail loop and train load-out facility connecting to the Norwich Park Branch Railway
- an ETL from the Eagle Downs Substation to the west
- a raw water supply pipeline
- a MIA, including workshops, offices and an on-site CHPP to process ROM coal from the Project; and
- an on-site landfill for the disposal of certain waste streams generated on-site.

The Coordinator-General declared the Project to be a 'coordinated project for which an EIS is required under section 26(1)(a) of the Queensland *State Development and Public Works Organisation Act 1971* (SDPWO Act).

Three referrals have been made under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) regarding the three different components of the Project. The Commonwealth Minister has determined the following controlling provisions apply for each action under the EPBC Act:

1. Winchester South Project Mine Site and Access Road (EPBC 2019/8460):
    a. listed threatened species and communities (sections 18 and 18A); and
    b. a water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).
2. Winchester South Project Water Pipeline (EPBC 2019/8459):
    a. listed threatened species and communities (sections 18 and 18A).



Legend

- Road
- Watercourse
- Railways
- Study Area
- NRM Region
- Isaac Regional Council
- Winchester South Mining Lease Application

Coal Resource Site

- Approved/Operating Coal Mine
- Care and Maintenance
- Proposed Coal Mine

N

Scale 1:500,000 (A4)

0 10 20 30

Kilometres

Coordinate System: GCS GDA 1994

Notes:
Coal Resource Sites: © Resource Strategies 2020
Topographic: © Geoscience Australia 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 1: PROJECT LOCATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

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3. Winchester South Project ETL (EPBC 2019/8458):
    a. listed threatened species and communities (sections 18 and 18A).

The EIS process under Part 4 of the SDPWO Act has been accredited under the Bilateral Agreement for the assessment of the Project under the EPBC Act. The EIS therefore addresses both *Environmental Protection Act 1994* (EP Act) (State) and EPBC Act (Commonwealth) matters, in accordance with the Terms of Reference (ToR) for the EIS, which was issued in September 2019.

1.2 Scope of the assessment

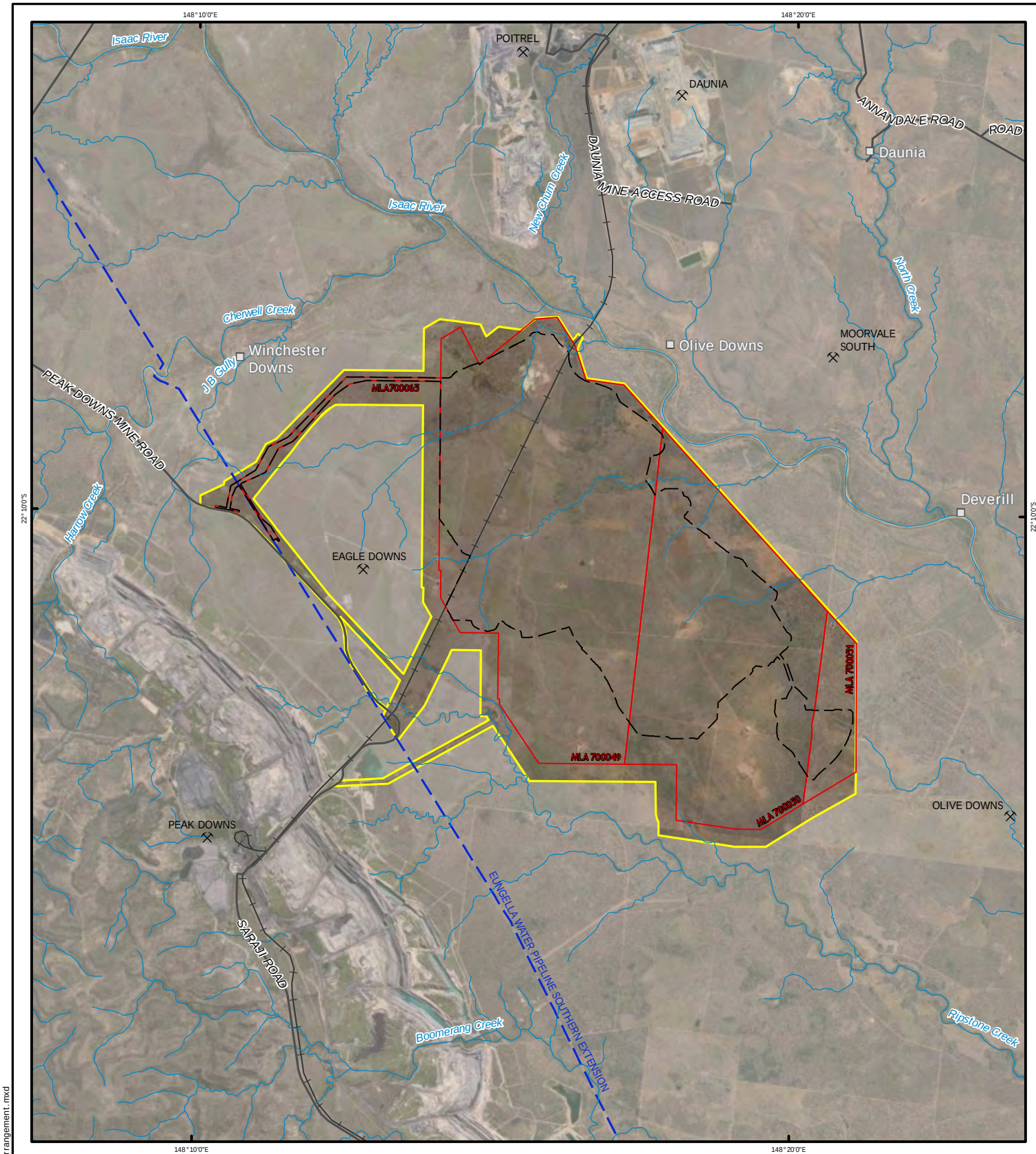
This report documents the terrestrial ecological values in the vicinity of the Project and provides an assessment of the potential impacts of the Project on terrestrial ecology. Specifically, it provides:

- a desktop review of relevant background information and available environmental databases;
- flora surveys to verify the extent, composition, condition and conservation values of:
    - Regional Ecosystems (REs) in accordance with Neldner *et al*. (2019)
    - potential Threatened Ecological Communities (TECs) protected under the EPBC Act; and
    - Environmentally Sensitive Areas (ESAs) identified under the EP Act.
- fauna surveys to identify fauna species assemblages and habitat types (including threatened species)
- targeted surveys for conservation significant flora and fauna species identified under the EPBC Act and Queensland *Nature Conservation Act 1992* (NC Act)
- habitat quality assessments in accordance with the *Guide to Determining Terrestrial Habitat Quality* Version 1.3 (Department of Environment and Science [DES], 2020b) for environmental offsets
- occurrence of Weeds of National Significance (WoNS) (Australian Weeds Committee [AWC], 2012) and restricted biosecurity matter under the Queensland *Biosecurity Act 2014* (Biosecurity Act)
- an assessment of the potential indirect, direct and cumulative impacts of the Project on terrestrial ecology (including threatened species and communities); and
- a description of recommended avoidance and mitigation measures and management plans to minimise impacts to terrestrial ecology.

1.3 Study Area

The Study Area for the Project is approximately 13,747.5 hectares (ha). The Study Area Indicative Surface Disturbance Extent encompassing the full extent of the Project (Figure 2), the full extent of MLA 700049, MLA 700050, MLA 700051, and MLA 700065, including a suitable buffer which ranges between 100 m and 500 m where land access for surveys could be obtained. The Study Areas north-eastern boundary (ie. Along MLA 700049, MLA 700050 and MLA 700051) is immediately adjacent to the Approved Olive Downs Project Waters Pipeline and Rail Spur (EPBC 2017/7870 and EPBC 2017/7868). As the Olive Downs Project is approved to remove ecological valves in this area, the Projects Study Area has not included this area. Notwithstanding, DPM Enviroscienses (DPM, 2018a, 2018b) completed surveys of this area, which have been used where relevant in this assessment. The Project area, which includes the open cut extent, waste rock emplacement areas and associated infrastructure areas, including the infrastructure corridor is approximately 7,130 ha and located within MLA 700049, MLA 700050, MLA 700051 and MLA 700065.

The Project primarily sits within the Winchester Downs (5CNS90 and 8SP277384), Wynette (4CNS15) and Iffley (11KL135) properties. The Study Area spans across two sub-regions, traversing sections of both the Northern Bowen Basin subregion and the Isaac – Comet Downs subregion.



Legend

- Homesteads
- Railways
- Road
- Watercourse
- Water Pipeline
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

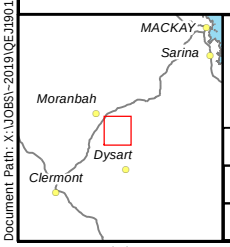
N

Scale 1:150,000 (A4)

0 2 4 6 8

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © ESRI 2019, Whitehaven 2019
Cadastre: © DNRME 2018
Coal Resource Site: © Resource Strategies 2020
Watercourse: © Geoscience Australia 2018
Homesteads: © DNRME 2018

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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	LW	30/10/2020

FIGURE 2: INDICATIVE GENERAL ARRANGEMENT

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Map Number	Job Number	Rev
1 of 1	QEJ19011	0

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1.4 Terms of reference

The ToR for the Project, released on 4 September 2019, describe the matters Whitehaven WS are to address in an EIS. The ToR concerning this terrestrial ecology assessment are detailed in full in Appendix A.

2 Existing environment

2.1 Regional context

The Project is located within the IRC LGA and the Fitzroy Natural Resource Management (NRM) Region within the Bowen Basin (Figure 1). The Fitzroy NRM region (approximately 156,000 square kilometres [km^2]) in composed of six river basins. The largest of the six basins, Fitzroy Basin, accounts for 93% of the region. Grazing is the most common land use with the majority of region dedicated to cattle production while agriculture occurs around townships of Emerald, Theodore and Biloela (Dougall *et al.*, 2014). The region is also a significant producer and exporter of coal and natural gas. The Fitzroy region hosts the majority of Queensland's active coal mines (Fitzroy Basin Association, 2018).

The Study Area is located approximately 30 km south-east of the township of Moranbah (Figure 1). The Study Area covers approximately 13,747.5 ha . There are several existing access tracks located throughout the Study Area as well as the Norwich Park Branch Railway which transects the western extent of the Study Area.

2.1.1 Brigalow Belt Bioregion

The Study Area is located within the Brigalow Belt bioregion which encompasses approximately 216,000 km^2 of central Queensland, extending from Townsville in the north to Narrabri in New South Wales (Sattler & Williams, 1999). *Acacia harpophylla* (Brigalow) forests and woodlands growing on clay soils are one of the major vegetation types that characterise the region (Sattler & Williams, 1999). While historically Brigalow vegetation covered up to six million hectares of the bioregion in Queensland, extensive broad scale clearing, predominantly for agriculture, has greatly reduced the extent of this community throughout the bioregion (Sattler & Williams, 1999). In addition to remnant Brigalow vegetation, other ecosystems that typify the bioregion include eucalypt forest and woodlands, grasslands, dry rainforest, cypress pine woodland and riparian communities (Sattler & Williams, 1999).

The Interim Biogeographic Regionalisation of Australia (IBRA) divides the Brigalow Belt bioregion into the Brigalow Belt North and Brigalow Belt South (Sattler & Williams, 1999). The geology of the Brigalow Belt North bioregion is characterised by Permian volcanics and Permian-Triassic sediments, Carboniferous and Devonian sediments and volcanics and Cambrian/Ordovician rocks (and associated Tertiary deposits) (Department of Natural Resources, Mines and Energy [DNRME], 2018).

The Brigalow Belt North bioregion comprises 13 provinces, two of which, the Northern Bowen Basin and Isaac-Comet Downs, traverse the Study Area.

2.1.1.1 Northern Bowen Basin Province

The north-western extent of the Study Area is located within the Northern Bowen Basin province of the Brigalow Belt Bioregion. This province is characterised by undulating landscapes associated with Triassic and Permian sediments of the Bowen Basin with small areas of basalt and Tertiary sediments (Sattler & Williams, 1999). Key vegetation communities observed within this province include:

- *Acacia harpophylla* (Brigalow) and *Eucalyptus cambageana* (Dawson gum) communities on clay soils
- open and shrubby woodlands of *E. crebra* (narrow-leaved ironbark) and *E. populnea* (poplar box) shallow texture-contrast soils
- native grasslands dominated by *Dichanthium sericeum* (bluegrass) on undulating plains; and
- woodlands and open woodlands of *E. crebra* and *Corymbia* spp. on sandstone ranges.

2.1.1.2 Isaac-Comet Downs Province

The south-west portion of the Study Area is located within the Isaac-Comet Downs province of the Brigalow Belt Bioregion. This province is characterised by undulating terrain on Tertiary and Cainozoic deposits, including tablelands and dissecting remnants on upper Tertiary surfaces (Sattler & Williams, 1999). Key vegetation communities observed within this province include:

- *Eucalyptus crebra* woodlands on undulating plateaus
- *Acacia catenulata* (bendee) and *A. shirleyi* (Lancewood) woodlands on rocky hills and mesas
- *Acacia harpophylla* (brigalow) and *Eucalyptus cambageana* (Dawson gum) communities on undulating clays and contrast soils on lower Tertiary surfaces
- *A. harpophylla* and *Eucalyptus coolabah* (coolabah) woodlands on alluvium; and
- native grasslands and *A. harpophylla* and eucalypt open woodlands on fine-grained Permian sediments.

2.2 Climate

The Fitzroy NRM region is characterised by a sub-tropical, semi-arid climate with high rainfall variability. The annual rainfall for the Moranbah area is approximately 614 millimetres (mm) and is predominantly seasonal, characterised by wet summers (December to February) and dry winters (Figure 3)[1]. The average monthly temperatures range between a maximum of 34.29 degrees Celsius (°C) and a minimum of 9.45°C recorded during December and July, respectively (Figure 4)[1].

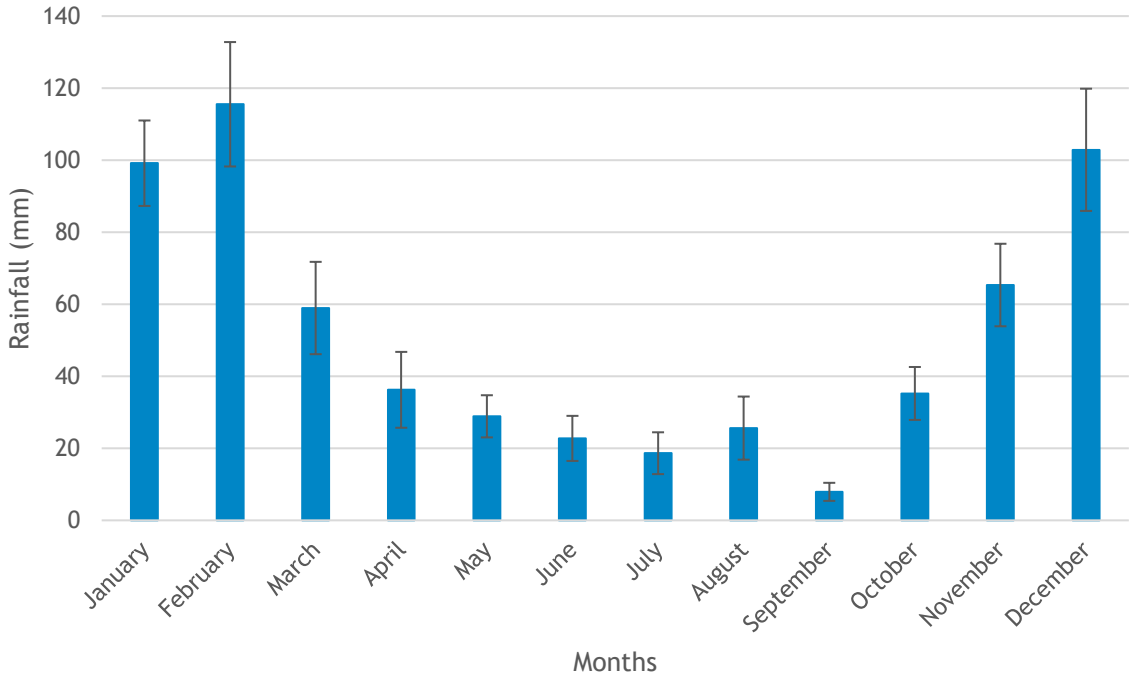


Figure 3. Average Monthly Rainfall for the Moranbah Area Between 1989 to 2019

[1] Meteorological data was collected at the Project's nearest Bureau of Meteorology (BOM) stations: 034038 and 34035.

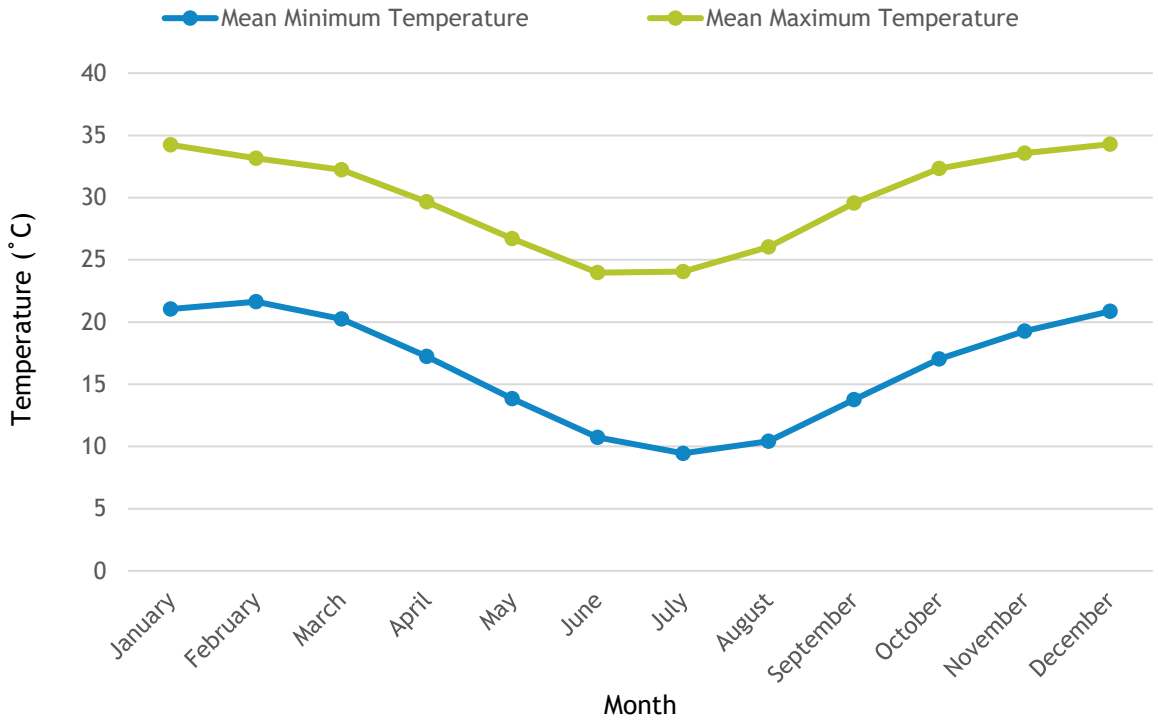


Figure 4. Average Monthly Temperatures for the Moranbah Area Between 1989 to 2019

2.3 Topography

The Study Area is located on a predominantly gently undulating to flat landscape, ranging from 180 metres (m) to 240 m Australian Height Datum (AHD). The surrounding landscape is relatively flat to undulating interspersed by Mt Coxendean (471 m AHD), Iffley Mountain (310 m AHD) and Coxen's Peak (415 m AHD) located east of the Study Area. The Harrow Range is also located south of the Study Area, adjacent to Saraji Mine, ranging from 280 m to 330 m AHD (DNRME, 2018).

2.4 Hydrology

The Study Area is located within the Isaac River drainage sub-basin of the Fitzroy Basin within the Fitzroy NRM region. The Isaac River drainage sub-basin is approximately 22,365 km^2 in area and encompasses the township of Moranbah, Dysart and Nebo. The Isaac River (stream order 6) meanders roughly parallel to the north and east of the Study Area boundaries. Several un-named, DNRME mapped minor tributaries of the Isaac River extend into the Study Area (DNRME, 2020c).

Ripstone Creek (stream order 3) traverses the southern extent of the Study Area, flowing in a south-easterly direction, before eventually draining into the Isaac River approximately 20 km south-east of the Study Area. Several minor drainage lines and streams of Ripstone Creek also traverse the southern extent of the Study Area (DNRME, 2020c).

2.5 Geology and land zones

DNRME (2018) detailed surface Geology Mapping and GeoScience Australia 1:250,000 geology mapping (Sheet SF 55-11) identified four potential land zones mapped within the Study Area. A summary of geology units and associated land zones is provided in Table 1.

Table 1. Geology and Land Zones within the Study Area

Geological Unit	Description	Land Zone
Qa	Quaternary floodplain alluvium comprising clay, silt, sand and gravels.	3
Qr/Czs/Czb	Cainozoic clay deposits and gently undulating clay plains (colluvial), sometimes containing gilgai micro-relief.	4
Qr/Czs	Cainozoic sand or clay loams plains (colluvial).	5
Puw/Pwj	Cainozoic/Proterozoic consolidated fine-grained sediments associated with the Rewan Group and Rangal/Fort Cooper Coal Measures (Blackwater Formation).	9

2.6 Groundwater

The hydrogeological regime relevant to the Project comprises the following hydrogeological units (SLR Consulting, 2021):

- Cainozoic sediments:
  - Quaternary alluvium – unconfined aquifer localised along Isaac River; and
  - regolith – unconfined and largely unsaturated unit bordering alluvium.
- Triassic Rewan Group – aquitard; and
- Permian coal measures with:
  - hydrogeologically 'tight' interburden units; and
  - coal sequences that exhibit secondary porosity through cracks and fissures.

Alluvial groundwater elevations range from around 179 m AHD at the northern end of the Project Area, and between approximately 162 m AHD to 166 m AHD to the south-east, increasing with proximity to the Isaac River (i.e. losing stream conditions) (SLR Consulting, 2021).

Overall, the regolith is considered to be largely unsaturated, with the presence of water restricted to lower elevation areas along the Isaac River and the lower reaches of its tributaries (i.e. Ripstone Creek). Flow within the regolith where it is saturated is a reflection of topography, flowing towards nearby drainage lines (SLR Consulting, 2021).

The Rewan Group comprises low hydraulic conductivity lithologies and is typically considered an aquitard (SLR Consulting, 2021).

The water levels in the coal measures within the Project Area generally follow the downstream flow gradient of the Isaac River, with south-easterly trending hydraulic gradients. Groundwater elevations range from around 188 m AHD in the north-west, down to 155 m AHD in the south-east of the Project Area (SLR Consulting, 2021).

The Isaac River is largely fresh, water within the Isaac River alluvium has recorded ranges from fresh to moderately saline with an average total dissolved solids (TDS) of 863 milligrams per litre (mg/L), ranging between 10 mg/L and 3,430 mg/L (SLR Consulting, 2021). Comparing the available data to relevant guideline levels, the summary results indicate that water within the Quaternary alluvium is generally suitable for stock water supply and short-term irrigation.

Water within the regolith material is generally highly saline, but can be brackish to moderately saline with an average TDS of 10,510 mg/L, ranging between 1,460 mg/L and 18,600 mg/L (SLR Consulting, 2021). Where water is present within the regolith material, it exhibits poorer quality compared to the alluvium and is not considered a suitable groundwater resource for livestock, irrigation, drinking water or aquatic ecosystems.

It is expected that the terrestrial Groundwater Dependent Ecosystems (GDEs) would not access water from the deeper Permian coal measures due to the depth to groundwater, and therefore, the potential impacts to water resource in the Cainozoic sediments has been assessed with respect to terrestrial GDEs.

2.7 Land use

Livestock grazing is the dominant land use within the Fitzroy NRM region, occupying an area of approximately 121,511 km^2 (78%) (Dougall *et al.*, 2014). Other notable land uses within the catchment include dryland cropping (5%), nature conservation (8%) and forestry (6%) (Dougall *et al.*, 2014). There are also extensive areas of resource mining activities within the Fitzroy NRM region, particularly within the northern and western parts of the region (Dougall *et al.*, 2014). The Study Area has a long history of cattle grazing and the original habitats have been subject to past clearance and modification.

2.8 Previous surveys

In December 2013, Ecological Survey & Management (EcoSM) prepared a *Terrestrial flora and fauna baseline report Winchester South Project* (EcoSM, 2013). The Study Area was confined to Mining Development Licence (MDL) 183 for the purposes of EcoSM's survey work (now MLA 700049, MLA 700050 and MLA 700051). Overall, four surveys were undertaken by EcoSM in the wet and dry seasons (two surveys in each season) to describe the ecological values. Key findings of the EcoSM (2013) report are summarised below.

2.8.1 Flora Survey

EcoSM (2013) conducted a dry season flora survey was undertaken between 26 October and 7 November 2011. Conditions for this period were very dry (< 30 mm of rain in October) and temperatures ranged from 16.4°C to 34.9°C. A late wet-season survey was also undertaken between 8 and 25 May in 2012 and 11 June 2012. Temperatures ranged from 6.8°C to 27.7°C during this survey period. Due to an exceedingly rainy preceding wet-season (January to May 2012, receiving 526.7 mm), conditions were optimal for detecting flora species as vegetative and floral characteristics were prominent, particularly in herbaceous and grass species. The dry season flora surveys were primarily undertaken to identify the type, distribution and status of vegetation communities while the wet season survey incorporated other floristic surveys. Field verification and mapping of remnant and high-value regrowth vegetation was undertaken at 468 sites in total, including 2 secondary sites, 35 tertiary sites and 74 modified quaternary sites. Data was collected at multiple sites within each RE.

A total of 40 additional ecological equivalence quadrats were sampled. Conservation significant species, TECs and REs were identified, and a floristic species list was created noting the relative abundance of each species.

Field validated REs within the previous Study Area that are not currently listed as conservation significant under the Queensland *Vegetation Management Act 1999* (VM Act) included: 11.3.25, 11.4.4, 11.5.3, 11.9.2 and 11.9.3. Field validated REs that are currently listed as conservation significant under the VM Act included:

- Endangered REs 11.3.1, 11.4.8 and 11.4.9; and
- Of Concern REs 11.3.2, 11.3.3, 11.3.4, 11.4.11, and 11.8.11.

TECs found within the Study Area included the Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin (Natural Grasslands TEC) and Brigalow (*Acacia harpophylla* dominant and co-dominant) (Brigalow TEC), which were primarily located in the northern extent of the Study Area except for a few patches scattered throughout. The EcoSM (2013) reported finding of *Dichanthium queenslandicum*. This is now thought to have been due to a misidentification, which is discussed further in Section 4.5.2 of this report. No additional Endangered, Vulnerable or Near Threatened (EVNT) floral species under the NC Act were ground-truthed at the time.

2.8.2 Fauna Survey

EcoSM (2013) conducted a pre-wet season survey between 10th and 17th November 2011. Weather conditions during this survey period were typically hot during the day and mild in the evening, ranging from 18.1°C to 35.4°C with no rain recorded. A post-wet season survey was undertaken in 2012 between 29th February and 7th March. Weather conditions were typically clear and warm. Temperatures ranged between 19.2°C and 35.9°C, and over 100 mm of rain was recorded within the Moranbah region the week prior to this survey. Seven systematic trap sites were established, each incorporating three pitfall traps, six funnel traps, 25 small Elliott traps, five large Elliott traps, two cage traps and one infrared camera trap. All traps were set for four nights each. In total, there were 1,152 traps nights over the study period. Other survey methods included 61 person hours of spotlighting, call playback (unspecified survey effort), 140 person hours of bird surveys, Anabat deployment for one night at 13 sites, 10 trap nights of harp trapping, 10 person hours of active searches for reptiles, frogs and small ground-dwelling mammals, opportunistic observations and habitat assessments. A total of nine supplementary surveys were also undertaken using spotlighting, bird surveys and/or active searches.

Three species listed as conservation significant (as of October 2020) were detected by EcoSM during field surveys conducted in 2011 and 2012:

- ornamental snake (*Denisonia maculata*) which is Vulnerable under both the EPBC Act and NC Act
- koala (*Phascolarctos cinereus*) which is Vulnerable under both the EPBC Act and NC Act; and
- Australian painted snipe (*Rostratula australis*) which is Endangered under the EPBC Act and Endangered under the NC act.

Two additional species were detected that were listed as near threatened (NT) under the NC Act at the time: the cotton pygmy-goose (*Nettapus coromandelianus*) and little pied bat (*Chalinolobus picatus*). Both of these species are no longer listed as Near Threatened under the NC Act.

3 Methods

The terrestrial ecological values of the Project were evaluated through a desktop assessment and a series of field assessments. The following section details the methods employed to conduct both the desktop (Section 3.1) and field assessments (Section 3.2).

3.1 Desktop assessment methods

The purpose of the desktop assessment is to consolidate information from relevant databases, available mapping, aerial photography and published literature to produce an initial characterisation of the ecological values of the Study Area and the surrounding landscape. In part, this background information guides the field survey requirements.

The desktop assessment sourced information from the:

- Protected Matters Search Tool (PMST) Database as issued by the Commonwealth Department of Agriculture, Water and the Environment (DAWE) (2020a)
- Regulated Vegetation Management Map issued by the DNRME (Version 11.0) (DNRME, 2020b)
- Queensland Remnant Regional Ecosystem mapping provided by DES (Version 11) (DES, 2018c) and associated Regional Ecosystem Description Database (Version 11.1) (Queensland Herbarium, 2019)
- DNRME Vegetation Management watercourse and drainage feature mapping (Version 4.0) (DNRME, 2020d)
- Wildlife Online Extract and WildNet data provided by the DES (DES, 2018d, 2020d)
- Queensland Herbarium HERBRECS Specimen database (Queensland Herbarium, 2017)
- DNRME Detailed Surface Geology Mapping (DNRME, 2018) and Geoscience Australia 1:250,000 geology mapping series (Geoscience Australia, 2020a)
- DES Biodiversity Planning Assessment mapping (DES, 2018a)
- Map of ESAs for Mining Leases, provided by DES (DES, 2019a)
- Protected Plants Flora Survey Trigger Map (DES, 2019b)
- Atlas of Living Australia species search (Atlas of Living Australia [ALA], 2020)
- BirdLife Australia (BLA) species search (BLA, 2020)
- GeoScience Australia 1:100,000 drainage network of Queensland (Geoscience Australia, 2020b)
- Latest available aerial photography (NearMap, 2020)
- a review of historical aerial photography from 1989 and 1990 to determine High Value Regrowth (DNRME, 2020a)
- map of Queensland Wetland Environmental Values provided by DES (2020c)
- DES Wetland Systems Mapping (Version 5.0) (DES, 2019c)
- Bioregional Assessment Programme National Groundwater Dependent Ecosystems Atlas (BOM, 2020); and

- existing Ecological Assessment Reports for the Project and other adjacent projects, including:
  - *Terrestrial flora and fauna baseline report Winchester South Project* (EcoSM, 2013)
  - Olive Downs Project: baseline offset survey investigation report, terrestrial fauna assessment and terrestrial flora assessment (DPM Envirosciences 2018a; 2018b; 2018c)
  - *Saraji East Coal Mine Project – Baseline environmental studies, terrestrial flora and fauna baseline study* (SKM, 2011)
  - *Arrow Bowen Gas Project, Environmental Impact Statement – Terrestrial Ecology Report*, (3D Environmental, 2012)
  - *Red Hill Mining Lease – Terrestrial Fauna Technical Report* (URS Australia, 2013)
  - BMA Bowen Basin Coal Growth Project (BHP Billiton Mitsubishi Alliance [BMA], 2009):
    - Caval Ridge Mine
    - Goonyella Riverside Mine Expansion; and
    - Daunia Mine.
  - *Moranbah Ammonium Nitrate Manufacturing Facility, Dyno Nobel Asia Pacific Ltd. Environmental Impact Statement* (GHD, 2006)
  - Isaac Downs Project (Stanmore IP South, 2020)
  - *Lake Vermont Coal Project*: *EIS Assessment Report under the Environmental Protection Act 1994* (Environment and Natural Resource Regulation, 2005); and
  - *Millennium Expansion Project Environmental Impact Statement*, Chapter 13: Nature Conservation (Peabody Energy Inc., 2011).

For desktop sources requiring a search extent, a 50 km buffer to the Study Area was applied.

3.1.1 Likelihood of occurrence assessment

A Likelihood of Occurrence Assessment evaluates the qualitative probability that a flora or fauna species, can physically occupy the Study Area during all or part (e.g. breeding season, migration) of its life cycle. The assessment evaluates:

- species-specific ecological and physiological requirements
- previously recorded species observations
- the resources and constraints present in the Study Area informed by the desktop assessment; and
- the resources and constraints present in the Study Area informed by the field surveys.

During the desktop assessment, the outcome of the Likelihood of Occurrence Assessment is used to guide the field design and planning phase. Threatened species that are known, likely or have the potential to occur in the Study Area were targeted during the field surveys (i.e. target species). Following the field surveys, the Likelihood of Occurrence Assessment is re-evaluated using the field data to modulate the target species list prior to further assessment.

The Likelihood of Occurrence Assessment outcome and criteria is detailed in Table 2. The complete Likelihood of Occurrence Assessment is detailed in Appendix D.

Table 2. Likelihood of Threatened Species to occur in the Study Area

Assessment Outcome	Criteria
known to occur	The species or population has been observed within the Study Area
likely to occur	Suitable habitat for a species or population occurs within the Study Area and nearby records are present
potential to occur	Suitable habitat for a species or population occurs within the Study Area but it is degraded or of limited extent, the species has never been recorded in the local area and/or habitat only support a portion of the species' life cycle
unlikely to occur	A low to very low probability that a species or population uses/occurs within the Study Area due to the lack of potential habitat or the Study Area is outside the species known range

3.1.2 Nomenclature

The Commonwealth of Australia's Style Manual (2002) states that common names of flora and fauna species are usually only capitalised if they contain proper names (e.g. Australian painted snipe). When lists of common names from different plant and animal groups appear together, the convention (i.e. using lower-case letters) will prevail.

Vegetation which is introduced/non-native (i.e. pest) has been demarcated by '*'.

3.2 Field assessment methods

Field surveys were conducted to identify and characterise the presence, extent and condition of contemporary ecological values within the Study Area. The methods employed adhere to the guidelines and methodologies prescribed or supported by the Queensland and Commonwealth governments (Sections 3.2.2 and 3.2.3).

3.2.1 Survey timing and conditions

Flora and Fauna surveys were conducted over two wet season periods and two dry season periods to account for the seasonal variation in species presence, abundance and habitat utilisation (e.g. breeding, foraging).

3.2.1.1 Dry Season 2018

A dry season ecology survey was conducted between 9th and 13th October 2018 within the Study Area. The weather conditions during this time were characteristic of a late 'dry season'. The region had received minimal rainfall during the months preceding the field assessment, recording approximately 34 mm of rainfall since April 2018. At the time of the survey, standing water was present only at farm dams scattered throughout the Study Area. Weather conditions at the time of the survey were dry, with daily maximum temperatures of approximately 35ºC to 38ºC. Milder temperatures (approximately 27ºC to 32ºC) in conjunction with scattered rainfall events (approximately 6 mm) were recorded on the last two days of the survey (12th and 13th October 2018)[2].

[2] Weather data recorded at Moranbah Airport (weather station number 34035), approximately 20 km from the Study Area (BOM, 2019).

3.2.1.2 Wet season 2019

A wet season ecology survey was conducted between 2nd and 10th May 2019. The survey followed a late start to the wet season as the region received approximately 180 mm of rain in the three months preceding the field assessment. Weather conditions at the time of the survey were cloudy, with daily maximum temperatures of approximately 25ºC to 29ºC. Milder temperatures were in conjunction with scattered rainfall events, measuring approximately 4 mm over the course of the survey (3rd, 5th and 7th May 2019).

3.2.1.3 Dry season survey 2019

A dry season ecology survey was conducted between 9th and 18th September 2019. At the time of survey, weather conditions were mostly sunny with maximum daily temperatures ranging between 28ºC and 34ºC. Temperatures stayed warm (19ºC to 25ºC) into the early evening throughout the nocturnal spotlighting surveys. Over the six months preceding the survey, the region received below average rainfall (approximately 50 mm). Standing water was only present within farm dams scattered throughout the Study Area. No rainfall events occurred during the assessment.

3.2.1.4 Wet season survey 2020

A wet season ecology survey was conducted between 12th and 21st February 2020. The survey followed a late start to the wet season as the region received approximately 127 mm of rain in the three months preceding the field assessment. Weather conditions at the time of the survey were cloudy, with daily maximum temperatures ranging from 35ºC to 38ºC. A number of thunderstorms occurred in the late afternoons in conjunction with patchy rainfall events across the Study Area, measuring approximately 17 mm over the course of the survey.

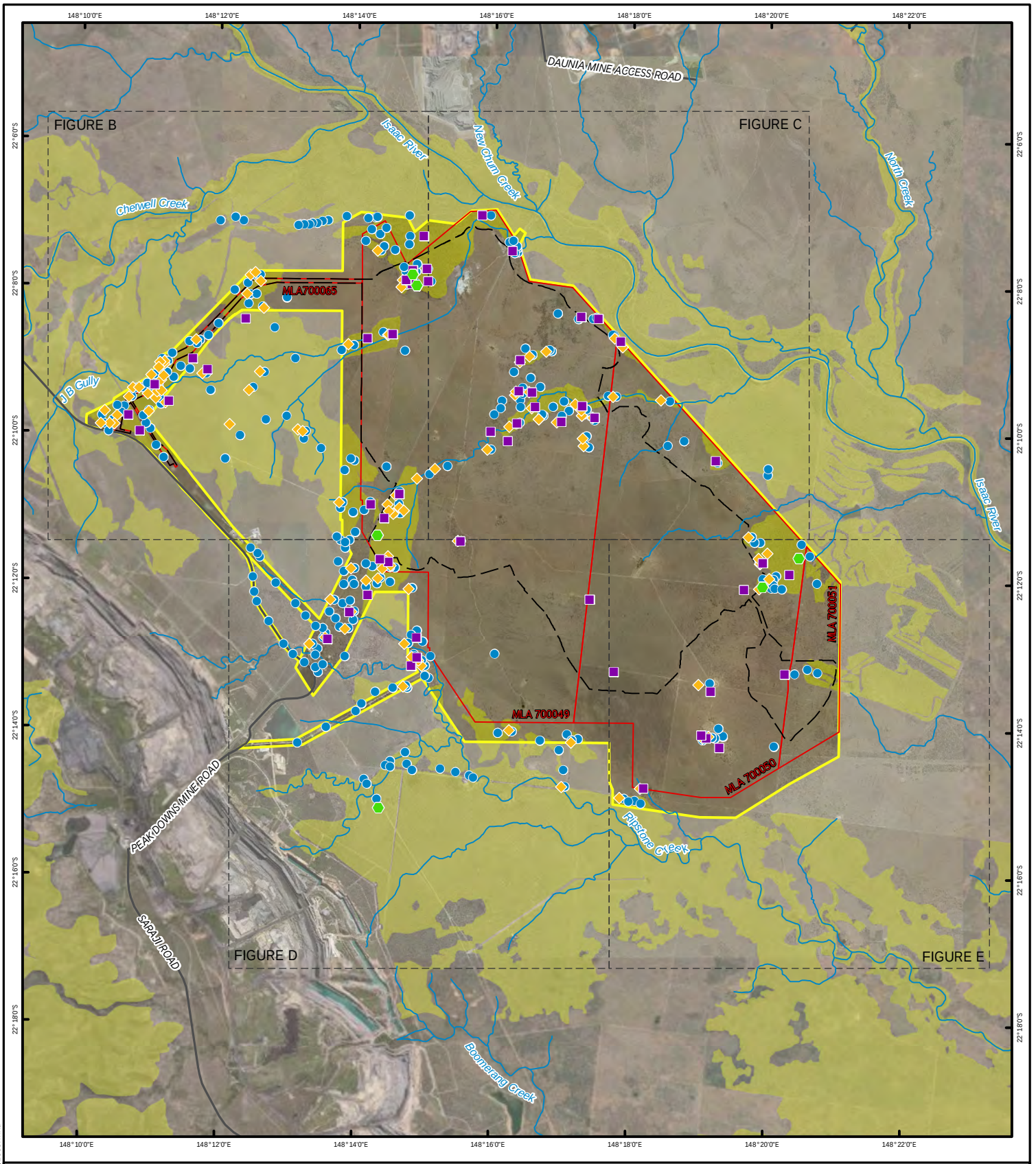
3.2.2 Flora survey methods

Flora surveys were conducted in accordance with the relevant Commonwealth and State guidelines:

- *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Neldner *et al.*, 2019)
- Conservation Advice criteria for each TEC (DAWE, 2020c)
- Random Meander Technique (Cropper, 1993)
- *Flora Survey Guidelines – Protected Plants* (*NC Act 1992*) (DES, 2020a); and
- *Guide to Determining Terrestrial Habitat Quality* (DES, 2020b).

3.2.2.1 Regional ecosystems

Ground-truthing and validating vegetation community mapping within the Study Area were conducted in accordance with the Queensland Government's *Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Neldner et al., 2020). Using this methodology, a combination of Tertiary and Quaternary vegetation surveys were carried out at survey sites selected during the Desktop Assessment (Sections 3.1.2, 3.3.1 and 3.3.2) in alignment with the Queensland Herbarium's CORVEG database (Figure 5A-E).



Legend

- Watercourse and Drainage Feature
- Road
- Figure Extent
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- DNRME Mapped Remnant Vegetation
- Quaternary Site
- Tertiary Site
- TEC Assessment Site
- Biocondition Site

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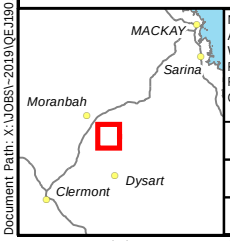

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Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Remnant Vegetation: © DNRME 2019
Cadastre: © DNRME 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 5A: FLORA SURVEY LOCATIONS OVERVIEW

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

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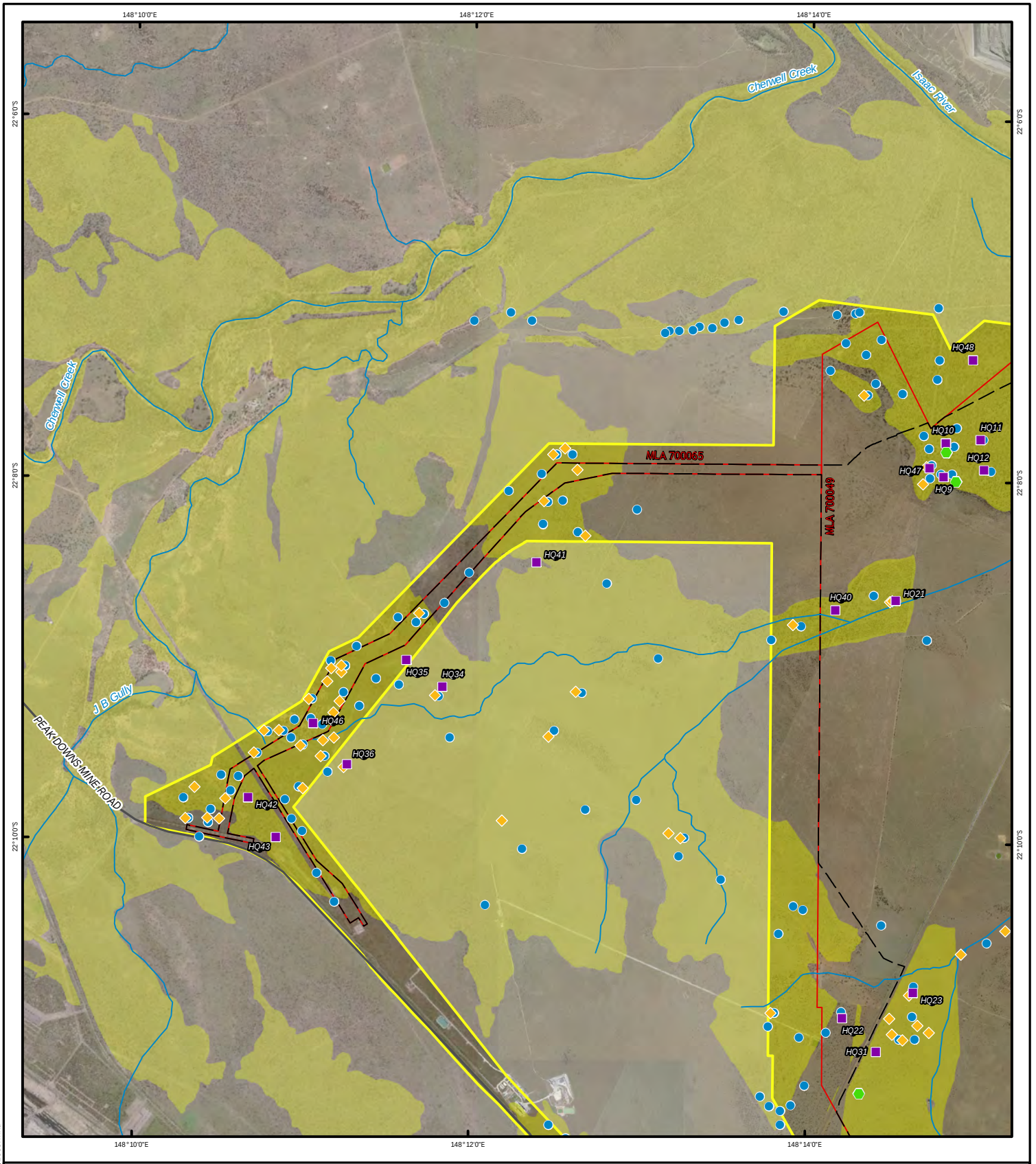

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- DNRME Mapped Remnant Vegetation
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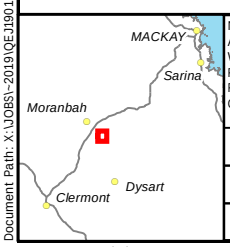

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Cadastre: © DNRME 2019

Rev	Description	Drawn	Approved	Date
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G	Issued for Review	DL	BD	30/10/2020

FIGURE 5B: FLORA SURVEY LOCATIONS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

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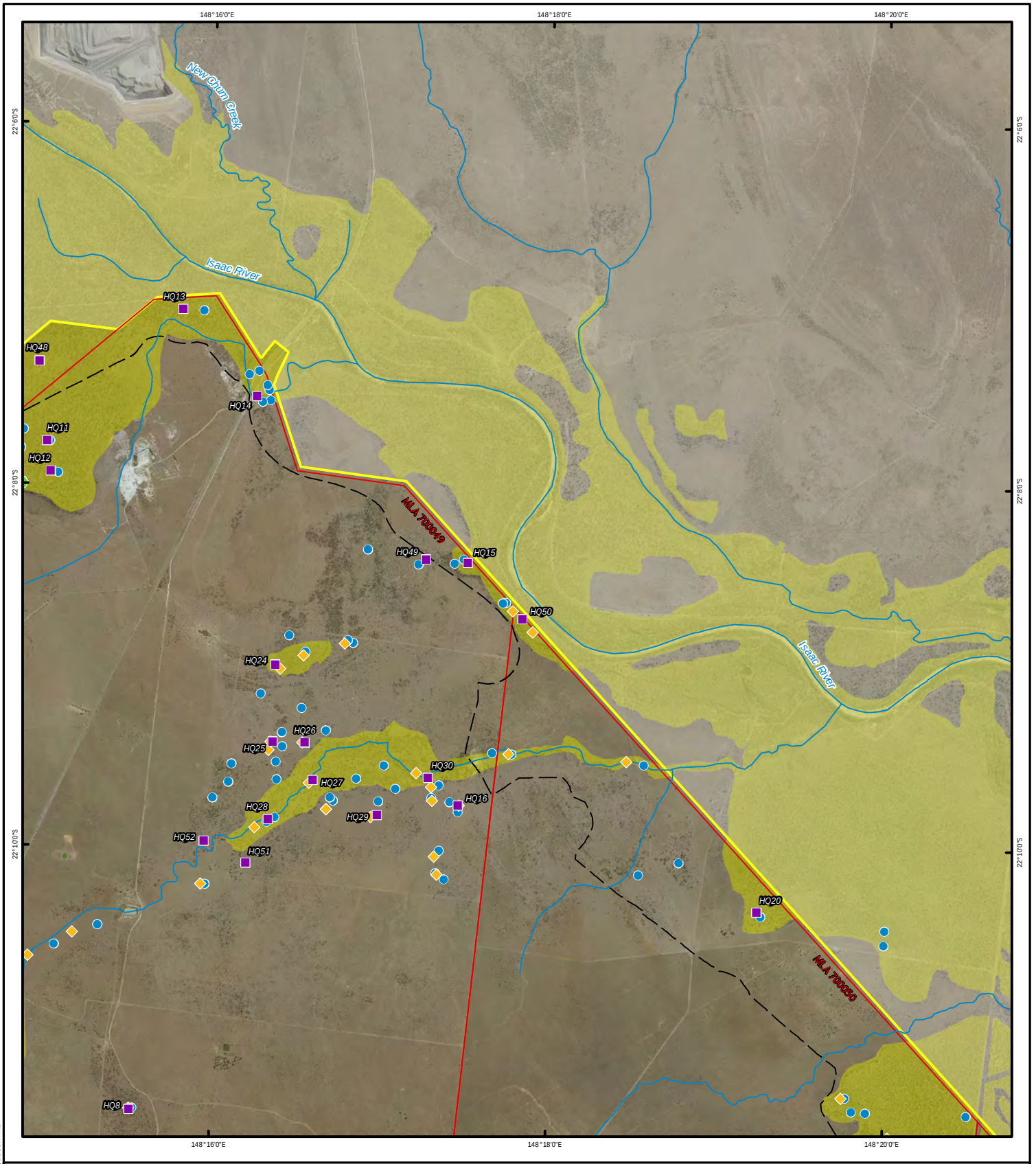

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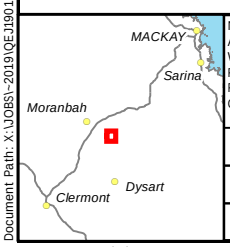

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G	Issued for Review	DL	BD	30/10/2020

FIGURE 5C: FLORA SURVEY LOCATIONS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

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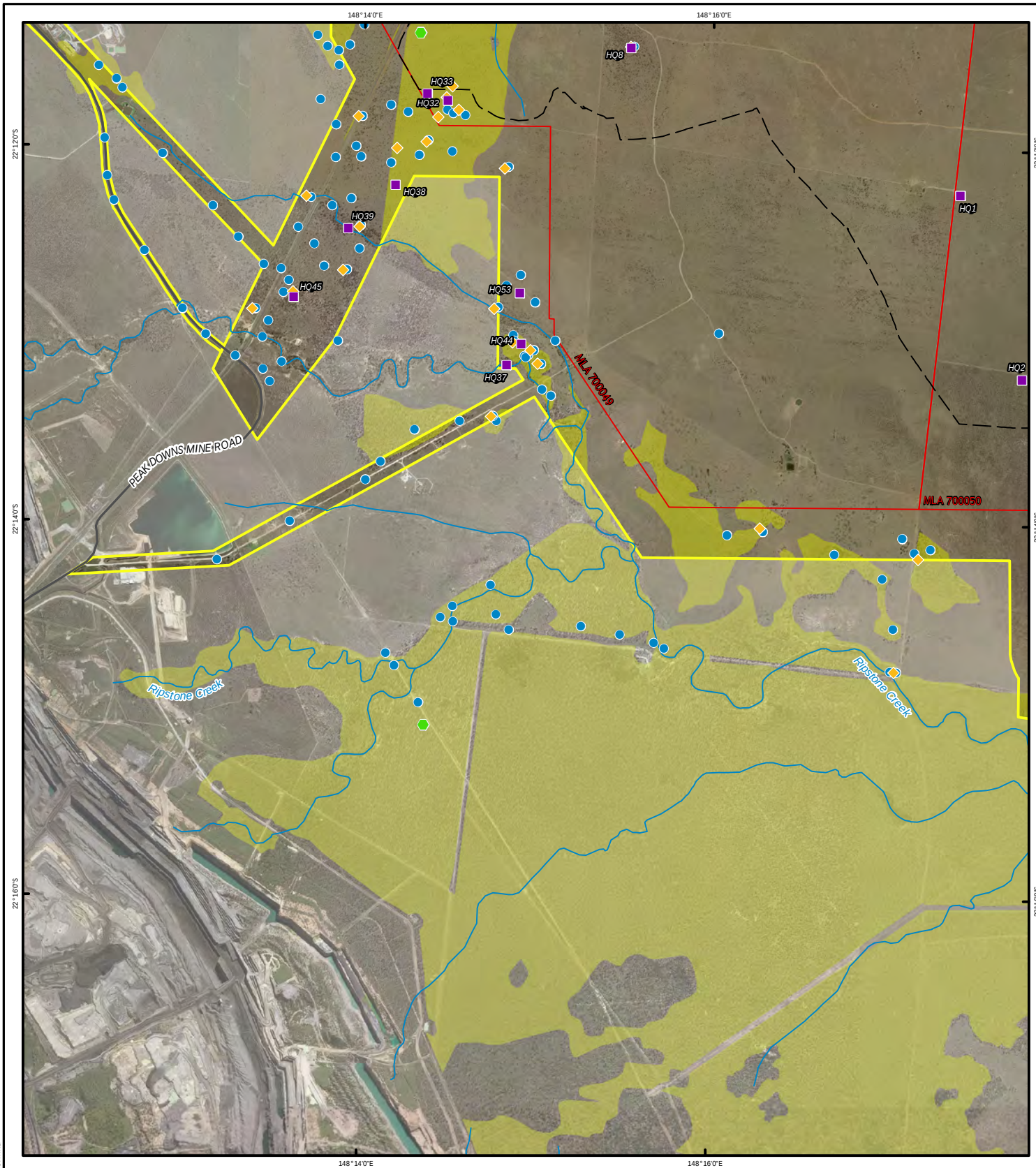

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- DNRME Mapped Remnant Vegetation
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- Tertiary Site
- TEC Assessment Site
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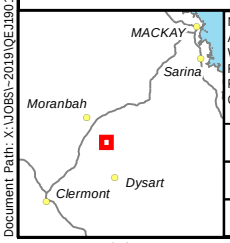

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Rev	Description	Drawn	Approved	Date
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G	Issued for Review	DL	BD	30/10/2020

FIGURE 5D: FLORA SURVEY LOCATIONS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

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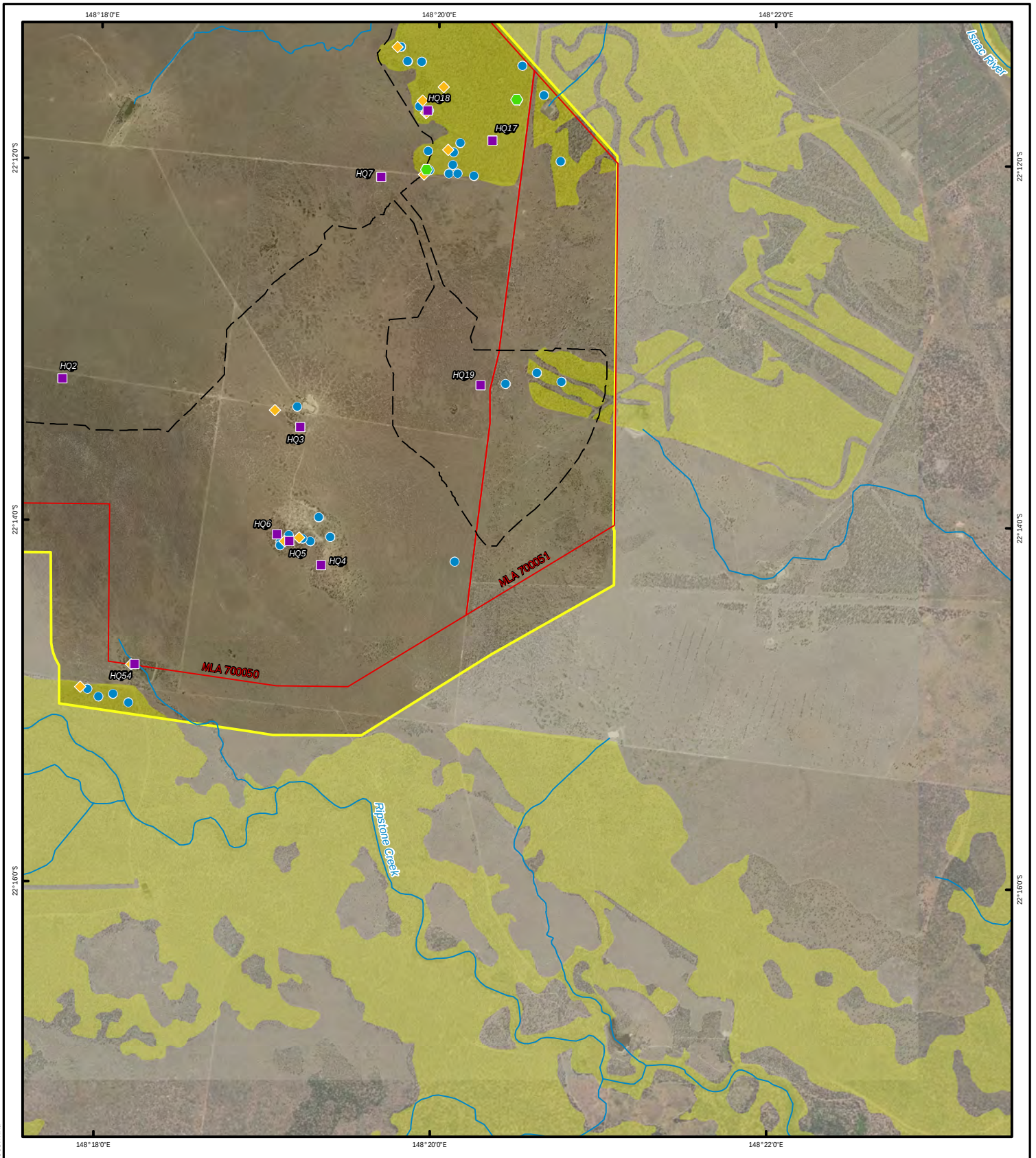

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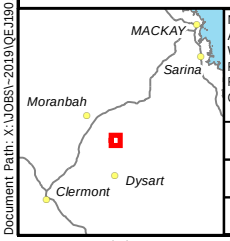
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Remnant Vegetation: © DNRME 2019
Cadastre: © DNRME 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 5E: FLORA SURVEY LOCATIONS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
5 of 5	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_5_FloraSurveyLocs.mxd

Tertiary surveys are relatively more comprehensive than quaternary surveys yet are limited in application to the wet season when favourable weather conditions promote the emergence of annual herbs and grasses which more accurately reflect species richness. In addition to a comprehensive list of species, data collected during a tertiary survey includes a measure of relative abundance and overall vegetation structure information such as height and cover. In contrast, quaternary surveys are a rapid assessment used to verify RE mapping and designate structure and condition status.

Vegetation was characterised as:

- **Remnant vegetation** - communities that conform with the definition under the VM Act and referenced by Neldner *et al*. (2019). Specifically, this comprises 'vegetation, part of which forms the predominant canopy of the vegetation:
  - covering more than 50% of the undisturbed predominant canopy
  - averaging more than 70% of the vegetation's undisturbed height; and
  - composed of species characteristic of the vegetation's undisturbed predominant canopy.'
- **Non-remnant vegetation** – all vegetation that is not mapped as remnant vegetation. This includes regrowth and communities that have been historically cleared/disturbed or heavily modified (i.e. improved pastures, weed encroachment etc) that failed to meet the structural and/ or floristic characteristics of remnant vegetation.

Information provided in the RE Technical Descriptions for the Brigalow Belt (DES, 2018d) and structural formations of vegetation as defined by Specht (1970) served as a baseline for the undisturbed canopy, height and species with which to compare the field data and ascertain vegetation class.

Heterogenous RE polygons mapped in the Study Area by DES (2018b) were ground-truthed and mapped as homogenous polygons.

3.2.2.2 Threatened ecological communities

In conjunction with Tertiary and Quaternary assessments, additional TEC assessments were undertaken in the field within relevant vegetation communities to verify if key diagnostic characteristics and condition thresholds for EPBC Act-listed TECs were met (Figure 5A-E). Specific condition criteria and characteristics used for the assessment are based on respective information provided within each 'approved listing advice' published for each TEC identified within the desktop assessment.

3.2.2.2.1 Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC

To determine whether a community meets the condition requirements of a Brigalow TEC (Department of the Environment [DotE], 2013a), brigalow ecological communities were assessed on whether they met the minimum thresholds pertaining to patch size and weed encroachment. Each community was also assessed on whether brigalow (*Acacia harpophylla*) was the dominant or co-dominant species within the tree layer. Using the recommendations of Butler (2007), remnant communities of poor condition were excluded from the Brigalow TEC if they included any of the following characteristics:

- brigalow patches that are smaller than 0.5 ha; and
- exotic perennial plants cover more than 50% of the patch, assessed in a minimum area of 0.5 ha (100 m by 50 m).

As described by the Queensland Herbarium (2019), 16 REs are associated with the Brigalow TEC within the Brigalow Belt North bioregion. Relevant Brigalow REs within the Study Area were assessed against the threshold criteria outlined in the Approved Conservation Advice (DotE, 2013a) to determine their status as the Brigalow TEC.

3.2.2.2.2 Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin TEC

The Commonwealth Listing Advice for the Natural Grasslands TEC (Threatened Species Scientific Committee [TSSC], 2009) has characterized the community as containing:

- a usually sparse or absent tree canopy (less than 10% projective crown cover)
- a shrub layer of less than 50% projected crown cover; and
- the dominance of perennial native grasses and the presence of at least three the indicator native grass species outlined by the TSSC (2009).

Within the Brigalow Belt Bioregion of Queensland, the Queensland Herbarium (2019) has defined the following REs as being associated with the Natural Grasslands TEC: 11.3.21, 11.4.4, 11.4.11, 11.8.11, 11.9.3, 11.9.12 and 11.11.17. Each community was assessed for whether they belong to at least one of these REs to determine whether it fits the classification of the TEC (TSSC, 2009).

Relevant REs must be a patch that is considered to be of 'good quality' or 'best quality' to be classified as the Natural Grasslands TEC. The thresholds for defining these conditions are outlined in Table 3.

Table 3. Condition Classes for the Natural Grasslands TEC

Criteria	Best quality	Good quality
Patch size	At least 1 ha; and	At least 5 ha; and
Grasses	At least 4 native perennial grass species from the list of perennial native grass indicator species; and	At least 3 native perennial grass species from the list of perennial native grass indicator species; and
Tussock cover	At least 200 native grass tussocks; and	At least 200 native grass tussocks; and
Woody shrub[1] cover	Total projected canopy cover of shrubs is less than 30%; and	Total projected canopy cover of shrubs is less than 50%; and
Introduced species	Perennial non-woody introduced species are less than 5% of the total projected perennial plant cover.	Perennial non-woody introduced species are less than 30% of the total projected perennial plant cover.
[1] The shrub layer is typically absent. However, where shrubs are present, they are defined as woody plants, more than 0.5 m tall that occupy the mid vegetation layer. The upper, or tree canopy layer, also is typically absent but may comprise scattered trees to less than 10% projective crown cover.		
Sampling would be based upon a quadrat size of 0.1 ha (e.g. 50 m x 20 m) selected in an area with the most apparent native perennial grass species. Unless exceptional circumstances apply, to maximise the assessment of condition, sites must be assessed during a good season, two months after cessation of disturbance (fire/grazing/mowing/slashing) and within two months of effective rain.		

3.2.2.2.3 Poplar Box Grassy Woodland on Alluvial Plains

Within the specified Brigalow Belt bioregion, the Poplar Box TEC is typically associated with the following Queensland REs: 11.3.2, RE 11.3.17, RE 11.4.7 and RE 11.4.12. Each vegetation community was assessed for whether they belong to at least one of these REs to determine whether it fits the classification of the TEC (Department of the Environment and Energy [DEE], 2019). As the only RE within the Study Area relevant to the Poplar Box TEC was RE 11.3.2 (Section 4.3), communities were assessed on whether they belonged to RE 11.3.2. Each community was also assessed according to the conservation advice on Poplar Box TEC (DEE, 2019), which states that the community must have the following structure:

- a tree crown cover >10% at patch scale
- a tree canopy that shows the following characteristics:
  - canopy trees can reach a potential height of at least 10 m or more
  - a dominance of poplar box (*Eucalyptus populnea*) within the canopy layer
  - hybrids of poplar box with other *Eucalyptus spp.* must be counted as part of the poplar box component when assessing the previous criterion
  - a crown cover of shrubs to small trees (1-10 m height) less than 30%; and
- a ground cover dominated by perennial native grasses, other native herbs and sometimes chenopods.

A list of native plants associated with this TEC can be found in Appendix A of the Conservation Advice (including listing advice) for the Poplar Box TEC (DEE, 2019).

3.2.2.3 Threatened flora

The random meander technique (Cropper, 1993) was used to survey for potential threatened flora throughout the Study Area. The random meander technique involves traversing potential habitat within the Study Area and searching for flora species that may not have been located using more structured search methods. This technique is particularly suitable for locating species that typically occur at very low densities or that may be distributed in isolated clumps. Targeted surveys for threatened species using the Cropper (1993) random survey technique was undertaken for:

- species identified within the ToR, including king bluegrass (*Dichanthium queenslandicum*), quassia (*Samadera bidwillii*) and Marlborough blue (*Cycas ophiolitica*); and
- species identified from the desktop assessment and literature review (refer to section 3.1) where potential habitat was identified within the Study Area.

3.2.2.4 Opportunistic observations

Flora species not otherwise detected via other survey methods (Sections 3.2.2.1 to 3.2.2.3), including pest species, are recorded as opportunistic observations.

3.2.3 Fauna survey methods

The fauna survey objectives were to identify and characterise:

- the species richness and general fauna assemblages within the Study Area
- the type and quality of fauna habitat present within the Study Area
- fauna Matters of National Environmental Significance (MNES); and
- fauna Matters of State Environmental Significance (MSES).

Fauna surveys were conducted in accordance with the relevant Commonwealth and State guidelines:

- *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (DES, 2018f)
- *Survey Guidelines for Australia's Threatened Mammals* (Cth) (Department of Sustainability, Environment, Water, Populations and Communities [DSEWPaC], 2011b)
- *Survey Guidelines for Australia's Threatened Reptiles* (Cth) (DSEWPaC, 2011c)
- *Survey Guidelines for Australia's Threatened Bats* (Cth) (Department of the Environment, Water, Heritage and the Arts [DEWHA], 2010a)
- *Survey Guidelines for Australia's Threatened Birds* (Cth) (DEWHA, 2010b)
- *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Cth) (DSEWPaC, 2011a)
- Species Profile and Threats Database (SPRAT) (Cth) (DAWE, 2020b)
- Species Approved Conservation Advice (Cth) (DAWE, 2020c)
- Species National Recovery Plans (Cth) (DAWE, 2020d); and
- Targeted species survey guidelines from the following sources:
  - *EPBC Act Referral Guidelines for the Vulnerable Koala* (DotE, 2014c)
  - Koala (*Phascolarctos cinereus*) – Spot Assessment Technique (SAT) (Phillips & Callaghan, 2011)
  - *Targeted Species Survey Guidelines for Yakka Skink (Egernia rugosa)* (Ferguson & Mathieson, 2014)
  - *Targeted Species Survey Guidelines for Common Death Adder (Acanthophis antarcticus*) (Rowland & Ferguson, 2012)
  - *Targeted Species Survey Guidelines for Painted Honeyeater (Grantiella picta)* (Rowland, 2012); and
  - *Targeted Species Survey Guidelines for Ghost Bat* (*Macroderma gigas)* (Hourigan, 2011).

Species identified through the likelihood of occurrance assessment (Appendix D) were targeted during Field Surveys (Section 3.1.1). A suite of methods was used to conduct the fauna surveys in the field including:

- establishing systematic trap sites for catch and release of fauna
- nocturnal spotlighting and call playback surveys
- auditory and visual bird surveys conducted early morning and evening
- Anabat detectors to detect and record the echolocation calls emitted by bats
- diurnal active searches; and
- fauna habitat surveys.

3.2.3.1 Systematic trap sites

Systematic trap sites consist of a suite of live capture/release methods used to target mammals, amphibians and reptiles (Table 4). Systematic trap sites are established in a variety of habitat types throughout the Study Area (Figure 6A-E) in accordance with the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (DES, 2018f).

Table 4. Methods deployed at each systematic trap site

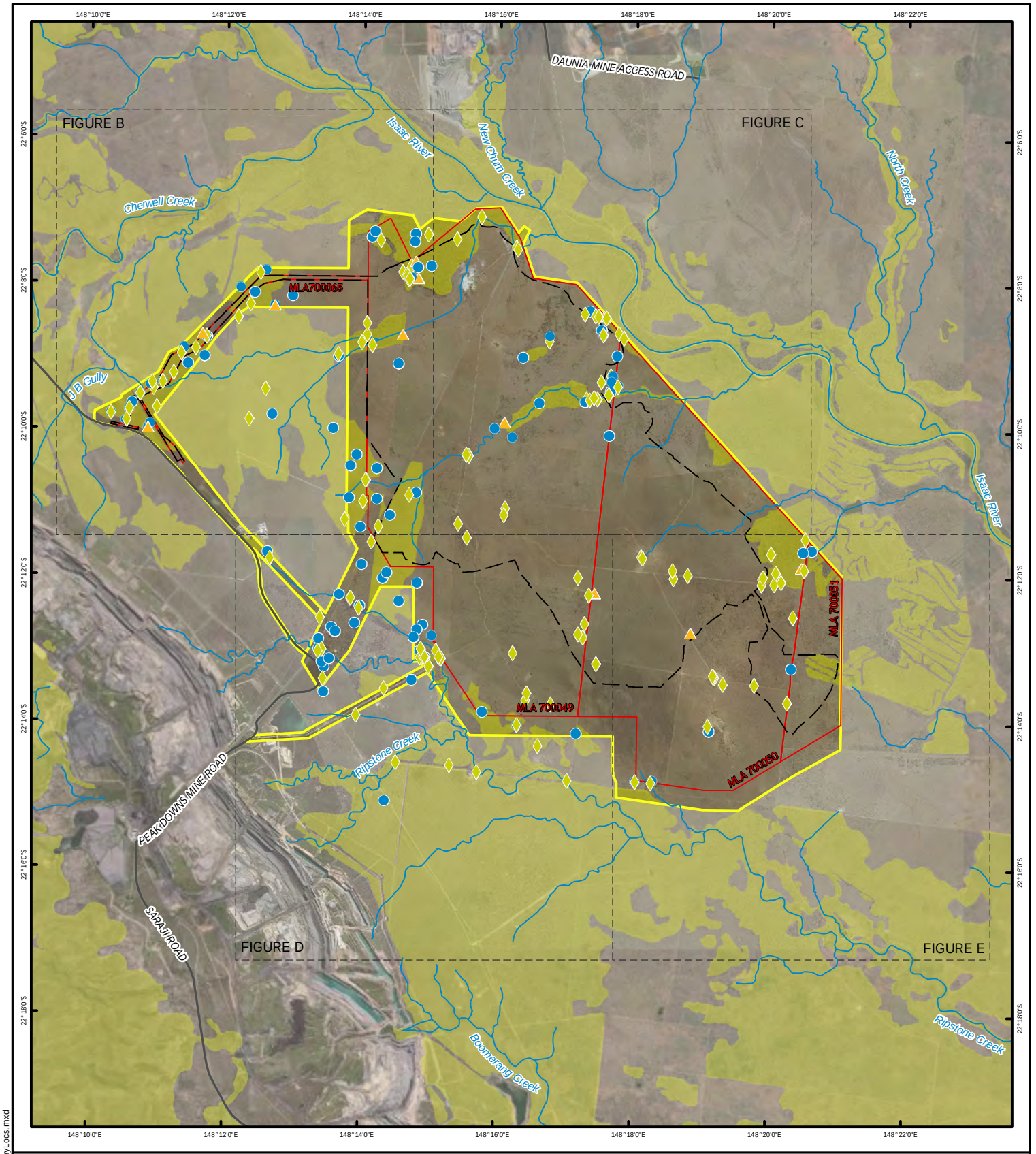
Trap type	Number	Method
Pitfall trap with drift fence	1	Four 20 L buckets excavated into the ground to be flush with the ground surface along a 15 m drift fence that directs fauna towards the bucket opening. A piece of polystyrene, water-soaked sponge and leaf litter were placed within each bucket. Ant repellent powder was sprinkled around the edge of the bucket lip to mitigate the risk of ant related fauna deaths. Pitfall trap lines are checked each morning and afternoon.
Funnel traps	5-8	Positioned on the ground parallel along the drift fence to assist in catching large reptiles that may escape buckets. Funnel traps are covered with hessian cloth to provide shade for fauna.
Elliot trap	20	Elliot traps (Type A and B) are baited with a mixture of oats, peanut butter, honey and vanilla essence. Traps are located adjacent to suitable microhabitat features (e.g. coarse woody debris, burrows, dense leaf litter/grass cover and rocky outcrops). Elliot traps are opened in the late afternoon, inspected each morning and closed during the day.
Cage trap	1	Cage traps are baited with a mixture of oats, peanut butter, honey and vanilla essence, as well as chicken necks and apple. Cage traps are covered with hessian cloth to provide shade for fauna. Cage traps are opened in the late afternoon, inspected each morning and closed during the day.
Baited infrared camera (aka camera trap)	1	Reconyx Hyperfire 2 Professional Series infrared cameras were directed towards a bait tube containing chicken necks and a mixture of oats, peanut butter, honey and vanilla essence. The camera was set to take bursts of three photos with a time between photos of one second and a quiet period of 30 seconds. The sensitivity was set to medium-high.

3.2.3.2 Nocturnal spotlighting/call playback

Nocturnal spotlight surveys target fauna that are most active and detectable at night. These surveys are conducted on foot using a hand-held and / or head torch to detect eye shine and investigate microhabitats (e.g. decorticating bark or coarse woody debris) within each habitat type in the Study Area (Figure 6A-E). Slow vehicle drive spotlighting was also undertaken when moving between survey sites.

Call playback was also undertaken prior to commencing spotlighting at each of the survey sites and involved broadcasting recorded calls of nocturnal species through a portable speaker in the effort to elicit a response. Each species call was played for a period of three minutes followed by two minutes of listening. Call playback of the following species was undertaken during the survey:

- southern boobook (*Ninox novaeseelandiae*)
- barking owl (*Ninox connivens*)
- spotted nightjar (*Eurostopodus argus*)
- Australian owlet-nightjar (*Aegotheles cristatus*)
- white-throated nightjar (*Eurostopodus mystacalis*); and
- koala (*Phascolarctos cinereus*).



Legend

- Watercourse and Drainage Feature
- Road
- Figure Extent
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- DNRME Mapped Remnant Vegetation
- Habitat Assessment Site
- Detailed Fauna Survey Site
- Supplementary Fauna Survey Site

N

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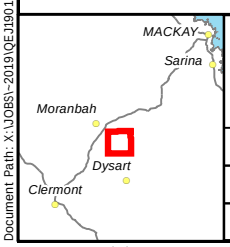
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: © Geoscience Australia 2018
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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 6A: FAUNA SURVEY LOCATIONS OVERVIEW

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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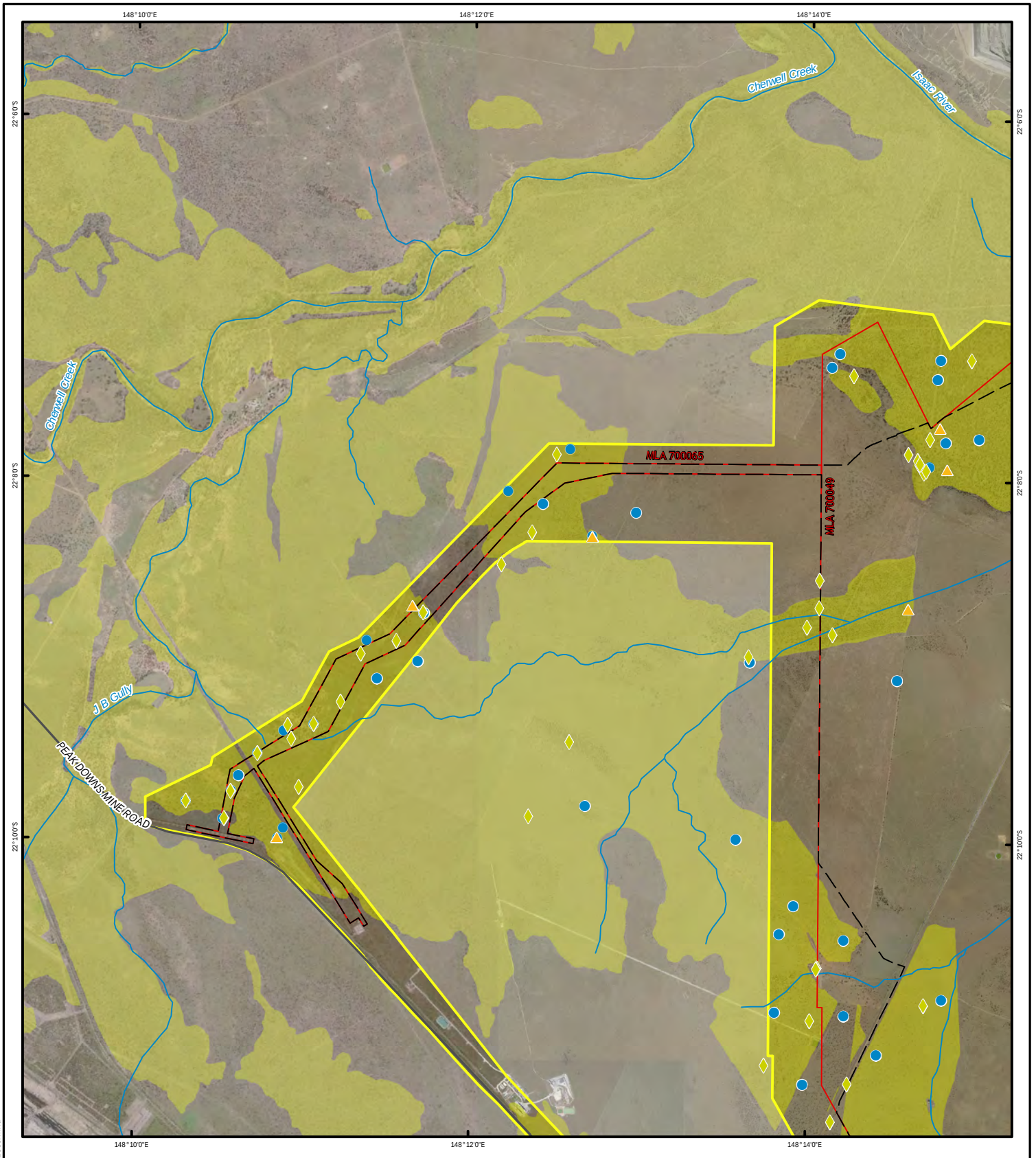
Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_6_FaunaSurveyLocs.mxd



Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- DNRME Mapped Remnant Vegetation
- Habitat Assessment Site
- Detailed Fauna Survey Site
- Supplementary Fauna Survey Site

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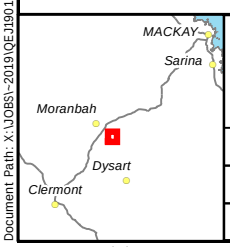
Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
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Watercourse: © Geoscience Australia 2018
Road: © PSMA 2014
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Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 6B: FAUNA SURVEY LOCATIONS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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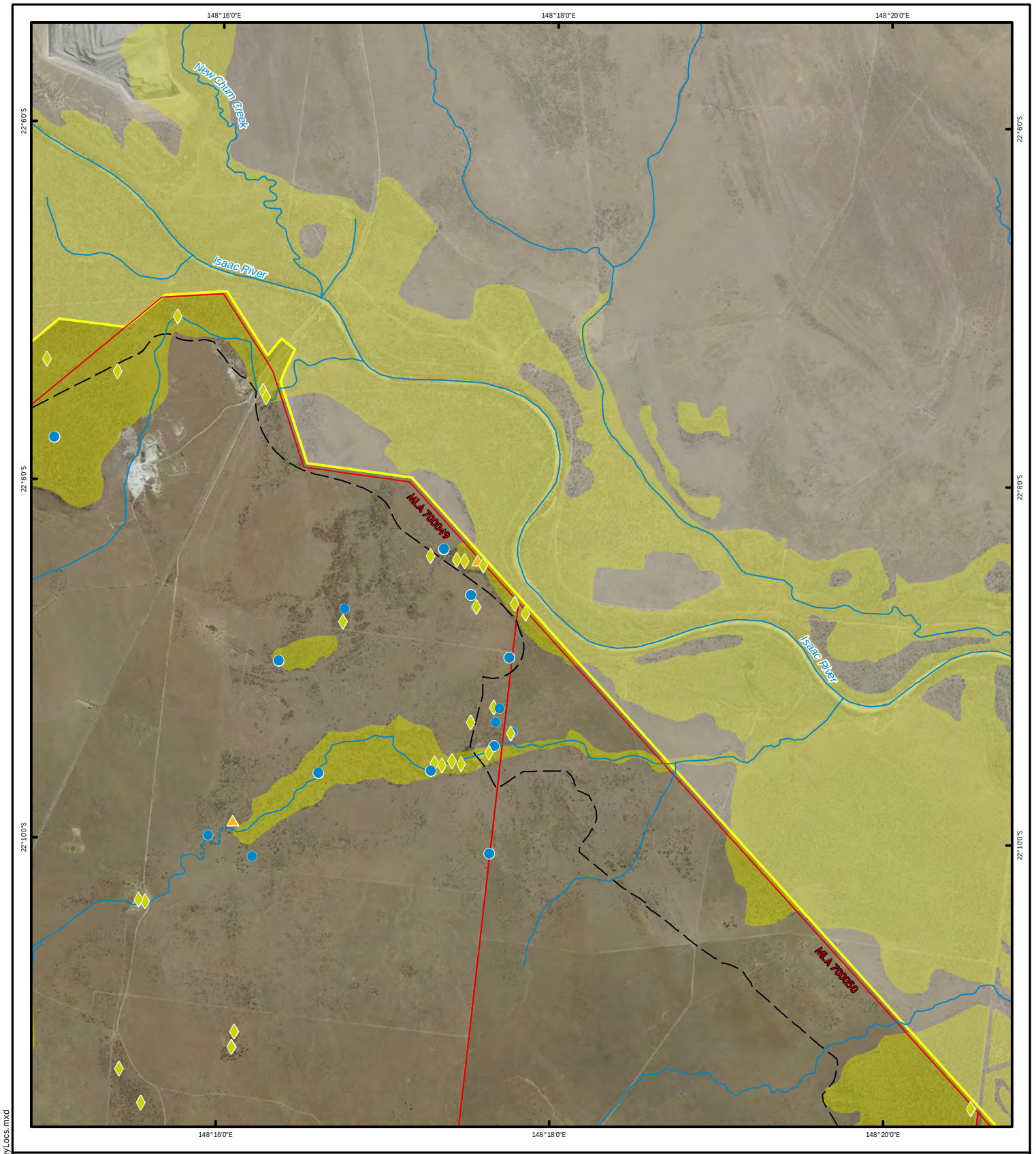
Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_6_FaunaSurveyLocs.mxd



Legend

- Watercourse and Drainage Feature
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- DNRME Mapped Remnant Vegetation
- Habitat Assessment Site
- Detailed Fauna Survey Site
- Supplementary Fauna Survey Site

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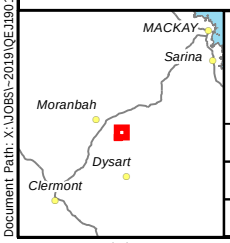
Projection: Transverse Mercator



Notes:
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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 6C: FAUNA SURVEY LOCATIONS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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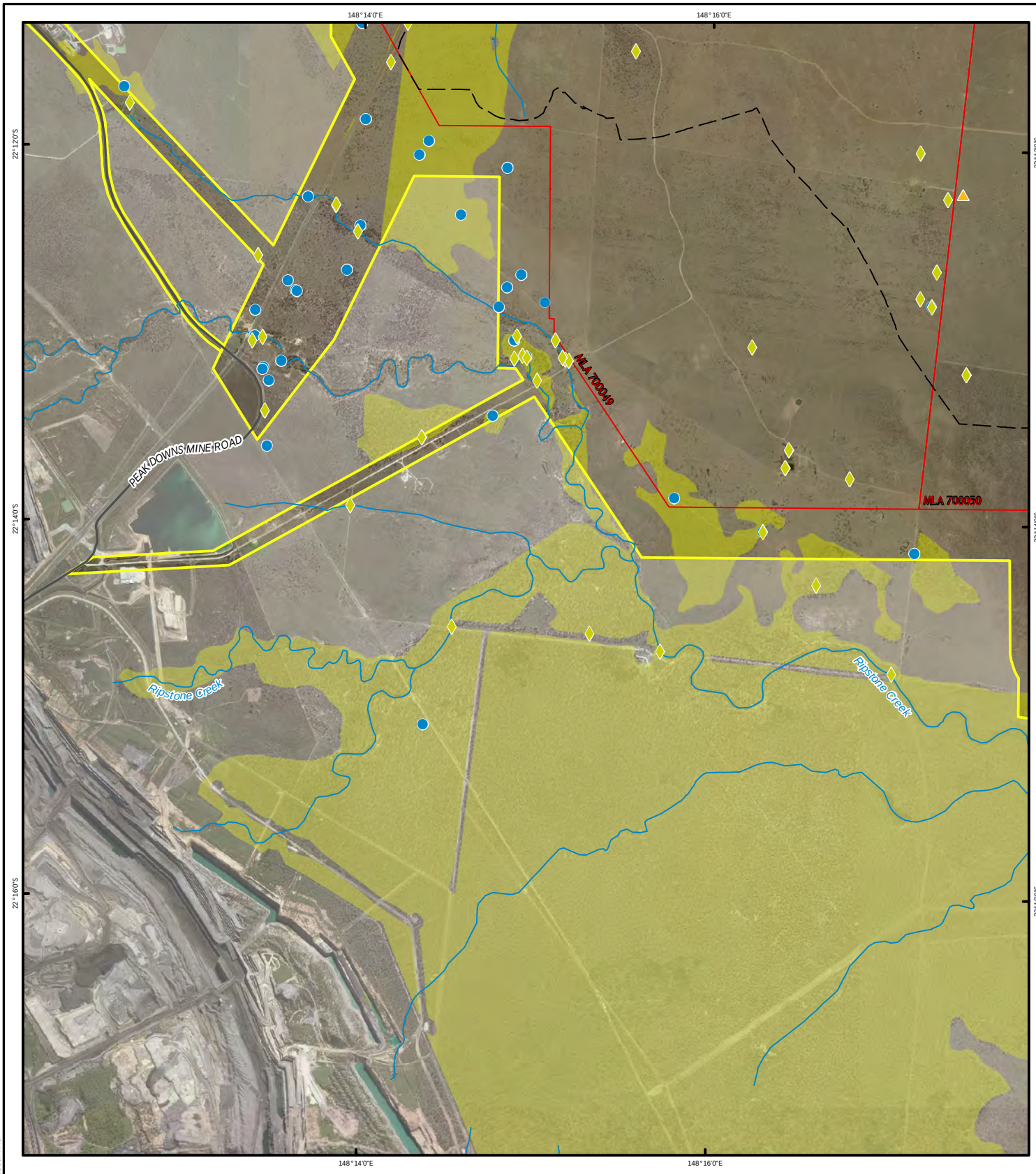
Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_6_FaunaSurveyLocs.mxd



Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- DNRME Mapped Remnant Vegetation
- Habitat Assessment Site
- Detailed Fauna Survey Site
- Supplementary Fauna Survey Site

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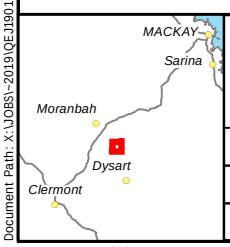

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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 6D: FAUNA SURVEY LOCATIONS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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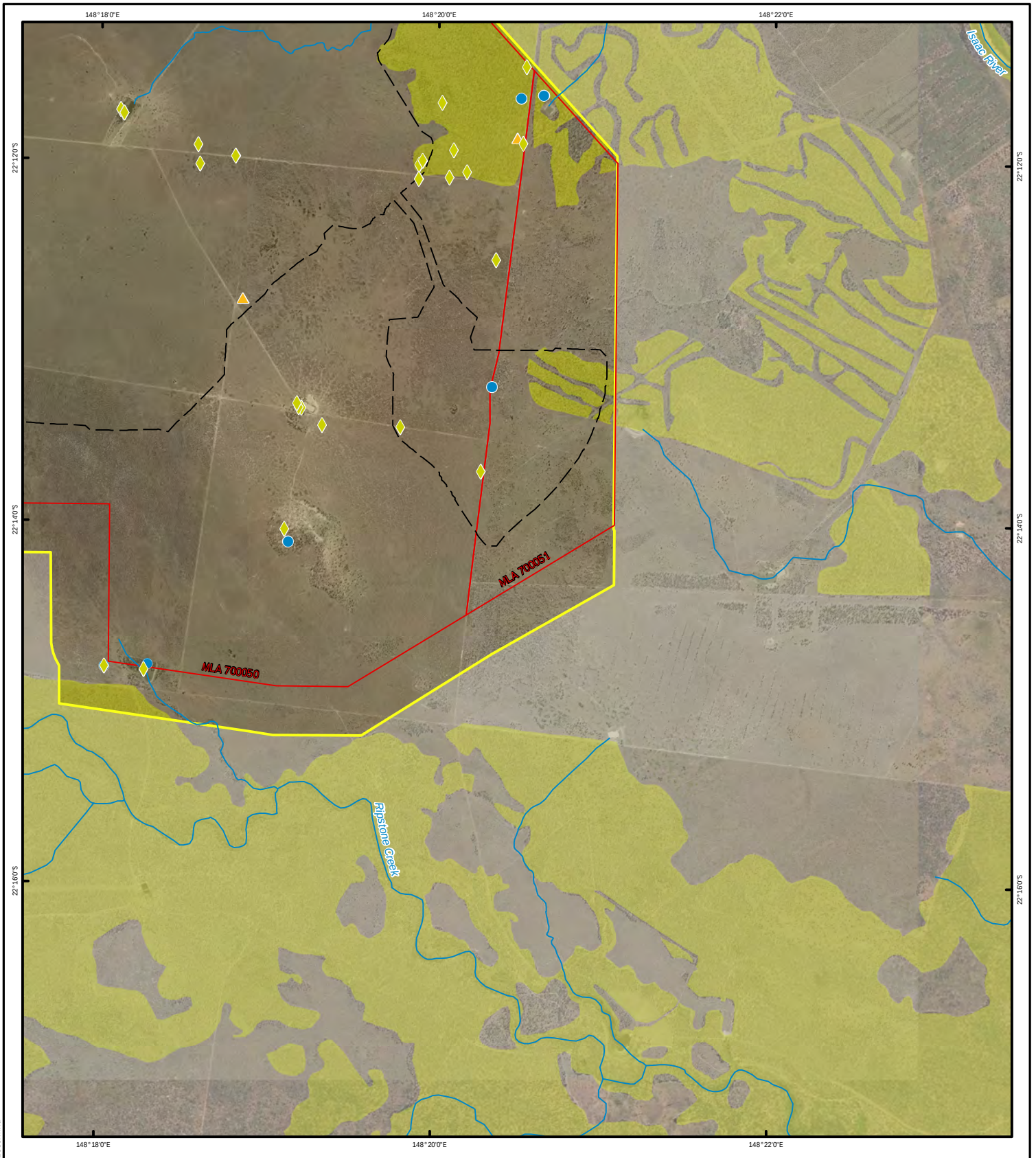
Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_6_FaunaSurveyLocs.mxd



Legend

- Watercourse and Drainage Feature
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- DNRME Mapped Remnant Vegetation
- Habitat Assessment Site
- Detailed Fauna Survey Site
- Supplementary Fauna Survey Site

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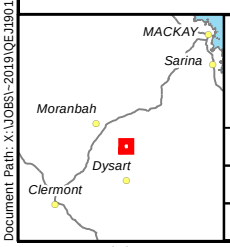
Projection: Transverse Mercator



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0	Issued for Use	DL	BD	27/11/2020
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FIGURE 6E: FAUNA SURVEY LOCATIONS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
5 of 5	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_6_FaunaSurveyLocs.mxd

3.2.3.3 Bird surveys

Standardised bird surveys were undertaken in the early morning and late afternoon across multiple sites within the Study Area (Figure 6A-E). Bird surveys occurred in accordance with the area search method prescribed by DEWHA (2010b). This survey involved two ecologists, equipped with binoculars, searching 1-3 ha of potential habitat and recording all species either observed or heard during the 15-30 min survey period.

3.2.3.4 Anabat

Anabat surveys involved the placement of Anabat SD2 detectors within suitable detection areas (e.g. farm dams, flyways and flowering trees) to detect echolocation calls of microbats foraging within the Study Area (Figure 6A-E). Anabats were set to operate from dusk until dawn each night within different locations to achieve spatial coverage across the Study Area.

3.2.3.5 Diurnal active searches

Active searches were undertaken from mid-morning to late afternoon and involved searching suitable microhabitat (e.g. fallen woody debris, leaf litter, decorticating bark) across all habitat types within the Study Area (Figure 6A-E). This survey method primarily targets reptiles and amphibians.

3.2.3.6 Threatened fauna

DEWHA, which later became DSEWPaC, published a series of survey guidelines for EPBC Act listed fauna species at risk. These guidelines standardised the effort and methods recommended to survey the following fauna assemblages:

- *Survey Guidelines for Australia's Threatened Birds* (DEWHA, 2010b)
- *Survey Guidelines for Australia's Threatened Mammals* (DSEWPaC, 2011b)
- *Survey Guidelines for Australia's Threatened Reptiles* (DSEWPaC, 2011c)
- *Survey Guidelines for Australia's Threatened Bats* (DEWHA, 2010a); and
- *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (DSEWPaC, 2011a).

Certain threatened fauna species however, have individual survey guidelines that target species-specific habitat and behaviour to increase detectability in the field. Species-specific survey methods were applied for the following species:

- *Targeted Species Survey Guidelines for Painted Honeyeater (Grantiella picta)* - (Rowland, 2012)
- *Targeted Species Survey Guidelines for Ghost Bat (Macroderma gigas)* - (Hourigan, 2011)
- koala (*Phascolarctos cinereus*) – Spot Assessment Technique (SAT) (Phillips & Callaghan, 2011)
- *Targeted Species Survey Guidelines for the Yakka Skink (Egernia rugosa)* (Ferguson & Mathieson, 2014) and the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (DSEWPaC, 2011a); and
- *Targeted Species Survey Guidelines for Common Death Adder (Acanthophis antarcticus)* (Rowland & Ferguson, 2012).

Detailed species-specific biological characteristics, habitat requirements and survey methods were also sourced from:

- Species Profile and Threats Database (SPRAT) (DAWE, 2020b); and
- Approved Conservation Advice (DotE, 2013a, 2014a, 2014b; DEWHA, 2008a, 2008b).

3.2.3.7 Fauna habitat assessment

Fauna habitat assessments were undertaken at 90 sites to characterise the suitability of fauna habitat throughout the Study Area, and to assist in identifying or refining threatened species habitat (Figure 6A-E). Habitat assessments primarily involved identifying and determining the abundance of macro and micro habitat features that are important in determining the likelihood or occurrence of threatened species. Habitat features collected included:

- koala food tree abundance and composition, habitat connectivity/movement corridors
- gilgai depth, soil crack depth and abundance, presence of amphibians
- rocky outcrop presence/abundance
- burrow abundance and size
- tree and log hollow abundance and size
- leaf litter abundance; and
- type / level of disturbance.

Broad habitat types were generated based on similarities among the macro and micro fauna habitat data in conjunction with data produced from the flora assessment methods. The fauna habitat types were mapped using a combination of Aerial Photography Interpretation (API) and field data. Habitat quality assessment surveys were also undertaken as described in Section 3.2.4.

3.2.3.8 Opportunistic fauna observations

Additional opportunistic surveys were undertaken to identify species or wildlife traces (i.e. bones, hair traces, tracks, scats, diggings, burrows, nests, skins) that could indicate the presence of cryptic fauna species. Pest fauna species were also recorded when detected opportunistically within the Study Area.

3.2.4 Habitat quality assessment methods

Habitat quality assessment surveys were undertaken in accordance with the DES' *Guide to Determining Terrestrial Habitat Quality Version 1.3* (2020b) (herein referred to as the Habitat Quality Guide). As per the Habitat Quality Guide, habitat quality was determined based on assessment of:

- Site-based attributes: assessed in accordance with Queensland Herbarium's BioCondition Assessment Manual Version 2.2 (Eyre et al., 2020). A summary of the attributes assessed is presented in Table 5. Field based attributes were then compared to relevant BioCondition benchmark scores to determine habitat quality.
- Species habitat attributes: assessed in accordance with the Habitat Quality Guide to determine a matter (impact or offset matter) area's ability to support a particular fauna species. Species habitat attributes were assessed for species considered likely or known to occur within the Study Area. A combination of BioCondition assessment data and fauna habitat assessment data were used to assess species habitat attributes for each species. A summary of the habitat attributes and associated indicators used for each species is presented in Table 6. As per the Habitat Quality Guide these indicators were determined based on a literature review. As different indicators have varying importance on habitat suitability, indicators were weighted depending on their importance.

In accordance with the Habitat Quality Guide, the number of sampling sites per Assessment Unit (AU) was revised where assessment units containing the same RE exhibit the same condition across the site (Department of Environment and Heritage Protection [DEHP], 2017). Quaternary and Tertiary assessments were undertaken in conjunction with terrestrial habitat quality assessments to assist in verifying vegetation type and condition across the Study Area.

Table 5. Site-based Attributes

Assessment plot	Attribute	Description
100 m x 50 m	large trees	Number of large trees per hectare, as determined by exiting BioCondition benchmarks for the associated RE
	tree canopy height	Median canopy height in metres of the ecologically dominant layer
	recruitment (%)	The proportion of overstorey species present at a site that are regenerating (<5 centimetre [cm] diameter at breast height [DBH])
	tree species richness	Native tree species richness and composition
100 m transect	tree canopy cover (%)	Vertical projection of the tree canopy crown cover along a transect
	shrub layer cover (%)	Vertical projection of the shrub layer cover of native shrubs
50 m x 20 m	coarse woody debris	The length of fallen woody logs and other coarse woody debris (>10 cm diameter and >0.5 m in length) per hectare
50 m x 10 m	native plant species richness	Native plant species richness, comprising shrubs, grasses and forbs/other
	non-native plant cover	Percentage cover of non-native/weed plant species
Five 1 m x 1 m	native perennial grass cover (%)	Average percentage cover of native perennial grass species
	litter cover	The average percentage cover of organic material such as fallen leaves, twigs and branches <10 cm diameter

Table 6. Species habitat-based attributes

Species	Habitat attribute	Indicator	Score	Weighting
ornamental snake	Quality and availability of food and habitat required for foraging	Abundance of amphibians	low (0) to high (5)	0.67
		Presence of water	absent (0), ephemeral (12.50), permanent (25)	0.33
	Quality and availability of habitat required for shelter and breeding	Soil crack abundance	absent (0) to high (5)	0.30
		Soil crack depth	absent (0) to deep (5)	0.30
		Abundance of woody debris	absent (0) to high (5)	0.30
		Litter abundance	absent (0) to high (5)	0.10
	Quality and availability of habitat required for mobility	Average patch size	<1 ha (0), 1-5 ha (8.3), 5-10 ha (16.6), >10 ha (25)	1.00
	Threat Abundance	Historical clearing	abundant (0) to absent (5)	0.40
		Cane toad abundance	high (0) to absent (5)	0.20
		Habitat degradation / cattle tramping	high (0) to absent (5)	0.40
koala	Quality and availability of food and habitat required for foraging	Abundance of koala food trees	absent (0) to high (5)	1.00
	Quality and availability of habitat required for shelter and breeding	Abundance of koala shelter trees / DBH >30 cm	absent (0) to high (5)	1.00
	Quality and availability of habitat required for mobility	Connectivity to remnant vegetation	completely fragmented (0) to highly connected (5)	1.00
	Threat Abundance	Historical clearing / fragmentation	abundant (0) to absent (5)	0.60
		Abundance of feral dogs	abundant (0) to absent (5)	0.20
		Vehicle strike risk	high (0) to absent (5)	0.20

Species	Habitat attribute	Indicator	Score	Weighting
greater glider	Quality and availability of food and habitat required for foraging	Abundance of food trees (Eucalyptus spp.)	absent (0) to high (5)	1.00
	Quality and availability of habitat required for shelter and breeding	Abundance of large hollows	absent (0) to high (5)	1.00
	Quality and availability of habitat required for mobility	Connectivity to remnant vegetation	completely fragmented (0) to highly connected (5)	0.50
		Average patch size	<1ha (0), 1-5ha (8.3), 5-10ha (16.6), >10ha (25)	0.50
	Threat Abundance	Historical clearing / fragmentation	abundant (0) to high (5)	0.50
		Bushfire risk	high (0) to low (5)	0.40
		Barbwire entanglement risk	abundant (0) to absent (5)	0.10
squatter pigeon (southern subspecies)	Quality and availability of food and habitat required for foraging	Vegetation condition	non-remnant (0), regrowth (8.3), mature regrowth (16.6), remnant (25)	1.00
	Quality and availability of habitat required for shelter and breeding	Average distance to water	>3 km (0), 1-3 km (12.5), <1 km (25)	1.00
	Quality and availability of habitat required for mobility	N/A	N/A	N/A
	Threat Abundance	Historical clearing	abundant (0) to absent (5)	0.50
		Cattle abundance	abundant (0) to absent (5)	0.25
		Abundance of pests (feral dogs / cats)	abundant (0) to absent (5)	0.25

Species	Habitat attribute	Indicator	Score	Weighting
Australian painted snipe	Quality and availability of food and habitat required for foraging	Presence of water	absent (0), ephemeral (12.50), permanent (25)	1.00
	Quality and availability of habitat required for shelter and breeding	Presence of small islands (isolated patches of vegetation within wetland)	absent (0) to abundant (5)	0.50
		Abundance of rushes and reeds	absent (0) to abundant (5)	0.50
	Quality and availability of habitat required for mobility	N/A	N/A	N/A
	Threat Abundance	Habitat degradation / cattle tramping	abundant (0) to absent (5)	0.50
		Abundance of pests (feral dogs / cats)	abundant (0) to absent (5)	0.50
common death adder	Quality and availability of food and habitat required for foraging	Abundance of amphibians / reptiles	absent (0) to high (5)	1
	Quality and availability of habitat required for shelter and breeding	Abundance of woody debris	absent (0) to high (5)	0.30
		Litter abundance	absent (0) to high (5)	0.10
	Quality and availability of habitat required for mobility	Average patch size	<1 ha (0), 1-5 ha (8.3), 5-10 ha (16.6), >10 ha (25)	1.00
	Threat Abundance	Historical clearing	abundant (0) to absent (5)	0.40
		Cane toad abundance	high (0) to absent (5)	0.20
		Habitat degradation / cattle tramping	high (0) to absent (5)	0.40

3.3 Survey effort

3.3.1 Flora

As part of this assessment the following survey effort was undertaken:

- 318 quaternary assessments
- 54 BioCondition assessments
- 6 tertiary assessments
- targeted searches (random meanders) for threatened species (refer to Sections 3.1.1 and 3.2.2.3); and
- 98 TEC assessments, including:
  - 4 Poplar Box TEC assessments
  - 51 Natural Grasslands TEC assessments; and
  - 43 Brigalow TEC assessments.

Flora surveys sites were selected through the use of aerial imagery, regional ecosystem mapping and geological information to stratify the Study Area. Sites were then selected which best represent the Study Area.

Flora survey sites were selected in accordance with the Methodology for Surveying and Mapping Regional Ecosystems and Vegetation Communities in Queensland (Neldner et al., 2020)

3.3.2 Fauna

The level of survey effort required to detect a particular species in the field is based on the:

- nature of the target species (e.g. home range size, population density)
- conditions within the Study Area (e.g. habitat availability); and
- recommended survey effort guidelines prescribed by the relevant State and/or Commonwealth regulators.

Fauna surveys sites were selected through the use of aerial imagery, regional ecosystem mapping and geological information to stratify the Study Area. Sites were then selected which best represent the Study Area.

Fauna survey sites were selected in accordance with the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (DES, 2018f).

Fauna surveys conducted within the Study Area aimed to meet the prescribed survey effort guidelines for each species listed in the ToR (Appendix A); however, in some cases, achieving the recommended survey effort in the guidelines was not necessary or impractical, particularly where effort was measured by survey hours per potential habitat area. While the recommended survey effort in the guidelines was not achieved for some species, the amount of survey effort undertaken is considered to be sufficient as survey effort was supplemented by habitat assessments and in some instances, the target species was confirmed to be present. Known or potentially occurring species (Section 3.1.1) where reaching recommended survey effort in the guidelines was considered impractical include the below (Tables 7 and 8).

Ornamental snake

The *Draft Referral Guidelines for Nationally Listed Brigalow Belt Reptiles* (DSEWPaC, 2011a) recommend 1.5 hours of spotlighting per hectare of suitable ornamental snake habitat. In context, this recommendation equates to over 6,000 hours of spotlighting within the Study Area. Multiple ornamental snake observations were recorded within the Study Area during the 115 hours of spotlighting survey effort across the four field surveys suggesting sufficient survey effort despite not achieving the recommended survey effort guidelines.

Yakka skink

The *Draft Referral Guidelines for Nationally listed Brigalow Belt Reptiles* (DSEWPaC, 2011a) recommends 1,310 ha of active searches based on area of potential habitat (i.e. 1.5 person hours/ha). The actual survey effort undertaken for the species is provided in Table 8 and includes a range of survey methods including 108 hours of active searches. Further survey effort was considered impractical as, while potential habitat occurs within the Study Area, the species has not been recorded within the Desktop Search Extent (i.e. previous surveys) and the completed survey effort was supplemented by habitat assessments.

Common death adder

There are no prescribed Commonwealth survey guidelines for this species, however the *Queensland Targeted Species Survey Guidelines – Common Death Adder (Acanthophis antarcticus),* (Rowland & Ferguson, 2012) recommends >80000 pitfall and funnel trap nights (i.e. >100 pitfall and funnel trap nights per ha of potential habitat. The actual survey effort undertaken for the species is provided in Table 8 and includes a range of survey methods including 148 pitfall and 213 funnel trap nights. Further survey effort was considered impractical as the species has been previously recorded within 4km of the Study Area, the Study Area contains potentially suitable habitat for the species, and the survey effort was supplemented by habitat assessments.

Dunmall's snake

The *Draft Referral Guidelines for Nationally listed Brigalow Belt Reptiles* (DSEWPaC, 2011a) recommends 1,310 ha of active searches based on area of potential habitat (i.e. 1.5 person hours/ha). The actual survey effort undertaken for the species is provided in Table 8 and includes a range of survey methods including 108 hours of active searches. Further survey effort was considered impractical as, while potential habitat occurs within the Study Area, the species has not been recorded within the Desktop Search Extent (i.e. previous surveys) and the completed survey effort was supplemented by habitat assessments.

Squatter pigeon

The *Survey Guidelines for Australia's Threatened Birds* (DEWHA, 2010b) recommends 343 hours of bird surveys based on potentially Suitable Breeding and foraging habitat, (i.e. diurnal bird surveys (area of transect) of 15 hours over 3 days for areas less than 50 ha). Further survey effort was considered impractical the species was detected during field surveys multiple times and the survey effort was supplemented by habitat assessments.

Undertaking the recommended survey effort for several other species, which were considered unlikely to occur in the Study Area (Section 3.1.1), was considered not warranted given the Study Area is outside the species known distribution and/or there are no nearby records. These species include (Tables 7 and 8):

- star finch (eastern subspecies) (*Neochmia ruficauda ruficauda*)
- northern quoll (*Dasyurus hallucatus*)
- ghost bat (*Macroderma gigas*)

- Allan's lerista (*Lerista allanae*); and
- red goshawk (*Erythrotriorchis radiatus*).

Again, the habitats in the Study Area have been previously surveyed as described in Section 2.7 and none of the above species have been previously recorded. A summary of the fauna survey effort is detailed in Table 7 and a comparison of survey effort against species-specific targeted survey guidelines is presented in Table 8.

3.4 Survey limitations

Ecological surveys have a range of inherent limitations associated with seasonal timing of the survey, variable climate conditions and species behaviour and ecology (e.g. cryptic, naturally rare). As such, the surveys conducted represent a "snapshot" in time and may not provide a true indication of presence or absence of flora and fauna species within the Study Area.

Four field surveys were conducted as part of the terrestrial ecology assessment by E2M to account for the seasonal variation in species presence, abundance and habitat utilisation (e.g. breeding, foraging). The two dry season surveys allowed for the broad ecological values within the Study Area to be characterised as well as environmental matters, such as perennial species, whose detection and identification are not seasonally dependent. The two wet season surveys were conducted following adequate rainfall events corresponding with peak activity of several fauna species (e.g. ornamental snake, Australian painted snipe) and resulted in the emergence of annual herbs, grasses and the presence of reproductive material on many species of flora.

The habitats in the Study Area were also previously surveyed in 2011 by EcoSM (Section 2.7), providing a good basis on which to undertake the terrestrial ecology assessment.

Table 7. Summary of fauna survey effort

Habitat Type	Survey Timing	Survey Method										
		Elliot (trap nights)	Cage (trap nights)	Pit fall (trap nights)	Funnel (trap nights)	Baited Infrared Camera (trap nights)	Anabat (nights)	Bird survey (person hours)	Active searches (person hours)	Spot-lighting (person hours)	Water source watch (person hours)	Koala SAT searches
Coolabah Wetland (1)	Dry Season 2018	60	3	12	15	3	1	8	4	2	0	1
	Wet Season 2019	80	4	16	24	6	2	8	2	8	0	0
	Dry Season 2019	0	0	0	0	0	0	0	0	0	0	0
	Wet Season 2020	0	0	0	0	0	0	0	1	0	2	0
Eucalypt Woodland (2a)	Dry Season 2018	60	3	12	15	3	1	12	6	10	0	2
	Wet Season 2019	160	8	32	48	10	4	21	17	8	0	4
	Dry Season 2019	0	0	0	0	0	7	16	16	0	0	0
	Wet Season 2020	80	4	16	24	12	5	14	12	3	0	3
Mature Regrowth / Disturbed Eucalypt Woodland (2b)	Dry Season 2018	0	0	0	0	0	0	0	0	0	0	0
	Wet Season 2019	0	0	0	0	2	2	2	2	0	0	0
	Dry Season 2019	0	0	0	0	0	0	4	4	0	0	0
	Wet Season 2020	0	0	0	0	0	0	1	1	0	0	1
Brigalow +/- Eucalyptus spp. Woodland (3a)	Dry Season 2018	0	0	0	0	0	0	2	2	0	-	0
	Wet Season 2019	0	0	0	0	0	0	2	2	8	-	0
	Dry Season 2019	0	0	0	0	21	0	8	8	2	-	0
	Wet Season 2020	80	4	16	24	11	6	3	6	11	4	0

Habitat Type	Survey Timing	Survey Method										
		Elliot (trap nights)	Cage (trap nights)	Pit fall (trap nights)	Funnel (trap nights)	Baited Infrared Camera (trap nights)	Anabat (nights)	Bird survey (person hours)	Active searches (person hours)	Spot-lighting (person hours)	Water source watch (person hours)	Koala SAT searches
Mature Regrowth / Disturbed Brigalow +/-Eucalyptus spp. Woodland (3b)	Dry Season 2018	60	3	12	15	3	1	8	2	2	-	0
	Wet Season 2019	80	4	16	24	6	2	14	6	14	-	0
	Dry Season 2019	0	0	0	0	7	0	4	4	14	-	0
	Wet Season 2020	80	4	16	24	9	0	3	5	3	2	0
Brigalow Regrowth (<2m) (3c)	Dry Season 2018	0	0	0	0	0	0	0	0	0	-	0
	Wet Season 2019	80	8	32	48	8	0	0	0	18	-	0
	Dry Season 2019	0	0	0	0	0	0	16	16	6	-	0
	Wet Season 2020	0	0	0	0	0	0	5	5	8	-	0
Riparian Blue Gum Open-forest (4)	Dry Season 2018	0	0	0	0	0	0	0	0	0	-	0
	Wet Season 2019	0	0	0	0	4	6	6	4	4	-	2
	Dry Season 2019	0	0	0	0	7	7	4	4	3	-	0
	Wet Season 2020	0	0	0	0	0	1	0	0	2	-	0
Native Grassland (5)	Dry Season 2018	0	0	0	0	0	0	0	0	0	-	0
	Wet Season 2019	0	0	0	0	0	0	2	2	0	-	0
	Dry Season 2019	0	0	0	0	0	0	0	0	2	-	0
	Wet Season 2020	0	0	0	0	0	0	3	3	0	-	0
Pastureland without Gilgai (6a)	Dry Season 2018	0	0	0	0	0	0	0	0	0	-	0
	Wet Season 2019	0	0	0	0	0	0	4	4	2	-	0
	Dry Season 2019	0	0	0	0	0	0	0	0	0	-	0
	Wet Season 2020	0	0	0	0	0	0	3	3	0	0	0

Habitat Type	Survey Timing	Survey Method										
		Elliot (trap nights)	Cage (trap nights)	Pit fall (trap nights)	Funnel (trap nights)	Baited Infrared Camera (trap nights)	Anabat (nights)	Bird survey (person hours)	Active searches (person hours)	Spot-lighting (person hours)	Water source watch (person hours)	Koala SAT searches
Pastureland with Gilgai (6b)	Dry Season 2018	0	0	0	0	0	0	0	0	0	-	0
	Wet Season 2019	0	0	0	0	0	0	0	2	6	-	0
	Dry Season 2019	0	0	0	0	0	0	0	0	0	-	0
	Wet Season 2020	0	0	0	0	0	0	4	4	6	0	0
Farm Dams (7)	Dry Season 2018	0	0	0	0	3	5	6	4	5	-	0
	Wet Season 2019	0	0	0	0	4	6	4	0	0	-	0
	Dry Season 2019	0	0	0	0	0	0	2	2	0	-	0
	Wet Season 2020	0	0	0	0	9	4	0	0	2	4	0
	Total	**820**	**45**	**180**	**261**	**128**	**60**	**189**	**153**	**149**	**12**	**13**

Table 8. Threatened fauna survey guidelines and effort

Species	Conservation status		Prescribed Commonwealth survey methods and effort	Prescribed Queensland survey methods and effort	Survey effort undertaken within the potential habitat within the Study Area
	EPBC Act	NC Act			
yakka skink (*Egernia rugosa*)	Vulnerable	Vulnerable	• [4]Surveys between late September and late March. • [4, 5]Active searches for burrow systems and communal defecation sites. The minimum survey effort required for this method is 1.5 person-hrs per ha over 3 days. • [4, 5]Species presence can be confirmed by trapping around the suspected burrows (1 Elliott trap and 1 cage trap), distant observation with binoculars or by shining a torch down the burrows at night.	• [8]Detectability increases with increased temperatures around mid-September to early October. • [8]Diurnal searches and camera trapping are the most reliable methods of detecting species presence. • [8]The minimum effort required varies per method, however 20 minutes of active searching per ha of potential habitat is recommended for active searches.	• 108 hours of active searches • 740 Elliott traps • 37 cage traps • 104 camera trap nights • 94 hrs of spotlighting
Allan's lerista (*Lerista allanae*)	Endangered	Endangered	• [4]Surveys between late September and late March. • [45]Active searches. The minimum survey effort required for this method is 1.5 person-hrs per ha over 3 days. • [5]Raking surface soil and leaf litter under logs or at the base of bushes or trees and turning objects where they shelter in combination with pitfall trapping at a time of year when the species is most likely to be active. • [5]6x10 L buckets spread along a 15 m fence adequate for detection.	[12]No species-specific guideline is provided, however general reptile survey methods and effort are: • 4 pitfall trapping buckets at 7.5 m intervals in a T-shaped design with 45 m of drift fence over 4 nights. • 6 funnel traps 3 m in on distal ends of T-design with 45 m of fence over 4 nights. • 2 x 30 min diurnal searches within two different 50 x 50 m quadrants of the survey site. • 2 x 30 min nocturnal searches within the survey site.	• 148 pitfall trap nights • 213 funnel trap nights • 108 hours of active searches • 94 hrs of spotlighting

Species	Conservation status		Prescribed Commonwealth survey methods and effort	Prescribed Queensland survey methods and effort	Survey effort undertaken within the potential habitat within the Study Area
	EPBC Act	NC Act			
common death adder (*Acanthophis antarcticus*)	N/A	Vulnerable	No survey guidelines available for this species.	• [9]Surveys should be undertaken in the breeding period (September to March), particularly at night when the species is most likely to be active. • [9]Nocturnal vehicle transects on roads and tracks with limited debris that bisect potential habitat on warm humid nights. • [9]>100 pitfall and funnel trap nights per ha of potential habitat.	• 148 pitfall trap nights • 213 funnel trap nights • 108 hours of active searches • 94 hrs of spotlighting
ornamental snake (*Denisonia maculata*)	Vulnerable	Vulnerable	• [4]Surveys between late September and late March. • [4]Diurnal searches. The minimum survey effort required for this method is 1.5 person-hrs per ha over 3 days. • [4]1.5 hrs of spotlighting per ha of potential habitat. • [4]Opportunistic road surveys. • [4]2 pitfall /funnel trap lines within each habitat.	[12]No species-specific guideline is provided, however general reptile survey methods and effort are: • 4 pitfall trapping buckets at 7.5 m intervals in a T-shaped design with 45 m of drift fence over 4 nights. • 6 funnel traps 3 m in on distal ends of T-design with 45 m of fence over 4 nights. • 2 x 30 person-min diurnal searches within two different 50 x 50 m quadrants of the survey site. • 2 x 30 person-min nocturnal searches within the survey site.	• 115 hrs of spotlighting • 75 hours of active searches • 120 pitfall trap nights • 174 funnel trap nights

Species	Conservation status		Prescribed Commonwealth survey methods and effort	Prescribed Queensland survey methods and effort	Survey effort undertaken within the potential habitat within the Study Area
	EPBC Act	NC Act			
Dunmall's snake (*Furina dunmalli*)	Vulnerable	Vulnerable	• [4]Surveys between late September and late March. • Diurnal searches. The minimum survey effort required for this method is 1.5 person-hrs per ha over 3 days. • [5]None known to reliably detect the species, however active searching of sheltering sites (rocks, logs or human-made debris), pitfall trapping or road driving at night (particularly after wet weather) are recommended.	[12]No species-specific guideline is provided, however general reptile survey methods and effort are: • 4 pitfall trapping buckets at 7.5 m intervals in a T-shaped design with 45 m of drift fence over 4 nights. • 6 funnel traps 3 m in on distal ends of T-design with 45 m of fence over 4 nights. • 2 x 30 person-min diurnal searches within two different 50 x 50 m quadrants of the survey site. • 2 x 30 person-min nocturnal searches within the survey site.	• 148 pitfall trap nights • 213 funnel trap nights • 108 hours of active searches • 94 hrs of spotlighting
red goshawk (*Erythrotriorchis radiatus*)	Vulnerable	Endangered	• [1]Search for characteristic nests within patches of the tallest forest. • [1]Driving slowly through woodland tracks and scanning groups of tall trees for nests. • [1]The minimum effort required for area searches is 50 hrs over 8 days for 50 ha.	• [12]No species-specific guideline is provided, however general diurnal bird survey methods and effort are: • 6 x 5 – 10 min area searches within a 100 x 100 m survey site.	• 189 hrs of diurnal bird surveys (total combined effort in all fauna habitat types) • Incidental detection of the species while conducting other surveys or moving across the overall survey site
Australian painted snipe (*Rostratula australis*)	Endangered	Endangered	• [1]Targeted stationary observations at wetlands of 10 hrs over 5 days; or • Land-based area searches or line transects at wetlands of 10 hrs over 3 days for areas less than 50 ha.	• [12]No species-specific guideline is provided, however general diurnal bird survey methods and effort are: • 6 x 5 – 10 min area searches within a 100 x 100 m survey site. • Incidental detection of the species while conducting other surveys or moving across the overall survey site.	• 189 hrs of diurnal bird surveys (total combined effort in all fauna habitat types) • 12 hrs of wetland / waterbody watches • Incidental detection of the species while conducting other surveys or moving across the overall survey site

Species	Conservation status		Prescribed Commonwealth survey methods and effort	Prescribed Queensland survey methods and effort	Survey effort undertaken within the potential habitat within the Study Area
	EPBC Act	NC Act			
curlew sandpiper (*Calidris ferruginea*)	Critically Endangered	Critically Endangered	• No survey guidelines available for this species. • [2]Surveys between September and March in wetlands.	[12]No species-specific guideline is provided, however general diurnal bird survey methods and effort are: • 6 x 5 – 10 min area searches within a 100 x 100 m survey site. • Incidental detection of the species while conducting other surveys or moving across the overall survey site.	• 189 hrs of diurnal bird surveys (total combined effort in all fauna habitat types) • 12 hrs of wetland / waterbody watches • Incidental detection of the species while conducting other surveys or moving across the overall survey site
squatter pigeon (southern subspecies) (*Geophaps scripta scripta*)	Vulnerable	Vulnerable	• [1]Diurnal bird surveys (area or transect) of 15 hrs over 3 days for areas less than 50 ha. • [2]Drive surveys of all unsealed roads early morning and late afternoon.	• [12]No species-specific guideline is provided, however general diurnal bird survey methods and effort are: • 6 x 5 – 10 min area searches within a 100 x 100 m survey site. • Incidental detection of the species while conducting other surveys or moving across the overall survey site.	• 189 hrs of diurnal bird surveys (total combined effort in all fauna habitat types) • Incidental detection of the species while conducting other surveys or moving across the overall survey site
painted honeyeater (*Grantiella picta*)	Vulnerable	Vulnerable	There are no survey guidelines available for this species.	• [10]Area searches during breeding season involving searches for nesting habitat and listening for calls. • [10]Surveys should be conducted on foot and target foraging habitat (i.e. mistletoes) and breeding habitat. • [10]The minimum effort required for this method is 4 hrs over 4 days.	• 189 hrs of diurnal bird surveys (total combined effort in all fauna habitat types) • Incidental detection of the species while conducting other surveys or moving across the overall survey site

Species	Conservation status		Prescribed Commonwealth survey methods and effort	Prescribed Queensland survey methods and effort	Survey effort undertaken within the potential habitat within the Study Area
	EPBC Act	NC Act			
star finch (eastern subspecies) (*Neochmia ruficauda ruficauda*)	Endangered	Endangered	• [1]Area searches or transect-point surveys in suitable habitat. • [1]Playback surveys during the morning and evening. • [1]Targeted searches and subsequent watches of waterholes during the dry season. • [1]The minimum effort required for these methods is 15 hrs over 5 days in areas of less than 50 ha for area searches; 15 hrs over 3 days in areas of less than 50 ha for call playbacks; and 10 hrs over 4 days for targeted surveys at waterholes.	[12]No species-specific guideline is provided, however general diurnal bird survey methods and effort are: • 6 x 5 – 10 min area searches within a 100 x 100 m survey site. • Incidental detection of the species while conducting other surveys or moving across the overall survey site.	• 189 hrs of diurnal bird surveys (total combined effort in all fauna habitat types) • Incidental detection of the species while conducting other surveys or moving across the overall survey site
northern quoll (*Dasyurus hallucatus*)	Endangered	-	[6]In areas up to 5 ha in size: • Cage trapping and Elliott trapping surveys are recommended. • The minimum effort required for these methods is 3 trap nights. • Trapping should be concentrated in rocky denning habitat, with some consideration of non-rocky foraging and dispersal habitats.	[12]No species-specific guideline is provided, however general terrestrial mammal survey methods and effort are: • 2 x 30 min spotlight searches within a 100 x 100 m survey site. • Camera trapping with one camera per site for minimum of 4 nights. • Hair tubes spaced 5 – 10 m apart in a linear or grid arrangement for a minimum of 4 nights, but preferably at least 2 weeks. • Scat and sign search and incidental detection can coincide with the active searches.	• 45 cage trap nights (total combined effort in all fauna habitat types) • 114 hrs of spotlighting (total combined effort in all fauna habitat types) • 153 hours of active searches (total combined effort in all fauna habitat types) • 128 camera trap nights (total combined effort in all fauna habitat types) • Incidental detection of the species while conducting other surveys or moving across the overall survey site

Species	Conservation status		Prescribed Commonwealth survey methods and effort	Prescribed Queensland survey methods and effort	Survey effort undertaken within the potential habitat within the Study Area
	EPBC Act	NC Act			
koala (*Phascolarctos cinereus*)	Vulnerable	Vulnerable	[3]Survey effort is not prescribed but several direct and indirect survey methods are prescribed including: • Nocturnal spotlighting; and • SAT surveys.	[12]No species-specific guideline is provided, however general terrestrial mammal survey methods and effort are: • 2 x 30 min active nocturnal and/or spotlight searches within a 100 x 100 m survey site. • 2 sessions of call playback at midpoint of survey site. • Scat and sign search and incidental detection can coincide with the active searches.	• 61 hrs of spotlighting • 13 SAT surveys
greater glider (*Petauroides volans*)	Vulnerable	Vulnerable	[6]No species-specific survey guidelines, however vehicle spotlighting and spotlighting transects may be used to detect gliders.	• [12]No species-specific guideline is provided, however general arboreal mammal survey methods and effort are: • 2 x 30 min spotlight searches within a 100 x 100 m survey site. • Scat and sign search and incidental detection can coincide with the active searches.	• 61 hrs of spotlighting
ghost bat (*Macroderma gigas*)	Vulnerable	Endangered	[7]No species-specific survey guidelines; recommended survey techniques for megabat species include mist nets, traps and visual surveys of roosting locations.	• [11]Active monitoring involving spotlighting, hand-held bat detectors and acoustic detection (due to their low-intensity calls, the bat must be <5 – 7 m from the microphone). • [11]Transects should be distributed to adequately represent the major habitat types within the Study Area. • [11]Harp traps, mist nets and roost searches are also recommended.	• 101 hrs of spotlighting • 60 nights of echolocation surveys with Anabat detectors (total combined effort in all fauna habitat types)

Species	Conservation status		Prescribed Commonwealth survey methods and effort	Prescribed Queensland survey methods and effort	Survey effort undertaken within the potential habitat within the Study Area
	EPBC Act	NC Act			
				• [11]The minimum effort required for these methods is 8 detector hrs/4 nights for active monitoring; 8 trap nights / 4 nights for harp traps; 8 mist net hrs/4 nights for mist nets; 2 hrs of roost searching per survey day.	
Corben's long-eared bat (*Nyctophilus corbeni*)	Vulnerable	Vulnerable	• [7]Surveys between October and April • [7]Harp traps and mist nets are effective for this species. • [7]Traps and nets should be distributed to represent major habitat types • [7]The minimum effort required for harp traps and mist nets, respectively, is 5 nights / 20 traps and 5 nights / 20 mist nets	• [12]No species-specific guideline is provided, however harp trapping is recommended to determine the presence of bat species whose calls cannot be separated or identified using bat detectors. • The minimum effort required for this method is 2 trap nights per sampling site	• 60 nights of echolocation surveys with Anabat detectors (total combined effort in all fauna habitat types)

1 *Survey Guidelines for Australia's Threatened Birds* (DEWHA, 2010b).
2 *Species Profile and Threats Database* (DAWE, 2020b).
3 *EPBC Act Referral Guidelines for the Vulnerable Koala* (DotE, 2014c).
4 *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (DSEWPaC, 2011a).
5 *Survey Guidelines for Australia's Threatened Reptiles* (DSEWPaC, 2011c).
6 *Survey Guidelines for Australia's Threatened Mammals* (DSEWPaC, 2011b).
7 *Survey Guidelines for Australia's Threatened Bats* (DEWHA, 2010a).
8 *Targeted Species Survey Guidelines – Yakka Skink (Egernia rugosa)* (Ferguson & Mathieson, 2014).
9 *Targeted Species Survey Guidelines - Common Death Adder (Acanthophis antarcticus)* (Rowland & Ferguson, 2012).
10 *Targeted Species Survey Guidelines - Painted Honeyeater (Grantiella picta)* (Rowland, 2012).
11 *Targeted Species Survey Guidelines - Ghost Bat (Macroderma gigas)* (Hourigan, 2011).
12 *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (DES, 2018f).

4 Flora Results

4.1 Flora diversity

E2M recorded 293 species of flora species systematically and opportunistically during field surveys, including:

- 257 native species; and
- 36 introduced species.

A detailed list of species recorded is provided in Appendix C.

4.2 General vegetation description

A general description of the vegetation is provided below. REs are discussed in Section 4.3.

4.2.1 Modified / disturbed non-remnant and young regrowth

The majority of the Study Area consists of improved/disturbed pasture dominated by non-native grasses and *Acacia harpophylla* regrowth shrublands (Plate 1). These areas have been subject to historical clearing (e.g. blade ploughing), livestock impacts, pasture improvement and weed encroachment. These areas are dominated by exotic pasture species or areas of canopy dieback. While some areas contain scattered paddock trees, they are not characteristic of a particular RE or exhibit suitable cover and structure. These communities varied in composition with the ground layer dominated by pasture species including *Cenchrus ciliaris**, *Bothriochloa pertusa**, *Melinis repens** and *Megathyrsus maximus**.

Regrowth shrublands (<4 m in height and 10 to 20% cover) dominated by *Acacia harpophylla* were observed throughout undulating clay plains within the central and southern extent of the Study Area. Other associated shrub species include *Atalaya hemiglauca*, *Lysiphyllum carronii* and *Citrus glauca*.

Plate 1: Modified/disturbed non-remnant and young regrowth

4.2.2 Eucalypt dominated woodlands to open woodlands on sandplains or depositional plains

Eucalypt dominated woodlands to open woodlands on sandplains or depositional plains were observed in association with alluvial and undulating rises within the northern, eastern and western extents of the Study Area as well as rises and undulating plains over fine-grained sedimentary rock within the central and western extents (Plate 2).

The community consists of a tree canopy (15-21 m in height and 10-20% cover) dominated by *E. populneus*, *E. melanophloia* and/or *E. orgadophila* with occasional *Corymbia dallachiana* and *C. erythrophloia* on rises. A subcanopy was sometimes present, particularly within REs 11.3.2 and 11.5.3, comprising younger *Eucalyptus* spp., *Lysiphyllum carronii*, *Acacia salicina* and *Alphitonia excelsa*. A very sparse shrub layer containing *Cassia brewsteri*, *Acacia excelsa*, *Grevillea striata*, *Eremophila mitchellii* and *Archidendropsis basaltica* was also observed. The ground layer typically comprises a combination of native and exotic pasture grasses, including *Cenchrus ciliaris**, *Heteropogon contortus*, *Chrysopogon fallax*, *Melinis repens** and associated forbs such as *Chrysocephalum apiculatum*, *Melhania oblongifolia*, *Sida* spp. and *Rhynchosia minima**.

This community was also subject to cattle grazing, pasture improvement and weed encroachment. One patch of this community was also found to comprise Poplar Box TEC under the EPBC Act, located within the northern extent of the Study Area (refer to Section 3.2.2.2).

Plate 2: Eucalypt dominated woodlands to open woodlands on sandplains or depositional plains

4.2.3 Acacia harpophylla (brigalow) open forests to woodlands on heavy clay soils

This vegetation type was recorded in association with alluvial, undulating clay plains and sedimentary rock throughout its extent in the Study Area (Plate 3).

The community is typically dominated by *Acacia harpophylla* and occasionally co-dominant with *Eucalyptus cambageana,* ranging from 10-17 m and 11-20% cover. Other associated canopy species include *E. coolabah*, *E. populnea* and *Owenia acidula*. A subcanopy of younger *A. harpophylla* and associated *Lysiphyllum carronii*, *Atalaya hemiglauca* and *Terminalia oblongata* is usually present. A sparse to moderate shrub layer containing *Carissa ovata*, *Geijera parviflora, Alectryon diversifolia, Citrus glauca* and juvenile canopy species is also present. The ground layer is dominated by *Cenchrus ciliaris** with *Bothriochloa pertusa**, *Chloris divaricata*, *Paspalidium caespitosum*, *Portulaca oleracea**, *Brunoniella australis* and *Enchylaena tomentosa*. Infestations of *Parthenium hysterophorus**, *Harrisia martinii** and *Opuntia* spp. was also observed within these communities throughout the Study Area.

This community is subject to cattle grazing, pasture improvement and weed encroachment. Mature regrowth vegetation also exhibited evidence of historical clearing (i.e. bade ploughing). Two small areas of this community were found to meet the condition criteria for Brigalow TEC under the EPBC Act; however both areas are situated outside of the Project area (refer to Section 3.2.2.2).

Plate 3: Acacia harpophylla (brigalow) open forests to woodlands on heavy clay soils

4.2.4 Native tussock grasslands

Native tussock grassland communities are located on gently undulating cracking-clay plains and loamy-clay plains over underlying fine-grained sedimentary rock (Plate 4).

The community is dominated by native grasses including *Dichanthium sericeum*, *Panicum decompositum*, *Sehima nervosum*, *Aristida latifolia*, *Astrebla squarrosa* and *Heteropogon contortus*. Small occurrences of exotic pasture grasses are commonly present throughout and include *Cenchrus ciliaris**, *Dichanthium aristatum** and *Bothriochloa pertusa**. Native forb species frequently recorded include *Neptunia gracilis*, *Calotis* spp., *Hibiscus verdcourtii*, *Pimelea haematostachya*, *Polymeria longifolia* and *Glycine* spp. Scattered emergent trees are sometimes present comprising *E. orgadophila* and *Corymbia dallachiana*. A very sparse shrub layer (0 to 5% cover) comprising *Atalaya hemiglauca*, *Vachellia farnesiana** and *Cassia brewsteri* was also sometimes recorded.

These communities exhibit varying levels of intrusion by exotic pastures species from adjacent disturbed areas, as well as environmental weeds (i.e. *Parthenium hysterophorus**). Several areas within this community were found to contain Native Grassland TEC under the EPBC Act.

Plate 4: Native tussock grasslands

4.2.5 Eucalypt dominated open forest and woodlands on drainage lines and alluvial plains

This vegetation community was located along watercourses within the Study Area including unnamed tributaries of the Isaac River within the northern extent, sections of Ripstone Creek, an unnamed watercourse in the southern extent and associated floodplains (Plate 5).

The community is characterised by a tree canopy (14-23 m in height and 16-25% cover) dominated by *Eucalyptus* species including *E. tereticornis*, *E. camaldulensis* and/or *E. coolabah* with *A. salicina* occasionally occurring. Other canopy species include *Acacia harpophylla* and *Corymbia clarksoniana*. A subcanopy comprising younger *Eucalyptus* spp., *Lysiphyllum hookeri*, *Terminalia oblongata* and/or *Melaleuca fluviatilis* is usually present. A sparse shrub layer containing juvenile canopy and subcanopy species as well as *Petalostigma pubescens* and *Cassia brewsteri* was also observed. The ground layer was typically dominated by exotic grasses, such as *Cenchrus ciliaris**, *Megathyrsus maximus** and *Melinis repens**, with associated native species including *Bothriochloa bladhii*, *Cyperus* spp. and *Leptochloa digitata*. Within RE 11.3.3c, the ground layer was dominated by *Eleocharis pallens*.

This community was subject to cattle grazing, pasture improvement (*C. ciliaris** and *Bothriochloa pertusa**) and weed encroachment (*Parthenium hysterophorus** and *Stylosanthes scabra**).

Plate 5: Eucalypt dominated open forests and woodlands on drainage lines and alluvial plains

4.2.6 Dry eucalypt woodlands to open woodlands on sandplains or depositional plains

The dry eucalypt woodland community was recorded on minor hillcrests within the south-eastern extent of the Study Area (Plate 6).

This open woodland community is characterised by a tree canopy (10-15 m in height and 6-15% cover) dominated by *E. crebra* with association *Corymbia clarksoniana*. A subcanopy is usually absent. A very sparse shrub layer containing *Cassia brewsteri*, *Psydrax spp*. and *Capparis lasiantha* is present. The groundlayer comprised and combination of native and exotic pasture grasses, including *Cenchrus ciliaris**, *Chrysopogon fallax*, *Bothriochloa pertusa**, *Aristida spp*. and forbs such as *Portulaca oleracea**, *Brunoniella australis* and *Rhynchosia minima**.

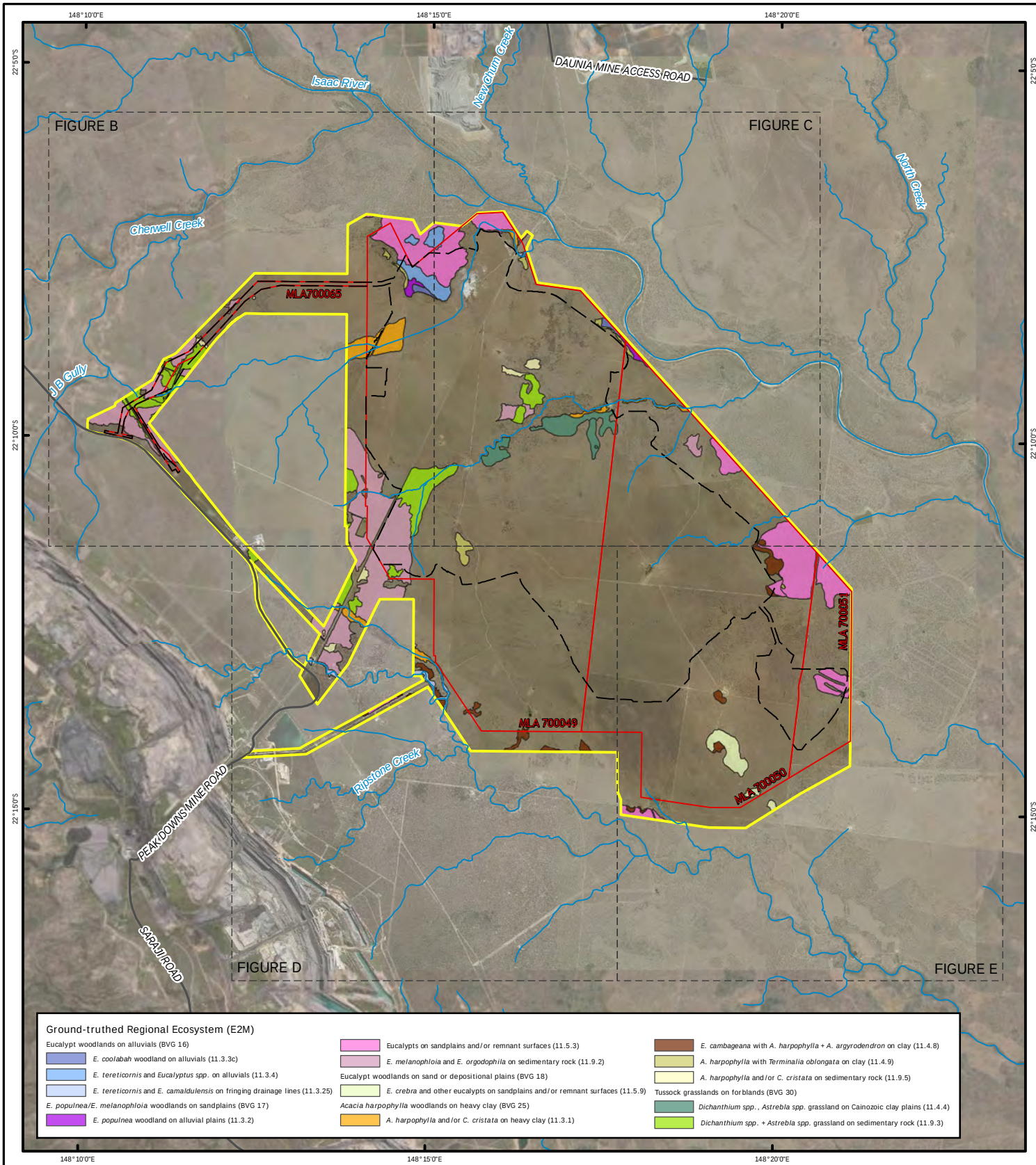
This community was also subject to cattle grazing, pasture improvement and weed encroachment.

Plate 6: Dry eucalypt woodlands to open woodlands on sandplains or depositional plains

4.3 Regional ecosystems

A total of approximately 2,116.2 ha of remnant REs was ground-truthed within the Study Area. A summary of REs, associated vegetation condition class and area is provided in Table 9 and depicted in Figure 7A-E.

Endangered (VM class) communities are predominantly associated with undulating clay plains (land zone 4) and alluvial channels (land zone 3) within the central and southern extents of the Study Area. Of concern (VM class) REs comprise approximately 105.2 ha within the Study Area, predominately associated with alluvial flats and fringing watercourses (land zone 3) within the northern and southern extents.



Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Figure Extent
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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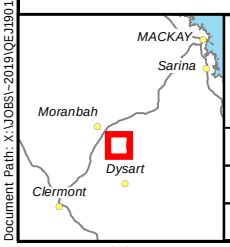

Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019
GTRE: © E2M 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/11/2020

FIGURE 7A: REMNANT REGIONAL ECOSYSTEMS BASED ON FIELD VERIFICATION OVERVIEW

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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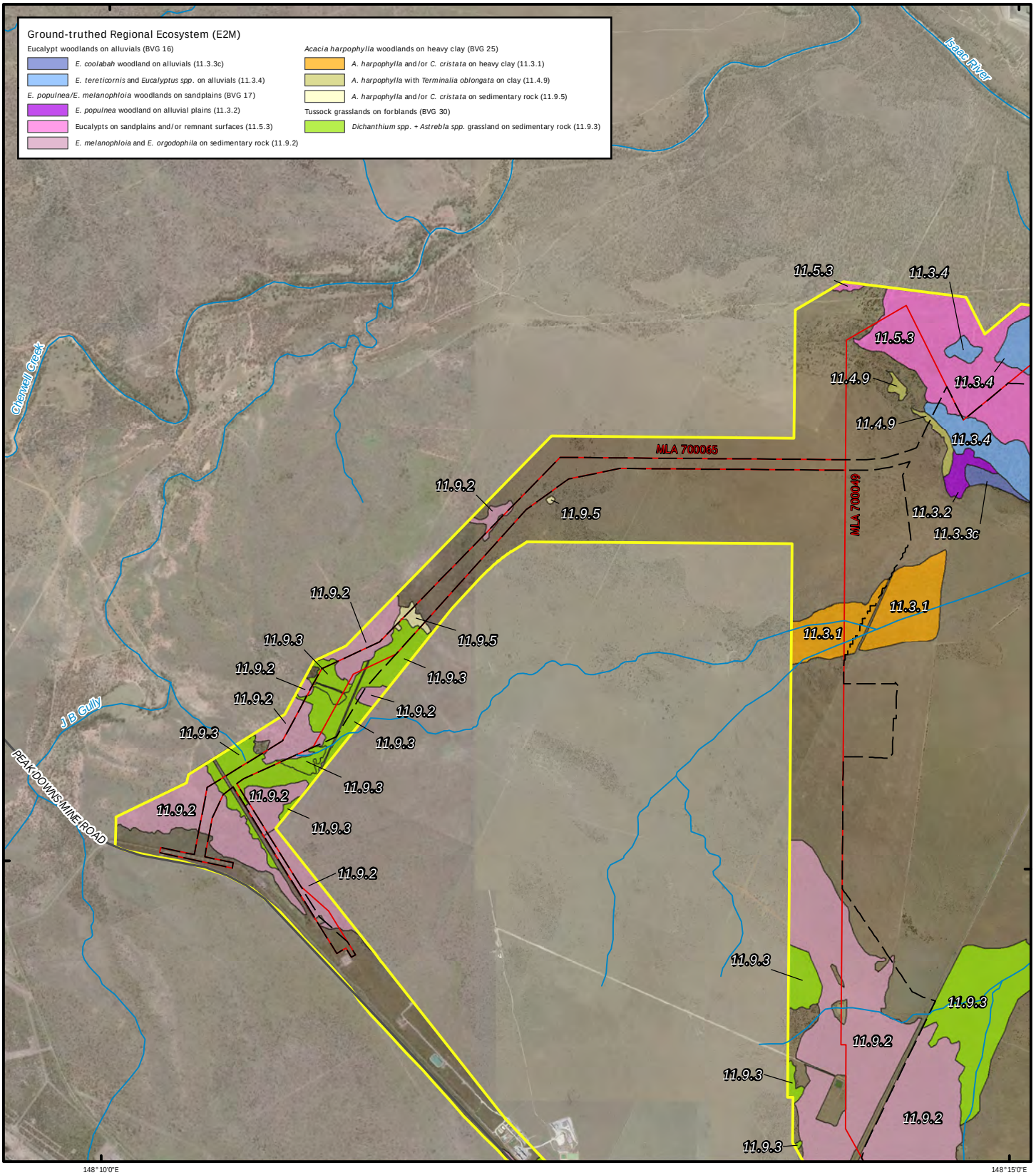

Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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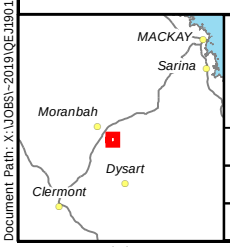

Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019
GTRE: © E2M 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/11/2020

FIGURE 7B: REMNANT REGIONAL ECOSYSTEMS BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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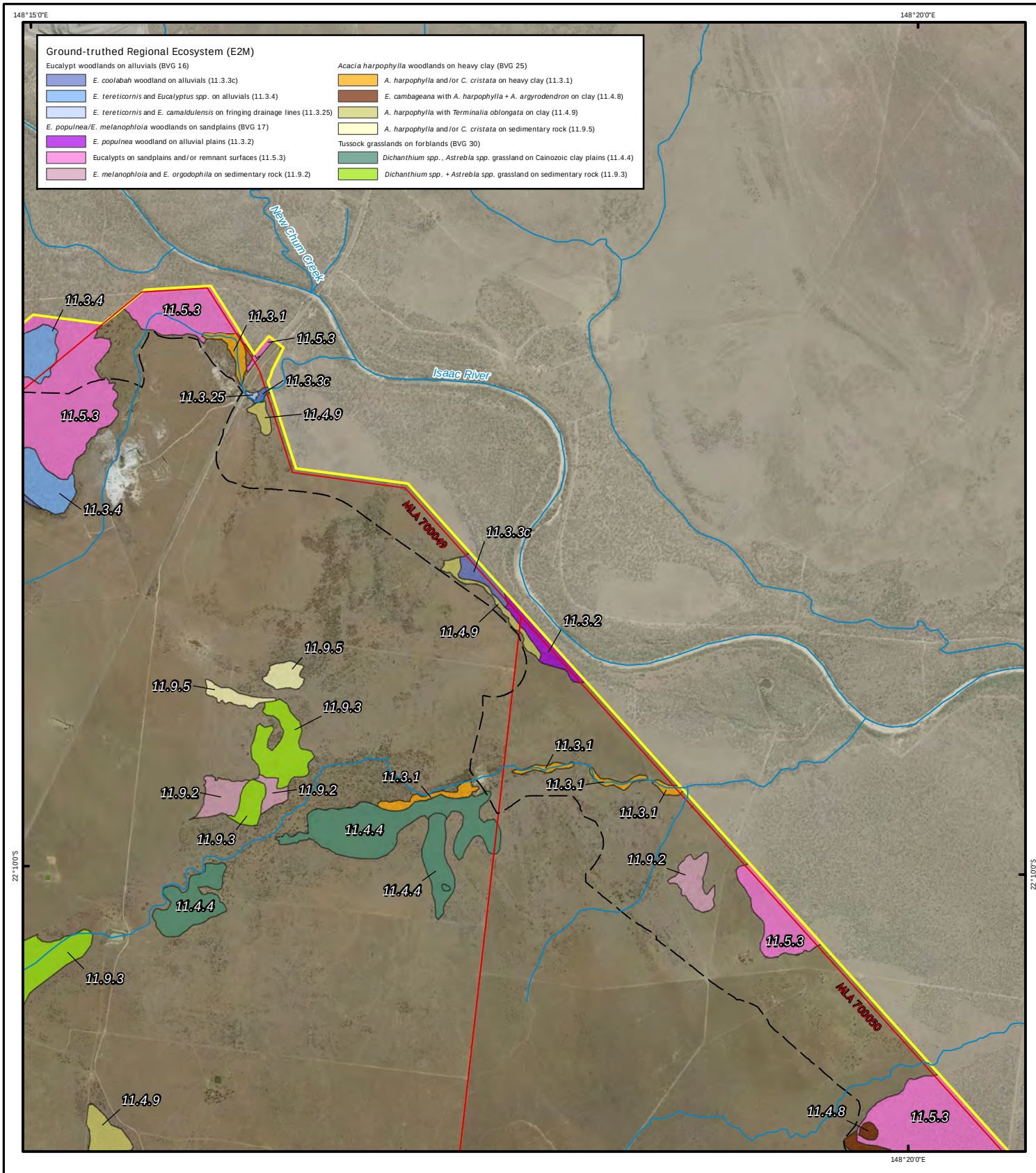

Legend

- Watercourse and Drainage Feature
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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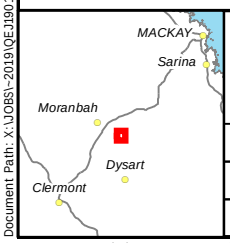

Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019
GTRE: © E2M 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/11/2020

FIGURE 7C: REMNANT REGIONAL ECOSYSTEMS BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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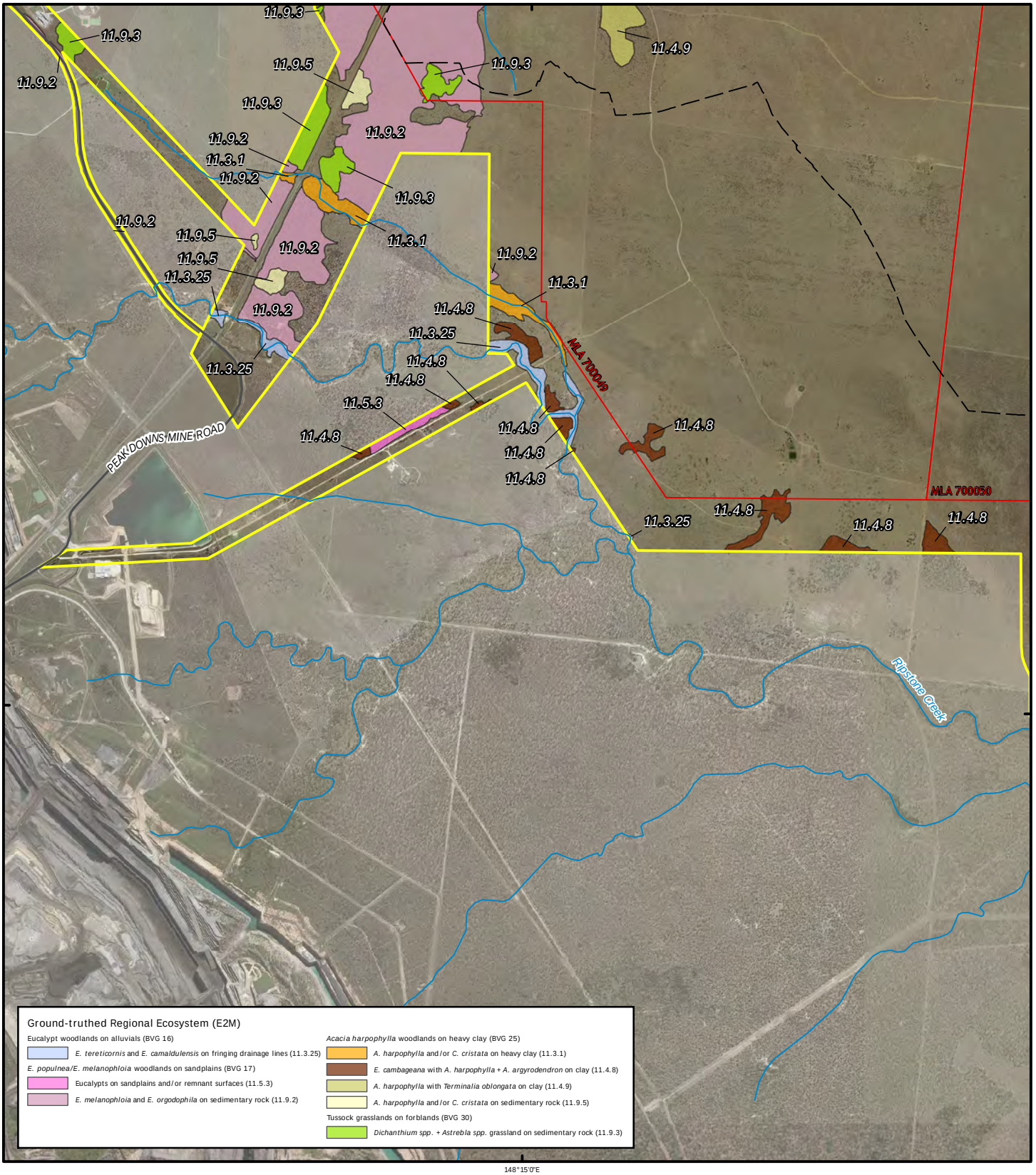

Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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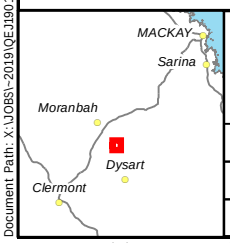

Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019
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Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/11/2020

FIGURE 7D: REMNANT REGIONAL ECOSYSTEMS BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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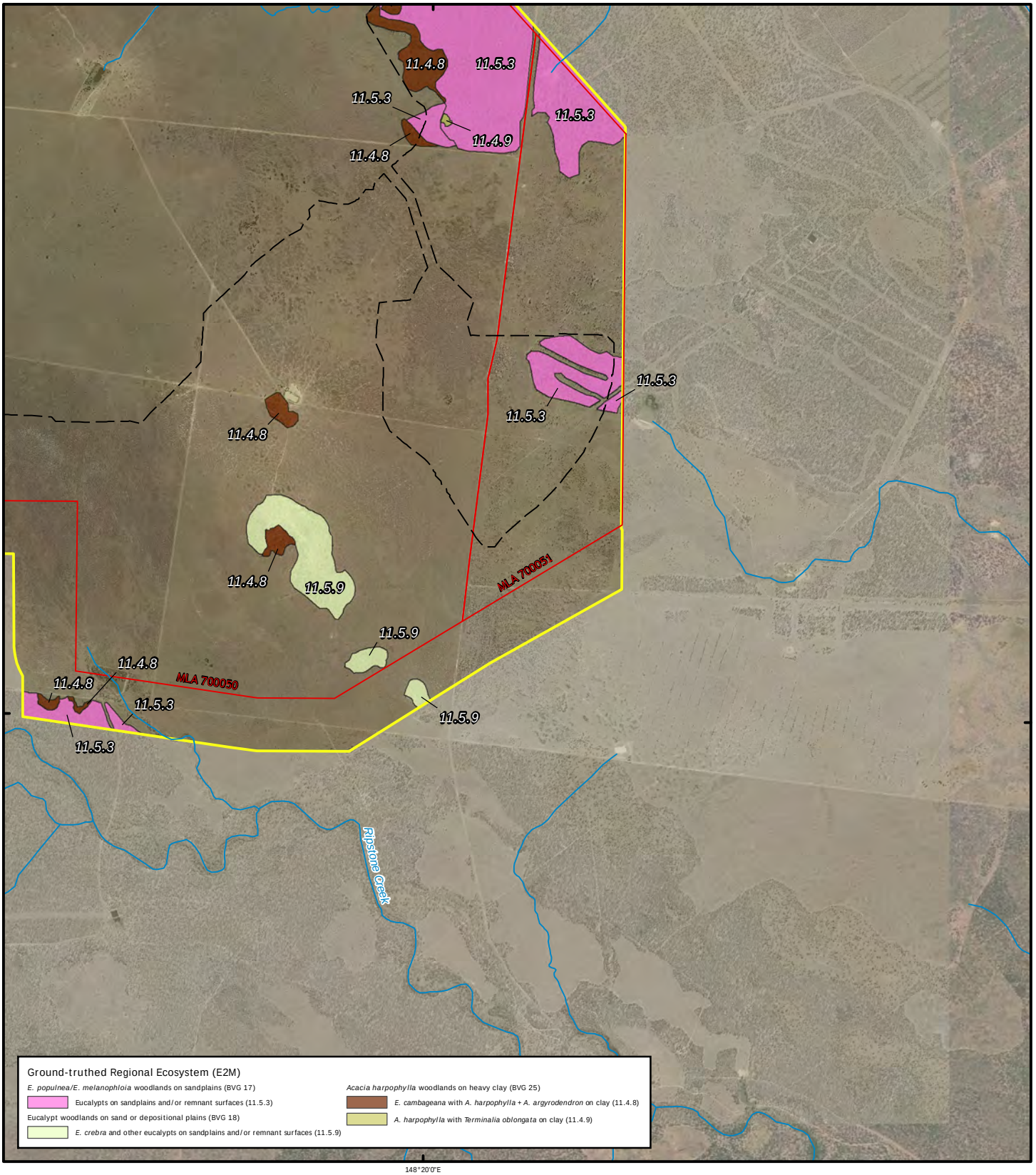

Legend

- Watercourse and Drainage Feature
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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Kilometres

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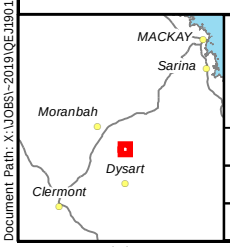

Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
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Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/11/2020

FIGURE 7E: REMNANT REGIONAL ECOSYSTEMS BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
5 of 5	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_7_GTRE.mxd

Table 9. Summary of ground-truthed regional ecosystems within the Study Area

RE	RE Description	Ground-truthed area (ha)
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	127.5
11.3.2 [A]	*Eucalyptus populnea* woodland on alluvial plains	22.2
11.3.3c	*Eucalyptus coolabah* woodland to open woodland (to scattered trees) with a sedge or grass understorey*	16.1
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains	66.9
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	23.3
11.4.4 [B]	*Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains	112.1
11.4.8 [C]	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	82.1
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	39.4
11.5.3	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	570.4
11.5.9	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces	64.8
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland on fine-grained sedimentary rocks	679.1
11.9.3 [D]	*Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks	281.1
11.9.5 [E]	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks	31.2

[A] 9.6 ha of RE 11.3.2 is also listed as Poplar Box TEC.
[B] 45.7 ha of RE 11.4.4 is also listed as Natural Grasslands TEC.
[C] 24.1 ha of RE 11.4.8 is also listed as Brigalow TEC.
[D] 58.4 ha of RE 11.9.3 is also listed as Natural Grasslands TEC.
[E] 4.8 ha of RE 11.9.5 is also listed as Brigalow TEC.

The extent of remnant vegetation throughout the Study Area is largely consistent with DNRME Vegetation Management mapping (DNRME, 2020b). Inconsistencies between the DNRME mapped and ground-truthed extents within the Study Area include:

- Areas of DNRME (2020b) mapped non-remnant vegetation, such as those within the southern extent of the Study Area, were found to have structure and cover consistent with remnant vegetation.
- Areas of DNMRE (2020b) mapped remnant vegetation containing RE 11.4.4 / 11.4.2 within the southern extent and RE 11.9.2 / 11.9.5 in the north-west extent of the Study Area were found to contain non-remnant vegetation following evidence of extensive dieback within the canopy.
- Remnant vegetation mapped by DNRME (2020b) containing land zone 9 within the central extent of the site (RE 11.9.2 / 11.9.5 was ground-truthed as consistent with land zone 4 (RE11.4.4). As described by Wilson & Taylor (2012), geological mapping within the Brigalow Belt does not always represent the true extent of clay plains. Extensive areas of Tertiary clay plains in the Brigalow Belt are shown as undifferentiated Cainozoic with unconsolidated sediments (i.e. Cz, Cza and Czs) (Wilson & Taylor, 2012). These areas can contain alluvials (Land zone 3), clay plains (Land zone 4) and sand plains (land zone 5) (Wilson & Taylor, 2012).
- Many areas of DNRME (2020b) mapped brigalow RE 11.4.9 were found to be consistent with RE 11.4.8, with associated *Eucalyptus cambageana* throughout.

- Small areas of native grassland were found to be dominated by non-native, introduced pasture species, particularly *Bothriochloa pertusa** (Indian bluegrass), *Parthenium hysterophorus** (parthenium) *Cenchrus ciliaris** (buffel grass) and *Dichanthium aristatum** (Angleton grass), not consistent with a remnant grassland RE. Similarly, the extent of some native grassland areas was found to be larger than those mapped by DNRME, such as those within the central extent.
- Areas of DNRME (2020b) mapped RE 11.5.9c within the northern extent of the Study Area were found to contain RE 11.3.4, occurring on a relictual alluvial ridge associated with the Isaac River and its tributaries.
- Review of geology mapping (Sheet SF55; 1:250,000) (GeoScience Australia, 2020a) did not identify any areas with underlying Cainozoic igneous rock (i.e. land zone 8 - basalt) within the Study Area. These areas were found to contain geology units (Pwb) consistent with fine-grained sedimentary rock (land zone 9). Consequently, areas mapped as containing REs 11.8.5, 11.8.11 and 11.8.13 were ground-truthed as REs 11.9.2, 11.9.3 and disturbed 11.9.5.
- DNMRE (2020b) heterogenous polygons were not found to contain all of the REs mapped.

4.4 Threatened ecological communities

The Commonwealth Protected Matters Report issued by the DAWE list three TECs known or likely to occur within the Study Area (DAWE, 2020a):

- Brigalow TEC
- Natural Grasslands TEC; and
- Poplar Box TEC.

An additional ecological community, Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions, was also identified as potentially occurring within the Study Area as part of the Initial Advice Statement for the Project (Whitehaven Coal Limited, 2019). Table 10 summarises the TECs identified in the Study Area.

Table 10. Summary of TECs recorded within the Study Area

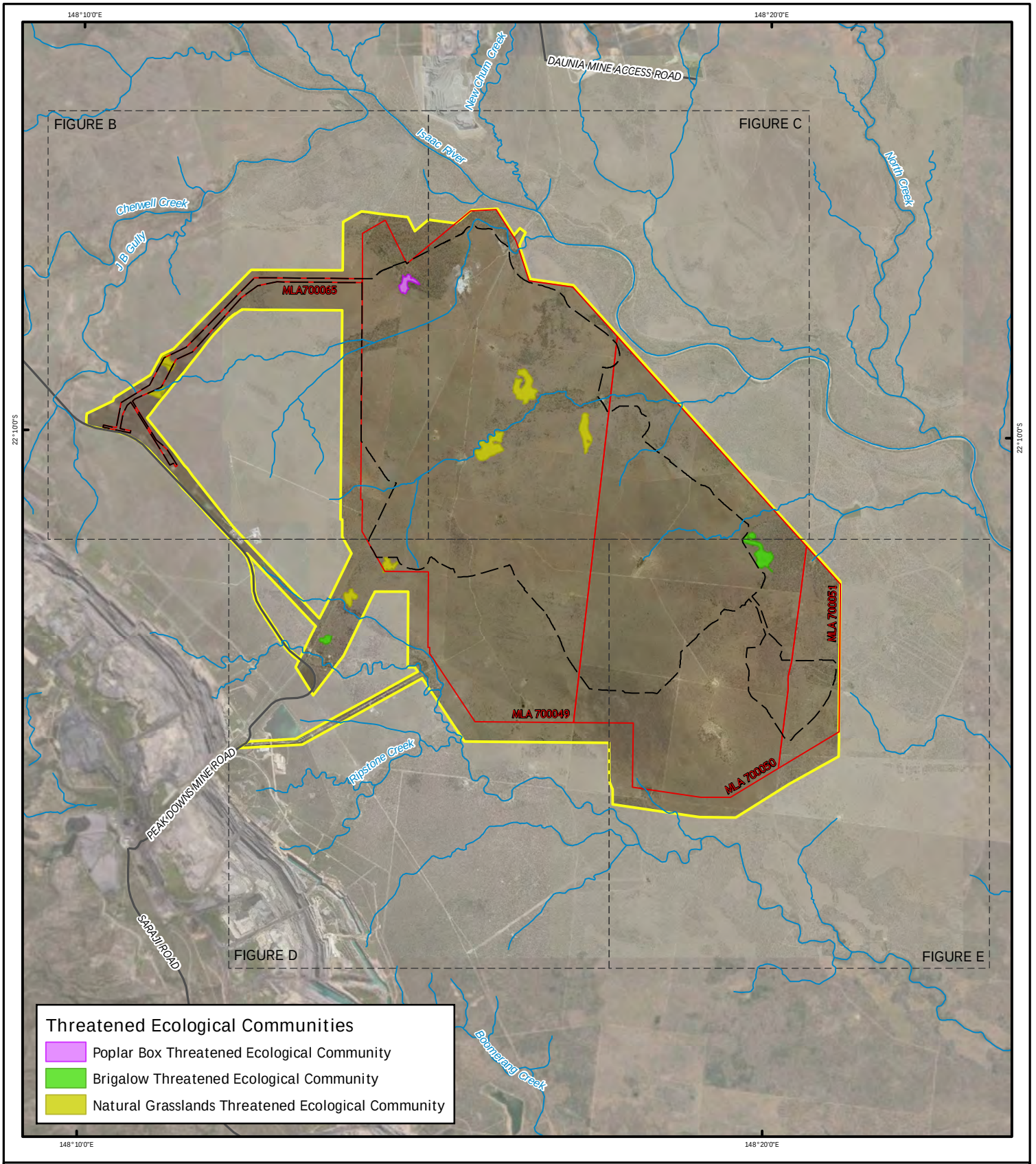
TEC	EPBC Act status	Presence within Study Area
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	**Confirmed Present** Approximately 24.1 ha of RE 11.4.8 and 4.8 ha of RE 11.9.5 met the Brigalow TEC condition criteria. Situated outside of the Project area.
Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	Endangered	**Confirmed Present** A total of 104.1 ha of 'good quality' Natural Grasslands TEC was recorded within the Study Area in association with mapped areas of REs 11.4.4 and 11.9.3.
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	**Confirmed Present** Approximately 9.6 ha of 'Class B' Poplar Box TEC was identified within the Study Area, represented by RE 11.3.2.
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	**Not present**

4.4.1 Brigalow (Acacia harpophylla dominant and co-dominant) TEC

Brigalow ecological communities within the Brigalow Belt Bioregion are comprised of twelve REs, of which all are brigalow dominant or co-dominant. To qualify as the Brigalow TEC, an occurrence of brigalow must meet minimum threshold conditions pertaining to patch size and weed encroachment. Several patches of brigalow-dominated REs were recorded during the field assessment located throughout the Study Area (RE 11.3.1, 11.4.8, 11.4.9 and 11.9.5) (Plate 7), however, the majority of brigalow-dominated REs surveyed did not meet the condition thresholds for the Brigalow TEC due to areas containing regrowth (<15 years old) and the cover of exotic perennial species (≥50%), particularly buffel grass (*C. ciliaris**), Indian bluegrass (*Bothriochloa pertusa)** and parthenium (*Parthenium hysterophorus**).

Brigalow TEC, totalling approximately 28.9 ha, were identified within the Study Area, but outside of the Project area (Figure 8A-E). The Brigalow TEC is represented by REs 11.4.8 and 11.9.5.

Plate 7. Brigalow TEC within the Study Area



Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- Figure Extent

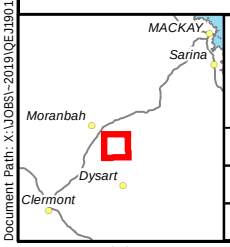
N

Scale 1:130,000 (A4)

0 1.5 3 4.5 6

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: © Geoscience Australia 2018
Road: © PSMA 2014
Cadastre: © DNRME 2019
TEC: © E2M 2019

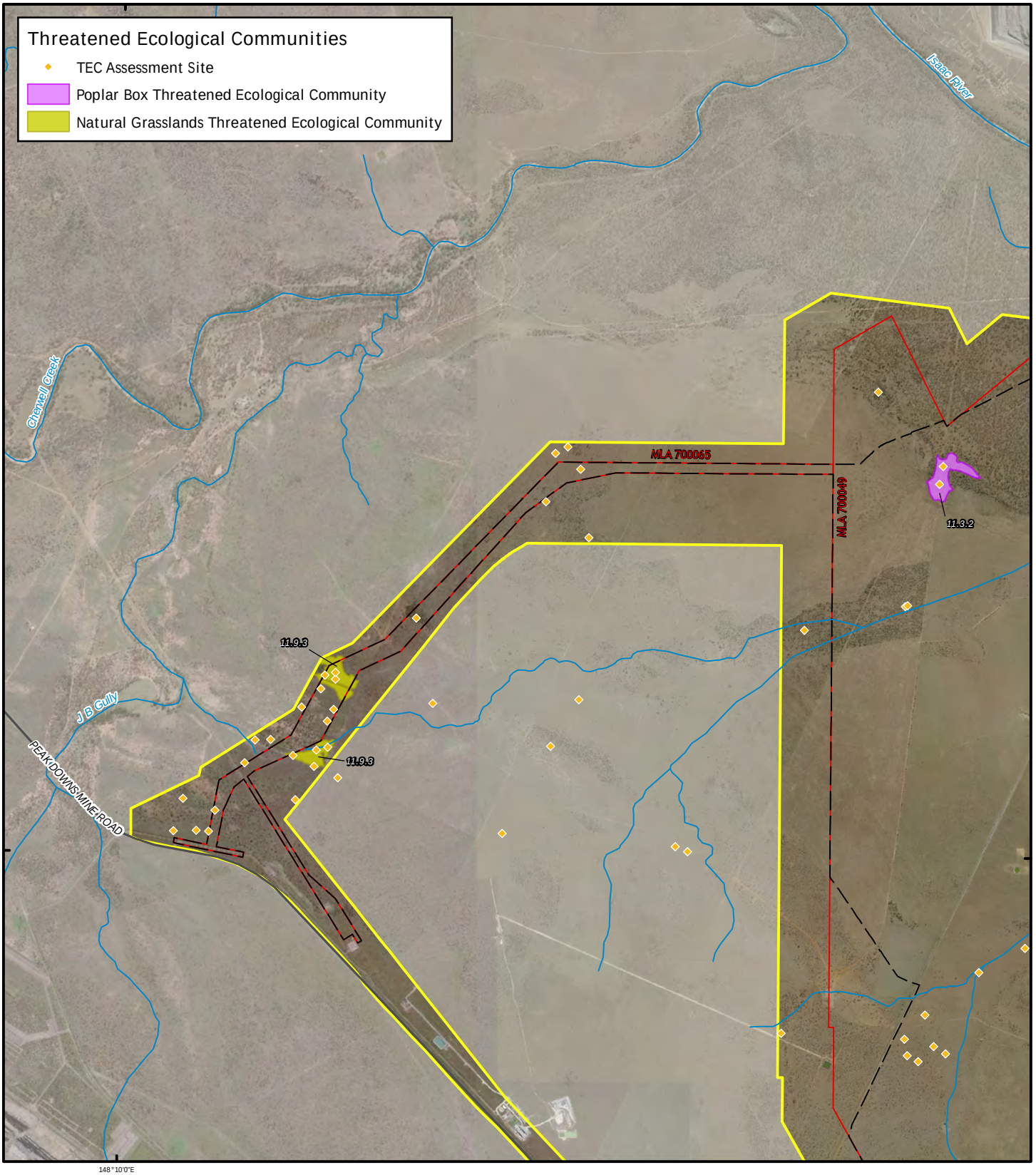
Rev	Description	Drawn	Approved	Date
0	Issued for Review	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 8A: THREATENED ECOLOGICAL COMMUNITIES UNDER THE EPBC ACT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 5	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_8_TEC.mxd



Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

N

Scale 1:53,000 (A4)

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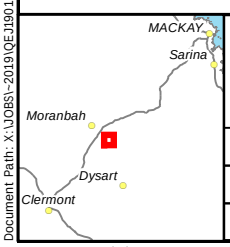
Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: © Geoscience Australia 2018
Road: © PSMA 2014
Cadastre: © DNRME 2019
TEC: © E2M 2019

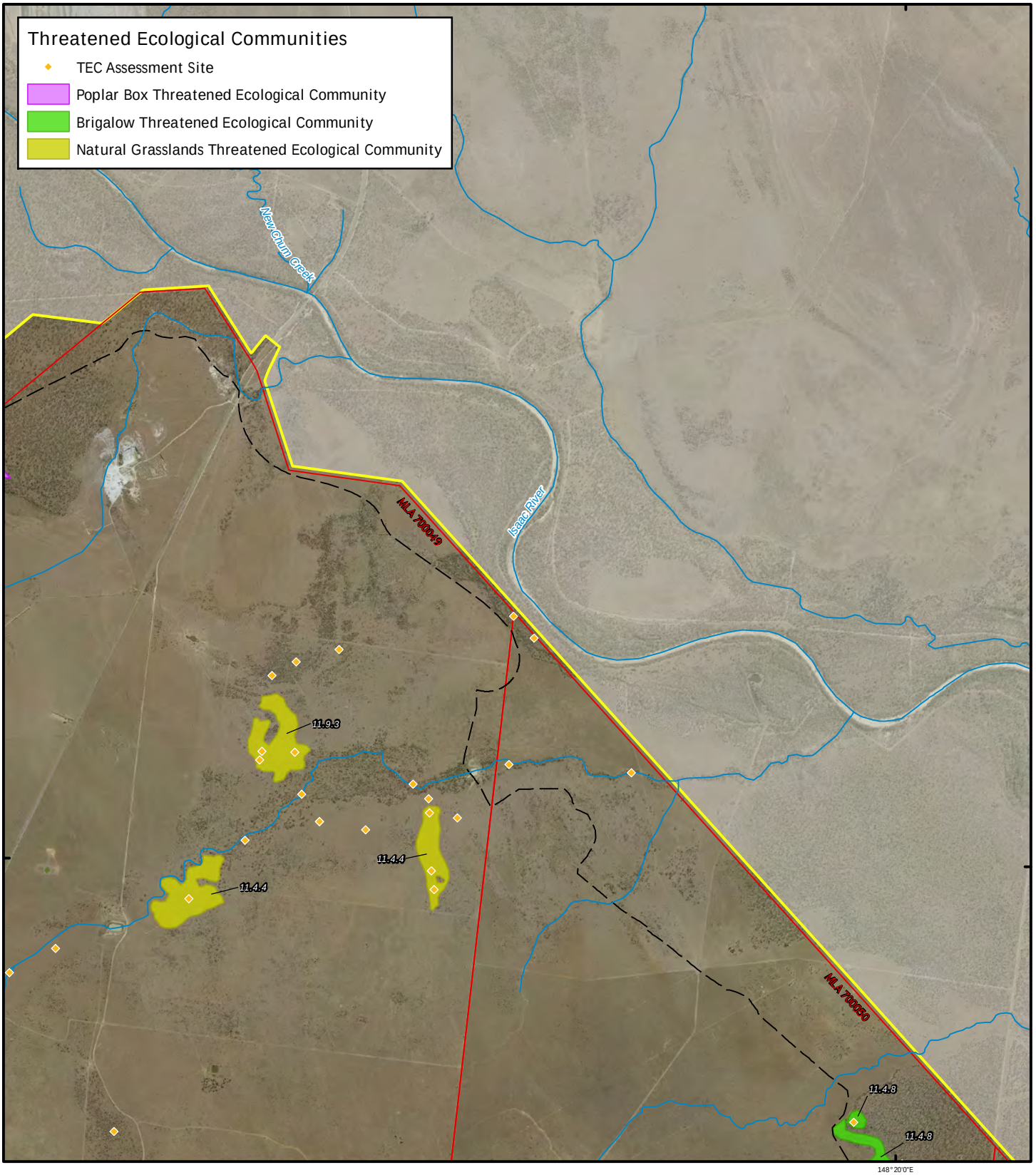
Rev	Description	Drawn	Approved	Date
0	Issued for Review	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 8B: THREATENED ECOLOGICAL COMMUNITIES UNDER THE EPBC ACT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
2 of 5	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_8_TEC.mxd



Legend

- Watercourse and Drainage Feature
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

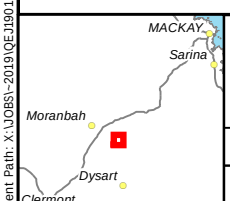
N

Scale 1:53,000 (A4)

0 0.5 1 1.5 2

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: © Geoscience Australia 2018
Road: © PSMA 2014
Cadastre: © DNRME 2019
TEC: © E2M 2019

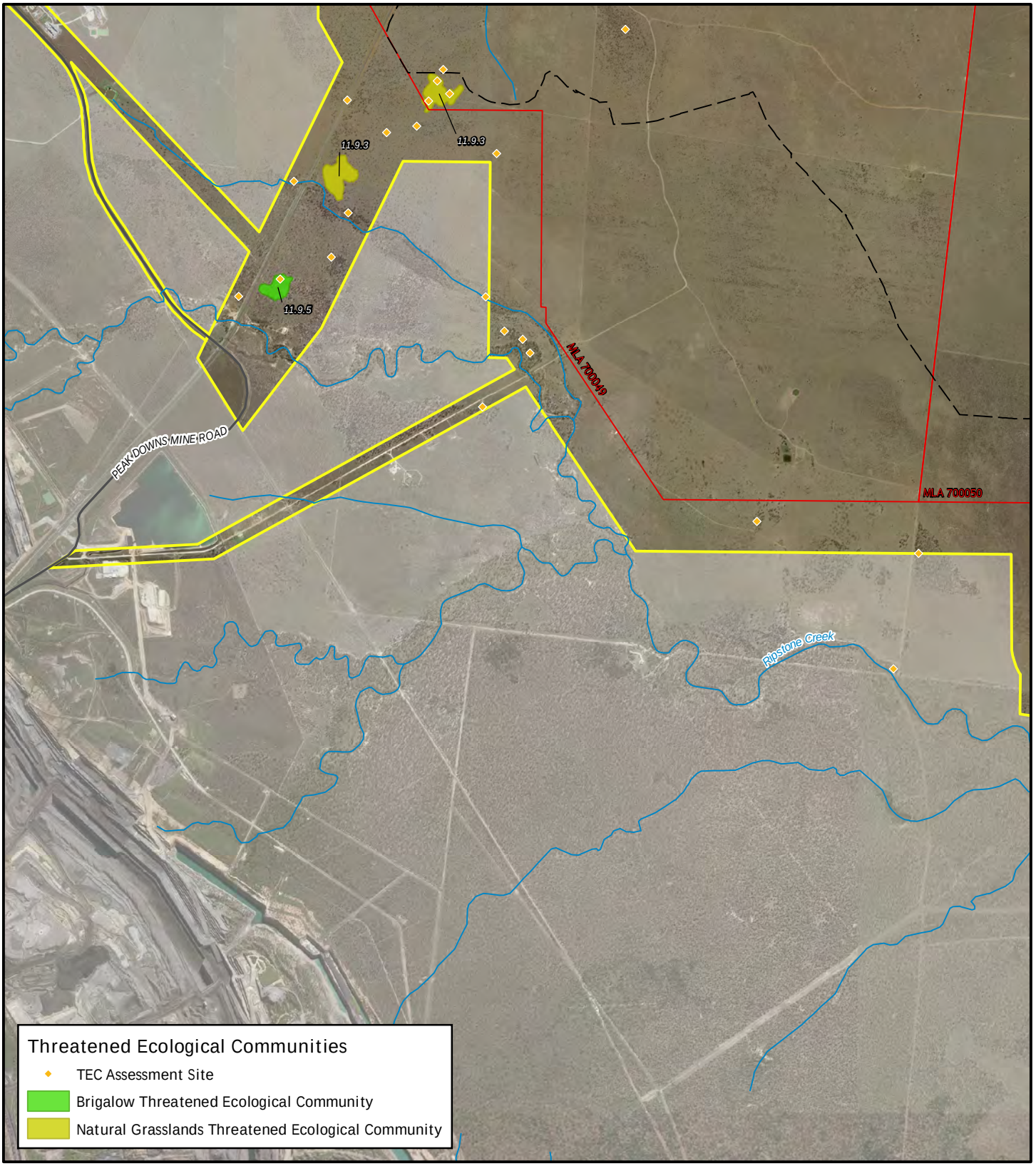
Rev	Description	Drawn	Approved	Date
0	Issued for Review	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 8C: THREATENED ECOLOGICAL COMMUNITIES UNDER THE EPBC ACT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
3 of 5	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_8_TEC.mxd



Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

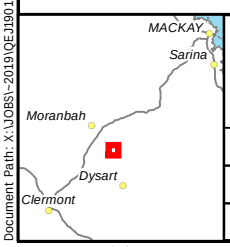
N

Scale 1:52,000 (A4)

0 0.5 1 1.5 2

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: © Geoscience Australia 2018
Road: © PSMA 2014
Cadastre: © DNRME 2019
TEC: © E2M 2019

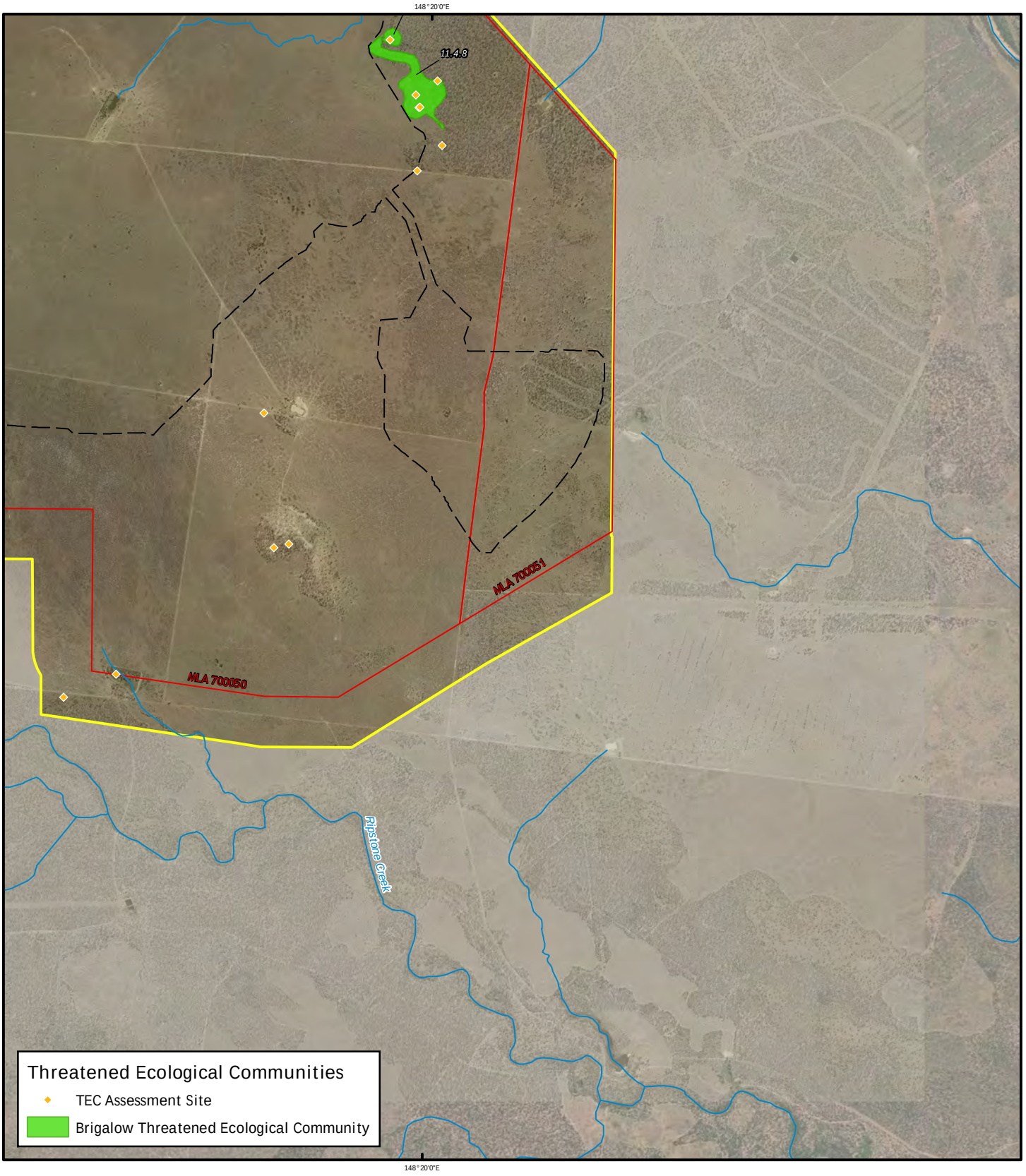
Rev	Description	Drawn	Approved	Date
0	Issued for Review	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 8D: THREATENED ECOLOGICAL COMMUNITIES UNDER THE EPBC ACT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
4 of 5	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_8_TEC.mxd



Legend

- Watercourse and Drainage Feature
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

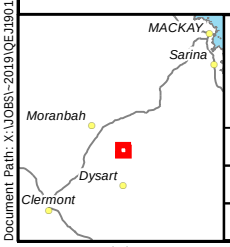
N

Scale 1:53,000 (A4)

0 0.5 1 1.5 2

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: © Geoscience Australia 2018
Road: © PSMA 2014
Cadastre: © DNRME 2019
TEC: © E2M 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Review	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 8E: THREATENED ECOLOGICAL COMMUNITIES UNDER THE EPBC ACT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
5 of 5	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_8_TEC.mxd

4.4.2 Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin TEC

Natural Grasslands TEC is comprised of native perennial grass species located on undulating plains and with minimal cover of woody vegetation. Due to their vulnerability to disturbance and degradation associated with agricultural land uses, two condition classes, 'best quality' and 'good quality', are described for the TEC. Determination of the associated condition class is dependent of a variety of criteria including patch size, richness of specific native grass indicator species, tussock density, woody cover and cover of exotic species.

A total of approximately 104.1 ha of field verified REs 11.4.4 and 11.9.3 within the Study Area were to found to meet the criteria for 'good quality' Natural Grasslands TEC (Plate 8). Native grass indicator species recorded within TEC areas included feather-top wiregrass *(Aristida latifolia)*, white speargrass *(Aristida leptopoda*), bull mitchell grass (*Astrebla squarrosa*), Queensland bluegrass *(Dichanthium sericeum*), native millet *(Panicum decompositum*), yabila grass *(P. queenslandicum*), *Paspalidium globoideum* and cup grass (*Eriochloa crebra)*. Due to the percentage foliage cover of non-native grasses (>5%), no 'best quality' Natural Grasslands TEC was observed within the Study Area.

Larger areas of REs 11.4.4 (native grasslands on Cainozoic clay plains) and 11.9.3 (native grassland on fine grained sedimentary rock) were recorded throughout the Study Area. These grassland communities, while dominated or co-dominated by native grasses did not meet condition criteria identified within the Listing Advice (TSSC, 2009). Specifically, these communities were found to contain:

- greater than 30% cover of non-native species, including Indian bluegrass *(B. pertusa**), buffel grass *(C. ciliaris**), parthenium (*Parthenium hysterophorus*)* and harrisia cactus (*Harrisia martinii**); and / or
- projective tree canopy cover exceeding 10%.

The extent of Natural Grasslands TEC within the Study Area is depicted on Figure 8A-E.

Plate 8. Natural Grasslands TEC observed during the in wet season 2019 survey

4.4.3 Poplar Box Grassy Woodland on Alluvial Plains

The Poplar Box TEC comprises grassy woodlands and open woodlands on active and relictual alluvial plains along the east coast of Australia. Three Condition Classes (Class A, B and C) are identified for the Poplar Box TEC and are based on the:

- crown cover of canopy trees
- percentage cover of native perennial vegetation in the groundlayer
- native species richness within the groundlayer; and
- density of mature trees (>30 cm DBH).

A total of 9.6 ha of 'Good Quality' (Class B) Poplar Box TEC, comprising one patch of RE 11.3.2, was identified within the northern extent of the Study Area (Figure 8A-C). This community is dominated by native vegetation within the groundlayer (approximately 65%), including *Chrysopogon fallax*, *Aristida holathera*, *Themeda triandra*, *Fimbristylis dichotoma*, *Perotis rara*, *Chrysocephalum apiculatum* and *Rostellularia adscendens*. The density of mature trees was recorded at approximately 14 trees/ha. Due to the percentage foliage cover of non-native grasses (>30%), the 'Class A' Poplar Box TEC criteria could not be met.

While other areas of RE 11.3.2 were recorded within the Study Area, these areas did not meet the Poplar Box TEC criteria due to:

- the cover of exotic pasture species (>50%); and /or
- <10 mature trees/ha.

Plate 9. Poplar Box TEC within the Study Area

4.5 Threatened flora

The desktop assessment identified nine threatened flora species listed under the EPBC Act and 21 listed under the NC Act as known to occur or potentially occurring within the wider locality (Appendix D). Previously recorded threatened flora species within and surrounding the Study Area are depicted in Figure 9. An assessment of likelihood of occurrence for threatened flora species based on species habitat preferences and distribution is provided in Appendix D.

One threatened flora species, *Solanum adenophorum* listed as Endangered under the NC Act, was identified within the Study Area during the field surveys. This species is discussed below in Section 4.5.1. One additional threatened flora species, king blue grass (*Dichanthium queenslandicum*) was previously recorded within the Study Area in association with surveys undertaken by EcoSM (2013). Discussion of this species is provided in Section 4.5.2.

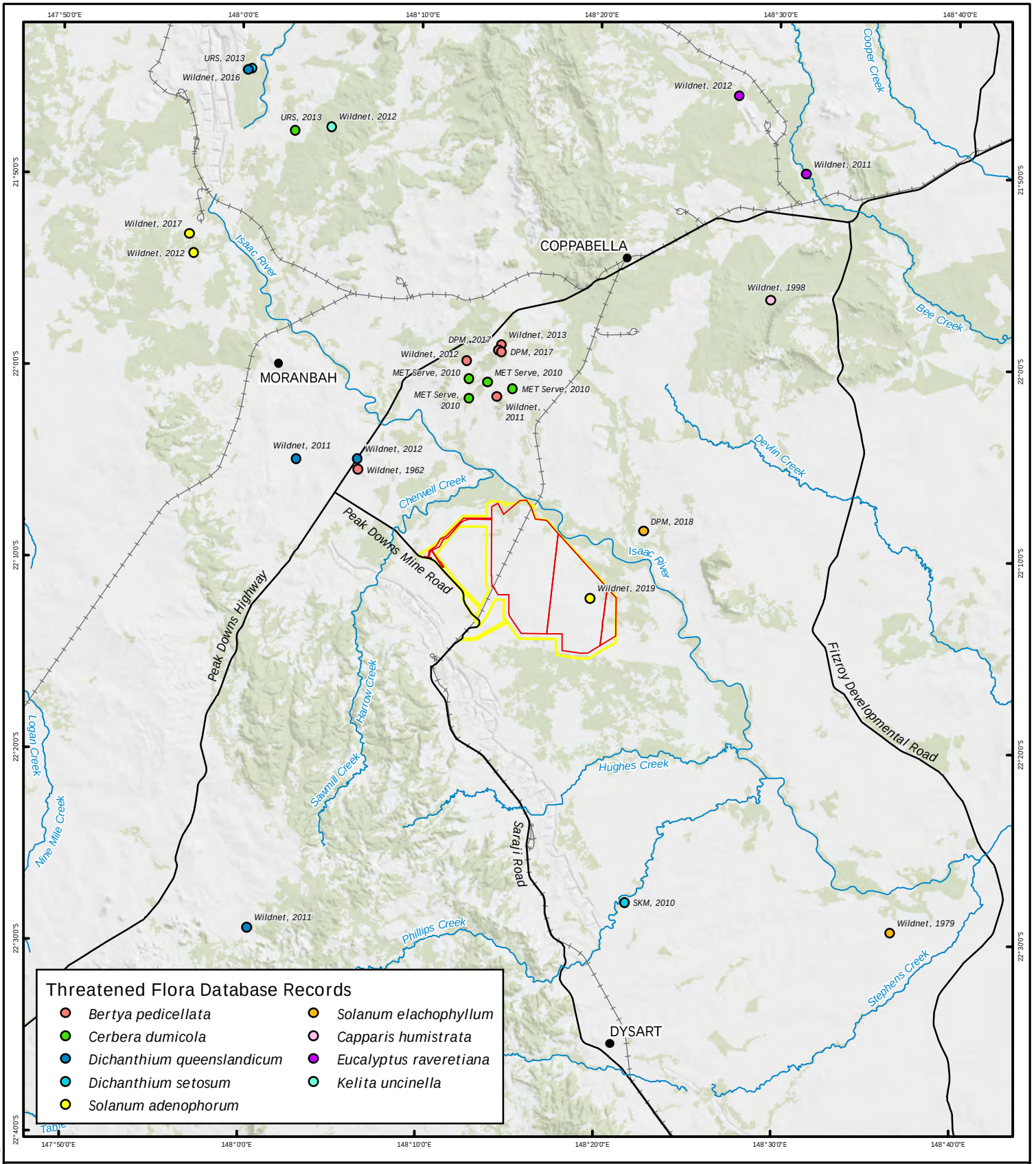
Three species listed as special least concern in Schedule 2 of the *Nature Conservation (Plants) Regulation 2020* were identified within the Study Area (Appendix C). Special least concern are least concern plant species subject to harvesting pressure because of their commercial value or their special characteristics (e.g. being slow growing or slow to reproduce).

4.5.1 Solanum adenophorum

S. adenophorum is a sprawling or prostrate herb to 0.3 m in height and is listed as Endangered under the NC Act. In Queensland the species has been recorded within the Dingo-Nebo-Clermont areas as well as west and north-west of Rockhampton within *Acacia harpophylla* (Brigalow) and *Acacia cambagei* (Gidgee) woodlands on deep cracking clays (Bean, 2004).

Adult leaves are dark green in colour, ovate and deeply lobed (3-4 on each side), growing to 3.5 to 5.5 cm in length and 2 to 4 cm wide (Bean, 2004) (Plate 10). Prickles are present along stems and on both leaf surfaces, along the midvein and lateral veins, ranging from 3 to 13 mm in length (Bean, 2004). The species has been recorded flowering in October and fruiting in May, September and October. Approximately 4 to 8, star-shaped, white flowers (8 to 10 mm long) are produced on a stalk (Bean, 2004; DES, 2019b) (Plate 10). Mature fruit are produced on a long pedicel (9 to 18 mm long) approximately 15 mm in size, round and yellowish green to green in colour (Bean, 2004) (Plate 10). The seeds of the species are dispersed by birds and mammals that feed on the fruit (Symon, 1979).

Plate 10. Solanum adenophorum leaf shape (left), fruit (middle) and flower (right)



Legend

- Road
- Railway
- Mining Lease Application
- Study Area

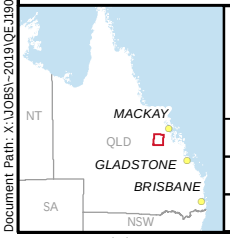
N

Scale 1:500,000 (A4)

0 5 10 15 20

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Mining Leases: © DNRME 2019
Railway: © DNRME 2019
Road: © PSMA 2014
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Flora records compiled from published EIS in surrounding region

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	24/03/2021
G	Issued for Review	DL	BD	30/10/2020

FIGURE 9: THREATENED FLORA SPECIES DATABASE RECORDS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_9_FloraEVNT.mxd

Three *Solanum adenophorum* individuals, were recorded at a single location within the Study Area during the wet season surveys in 2019 and 2020 (an additional two individuals). The species was recorded in association with regrowth *Acacia harpophylla* shrubland on undulating clay plains. The locations of individuals recorded and associated supporting habitat are depicted in Figure 10. Potential habitat for the species was also observed within the Study Area in association with remnant and regrowth brigalow communities on clay plains (i.e. REs 11.4.8 and 11.4.9).

4.5.2 King bluegrass (Dichanthium queenslandicum)

King bluegrass (*Dichanthium queenslandicum*) was previously recorded as present within the Study Area during surveys undertaken by EcoSM (2013). The species is a perennial grass endemic to central and southern Queensland, occurring on fertile heavy black soils near within the Fitzroy Basin and regions within the northern Darling Downs district (Stanley & Ross, 1989; TSSC, 2013). The species distribution overlaps with the Natural Grasslands TEC, both found in the Study Area (Section 4.1) (DSEWPaC, 2013b). Within its distribution, king bluegrass habitat includes native grasslands and open woodlands with a grassy understorey and a *Eucalyptus orgadophila*, *Corymbia erythrophloia*, *E. coolabah* tree layer. Within these habitats the species occurs in association mainly with other bluegrasses (*Dichanthium* spp. and *Bothriochloa* spp.) and other native grasses associated with heavy, black soil types (Simon, 1982).

To delineate the species' habitat and estimate the population density in the field, E2M comprehensively surveyed the same area during the wet season 2019 survey. Specimens of the suspected king bluegrass were collected and submitted to the Queensland Herbarium for formal identification from the same locations where they had been previously recorded undertaken by EcoSM. The Queensland Herbarium confirmed the grass species to be *Sehima nervosum*. Previous records of king bluegrass observed during the 2013 survey are considered likely to have been misidentified. Following comprehensive searches during both wet season surveys, E2M did not detect king bluegrass within the Study Area, reducing the species likelihood of occurrence. This species is not considered further.

4.6 Environmentally sensitive areas

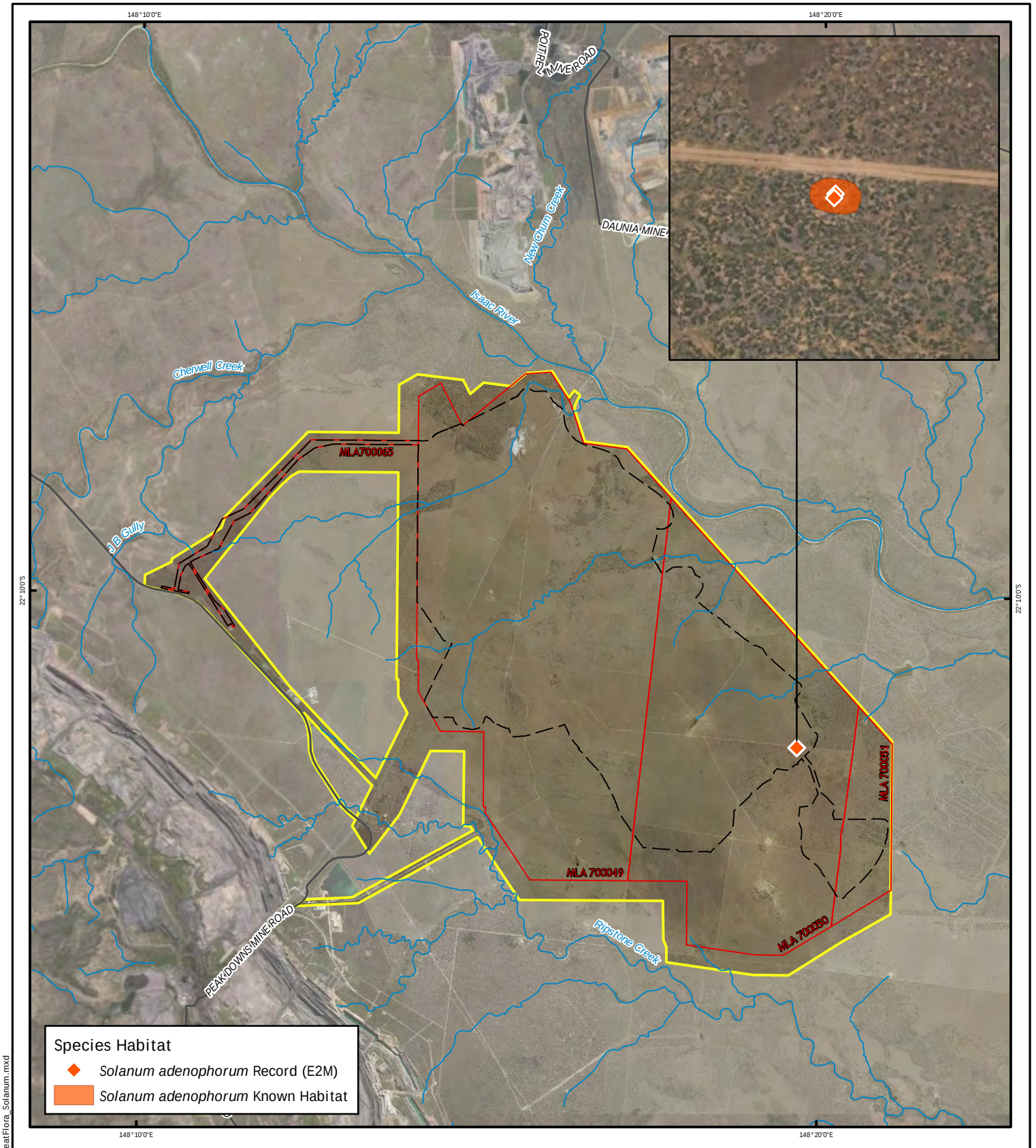
Category A ESAs include national parks, conservation parks and forest reserves listed under various State legislative instruments, including the NC Act and the Great Barrier Reef Regions listed under the Commonwealth *Great Barrier Reef Marine Park Act 1975*. No Category A ESAs are present within the Study Area.

Field verifications of REs identified that four REs (11.3.1, 11.4.8, 11.4.9 and 11.9.5), classified as Category B ESAs are present within the Study Area. The field verified Category B ESA REs cover an approximate area of 280.2 ha within the Study Area.

4.7 Pest flora

Five weed species listed as WoNS and/or restricted matters under the Biosecurity Act were recorded within the Study Area (Table 11). The 'general biosecurity obligation' under Part 1 of the Biosecurity Act states all individuals and organisations are responsible for biosecurity risks and threats under their control.

Parthenium was recorded in moderate to high densities (3-5 individuals per 10 square metres [m^2]) within undulating, clay plains and alluvial areas throughout the Study Area. Scattered individuals (1-2 individuals per 10 m^2) of *Harrisia martinii* and *Opuntia* spp. were observed throughout the Study Area, particularly within vegetation on clay plains.



Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Indicative Surface Disturbance Extent
- Mining Lease Application Boundary

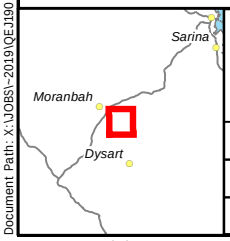
N

Scale 1:130,000 (A4)

0 1.5 3 4.5 6

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: © Geoscience Australia 2018
Road: © PSMA 2014
Cadastre: © DNRME 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 10: *SOLANUM ADENOPHORUM* HABITAT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_10_NCACT_ThreatFlora_Solanum.mxd

Table 11. Pest flora species recorded within the Study Area

Scientific name	Common name	WONS[1]	Biosecurity Act status	Location and relative abundance
Cryptostegia grandiflora	rubber vine	WoNS	Category 3	Scattered individuals in the northern extent in alluvial woodlands
Harrisia martinii	Harrisia cactus	-	Category 3	Scattered individuals on clay plains and waterways
Opuntia stricta	common prickly pear	WoNS	Category 3	Scattered individuals on clay and sand plains
Opuntia tomentosa	velvety tree pear	WoNS	Category 3	Scattered individuals on clay and sand plains
Parthenium hysterophorus	parthenium	WoNS	Category 3	Moderate to high clusters on clay plains and waterways, in particularly Res 11.4.8, 11.4.9 and 11.3.25.

[1] Weeds of National Environmental Significance.

4.8 Groundwater dependent ecosystems

GDEs are ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis for maintenance of the ecosystem (Richardson *et al.*, 2011). GDEs are classified by Doody *et.al.*, (2019) into three broad types:

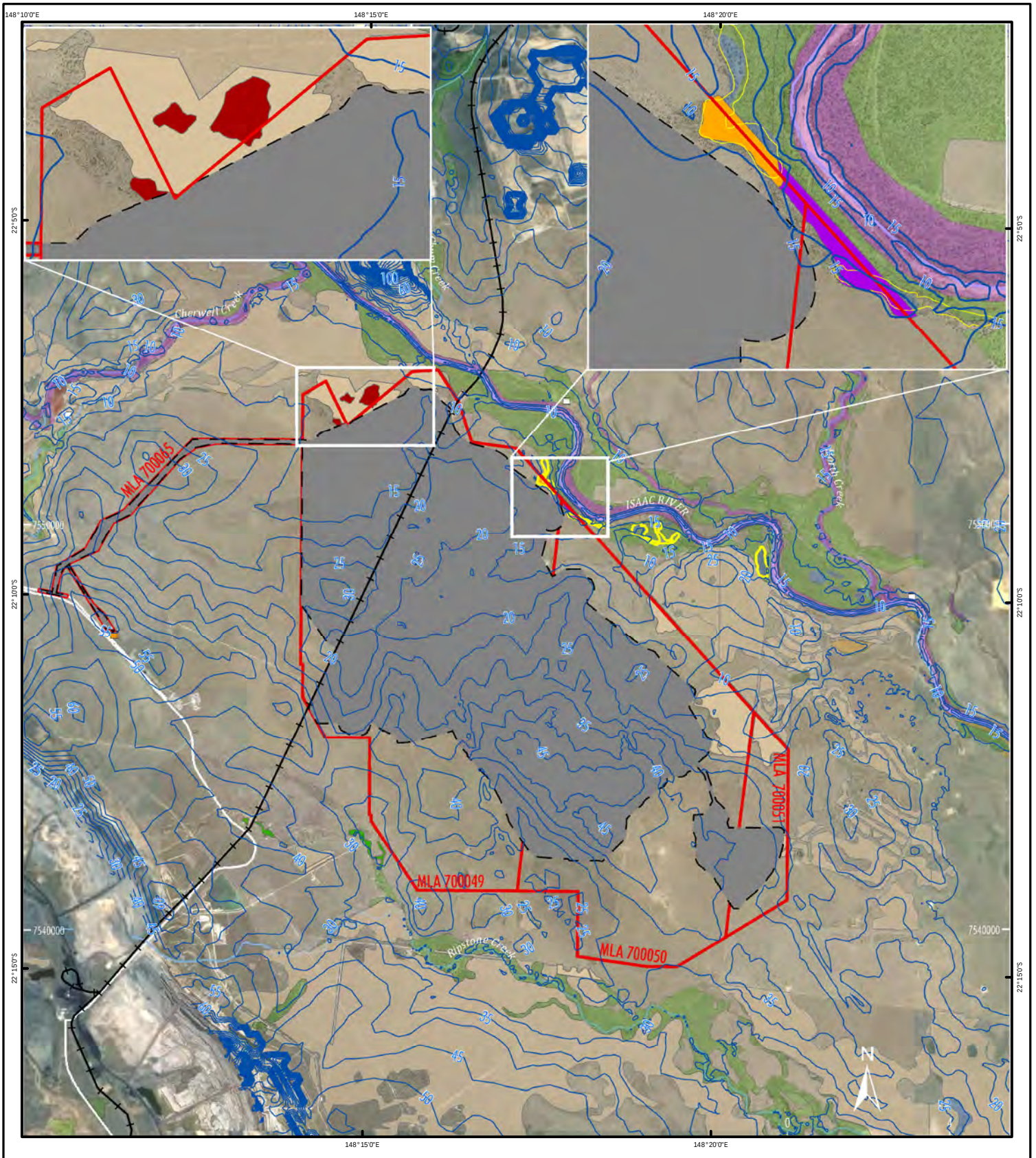
- ecosystems dependent on the surface-expression of groundwater (i.e. aquatic GDEs)
- aquifer and cave ecosystems (i.e. subterranean GDEs); and
- ecosystems dependent on the sub-surface presence of groundwater (i.e. terrestrial GDEs, including some riparian vegetation communities).

The sub-sections below provide an assessment of the potential occurrence of terrestrial GDEs in the area surrounding the Project. Potential aquatic GDEs are assessed within the *Winchester South Project Aquatic Ecology and Stygofauna Assessment* (Ecological Service Professionals [ESP], 2021).

4.8.1 Groundwater Dependent Ecosystems Atlas

The *Groundwater Dependent Ecosystems Atlas* (GDE Atlas) (BOM, 2020) provides a model of potential GDEs across Australia based on a national-scale analysis or regional studies. Several terrestrial systems within the vicinity of the Project are mapped in the GDE Atlas (BOM, 2020) as low, moderate and high potential for groundwater interaction (Figure 11).

The GDE mapping in the GDE Atlas (BOM, 2020) comes from two broad sources, either national-scale analysis or more detailed analysis based on regional studies. The mapping of terrestrial GDEs in the area surrounding the Project is based on the more course national-scale analysis, hence a review of the mapping is provided below based on field surveys.



LEGEND
Mining Lease Application Boundary
Indicative Surface Disturbance Extent
Depth to Water (5 m Contour)

Vegetation Communities with Potential for Groundwater Dependence
Ground-truthed (E2M, 2020)
RE 11.3.2
RE 11.3.25
RE 11.3.3c
RE 11.3.4
RE 11.5.3

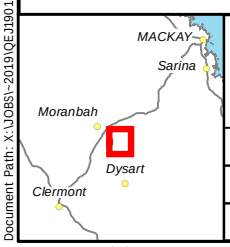
State Mapped (Dominant) (DNRME, 2020)
RE 11.3.25
RE 11.3.2
RE 11.3.3
RE 11.3.4
RE 11.3.27b
RE 11.5.3
Palustrine Wetland (ESP, 2020)

N

Scale 1:128,000 (A4)

0 1.5 3 4.5 6
Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Review	RS	RS	27/11/2020
G	Issued for Review	RS	RS	02/11/2020

FIGURE 11: TERRESTRIAL VEGETATION AND GROUNDWATER DEPTH

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_11_GDE.mxd

The GDE Atlas (BOM, 2020) identifies the following potential terrestrial GDEs in the vicinity of the Project (Figure 11):

- the riparian vegetation along the Isaac River and Cherwell Creek is mapped as having high potential for groundwater interaction
- the terrestrial vegetation associated with wetlands on the Isaac River floodplain and its tributaries is mapped as having high potential for groundwater interaction
- terrestrial vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands) mapped as having moderate potential for groundwater interaction; and
- some areas of terrestrial vegetation in the vicinity of the Project are mapped as having low potential for groundwater interaction, including areas in the north and south-west of the Project area.

The above features are described below.

4.8.2 Riparian Vegetation Along Isaac River and Cherwell Creek

As discussed in Sections 4.2.5 and 4.3, the riparian vegetation associated with the Isaac River and Cherwell Creek consists of RE 11.3.25 and comprises predominantly canopy species of *Eucalyptus tereticornis*, *Eucalyptus camaldulensis*, *Eucalyptus coolabah*, *Eucalyptus populnea* and *Melaleuca fluviatilis*. Trees along the Isaac River grow from fringes of the stream bed up to the high bank (recorded up to 8 m higher than the stream bed [ESP, 2021]). Cherwell Creek is less incised, with the high bank recorded 3-6 m higher than the stream bed (ESP, 2021).

The Isaac River and Cherwell Creek are ephemeral and only flow briefly after rainfall. Data from the Deverill gauging station on the Isaac River indicates surface flow is likely to only occur in the wetter months from November to April, reducing to shallow subsurface flows from May to October (WRM Water & Environment Pty Ltd [WRM], 2021). The Isaac River and Cherwell Creek are largely a losing system (i.e. not fed by groundwater but instead recharges groundwater) resulting in the water draining through the alluvial sediments to the underlying, local groundwater table (SLR Consulting, 2021). SLR Consulting (2021) described that occasional periods of baseflow to the Isaac River from the underlying alluvium may occur after prolonged rainfall events or following flood events. Under these conditions, recharged alluvial sediments would drain to the Isaac River as the hydraulic gradient reverses and sustains stream-flow for a short period after the rainfall event as water levels in the waterway fall (SLR Consulting, 2021).

The depth to groundwater in the Quaternary alluvium beneath the riparian vegetation along the Isaac River ranges from 6 to 12 m below ground level [mbgl] and along the Isaac River ranges from 3 to 12 mbgl (SLR Consulting, 2021). During and following wet seasons, the groundwater levels are likely to be higher, and more accessible by the riparian vegetation, however at these times water is also available in the soil profile from rainfall (surface water) infiltration. During and following flooding events, the riparian vegetation is unlikely to be dependent on sub-surface presence of groundwater.

During dry seasons, the depth to groundwater would increase and may either become a more important source of water for the trees or become too deep for trees to access. It is possible that the sub-surface presence of groundwater is used by larger trees during these times, as some these species have been reported to use groundwater when the depth is within this range (Orellana, *et al.*, 2012; Kath *et al.*, 2014). If the trees do use the sub-surface presence of groundwater, the dependency is likely to be facultative given the water available in the soil profile from rainfall would be used during the wet season. Facultative GDEs can require groundwater in some locations but not in others, particularly where an alternative source of water can be accessed to maintain ecological function. These trees can use groundwater when it is available; however, will survive without it (Eamus *et al.*, 2006).

Therefore it is likely that the riparian vegetation associated with the Isaac River and Cherwell Creek (RE 11.3.25) has a moderate to high potential to meet the definition of a terrestrial GDE, and any dependency on groundwater in the Quaternary alluvium is likely to be facultative, during dry times.

4.8.3 Vegetation Associated with Wetlands on the Isaac River Floodplain and its Tributaries

There are various patches of woodland associated with ephemeral wetlands on the Isaac River floodplain and its tributaries that are mapped as having high or moderate potential for groundwater interaction due to sub-surface presence of groundwater (i.e. terrestrial GDEs) in the GDE Atlas (BOM, 2020).

The *Winchester South Project Aquatic Ecology and Stygofauna Assessment* (ESP, 2021) describes how these ephemeral wetlands are not likely to be aquatic GDEs as these wetlands do not receive groundwater discharge, rather, the clay-rich substrates of these wetlands are likely to hold surface water run-on for extended periods, thereby creating the temporary aquatic habitat.

The riparian vegetation surrounding these ephemeral wetlands comprises woodlands dominated by *Eucalyptus coolabah*, with *Eucalyptus populnea* (within RE 11.3.3c or 11.3.27) (DES, 2018c) (Figure 11). Both of these eucalypt species are known to be facultative users of groundwater in some locations (Doody *et al.*, 2019; Kath *et al.*, 2014; Orellana *et al.*, 2012). In the Study Area, these species have been observed in a number of locations where groundwater is in excess of 40 mbgl (after SLR Consulting [2021]) and too deep for the trees to access (e.g. REs 11.3.1 and 11.5.3).

Depth to groundwater in the Quaternary alluvium beneath the wetlands ranges from 12 to 15 mbgl (SLR Consulting, 2021). At this depth, it is possible that these trees could potentially access groundwater, however due to their location on the banks of the wetland, these trees would experience periodic inundation and the primary water source would be from rainfall (surface water) infiltration, with the clay-rich substrates of these wetlands likely to hold surface water run-on for extended periods.

Therefore, it is likely that the riparian vegetation surrounding these ephemeral wetlands has a moderate potential to meet the definition of a terrestrial GDE, and any dependency on groundwater is likely to be facultative, during dry times.

4.8.4 Vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands)

There are various patches of woodland dominated by RE 11.3.2 (*Eucalyptus populnea*) on the floodplains of the Isaac River and Ripstone Creek (outside of wetlands – discussed above) that are mapped as having moderate potential for groundwater interaction due to sub-surface presence of groundwater (i.e. terrestrial GDEs) in the GDE Atlas (BOM, 2020).

As discussed above, *Eucalyptus populnea* is known to be facultative users of groundwater in some locations (Kath *et al.*, 2014). In the floodplain locations, *Eucalyptus populnea* is most likely to access to groundwater following floods when groundwater levels rise. Depth to groundwater in these floodplain locations ranges from 9 to 16 mbgl in the Quaternary alluvium (SLR Consulting, 2021).

It is considered likely that the woodland dominated by RE 11.3.2 has a moderate potential to meet the definition of a terrestrial GDE, and any dependency on groundwater is likely to be facultative, during dry times.

4.8.5 Vegetation in the Vicinity of the Project Mapped as having Low Potential for Groundwater Interaction

There are various patches of woodland in the vicinity of the Project that are mapped as having low potential for groundwater interaction due to sub-surface presence of groundwater (i.e. terrestrial GDEs) in the GDE Atlas (BOM, 2020).

One of these patches of woodland is within the northern portion of MLA 700049 and consists of mostly RE 11.5.3, but also with REs 11.3.2 and 11.3.4. Other patches of woodland mapped as having low potential for groundwater interaction (BOM, 2020) occur on the eastern boundary of the MLAs (also RE 11.5.3). These REs comprise of mainly *Eucalyptus populnea* (which is discussed above as a facultative user of groundwater in some locations). The depth to groundwater in the regolith beneath these patch ranges from 12 to 23 mbgl (SLR Consulting, 2021). Water within the regolith material is generally highly saline, but can be brackish to moderately saline with an average TDS of 10,510 mg/L, ranging between 1,460 mg/L and 18,600 mg/L (SLR Consulting, 2021). As shown on Figure 11, RE 11.5.3 occurs elsewhere were groundwater is in excess of 40 mbgl (after SLR Consulting [2021]) and too deep for the trees to access.

Therefore it is considered that these woodland patches have a low potential to meet the definition of a terrestrial GDE, and any dependency on groundwater in the regolith is likely to be facultative, during dry times (if at all). It is unlikely that these REs would be dependent on the groundwater due to the poor quality (high salinity) of the groundwater source.

4.8.6 Potential Groundwater Dependent Ecosystems

Riparian vegetation associated with the Isaac River and Cherwell Creek (RE 11.3.25) is considered to have a moderate to high potential to be a facultative terrestrial GDE. There is a low to moderate potential that the areas of REs 11.3.2, 11.3.3c, 11.3.4 and 11.5.3 comprising woodlands dominated by *Eucalyptus coolabah* and *Eucalyptus populnea* are facultative terrestrial GDEs in some locations. In locations where these RE's are able to use groundwater as part of the plants water use, they do not necessarily rely on groundwater for continued survival. Table 12 provides a summary of the REs and the potential for groundwater dependence.

Table 12. Vegetation Communities near the Project and Potential for Groundwater Dependence

RE Number	Vegetation Community Description	Potential for Groundwater Dependence
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Nil
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	Low to moderate potential facultative GDE
11.3.3c	*Eucalyptus coolabah* woodland to open woodland (to scattered trees) with a sedge or grass understorey	Moderate potential facultative GDE
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains	Low potential facultative GDE
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Moderate to high potential facultative GDE
11.3.27	Freshwater wetlands with fringing eucalypt woodlands	Moderate potential facultative GDE
11.4.4	*Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains	Nil

RE Number	Vegetation Community Description	Potential for Groundwater Dependence
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Nil
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Nil
11.5.3	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	Low potential facultative GDE
11.5.9	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces	Nil
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland on fine-grained sedimentary rocks	Nil
11.9.3	*Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks	Nil
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks	Nil

5 Fauna Results

This section details the finding of the:

- holistic assessment of the generic fauna species/habitat values within the Study Area (Section 5.2)
- evaluation of the 17 threatened terrestrial fauna species (Section 5.3.1) stipulated by the Project's ToR (a detailed Likelihood of Occurrence Assessment is provided in Appendix D); and
- fauna species determined known or likely to occur within the Study Area (Sections 5.3.2 to 5.4.4) as per the Likelihood of Occurrence and Desktop Assessment (refer to Section 3.1 and Appendices B and D).

5.1 Fauna diversity

Nearly 400 fauna species have been recorded within 50 km of the Study Area (DES, 2020d; ALA, 2020). Most of these species are commonly occurring or abundant and listed as Least Concern under the NC Act and EPBC Act. During the four field surveys, E2M recorded 186 species of terrestrial vertebrate fauna in the Study Area, including 178 native species and eight pest/introduced species. Birds accounted for over half (61%) of the recorded fauna species while mammals, reptiles and amphibians composed 18%, 16% and 5% of records, respectively. Refer to Appendix C for a full species list.

Species richness was greatest within the remnant woodlands supporting a complex understorey and an abundance of microhabitat features (e.g. Habitat 2a and 3a). Species richness was comparatively greater within areas adjacent to water sources (e.g. farm dams) despite a high level of disturbance (e.g. cattle grazing, cleared native vegetation). Species richness was relatively low in pastureland historically cleared of native vegetation and regularly subjected to impacts from cattle grazing.

5.2 Fauna habitat types

The Study Area can be delineated into eleven broad habitat types based largely on vegetation type and structure (Table 13). The description of each fauna habitat type is presented in Section 5.2.1 to Section 5.2.11. The occurrence of each habitat type across the Study Area is presented in Figure 12A-E.

Table 13. Broad Fauna habitat and their associated REs

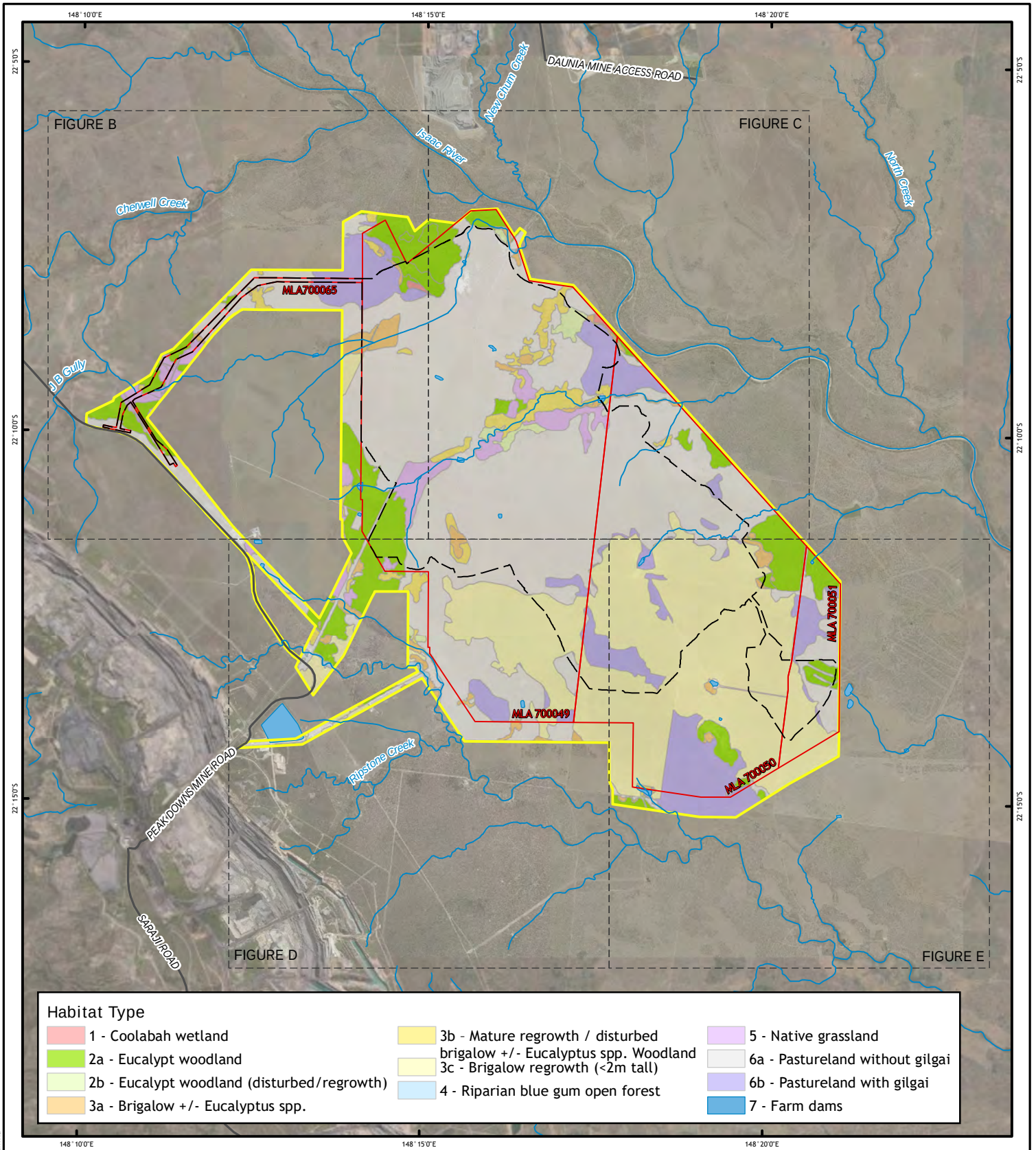
Broad Fauna Habitat Type		Associated RE
Habitat 1	coolabah wetland	11.3.3c
Habitat 2a	eucalypt woodland	11.3.2, 11.3.3c, 11.3.4, 11.3.7, 11.4.2, 11.5.3, 11.5.9, 11.9.2
Habitat 2b	mature regrowth / disturbed eucalypt woodland	Regrowth/disturbed areas
Habitat 3a	brigalow +/- *Eucalyptus spp*. woodland	11.3.1, 11.4.8, 11.4.9, 11.9.5
Habitat 3b	mature regrowth / disturbed brigalow +/- Eucalyptus spp. woodland	Regrowth/disturbed areas
Habitat 3c	brigalow regrowth (<2m tall)	Regrowth/disturbed areas
Habitat 4	riparian blue gum open forest	11.3.25
Habitat 5	native grassland	11.4.4 and 11.9.3
Habitat 6a	pastureland without gilgai	Regrowth/disturbed areas
Habitat 6b	pastureland with gilgai	Regrowth/disturbed areas
Habitat 7	farm dams	N/A

5.2.1 Habitat 1 - Coolabah Wetland

This habitat consists of large mature *Eucalyptus coolabah* surrounding periodically inundated palustrine wetlands in two locations in the north of the Study Area. The large *Eucalyptus coolabah* trees provide a moderate to high abundance of hollows ranging from small (<10 cm diameter) to large (>30 cm diameter) in size, providing suitable habitat for arboreal mammals (e.g. greater glider, which was observed within this habitat during the survey), hollow nesting birds and roosting microbats (Plate 11). The abundance of *Eucalyptus coolabah* throughout this habitat also provides foraging resources for koalas (scats were observed within this habitat during the survey).

The ground layer supports moderate leaf litter cover and woody debris, as well as contains many deep soil cracks. This complex ground layer provides habitat for numerous reptiles, small mammals and amphibians. Additionally, as this habitat is seasonally inundated by water it provides additional fauna habitat for amphibians and species known to prey on amphibians (e.g. ornamental snake, which was recorded in this habitat during field surveys).

This habitat type is equivalent to RE 11.3.3c (*Eucalyptus coolabah* woodland to open woodland [to scattered trees] with a sedge or grass understorey).



Legend

- Watercourse and Drainage Feature
- Road
- Figure Extent
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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Kilometres

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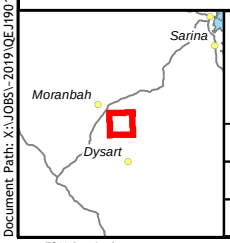

Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 12A: FAUNA HABITAT TYPES OVERVIEW

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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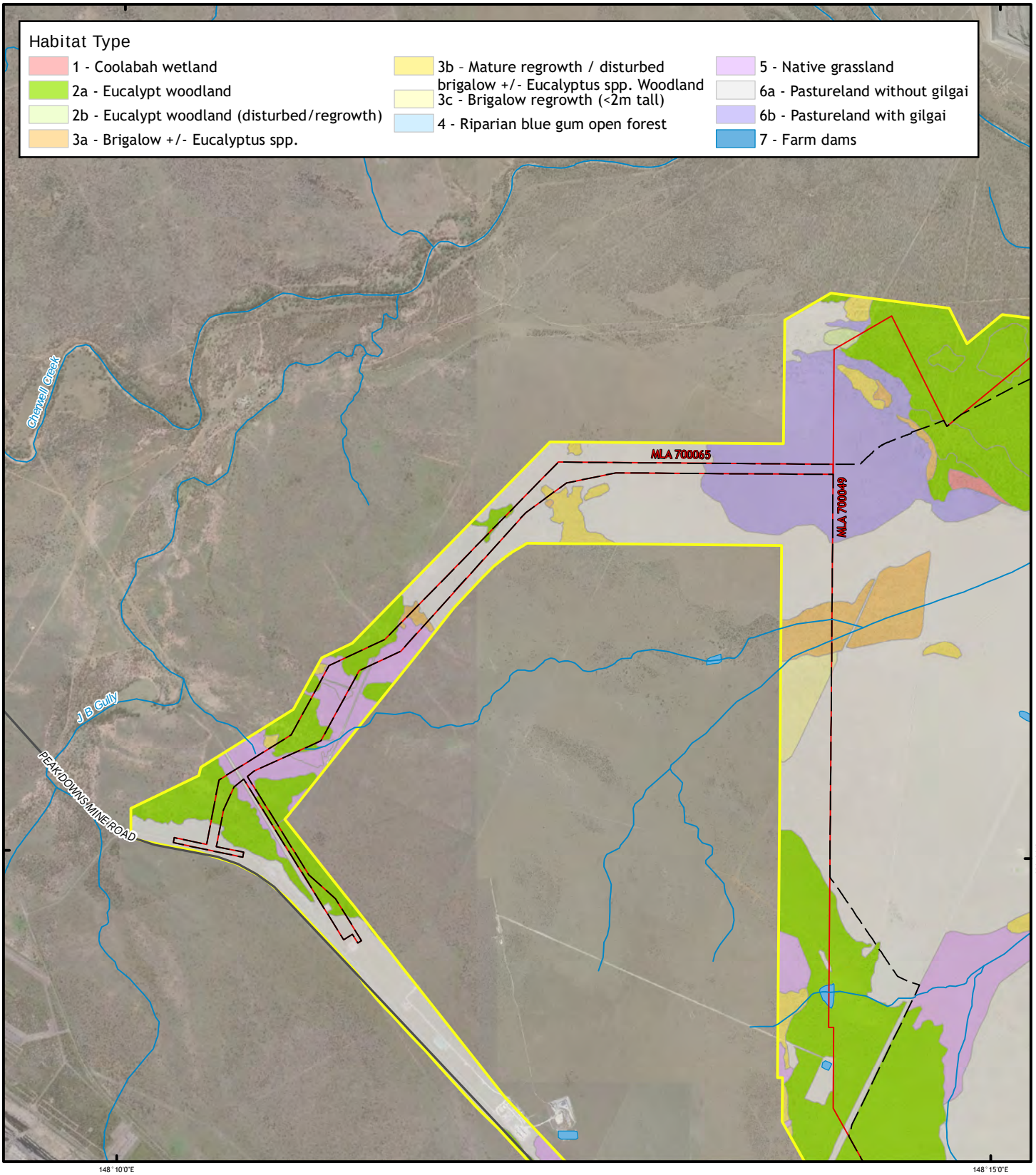

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- Road
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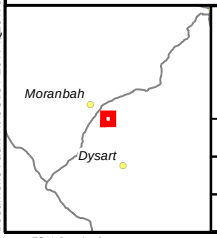

Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
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Habitat Types: © E2M 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 12B: FAUNA HABITAT TYPES

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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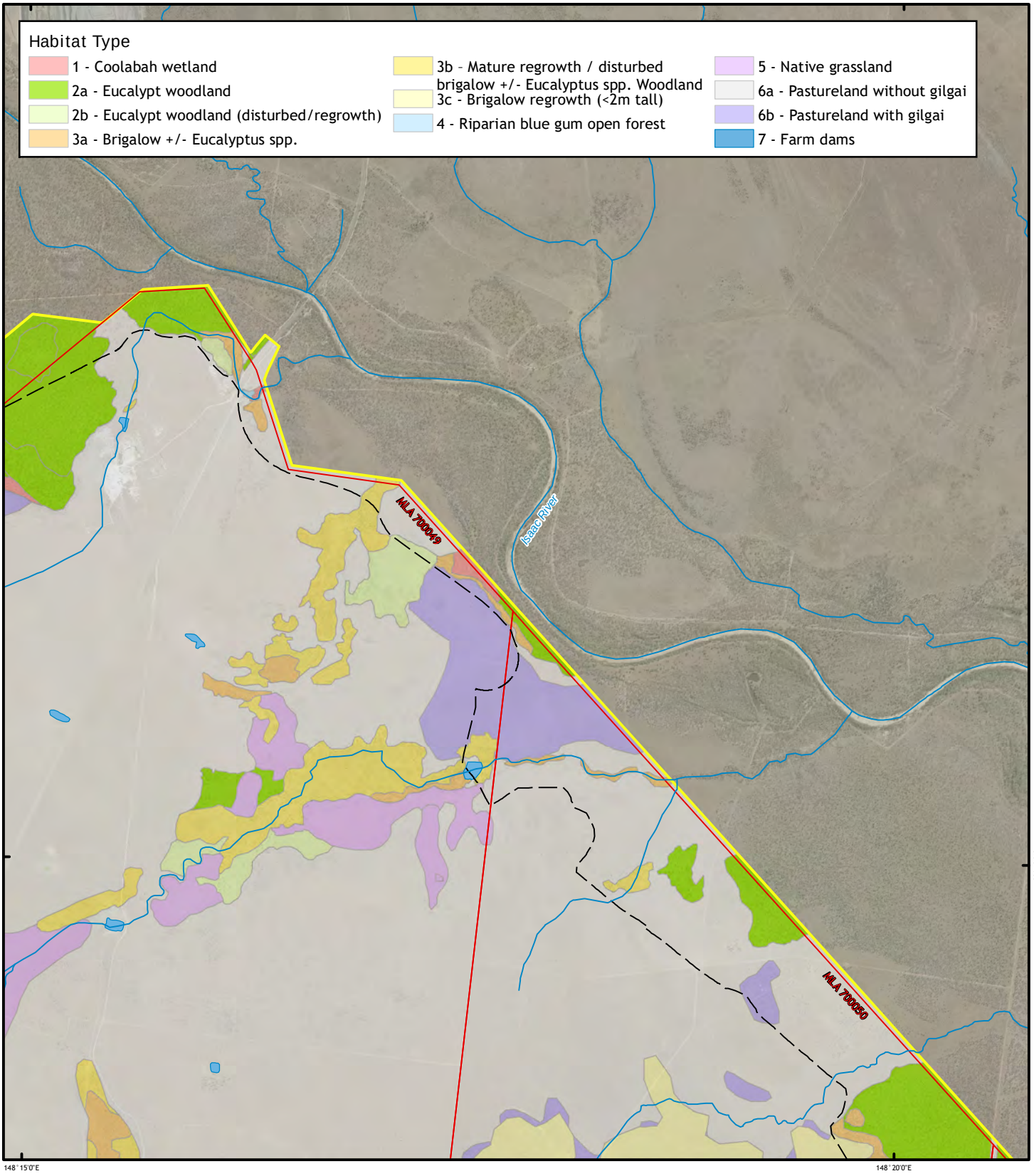

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- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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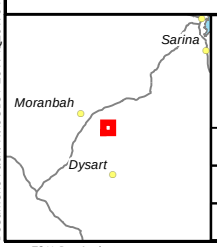

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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 12C: FAUNA HABITAT TYPES

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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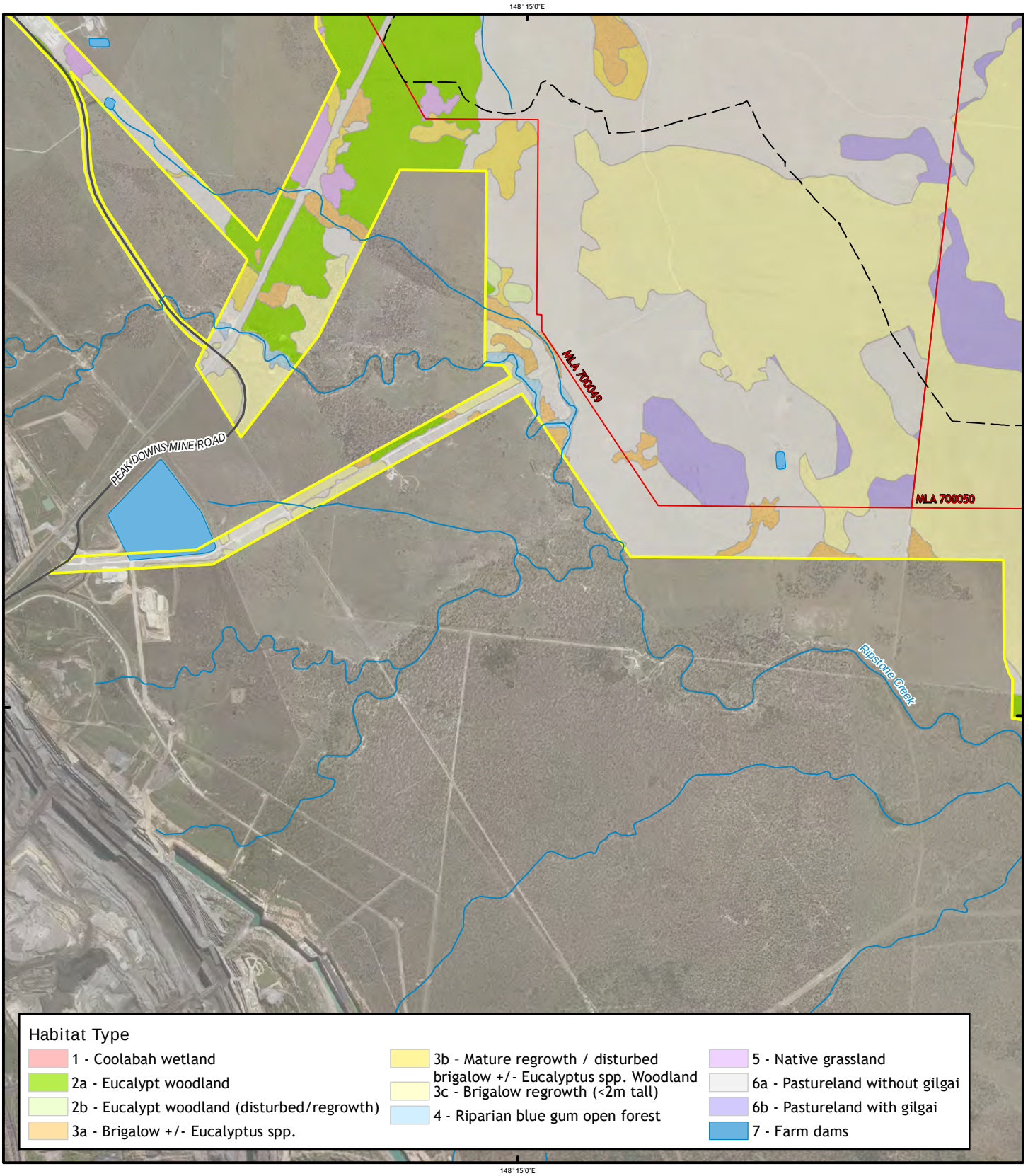

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- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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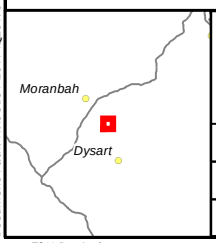

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Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 12D: FAUNA HABITAT TYPES

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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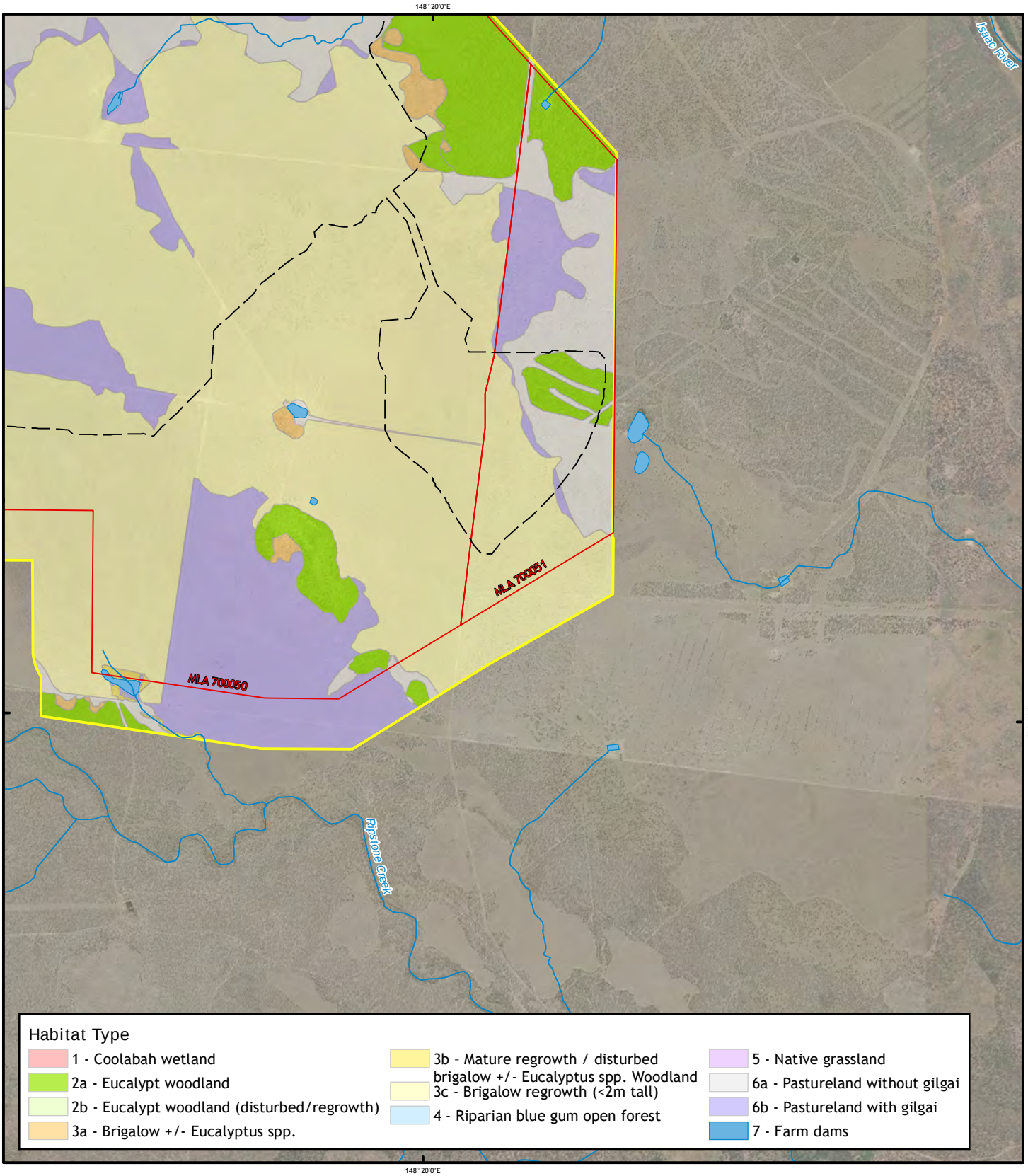

Legend

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- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

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Kilometres

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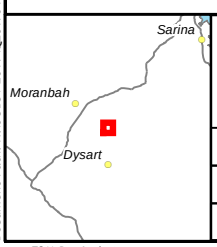

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Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 12E: FAUNA HABITAT TYPES

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
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Plate 11. Typical coolabah wetland habitat (fauna habitat type 1)

5.2.2 Habitat 2a – Eucalypt Woodland

Eucalypt Woodlands in the Study Area are generally comprised of scattered eucalypts, bloodwoods and ironbarks over an understory of grasses and sparse shrubs. Eucalypt Woodlands range in height between 7 m and 22 m and in canopy cover from 20% - 50%. Within the Study Area, this habitat type consists predominantly of mature poplar box woodland with occasional and scattered patches of locally dominant blue gum, silver-leaved ironbark, mountain coolabah or Dawson gum (Plate 12). Eucalypt Woodland within the Study Area is concentrated where clearing for agricultural or pastoral activities was limited.

The habitat features within the eucalypt woodland contain a low to moderate abundance of small to large tree hollows providing suitable habitat for arboreal mammals (e.g. greater glider), hollow nesting birds (e.g. parrots) and roosting microbats. Eucalypts also provide a foraging resource for koala. The ground layer within this habitat type has a shallow layer of leaf litter and a moderate abundance of woody debris. These microhabitat features provide refuge and foraging opportunities for reptiles, amphibians and small mammals.

The REs within the Study Area associated with this habitat type include:

- RE 11.3.2 (poplar box woodland on alluvial plains)
- RE 11.3.3c (*Eucalyptus coolabah* woodland to open woodland [to scattered trees] with a sedge or grass understory)
- RE 11.3.4 (blue gum and/or *Eucalyptus* spp. woodland on alluvial plains)
- RE 11.3.7 (*Corymbia spp*. woodland on alluvial plains)
- RE 11.4.2 (*Eucalyptus spp*. and/or *Corymbia spp*. grassy or shrubby woodland on Cainozoic clay plains)
- RE 11.5.3 (poplar box +/- silver-leaved ironbark +/- *C. clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces)
- RE 11.5.9 (*Eucalyptus crebra*, other *Eucalyptus spp*. and *Corymbia spp*. woodland on Cainozoic sand plains and/or remnant surfaces); and
- RE 11.9.2 (silver-leaved ironbark +/- mountain coolabah woodland on fine-grained sedimentary rocks).

Plate 12. Typical eucalypt woodland habitat (fauna habitat type 2a)

5.2.3 Habitat 2b – Mature Regrowth / Disturbed Eucalypt Woodland

The disturbed eucalypt woodland habitat differs from the eucalypt woodland (Habitat 2a) in that it has been subject to tree thinning or historical clearing (Plate 13). Tree thinning typically reduces the abundance of microhabitat features such as leaf litter, coarse woody debris and tree hollows thereby reducing the quality of habitat for fauna species that require those features for one or more stages of their life cycle (e.g. breeding). Within the Study Area, mature trees within the disturbed eucalypt woodland have been ringbarked, a common practice that kills the tree in-situ and creates stags. The abundance of stags within the disturbed eucalypt woodland habitat was found to support small hollows and contribute to coarse woody debris on the ground. The sparse canopy however, limited vegetation structure and lack of ground cover limits this habitat type to generalist fauna species.

Plate 13. Typical disturbed eucalypt woodland habitat (fauna habitat type 2b)

5.2.4 Habitat 3a - Brigalow +/- Eucalyptus spp. Woodland

This fauna habitat type consists of mature brigalow with or without emergent coolabah / Dawson gum on cracking clay soils (Plate 14). The canopy cover is variable (20-80%) and predominately brigalow therefore lacking an abundance of medium or large sized hollows. The shrub layer is diverse in species composition and often includes wilga (*Geijera parviflora*), false sandalwood (*Eremophila mitchellii*) and yellowwood (*Terminalia oblongata*). The ground layer is sparsely vegetated yet consists of abundant coarse woody debris, moderate leaf litter cover and deep soil cracks. Deep soil cracks provide microhabitat for fauna, such as amphibians and reptiles, particularly during the wet season when the woodland is inundated. The vulnerable listed ornamental snake was observed within this habitat type in Study Area during the 2019 and 2020 wet season surveys. Additionally, the Australian painted snipe has been previously detected within this habitat type during wet season surveys undertaken in 2013 (EcoSM, 2013).

The REs within the Study Area that are associated with this habitat type include:

- RE 11.3.1 (brigalow and/or belah open forest on alluvial plains)
- RE 11.4.8 (Dawson gum woodland to open forest with brigalow or *A. argyrodendron* on Cainozoic clay plains)
- RE 11.4.9 (brigalow shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains); and
- RE 11.9.5 (brigalow and or belah open forest on fine grained sedimentary rocks).

Plate 14. Typical Brigalow +/- Eucalyptus spp. Woodland (fauna habitat 3a)

5.2.5 Habitat 3b - Mature Regrowth / Disturbed Brigalow +/- Eucalyptus spp. Woodland

Within the Study Area this habitat type consists of regrowth brigalow (> 2m tall) with occasional coolabah on cracking clay soils (Plate 15). Like the brigalow/coolabah woodland, the disturbed woodland contains few medium or large sized hollows and has a complex understorey containing abundant coarse woody debris, leaf litter and deep soil cracks. These microhabitat features provide habitat for reptiles, small mammals and amphibian species, including ornamental snake. Ornamental snakes were recorded during the 2019 and 2020 wet season surveys within the gilgai and ephemeral drainages present in this habitat type.

Plate 15. Typical Mature Regrowth Brigalow +/- Eucalyptus spp. Woodland (fauna habitat type 3c)

5.2.6 Habitat 3c - Brigalow Regrowth (<2m tall)

This fauna habitat has been historically cleared and consists of regrowth brigalow up to 2 m tall on cracking clay soils (Plate 16). This habitat type provides foraging opportunities for birds of prey including eagles, falcons, hawks, kestrels, kites and owls as well as large mammals including eastern grey and red kangaroos. The dense, low shrub cover also provides refuge habitat for small mammals and reptiles. During the wet season, the clay soils become inundated within gilgai and provide suitable habitat for amphibians and ornamental snakes. Ornamental snakes were recorded during the 2019 and 2020 wet season surveys within this habitat type.

Brigalow regrowth occurs in several large patches throughout the interior of the Study Area. Connectivity of these patches to remnant vegetation is low, primarily surrounded by cleared grazing paddock with only small areas connecting to remnant vegetation. Parthenium was abundant throughout this habitat type.

Plate 16. Typical Brigalow Regrowth (<2m tall) habitat (fauna habitat type 3c)

5.2.7 Habitat 4 – Riparian Blue Gum Open-forest

The riparian blue gum forest habitat predominantly consists of mature blue gums and occasionally scattered patches of coolabah along alluvial waterways, in particular Isaac River and Ripstone Creek, within the Study Area. This habitat type contains a large abundance of tree hollows (of all sizes), dense canopy cover, a complex understorey and abundant coarse woody debris and leaf litter cover (Plate 17).

The tree hollows and mature eucalypts provide suitable refuge and foraging habitat for the vulnerable listed greater glider as well other glider species and hollow dependent birds and microbats. As an important koala food tree, the blue gum forest provides suitable habitat for koala. Evidence of both greater glider and koala were observed within this habitat type during field surveys. The high structural complexity of the habitat with multiple stratum provides suitable foraging for numerous bird species and the presence of moderate levels of woody debris and ephemeral water provides habitat for reptile and amphibians.

This habitat type comprised RE 11.3.25 (blue gum or river red gum [*E. camaldulensis*] woodland fringing drainage lines).

Plate 17. Typical riparian blue gum forest habitat (fauna habitat type 4)

5.2.8 Habitat 5 - Native Grassland

Native Grassland habitat is composed of perennial native grasses on loam or clay soils. This habitat type generally has comparatively low overall habitat value yet offers specific niche refuge, forage and/or breeding habitat for species of reptile, small mammals and ground-nesting birds (e.g. Australasian pipit) (Plate 18). The main identified threats to natural grasslands are grazing, cropping, pasture improvement and weed encroachment (DEWHA, 2008a). Within the Study Area, native grasslands are permeated with improved pasture grasses (e.g. buffel grass) and parthenium.

The REs within the Study Area associated with this habitat type are RE 11.4.4 and RE 11.9.3.

Plate 18. Typical native grassland habitat (fauna habitat 5)

5.2.9 Habitat 6a - Pastureland without Gilgai

Pastureland has been historically cleared of native vegetation and reseeded with improved pasture grass species to support livestock grazing. Pastureland generally provides low habitat value for native fauna due to lack of microhabitat features and exposure to ongoing disturbance from cattle grazing (Plate 19). Where scattered regrowth vegetation is present within Pastureland, its low density precludes it from qualifying for the fauna habitat types characterised by regrowth vegetation (i.e. habitat type 2b, 3b and 3c). Habitat 6a was distinguished from habitat 6b due to the lack of gilgai, which are an important microhabitat feature for numerous species.

Pastureland within the Study Area is not associated with any RE.

Plate 19. Typical pastureland without gilgai (fauna habitat 6a)

5.2.10 Habitat 6b -Pastureland with Gilgai

As with Habitat 6a, this fauna habitat type consists of pastureland largely cleared of native vegetation. It generally provides low habitat value for most native fauna, however the presence of gilgai provides niche habitat for ornamental snake. Specifically, this refers to the ephemeral presence of water and deep cracking clay soils (Plate 20). The depth and abundance of gilgais and associated cracking clay soils, within this habitat type varied between areas with some areas lacking necessary microhabitat features for ornamental snake (Plate 21).

The habitat is subject to the effects of cattle grazing, namely soil compaction, therefore Pastureland with Gilgai is of less quality than other habitat types with deep, cracking clay soil but of better quality than pastureland without gilgai. Where scattered regrowth vegetation is present within pastureland, its low density precludes it from qualifying for the fauna habitat types characterised by regrowth vegetation (i.e. habitat type 2b, 3b and 3c).

Plate 20. Typical pastureland with deep gilgai and deep cracking clay soils (fauna habitat 6b)

Plate 21. Typical pastureland with shallow gilgais and shallow cracking clay soils (fauna habitat 6b)

5.2.11 Habitat 7 - Farm Dams

Farm dams within the Study Area provide a permanent supply of fresh water in an otherwise predominantly dry environment. As such, many fauna assemblages are found in proximity including amphibians, birds, macropods, microbats and water dependent small mammals (e.g. a water rat (*Hydromys chrysogaster)* was observed in several farm dams throughout the Study Area). The vulnerable listed squatter pigeon is typically also located adjacent to permanent water sources. Squatter pigeons were detected at a dam within the Study Area during multiple survey events (Section 5.3.4). Additionally, the cracking clay soils observed at several dams also provides suitable habitat (of varying quality depending on the level of disturbance [i.e. cattle]) for ornamental snake which preys upon amphibians that utilise the dam for breeding. Australian painted snipe also has the potential to intermittently forage within farm dams and has been previously detected within riparian areas of the Study Area. Common fauna species observed at farm dams during the field assessments include Australian wood duck (*Chenonetta jubata*), Pacific black duck (*Anas superciliosa*) and Australasian darter (*Anhinga novaehollandiae*).

5.3 Threatened fauna

5.3.1 Likelihood of Occurrence Assessment

The desktop assessment identified six fauna species listed under both the EPBC Act and NC Act, two fauna species listed under the NC Act as recorded/known to or potentially occurring and four fauna species listed under the EPBC Act as migratory within the wider locality (Appendix D). An assessment of the likelihood of occurrence for threatened fauna species based on species habitat preferences and distributions is provided in Appendix D. Species recorded/known to or potentially occurring are further described within the following subsections (Sections 5.3.1 to 5.4.4).

Of the 17 fauna species listed in the ToR considered as part of the likelihood of occurrence assessment, five were identified as potentially or known to occur:

- ornamental snake
- koala
- greater glider
- squatter pigeon; and
- Australian painted snipe.

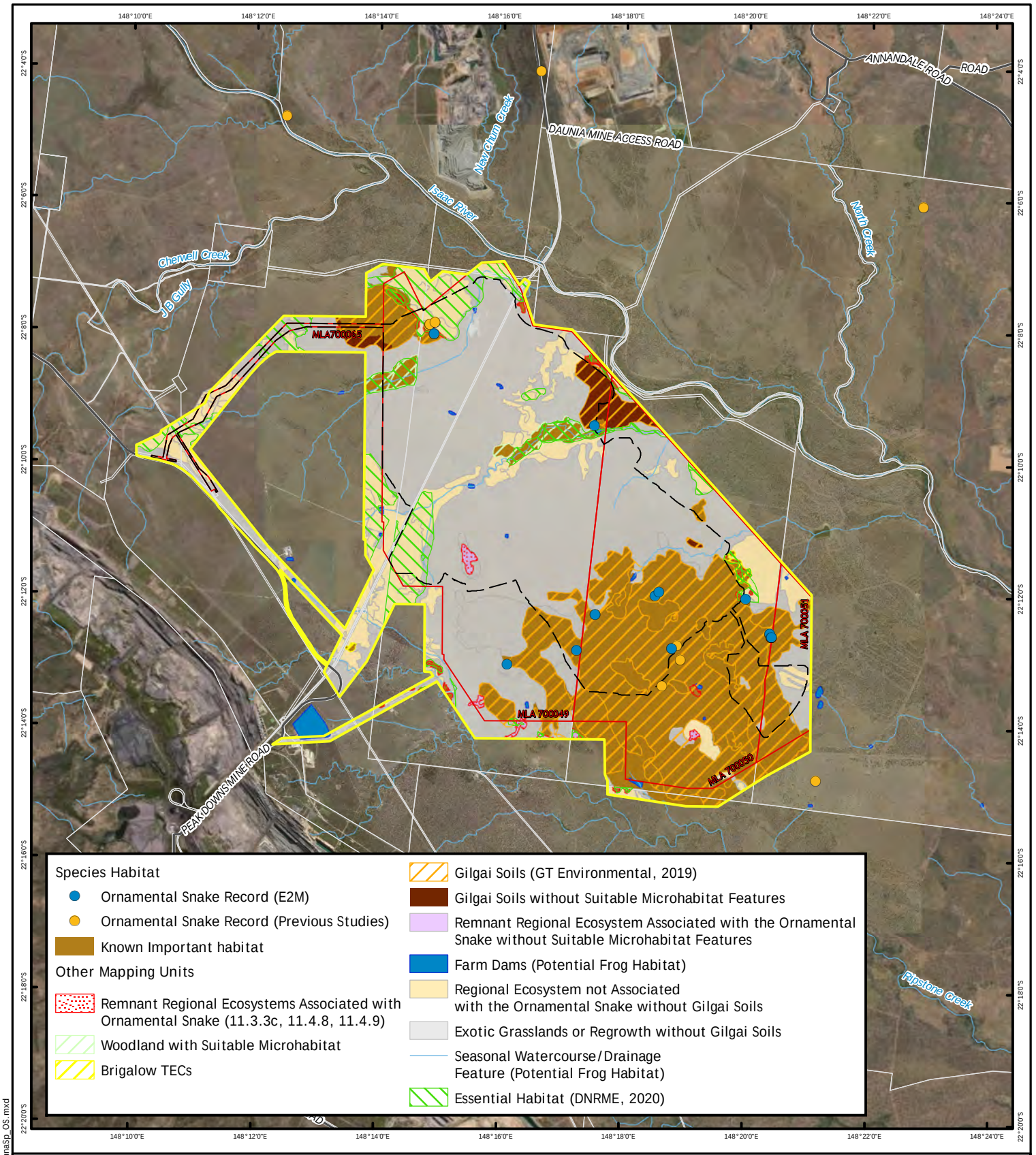
These species are described in detail within the following sub-sections (5.3.2 to 5.5.4).

The remaining 12 species identified within the ToR were identified as unlikely to occur by the Likelihood of Occurrence Assessement (Appendix D). Appendix D contains a habitat description listing under the EPBC Act and/or NC Act and the determined likelihood of occurrence for all species identified during the desktop assessment (including those listed in the ToR).

5.3.2 Ornamental Snake (*Denisonia maculata*)

The ornamental snake was recorded at multiple locations throughout the Study Area, primarily within Habitat Type 3c (Brigalow Regrowth [<2 m tall]) that contains well developed gilgai (Figure 13). Thirteen ornamental snakes were recorded during the wet season 2019 survey (7 records) and the wet season 2020 survey (6 records). Figure 13 also shows ornamental snake records from previous studies undertaken in the area.

Ornamental snakes are small (500 mm), nocturnal, venomous snakes predominately olive in colour with a black crown and distinctly barred lips (Plate 24). The species is a habitat specialist closely associated with gilgai supporting deep cracking clay soils and amphibians when inundated (DSEWPaC, 2011a). As a specialist predator of frogs, the flooded gilgai support habitat for prey species such as green tree frogs (*Litoria caerulea)* and greenstripe frogs (*Cyclorana alboguttata)*, both regularly recorded throughout gilgai in the Study Area during the wet season survey. As the water ebbs and the gilgai dries, deep cracks within the clay soil provide refuge habitat for the ornamental snake during the day and throughout prolonged dry periods (Plate 25). Gilgai are associated with brigalow (*Acacia harpophylla*), gidgee (*A. cambagei*), blackwood (*A. argyrodendron*) and/or coolabah (*Eucalyptus coolabah*) dominant vegetation communities (DotE, 2014a).



Legend

- Road
- Study Area
- Indicative Surface Disturbance Extent
- Mining Lease Application Boundary
- Cadastre

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Scale 1:144,000 (A4)

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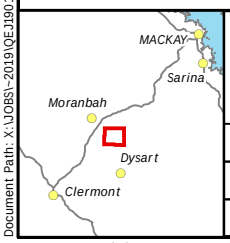
Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © ESRI 2019
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Road: © PSMA 2014
Wetlands: © DNRME 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 13: ORNAMENTAL SNAKE HABITAT

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Map Number	Job Number	Rev
1 of 1	QEJ19011	0

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Within the Study Area, ornamental snake habitat generally comprises remnant and regrowth brigalow, coolabah and pastureland dominated vegetation communities that contain gilgai or ephemeral drainages (Plate 22). The microhabitat features where ornamental snakes were detected are characterised by:

- gilgai of varying depth (shallow to deep) with cracking clay soils (cracks depth varied between shallow and deep) (Plate 25)
- coarse woody debris and/or ground litter
- regrowth brigalow (dominant)
- weeds, most frequently parthenium
- presence of native amphibians; and
- contiguous habitat patches.

Plate 22. Suitable ornamental snake habitat within Habitat Type 3c

Plate 23. Unsuitable ornamental snake habitat within Habitat Type 6b

Plate 24. Ornamental snake observed within the Study Area

Plate 25. Soil cracks observed within ornamental snake habitat

The most common RE the ornamental snake was recorded utilising was RE 11.4.8 (brigalow and/or belah shrubby open forest on Cainozoic clay plains). Habitat for the ornamental snake in the Study Area is mapped on Figure 13. Specifically, ornamental snake habitat within the Study Area comprises REs associated with the ornamental snake (RE 11.3.3, 11.4.8, 11.4.9) (DSEWPaC, 2011a) (except for a patch without suitable microhabitat features), a few patches of woodland with suitable microhabitat features (drainage features), Brigalow TEC, and gilgai soils with suitable microhabitat features. The habitat is mapped as known important habitat because as the species were recorded in these areas and they contain suitable microhabitat features of which the species relies.

In total, ornamental snake habitat covers approximately 4,340.4 ha of the Study Area and 1,834.2 ha of the Project area (Figure 13).

5.3.3 Koala (Phascolarctos cinereus)

The SPRAT Database (DAWE, 2020b) broadly defines koala habitat as any forest, woodland or shrubland containing koala food trees. Koala food trees are primarily *Eucalyptus* species supplemented by certain species in the genera of *Corymbia, Angophora* and *Lophostemon*. In addition to the presence of food trees, the SPRAT profile (DAWE, 2020b) references the value of shelter (non-food) trees for koala thermoregulation as well as the importance of habitat connectivity.

Native vegetation within the Study Area has largely been historically cleared in favour of pastureland. Remaining contiguous patches of remnant eucalypt woodland are mainly restricted to the riparian areas associated with the Isaac River, Cherwell Creek, Ripstone Creek and their tributaries. Correspondingly, 72% of all the previously recorded koala observations in a 20 km radius of the Study Area are located along watercourses where there is a higher density of koala food trees and habitat connectivity (Plate 26). Within the Study Area, evidence of the species (scats and scratches) was recorded at two locations both associated with large intact areas of eucalypt dominated communities adjoining riparian areas (Plate 26).

Nine REs within the Study Area are characterised by eucalyptus species and have potential to support koala habitat: RE 11.3.2, 11.3.25, 11.3.3c, 11.3.4, 11.4.8, 11.5.3, 11.5.9 and 11.9.2. Evaluating the suitability of potential koala habitat within the Study Area (remnant and regrowth vegetation) considered the following during in-situ habitat assessment surveys:

- direct observation or indirect evidence (e.g. scat, tree markings) of koala occurrence
- the abundance and maturity of koala food trees
- extent of canopy cover (limit exposure and facilitate koala movement)
- connectivity amongst koala habitat within fragmented landscapes; and
- the presence of threats (e.g. predation and vehicles).

Studies of koala distribution, habitat utilisation and diet in central Queensland identified *Eucalyptus populnea*, *E. coolabah*, *E. tereticornis* and *E. crebra* or *E. drepanophylla* as key diet species for koalas in the region (Melzer *et al.*, 2014; Melzer *et al.*, 2018; Ellis *et al.*, 2018). *E. camaldulensis* is also considered to be a primary food tree for koalas in central Queensland (Australian Koala Foundation [AKF], 2015).

It is important to note that not all REs comprising koala food trees are default koala habitat. The habitat features that influence the suitability of koala habitat are evaluated collectively, rather than individually, and in the context of species-specific physiological requirements and constraints. Habitat fragmentation is a prominent threat responsible for the decline of koala populations throughout their range. While koalas are mobile and able to traverse open spaces, they are highly susceptible to predation, vehicle strike or misadventure whilst on the ground. The presence of wild dogs recorded within the Study Area decreases the suitability of fragmented habitat as does the absence of connectivity/movement corridors. Koala food trees within a fragmented landscape are of minimal value to koalas if the food trees are inaccessible.

The koala habitat is comprised of remnant and regrowth eucalypt woodland with food trees (Plates 26 and 27) (Figure 14). The areas of remnant and regrowth eucalypt woodland without food trees is also shown on Figure 14 and not considered to be potential habitat for the Koala (Plate 28). The majority of regrowth areas within the Study Area were not considered suitable koala habitat due to the low abundance of koala shelter trees and low canopy cover.

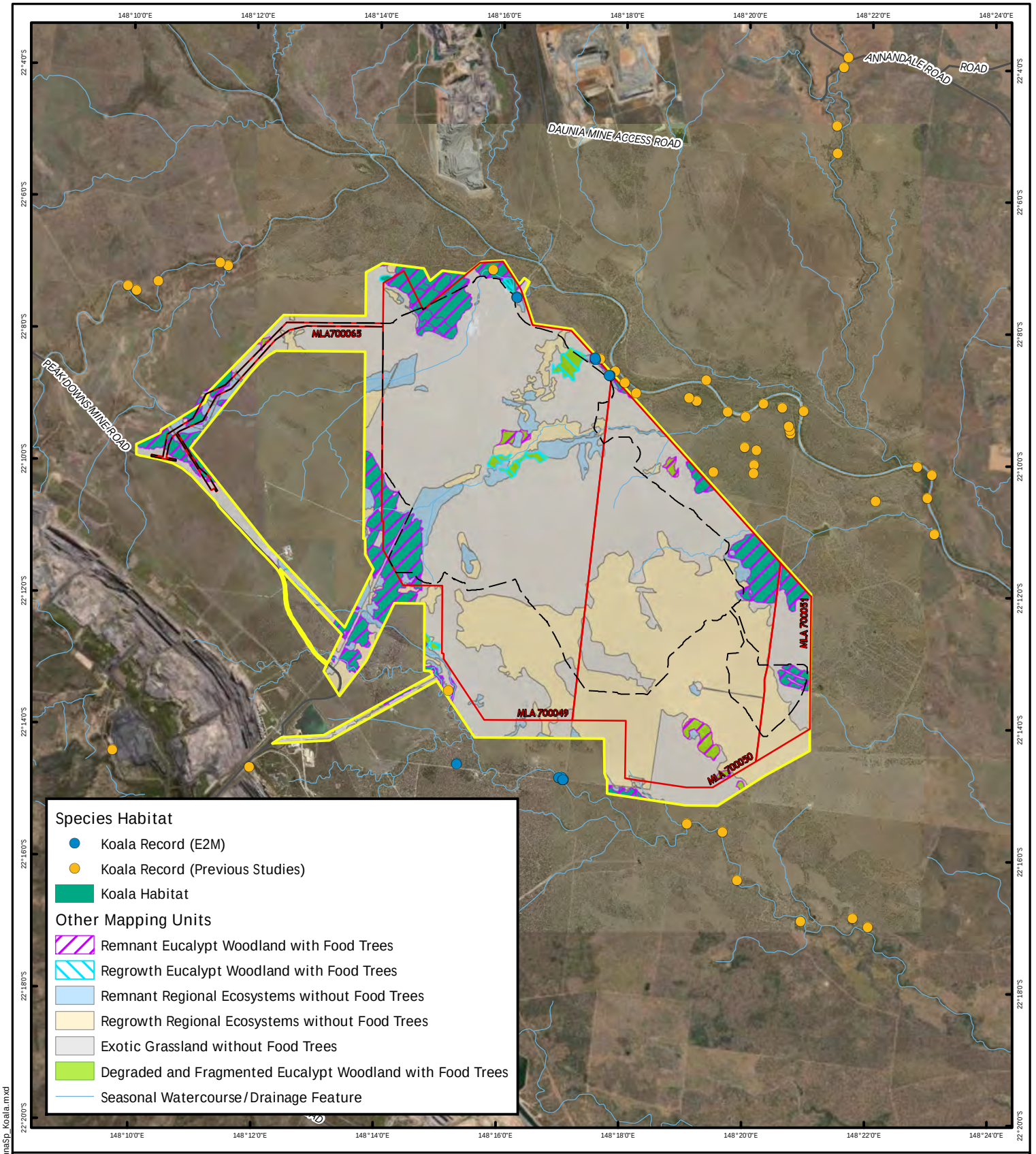
Although RE 11.4.8 is described as *Eucalyptus cambageana* woodland with *Acacia harpophylla* on Cainozoic clay plains, patches of this RE within the Study Area were dominated by *Acacia harpophylla* with a very low abundance of *Eucalyptus cambageana* (Plate 28). The lack of koala food trees within this RE excluded areas of 11.4.8 as koala habitat.

In total, 1,344 ha of suitable koala habitat was identified within the Study Area and 314.5 ha was identified within the Project area (Figure 14).

Plate 26. Koala pellet recorded within remnant RE 11.5.3 during the wet season 2019 survey

Plate 27. Typical suitable koala habitat within the Study Area (RE 11.5.3)

Plate 28. Unsuitable koala habitat – low abundance of koala food trees (RE 11.4.8)



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- Indicative Surface Disturbance Extent
- Mining Lease Application Boundary

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Kilometres

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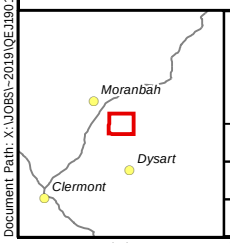
Projection: Transverse Mercator



Notes:
Aerial Imagery: © ESRI 2019, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Cadastre: © DNRME 2019
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0	Issued for Use	DL	BD	27/11/2020
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FIGURE 14: KOALA HABITAT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

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5.3.4 Greater glider (Petauroides volans)

Greater glider habitat is largely restricted to eucalypt forests and woodlands. The species diet comprises mostly eucalypt leaves and sometimes eucalypt flowers (TSSC, 2016a). During the day, greater gliders shelter in large tree hollows and a strong correlation exists between the number of large hollows abundance and the number of greater gliders (Andrews *et al.*, 1994). They are typically found at their highest abundance in montane, moist eucalypt forests that are mature and have large trees with hollows (TSSC, 2016a). The greater glider also favours a diverse range of eucalypt species within their local range because of variability in food preference across seasons (Kavanagh, 1984). There is no definition to distinguish breeding, foraging and dispersal habitats within the SPRAT database (DAWE, 2020b) or approved conservation advice (TSSC, 2016a), however their breeding and foraging habitat is likely the same or similar due to their dependence on eucalypt species and large hollows for both processes. Unlike the koala, greater gliders are not known to disperse across land that does not contain suitable food and shelter trees (TSSC, 2016a). This means they require connectivity of appropriate woodlands between patches of habitat and are sensitive to habitat fragmentation. As such, dispersal habitat is roughly the same as breeding and foraging habitat for the greater glider.

Greater gliders are particularly sensitive to forest clearance (Tyndale-Biscoe & Smith, 2019). Eyre (2002) correlated a decline in population density relative to habitat loss of greater than 15% of suitable habitat. As such, the extent of suitable habitat within the Study Area is limited to contiguous eucalypt dominated communities with a high abundance of large-hollow-bearing trees (Plate 29).

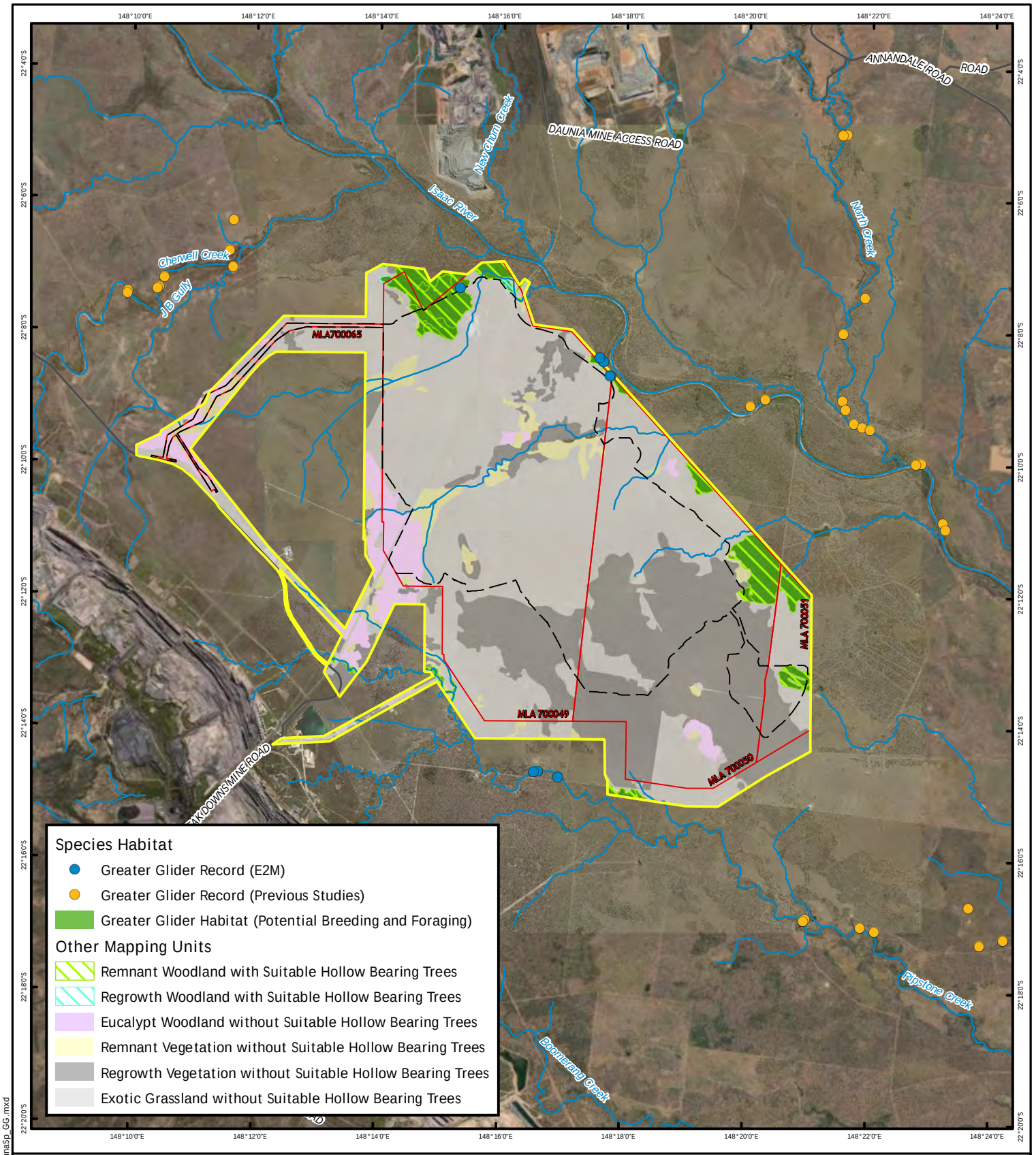
Suitable greater gilder habitat within the Study Area is shown on Figure 15 and consists of areas of five different REs with low fragmentation and high abundances of hollow-bearing trees, including:

- RE 11.3.2
- RE 11.3.25
- RE 11.3.3c
- RE 11.3.4; and
- RE 11.3.5.

In total approximately 703.6 ha and 167.1 ha of suitable habitat occurs within the Study Area and the Project area, respectively (Figure 15) (Plate 30). Areas of eucalypt woodland, remnant vegetation and regrowth without hollows are also mapped on Figure 15 and not considered to be habitat for the Greater Glider.

Plate 29. Typical suitable greater gilder habitat within the Study Area (RE 11.3.3c)

Plate 30. Greater glider observed within Study Area



Legend

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- Road
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- Indicative Surface Disturbance Extent
- Mining Lease Application Boundary

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Kilometres

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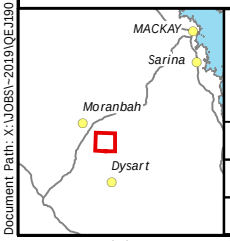

Notes:
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Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	30/10/2020

FIGURE 15: GREATER GLIDER HABITAT

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Map Number	Job Number	Rev
1 of 1	QEJ19011	0

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5.3.5 Squatter pigeon (southern subspecies) (*Geophaps scripta scripta*)

Squatter pigeon foraging and breeding habitat consists of remnant or regrowth open-forest to sparse, open-woodland or low-woodland dominated by Eucalyptus, Corymbia, Acacia or Callitris species on:

- well-draining, sandy or loamy soils on low, gently sloping, flat to undulating plains and foothills (i.e. land zone 5); and
- lateritic (duplex) soils on low 'jump-ups' and escarpments (i.e. land zone 7) (Squatter Pigeon Workshop, 2011; DAWE, 2020b).

It is distinguished by ground-layer vegetation that:

- consists of patchy, native, perennial tussock grasses, or a mix of perennial tussock grasses and low shrubs or forbs; and
- does not cover more than 33% of the ground (Squatter Pigeon Workshop, 2011; DAWE, 2020b).

Foraging habitat is within 3 km of a suitable, permanent or seasonal waterbody, while breeding habitat is located within 1 km of a suitable, permanent or seasonal waterbody (Squatter Pigeon Workshop, 2011; DAWE, 2020b). Within the Study Area, permanent water sources are limited to farm dams and water troughs.

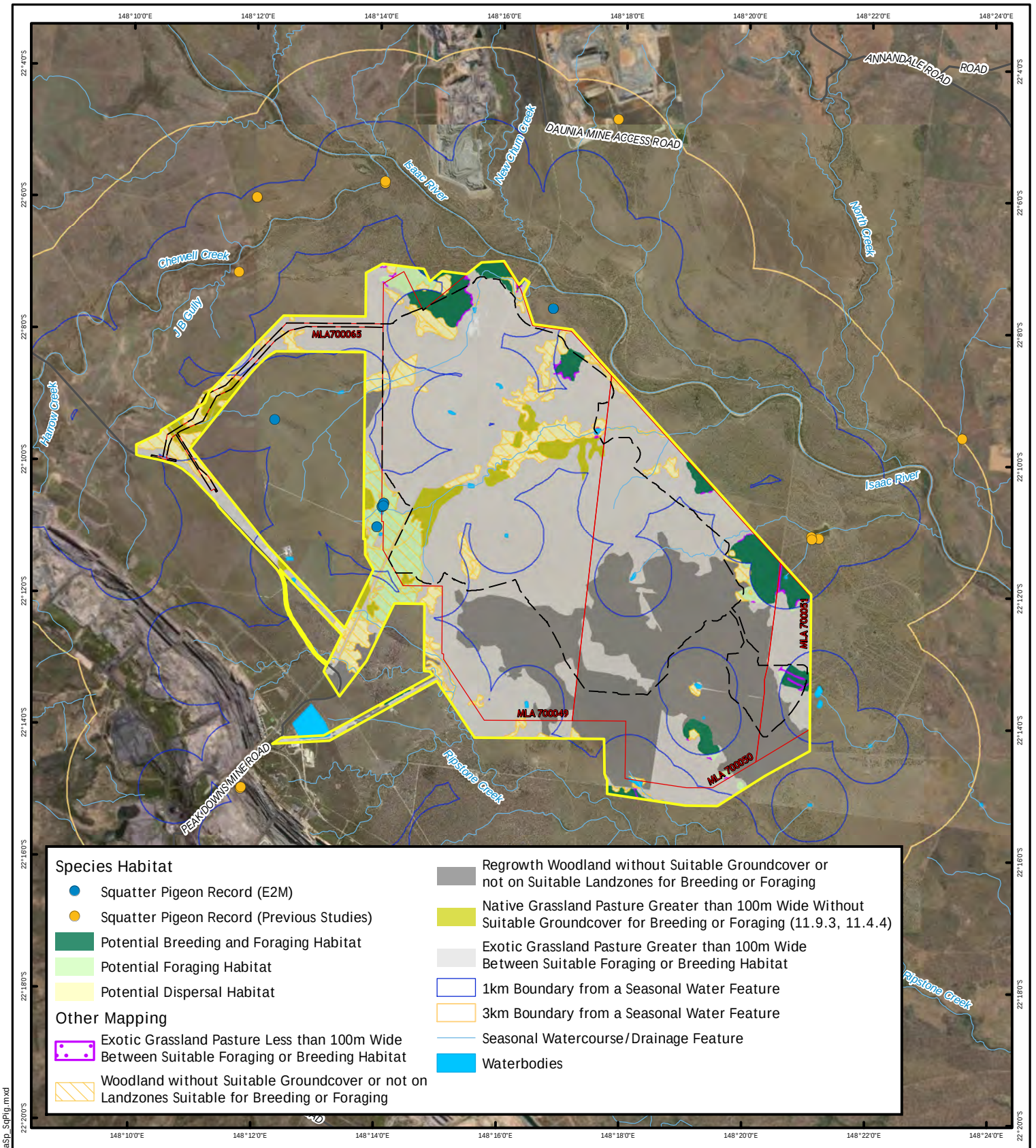
Dispersal habitat is any forest or woodland occurring between patches of foraging or breeding habitat which facilitates movement between patches of foraging habitat, breeding habitat and/or waterbodies. Dispersal habitat includes vegetation where the groundcover layer has been thinned through current land use practices in a way that suits the species (e.g. light cattle grazing). The species does disperse into highly modified or degraded habitats, including cleared areas which are within 100 m of remnant trees or patches of habitat.

While squatter pigeons were recorded across multiple survey events, they were only recorded in low abundances (i.e. single individuals or pairs). Within the Study Area itself, squatter pigeons were recorded from a single area within the vicinity of a farm dam located along the western boundary, where they were recorded over multiple survey events (Figure 16). Based on the SPRAT Database the habitat surrounding the dam (land zone 9) is not consistent with land zones in which the species is known to forage and breed (i.e. land zones 5 and 7). However, given the frequency at which the species was recorded on land zone 9, areas of remnant woodland on land zone 9 within 3 km of the dam are considered to provide suitable foraging habitat for the species in this Study Area (Plate 32). Other surveys conducted in central Queensland have also recorded squatter pigeon (southern subspecies) in land zones other than 5 and 7 (Penn, unpublished).

Squatter pigeon (southern subspecies) foraging habitat was mapped consistent with the above habitat description within 3 km of a suitable, permanent or seasonal waterbody (Figure 16). Breeding habitat was mapped within 1 km of permanent water (Figure 16). Dispersal habitat was mapped as any vegetation community (remnant, non-remnant or regrowth) located between two patches of foraging and/or breeding habitat (including exotic grassland pasture less than 100 m wide between suitable foraging and breeding habitat).

There is approximately 120.7 ha of foraging habitat and 140.5 ha of breeding habitat for the squatter pigeon (southern subspecies) within the Project area and 574.8 ha of foraging habitat and 572.9 ha of breeding habitat within the Study Area.

The mapping excludes exotic (or native) grassland pasture greater than 100 m wide between suitable foraging and breeding habitat as well as woodland (and regrowth woodland) without suitable groundwater or not on land zones suitable for foraging and breeding.



Legend

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- Mining Lease Application Boundary

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Kilometres

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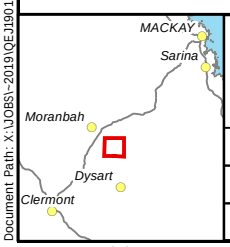

Notes:
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0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 16: SQUATTER PIGEON HABITAT

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1 of 1	QEJ19011	0

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Plate 31. Squatter pigeon (southern subspecies) at a farm dam within the Study Area during the wet season 2019 survey

Plate 32. Squatter pigeon (southern subspecies) foraging habitat located near western dam (RE 11.9.2)

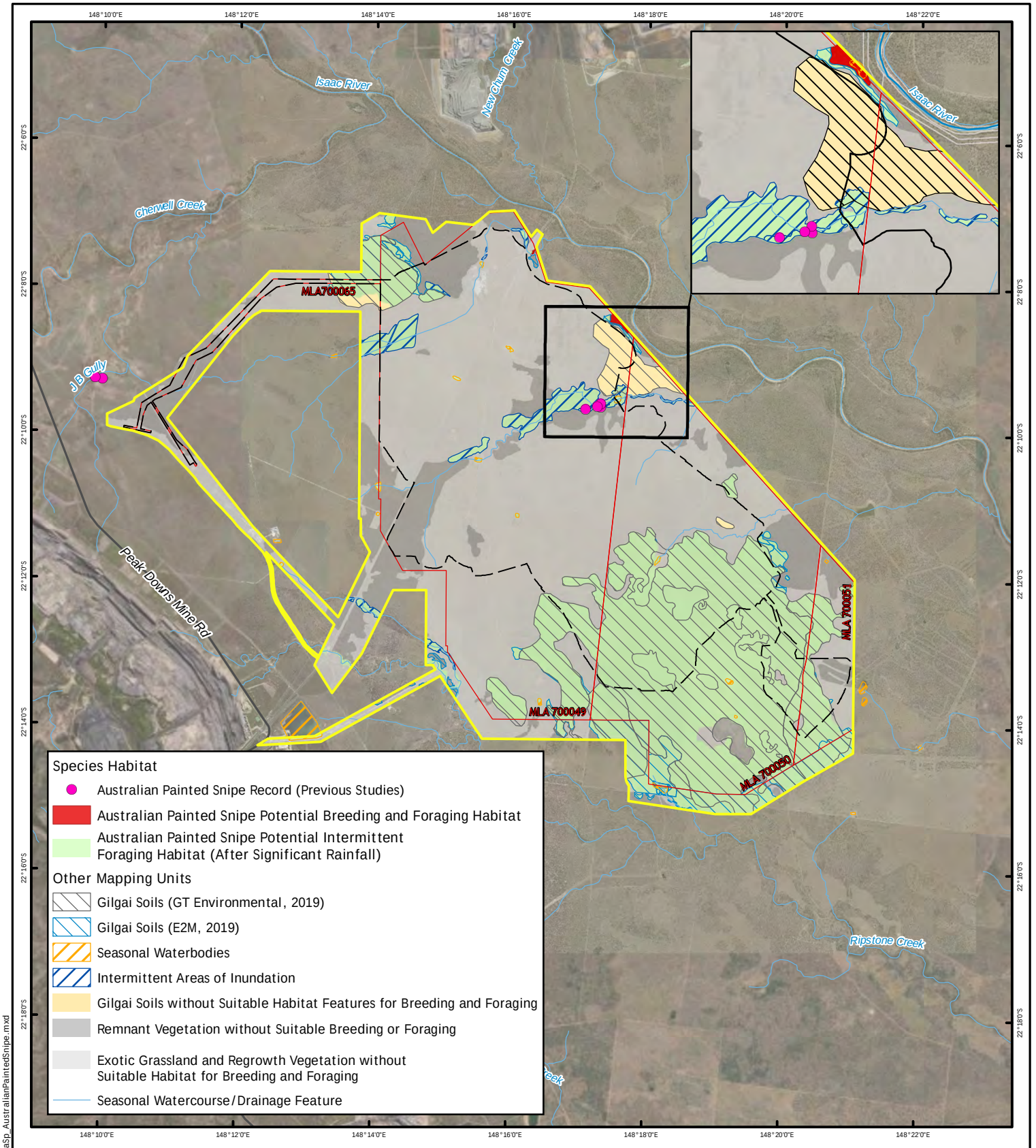
5.3.6 Australian Painted Snipe (*Rostratula australis*)

Australian painted snipe generally forages in a variety of shallow wetlands yet breeding habitat requires specific microhabitat features such as exposed mud, dense low cover, on or near a small island within a shallow, freshwater wetland (Rogers *et al.*, 2005). Breeding habitat for the species is very specific and includes shallow wetlands with areas of bare wet mud with canopy cover nearby. Nests are almost always recorded on or near small islands in freshwater wetlands, which provide a combination of water, exposed mud, dense low cover and sometimes dense canopy cover (Rogers *et al.*, 2005). Areas within the Study Area that provide potentially suitable breeding habitat are restricted to RE 11.3.3c on the floodplain of the Isaac River (Plate 33), while intermitted foraging habitat is more widely available across the Study Area (Figure 17). These intermittent foraging areas include ephemeral gilgai areas (Plate 34) and farm dams (lacustrine wetlands), intermittent waterbodies associated with drainage features (RE 11.3.1).

While the species was not detected during the wet field surveys, the species has been previously recorded within the Study Area by EcoSM in 2013. The observation was made within a brigalow lined waterway in the central portion of the Study Area (RE 11.3.1), consistent with the mapped intermittent foraging habitat. Additionally, the species has been recorded along wetland and riparian habitat during ecological surveys for adjacent projects (DPM Enviros ciences, 2018b; SKM, 2011) (Figure 17).

In total approximately 9.2 ha of potential breeding and foraging habitat occurs within the Study Area, none of which occurs in the Project area (Figure 17). In addition, 1,859.3 ha of potential intermittent foraging habitat (after significant rainfall) associated with gilgai soils and a small wetland occurs within the Project area and 4,407.7 ha within the Study Area (Figure 17). A small wetland associated with RE 11.3.3c occurs in the north of the Project area, however this is not considered to provide potential breeding habitat, as it is small in size and lacks any islands which Australian painted snipe usually nest on (Rogers *et al.*, 2005). This area was therefore identified as intermittent foraging habitat.

The mapping excludes gilgai soils without suitable habitat features for breeding and foraging, remnant vegetation without suitable habitat features for breeding and foraging, and exotic grassland and regrowth vegetation without suitable habitat features for breeding and foraging (Figure 17).



Legend

- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

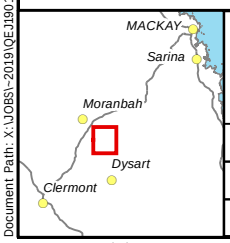
N

Scale 1:130,000 (A4)

0 2 4 6 8

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Wetlands: © DNMRE 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 17: AUSTRALIAN PAINTED SNIPE HABITAT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_17_ThreatFaunaSp_AustralianPaintedSnipe.mxd

Plate 33. Potentially suitable breeding habitat within Palastrine wetlands to the north of the Project area

Plate 34. Intermittent foraging habitat associated with gilgai soils

5.3.7 White-throated Needletail (*Hirundapus caudacutus*)

The white-throated needletail is listed as a vulnerable species under the EPBC Act and the NC Act as well as a marine and migratory species under the EPBC Act. The white-throated needletail was not detected during the field assessments, however the species has been previously recorded within the vicinity (50 km) of the Study Area (DES, 2020d; ALA, 2020) and is considered likely to occur within the Study Area.

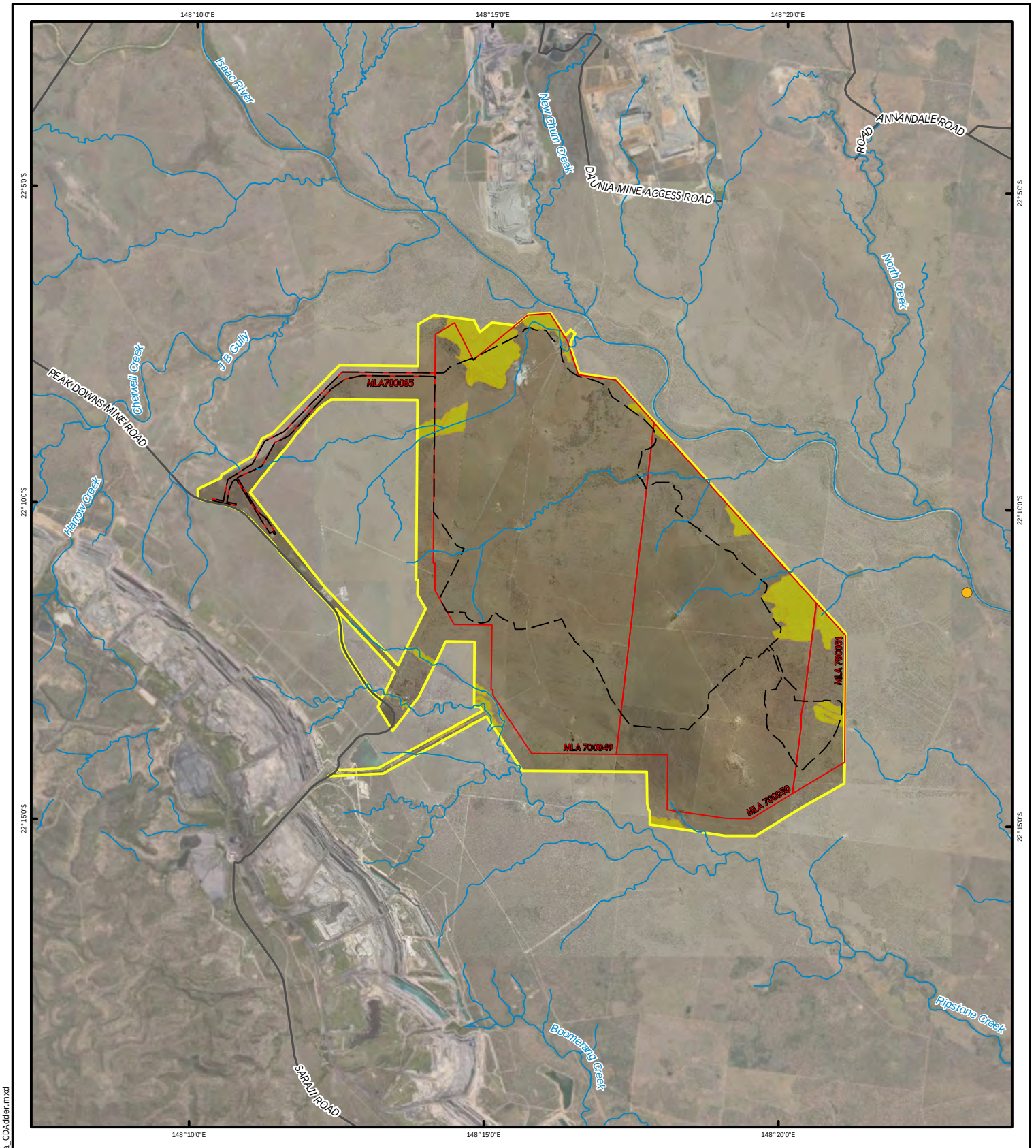
The white-throated needletail is widespread across eastern and south eastern Australia (TSSC, 2019). In Queensland it occurs in all coastal regions including inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains (TSSC, 2019).

In Australia, the species is primarily aerial, from heights of 1 m up to 1000 m above the ground. While they do occur over most habitat types, they are predominately recorded above wooded areas (TSSC, 2019). The species does not breed in Australia, restricted to foraging during their non-breeding season (TSSC, 2019).

5.3.8 Common Death Adder (Acanthophis antarcticus)

The common death adder is found in a variety of habitat types that support the accumulation of dense leaf litter (DES, 2017). This essential microhabitat attribute affords the species camouflage and foraging opportunities.

The species was not recorded by E2M within the Study Area during the field assessment; however the common death adder has previously been recorded approximately 6.5 km to the east of the Project, near the Isaac River (Figure 18). The existing record was reported to be a large specimen found dead (presumably by cane toad poisoning) on the Iffley property during fauna surveys by 3D Environmental / Ecosmart for the Arrow Bowen Gas Project in 2011, in a patch of brigalow (*Acacia harpophylla*) with gilgai (pers. comm. Mark Sanders 16 February 2018 in DPM Envirosciences, 2018b). Within the broader landscape, the common death adder has been recorded approximately 61 km and 71 km from the Study Area (Figure 19) (DES, 2020d).



Legend

- Watercourse and Drainage Feature
- Road
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

Species Habitat

- Common Death Adder (Previous Studies)
- Common Death Adder Habitat

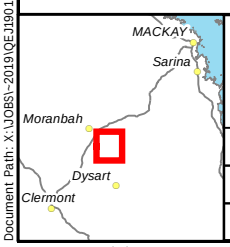
N

Scale 1:150,000 (A4)

0 1.5 3 4.5 6

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019
GTRE: © E2M 2019

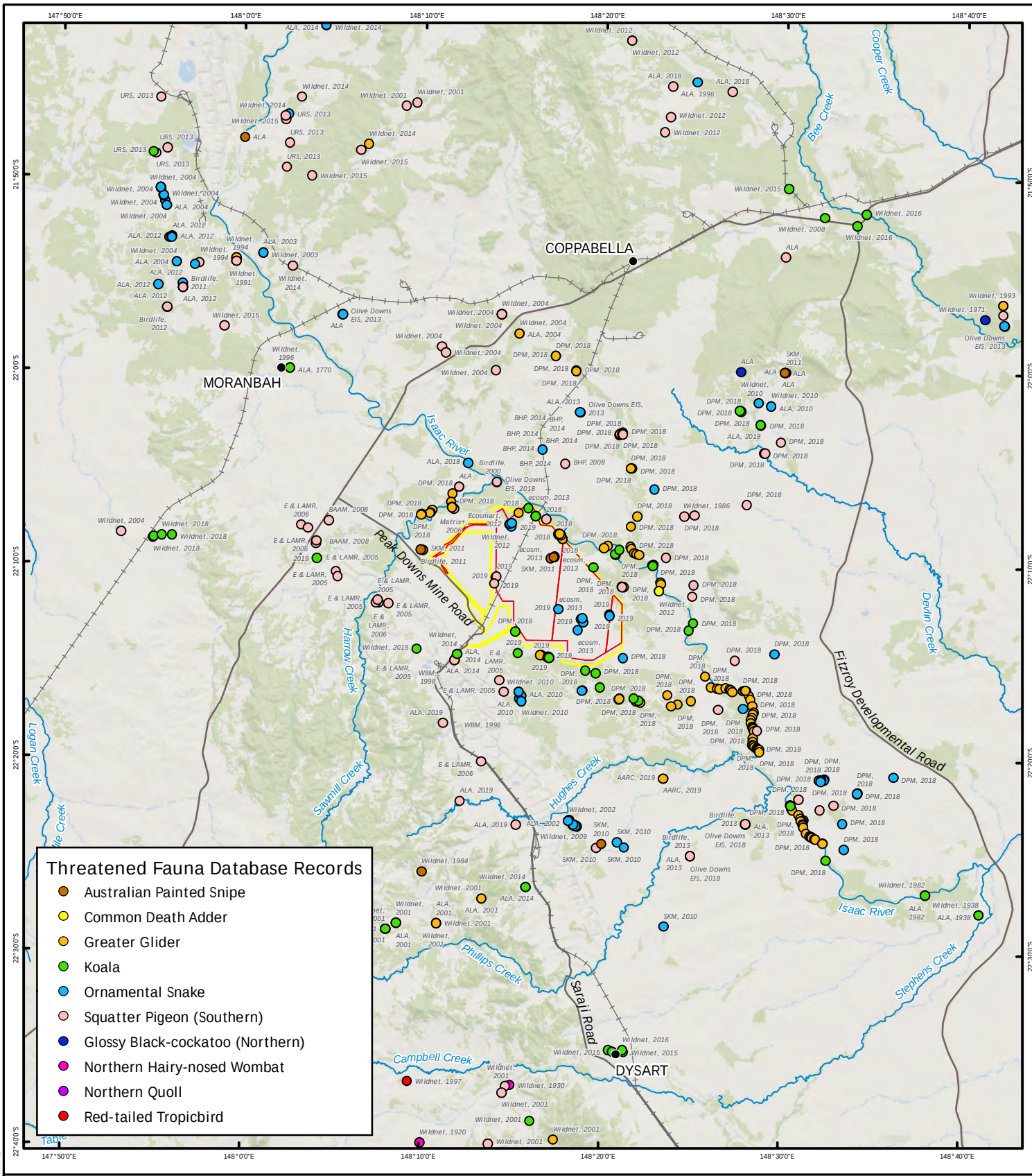
Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	16/10/2020

FIGURE 18: COMMON DEATH ADDER HABITAT

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_18_MSES_Fauna_CDAdder.mxd



Legend

- Road
- Railway
- Mining Lease Application Boundary
- Study Area

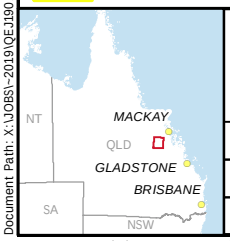
N

Scale 1:500,000 (A4)

0 5 10 15 20

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Mining Leases: © DNRME 2019
Railway: © DNRME 2019
Road: © PSMA 2014
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Fauna records compiled from published EIS in surrounding region

Rev	Description	Drawn	Approved	Date
1	Issued for Use	DL	BD	24/03/2021
0	Issued for Use	DL	BD	27/11/2020

FIGURE 19: THREATENED FAUNA SPECIES DATABASE RECORDS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	1

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_19_FaunaEVNT.mxd

Similar to the conclusion made by DPM Envirosciences (2018b), the species has a very broad habitat range and may be associated with any of the habitat types containing remnant vegetation located in the Study Area (Figure 18). However, if it were to occur, it would only be expected to occur in very low numbers. As this species has a very broad habitat range and was not recorded within the Study Area despite recent targeted surveys, it is considered unlikely that there would be a significant impact on the common death adder.

5.3.9 Short-beaked Echidna (*Tachyglossus aculeatus*)

The short-beaked echidna is listed as 'special least concern' under the NC Act due to its significant cultural importance. The species is relatively widespread and occur in a variety of habitat and has been detected during previous ecological assessments in the local area. Within the Study Area, potential habitat includes remnant, mature regrowth and regrowth woodlands equating to approximately 6,134 ha of the Study Area.

5.4 Migratory fauna

Seventeen migratory birds were identified during the Desktop Assessment as having the potential to occur within the Study Area, however when evaluated against the Likelihood of Occurrence Assessment criteria and the results of the field surveys, only four species were considered likely to occur or known to occur (as discussed below). Habitat features were either absent or a species observation had never been recorded within the Study Area or the broader landscape to support the remaining 13 migratory species. The full likelihood of occurrence assessment is presented in Appendix D.

It was determined that the Study Area does not contain important habitat for migratory species as it does not include (DotE, 2013b):

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or
- habitat that is of critical importance to the species at life-cycle stages, and/or
- habitat utilised by a migratory species which is at the limit of the species range, and/or
- habitat within an area where the species is declining.

5.4.1 Fork-tailed swift (*Apus pacificus*)

One fork-tailed swift was recorded within the Study Area by E2M during the wet season 2020 survey. The species is listed as marine and migratory under the EPBC Act and is subject to the China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA). Fork-tailed swift breed in Siberia from August to September, migrating to Australia in October, where they are almost exclusively aerial.

5.4.2 Satin flycatcher (Myiagra cyanoleuca)

One satin flycatcher was recorded within the Study Area by E2M during the wet season 2019 survey. Satin flycatchers migrate between northern Australia/New Guinea during winter months and south-eastern Australian in summer. The species moves through Queensland from late August to November, inhabiting eucalypt dominated woodlands and open forests (Blakers *et al.*, 1984; Nielsen, 1991). Within the Study Area, satin flycatcher habitat comprises the eucalypt woodland, coolabah wetlands, and blue gum open forest/riparian habitat types.

5.4.3 Latham's snipe (Gallinago hardwickii)

Latham's snipe is listed as a marine and migratory species under the EPBC Act, subject to the Convention of the Conservation of Migratory Species of Wild Animals (BONN Convention) as well as the JAMBA and ROKAMBA. Latham's snipe breed in Japan and on the east Asian mainland, and migrate to south-eastern Australia during summer months where they occupy a variety of habitat types including freshwater wetlands, crops/pastures and coastal swamps.

The species has been previously recorded within the desktop search extent and is considered likely to occur within the Study Area's wetlands, farm dams and inundated drainages.

5.4.4 Glossy ibis (Plegadis falcinellus)

The glossy ibis is listed as a marine and migratory species under the EPBC Act and subject to the BONN Convention. The species has a widespread, global distribution but within Queensland, the species migrates between its core breeding habitat and its non-breeding habitat. Breeding habitat is restricted to a limited number of locations. Most breeding records in Queensland are in the State's far south-west. Non-breeding habitat is varied and includes freshwater wetlands, flood plains, reservoirs, ponds and cultivated areas.

The species has been previously recorded within the desktop search extent. Farm dams and ephemeral wetland areas within the Study Area are considered to provide potential habitat for the species. Glossy ibis is considered likely to occur.

5.5 Pest fauna

Eight pest fauna species were observed during field assessments within the Study Area:

- cane toad (*Rhinella marina*)
- common myna (*Acridotheres tristis*)
- cat (*Felis catus*)
- European hare (*Lepus europaeus*)
- European rabbit (*Oryctolagus cuniculus*)
- house mouse (*Mus musculus*)
- pig (*Sus scrofa*); and
- wild dog (*Canis lupus*).

These species are not associated with a specific habitat type and are wide ranging in area. Generally, all pest species were detected in low to moderate abundances. European rabbits were observed relatively more frequently compared to other pest species, though dogs and cats were also recorded across the majority of the Study Area.

Wild dog and feral cat are known threatened processes for several threatened fauna species, including koala and squatter pigeon (southern subspecies). Wild dogs are well documented to opportunistically predate koalas (DAWE, 2020b) while feral cats and foxes (not detected during field surveys, but likely to occur within the Study Area) are a known threatening process affecting squatter pigeon (southern subspecies) populations (DAWE, 2020b).

Cane toads were observed in abundance throughout the Study Area including within the brigalow regrowth (Habitat 3c) where they co-exist with ornamental snake habitat. As a specialist predator of amphibians, the ornamental snake is likely to predate small cane toads potentially resulting in the snake's mortality.

6 Survey Results Summary

6.1 MNES survey results summary

A summary of MNES that are known or likely to occur within the Study Area is provided in Table 14 and depicted on Figure 20.

6.2 MSES survey results summary

The following environmental matters identified within the Study Area qualify as MSES:

- regulated vegetation
- connectivity
- wetlands and watercourses; and
- protected wildlife habitat.

6.2.1 Regulated vegetation

MSES regulated vegetation includes prescribed REs containing remnant vegetation. MSES regulated vegetation within the Study Area are:

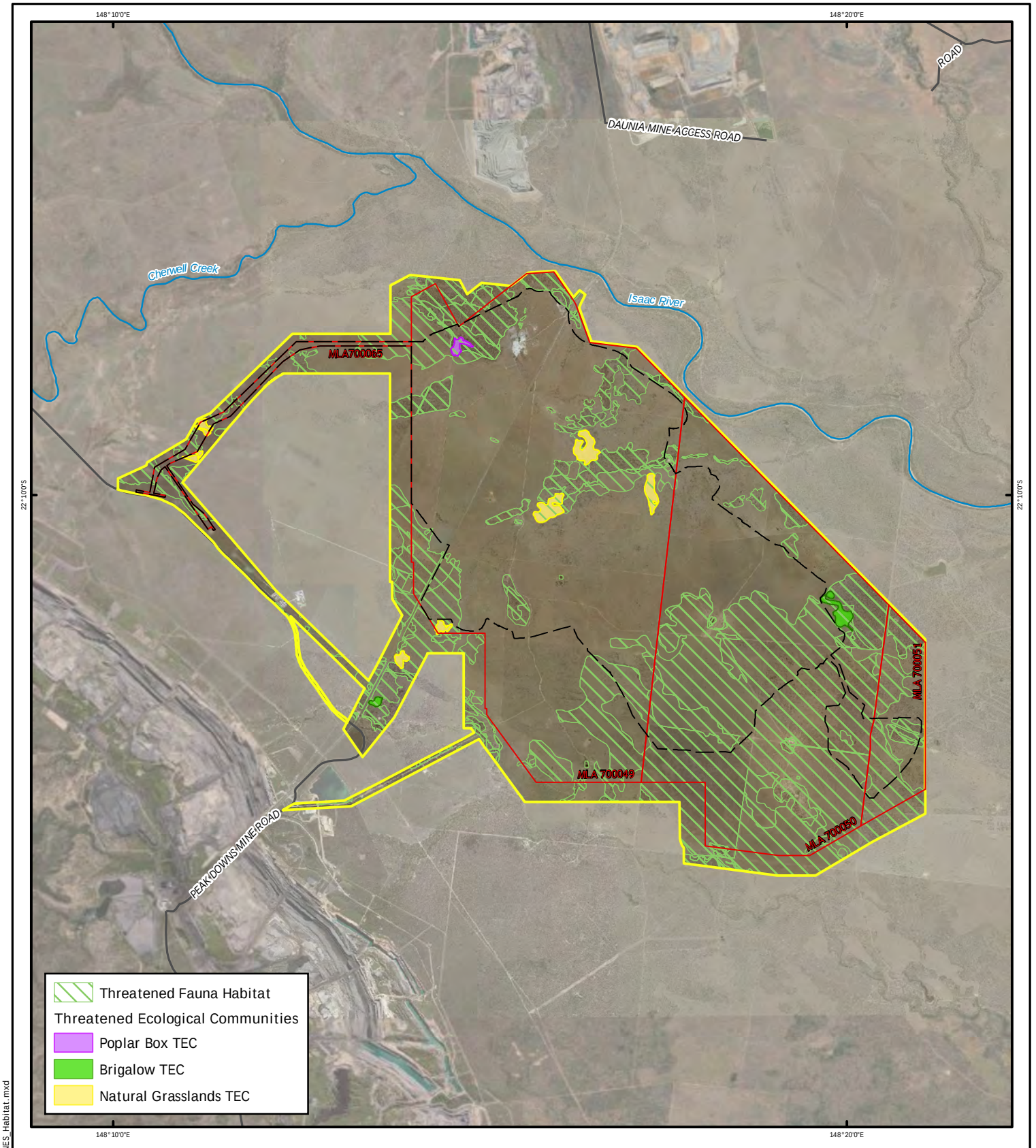
- REs listed as endangered or of concern under the VM Act (seven REs)
- REs that intersect with an area shown as a wetland on the Queensland vegetation management wetlands map (to the extent of the intersection)
- an area of essential habitat as per the essential habitat map for flora and fauna listed as endangered, vulnerable or near threatened under the NC Act; and
- REs located within the defined distance[3] from the defining banks of a relevant watercourse or drainage feature on the vegetation management watercourse and drainage feature map.

A summary of MSES Regulated Vegetation ground-truthed within the Study Area is provided within Table 15.

[3] ***defined distance***, for a regional ecosystem, means a distance identified in the *Queensland Environmental Offsets Policy* as the relevant distance from the defining banks of a relevant watercourse or relevant drainage feature.

Table 14. MNES identified within the Study Area

Community/Species	EPBC Act status	Area (ha) within Study Area	Comment	Relevant section
Nationally Threatened Ecological Communities				
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	28.9	Associated with patches of RE 11.4.8 and 11.9.5	Section 4.4.1
Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	Endangered	104.1	Areas of remnant RE 11.4.4 and 11.9.3	Section 4.4.2
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	9.6	One area of remnant RE 11.3.2	Section 4.4.3
Nationally Threatened Species				
Denisonia maculata **ornamental snake**	Vulnerable	4,340.4	Known to occur; associated with areas containing deep gilgai and soil cracks	Section 5.3.2
Phascolarctos cinereus **koala**	Vulnerable	1,355.1	Known to occur; associated with eucalypt dominated communities	Section 5.3.3
Petauroides volans **greater glider**	Vulnerable	703.6	Known to occur; associated with eucalypt dominated communities containing large hollows	Section 5.3.4
Geophaps scripta scripta **squatter pigeon (southern subspecies)**	Vulnerable	572.9 (breeding / foraging) 574.8 (foraging) 1,158.1 (dispersal)	Known to occur; associated with remnant and growth woodland on LZ5 and LZ9	Section 5.3.5
Rostratula australis **Australian painted snipe**	Endangered	9.2 (breeding / foraging) 4,407.7 (intermittent foraging)	Known to occur; associated with wetlands, flooded drainage lines and farm dams	Section 5.3.6
Hirundapus caudacutus **white-throated needletail**	Vulnerable	N/A	Likely to occur; almost exclusively aerial; likely to forage aerially above the Study Area	Section 5.3.7
Migratory species				
Apus pacificus **fork-tailed swift**	marine, migratory (CAMBA, JAMBA, ROKAMBA)	N/A (the Study Area is unlikely to contain important habitat)	Known to occur; likely to forage aerially above the Study Area	Section 5.4.1
Myiagra cyanoleuca **satin flycatcher**	marine, migratory	N/A (the Study Area is unlikely to contain important habitat)	Known to occur	Section 5.4.2
Gallinago hardwickii **Latham's snipe**	marine, migratory (BONN, JAMBA, ROKAMBA)	N/A (the Study Area is unlikely to contain important habitat)	Likely to occur	Section 5.4.3
Plegadis falcinellus **glossy ibis**	marine, migratory (BONN)	N/A (the Study Area is unlikely to contain important habitat)	Likely to occur	Section 5.4.4



Legend

- Watercourse and Drainage Feature
- Road
- Primary Study Area
- Indicative Surface Disturbance Extent
- Mining Lease Application Boundary

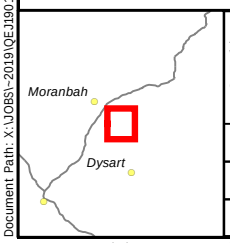
N

Scale 1:130,000 (A4)

0 2 4

Kilometres

Coordinate System: GCS GDA 1994



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 20: MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_20_Verified_MNES_Habitat.mxd

Table 15. MSES Ground-truthed Regulated Vegetation

RE	Status (VM class)	Structure Category	Area (ha) within Study Area
Endangered and Of Concern REs			
11.3.1	Endangered	Mid-dense	127.5
11.3.2 [A]	Of Concern	Sparse	22.2
11.3.3c	Of Concern	Sparse	16.1
11.3.4	Of Concern	Sparse	66.9
11.4.8 [B]	Endangered	Sparse	82.1
11.4.9	Endangered	Sparse	39.4
11.9.5 [C]	Endangered	Mid-dense	31.2
Regulated Vegetation within the defined distance of a mapped Vegetation Management wetland			
11.3.3c[#]	NA	N/A	8
Regulated Vegetation within the Defined Distance of a Vegetation Management Watercourse			
11.3.1	Endangered	Mid-dense	6.4
11.3.3c	Of Concern	Sparse	0.3
11.3.25	Least Concern	Sparse	3.2
11.4.4 [D]	Least Concern	Grassland	0.1
11.5.3	Least Concern	Sparse	0.9
11.9.2	Least Concern	Sparse	0.8
11.9.3 [E]	Least Concern	Grassland	6.7
Essential habitat[1]			
Denisonia maculata ornamental snake	N/A	N/A	1,338.0

[1] Based on DNRME mapping, the actual area of habitat for the ornamental snake is provided in Table 16.

[A] 9.6 ha of RE 11.3.2 is also listed as Poplar Box TEC and is included in the quantities listed in Table 14.

[B] 24.1 ha of RE 11.4.8 is also listed as Brigalow TEC and is included in the quantities listed in Table 14.

[C] 4.8 ha of RE 11.9.5 is also listed as Brigalow TEC and is included in the quantities listed in Table 14.

[D] 45.7 ha of RE 11.4.4 is also listed as Natural Grasslands TEC and is included in the quantities listed in Table 14.

[E] 58.4 ha of RE 11.9.3 is also listed as Natural Grasslands TEC and is included in the quantities listed in Table 14.

[#] The occurrence of RE 11.3.3c in the Project area is not within a mapped Vegetation Management Wetland.

6.2.2 Connectivity areas

A connectivity area is defined as a prescribed regional ecosystem that contains an area of land required for ecosystem functioning (DES, 2020a; DEHP, 2014). Therefore, all remnant vegetation within the Study Area is considered to potentially contain connectivity values. The Study Area contains approximately 2,116.2 ha of connectivity area.

6.2.3 Wetlands and watercourses

The following wetlands and watercourses are MSES:

- wetlands in a Wetland Protection Area as shown on the map of Great Barrier Reef wetland protection areas
- wetlands of High Ecological Significance (HES) as shown on the map of Queensland wetland environmental values; and
- wetland or watercourse in a high ecological value waters as identified under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019*.

No wetland Protection Areas, HES wetlands or high ecological value waters traverse the Study Area.

6.2.4 Protected wildlife habitat

The following protected wildlife habitat qualifies as a MSES:

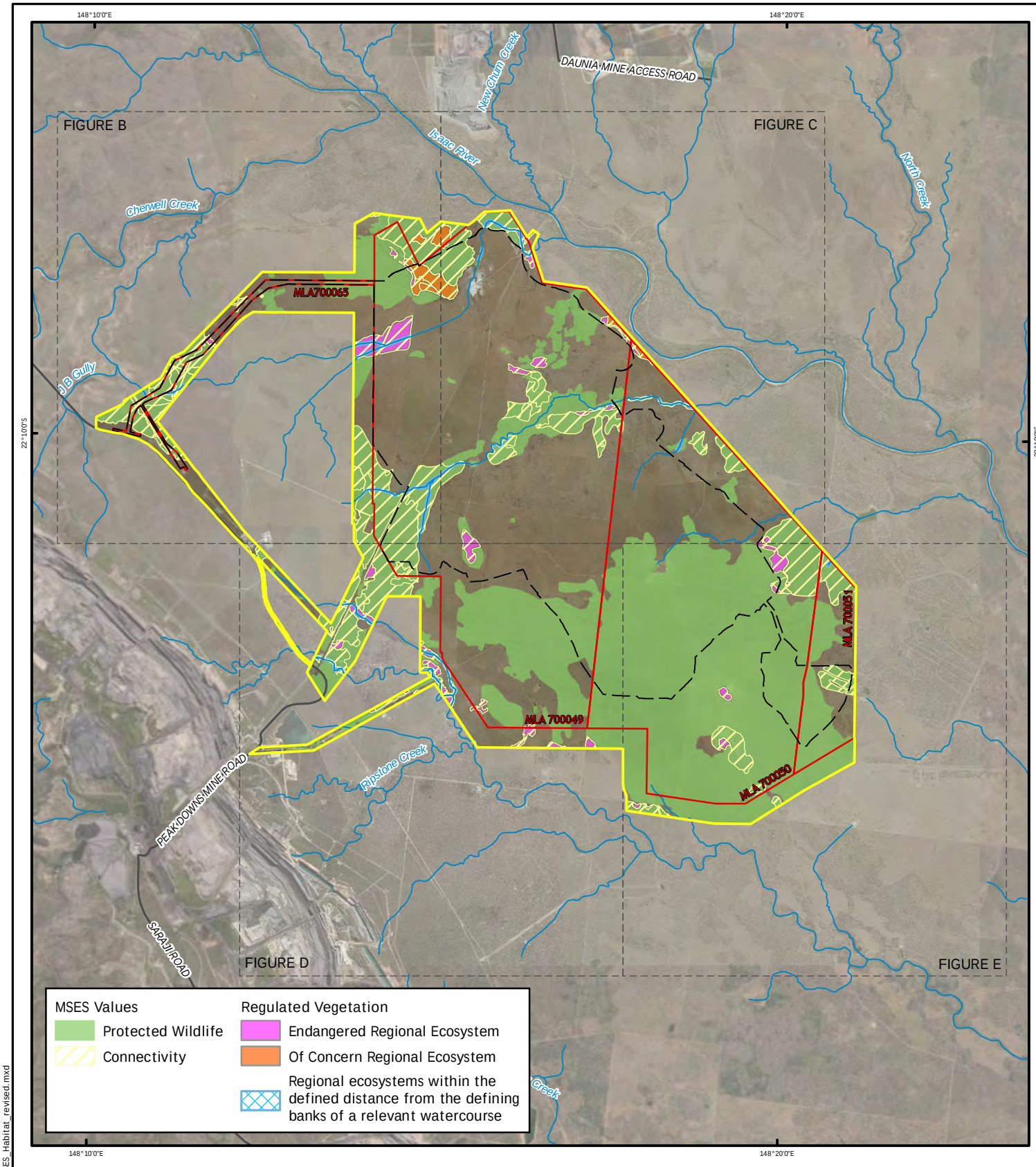
- habitat for endangered or vulnerable listed flora and fauna listed under the NC Act
- habitat for special least concern fauna under the NC Act
- koala habitat area (under section 7B[1] of the Queensland *Nature Conservation (Koala) Conservation Plan 2017*); and
- a high-risk area on the flora survey trigger mapping.

Habitat is defined in DEHP (2014) as *'the area occupied, or periodically or occasionally occupied, by any species, population or ecological community and includes all the different aspects (both biotic and abiotic) used by species during the different stages of their life cycles.'*

A summary of Protected Wildlife Habitat and associated species is provided in Table 16 and depicted in (Figure 21A-E).

Table 16. MSES Protected Wildlife Habitat within the Study Area

Habitat type/species	NC Act status	Area of habitat (ha)	Relevant section
Solanum adenophorum	Endangered	0.2 (known) 3,717.3 (potential habitat)	Section 4.5.1
Denisonia maculata **ornamental snake**	Vulnerable	4,340.4	Section 5.3.2
Phascolarctos cinereus **koala**	Vulnerable	1,355.1	Section 5.3.3
Petauroides volans **greater glider**	Vulnerable	703.6	Section 5.3.4
Geophaps scripta scripta **squatter pigeon (southern subspecies)**	Vulnerable	572.9 (breeding / foraging) 574.8 (foraging) 1,158.1 (dispersal habitat)	Section 5.3.5
Rostratula australis **Australian painted snipe**	Endangered	9.2 (breeding / foraging) 4,407.7 (intermittent foraging)	Section 5.3.6
Hirundapus caudacutus **white-throated needletail**	Vulnerable	N/A	Section 5.3.7
Acanthophis antarcticus **common death adder**	Vulnerable	873.6	Section 5.3.8
Tachyglossus aculeatus **short-beaked echidna**	Special Least Concern (non-migratory)	6,134	Section 5.3.9



Legend

- Watercourse and Drainage Feature
- Road
- Primary Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

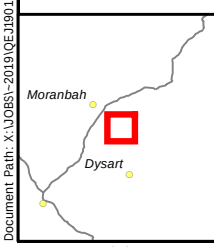
N

Scale 1:130,000 (A4)

0 2 4

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019

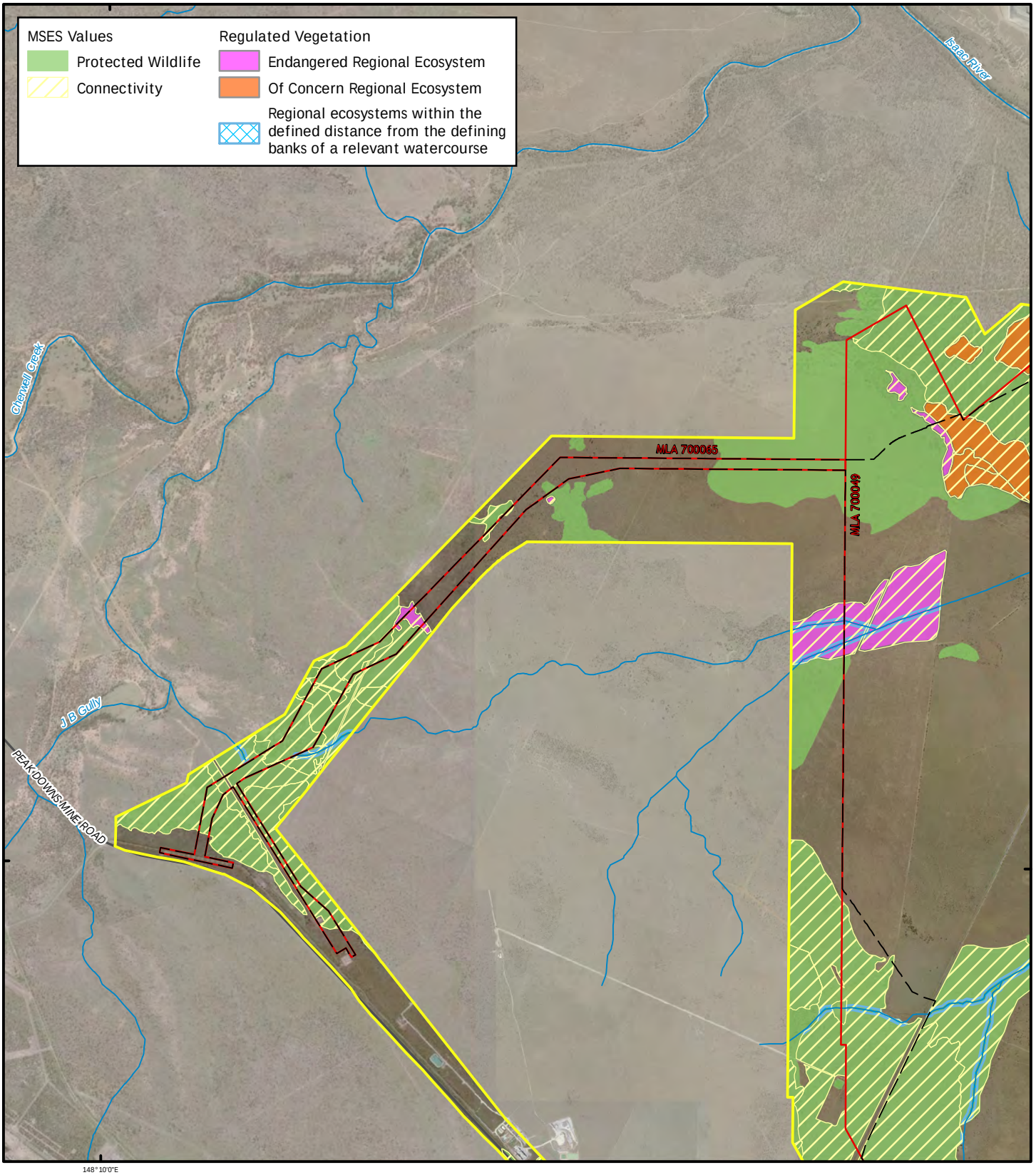
Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 21A: MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE BASED ON FIELD VERIFICATION OVERVIEW

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_21_Verified_MSES_Habitat_revised.mxd



Legend

- Watercourse and Drainage Feature
- Road
- Primary Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

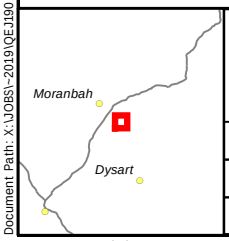
N

Scale 1:51,000 (A4)

0 2

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 21B: MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

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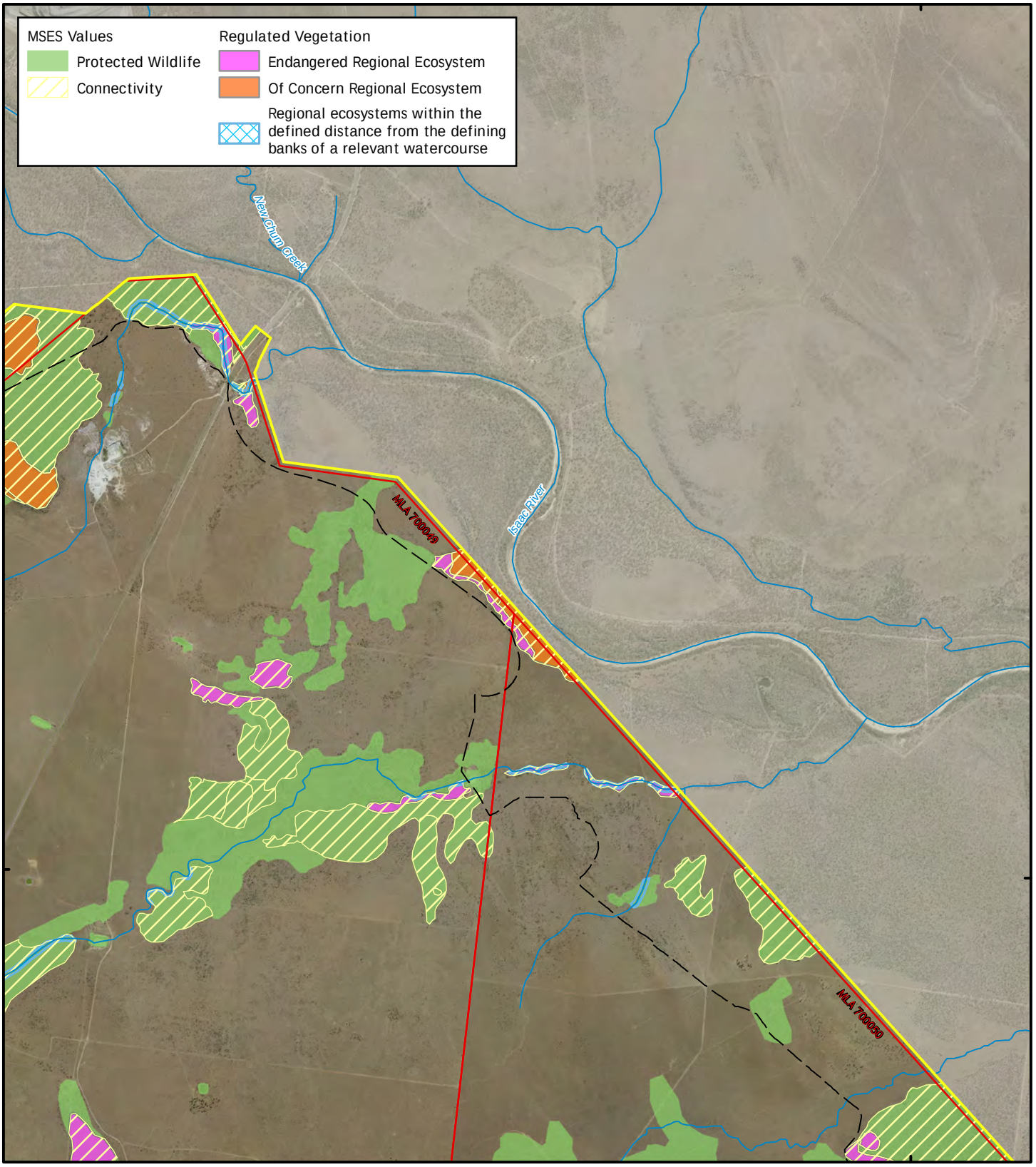


Legend

- Watercourse and Drainage Feature
- Road
- Primary Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

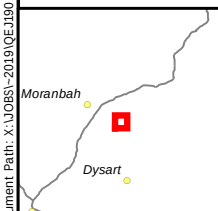
N

Scale 1:51,000 (A4)

0 2

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019

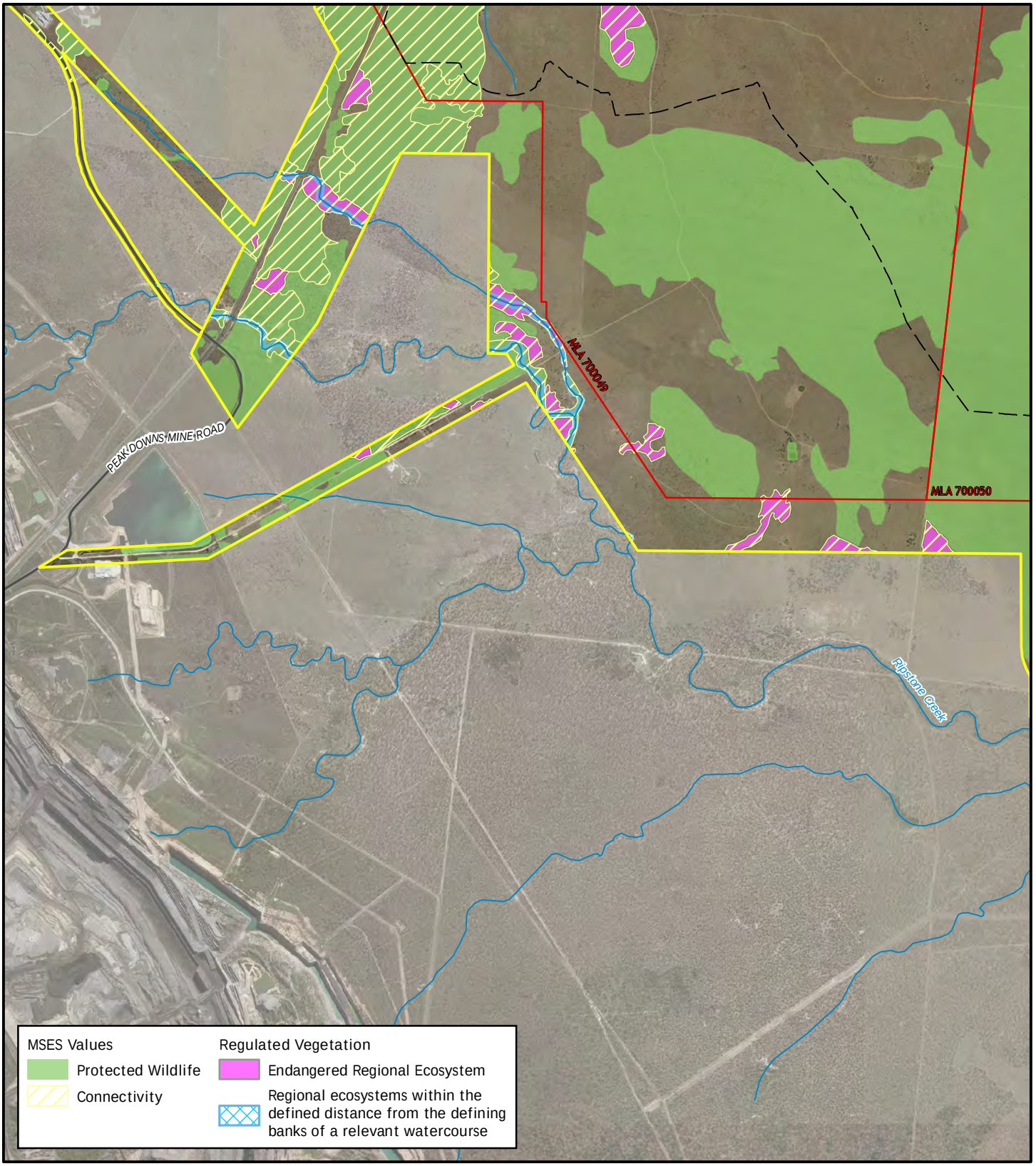
Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 21C: MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_21_Verified_MSES_Habitat_revised.mxd



Legend

- Watercourse and Drainage Feature
- Road
- Primary Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

N

Scale 1:51,000 (A4)

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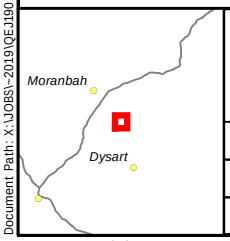
Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019

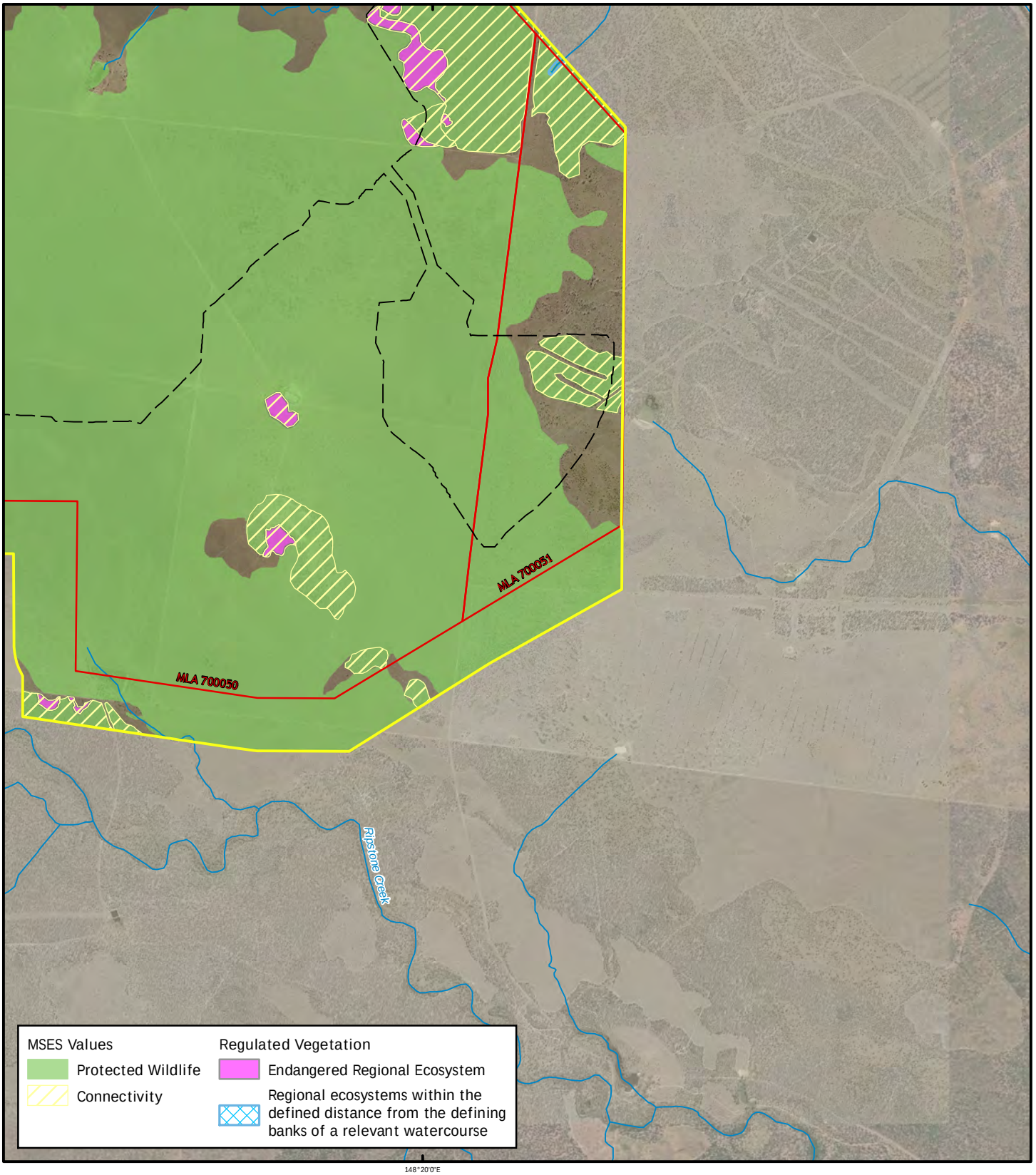
Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 21D: MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_21_Verified_MSES_Habitat_revised.mxd



Legend

- Watercourse and Drainage Feature
- Road
- Primary Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

N

Scale 1:51,000 (A4)

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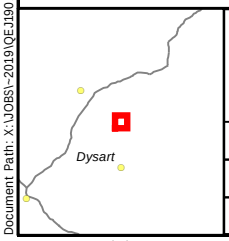
Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
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Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 21E: MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE BASED ON FIELD VERIFICATION

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\~2019\QEJ19011\GIS\QEJ19011_TEA_21_Verified MSES_Habitat_revised.mxd

7 Potential impacts

7.1 Native vegetation clearance

The overall extent of the surface disturbance associated with the Project area is approximately 7,130 ha. The majority (90%, 6,408.6 ha) of vegetation within the Project area has been historically cleared in favour of livestock grazing and agriculture and exists in a non-remnant state[4]. The Project would require the progressive removal of 719.9 ha of the remaining remnant vegetation in the Study Area (Table 17).

The Project would impose the greatest impact to REs associated with Natural Grasslands, making up 38.6% (277.7 ha) of the remnant vegetation. The remnant vegetation to be cleared is mostly comprised of vegetation that is Least Concern under the VM Act (555.6 ha, 78%), however, the Project would result in vegetation clearing within two TECs listed under both the VM Act and the EPBC Act, namely:

- approximately 80.9 ha of Natural Grasslands TEC (REs 11.4.4 and 11.9.3, EPBC Act: 'Endangered'); and
- approximately 9.6 ha of Poplar Box TEC (RE 11.3.2, EPBC Act: 'Endangered').

Approximately 28.9 ha of Brigalow TEC (REs 11.4.8 and 11.9.5, EPBC Act: 'Endangered') was identified within the Study Area but it is located outside of the Project area.

The native vegetation communities/REs to be cleared more commonly occur in the surrounding landscapes to the Study Area. Table 17 also provides the total area of each RE within the subregions (Northern Bowen Basin subregion and Isaac-Comet Downs subregion) as reported by (Accad *et al.*, 2019). Less than 0.2% of the REs in the subregions would be cleared by the Project.

The proposed mitigation measures to be implemented to reduce potential impacts on native vegetation clearing are presented in Section 10. A significant impact assessment of these are discussed further in Sections 10.2 and 10.3 with an MNES Impact Assessment provided in Appendix G and a summary of the REs provided in Appendix E.

7.2 Fauna habitat removal

Habitat within the Study Area was categorised into 11 broad habitat types (refer to Section 5.2) based on vegetation type and structure. The total area of each habitat type situated within the Project area is summarised in Table 18.

The majority (approximately 59.3%, 4,220.89 ha) of the Project area is pastureland (without gilgai) (Habitat 6a) containing little habitat value for generic or threatened fauna species. The regrowth and remnant vegetation communities (Habitats 1 to 3b) however were found to support a diversity of fauna species and habitat features. The habitat features for threatened fauna species have been mapped on Figures 13 to 18.

The Project would also remove farm dams (Habitat 7) and portions of ephemeral unnamed waterways that traverse the open cut extent and waste rock emplacement. These are further described in the Aquatic Ecology Assessment (ESP, 2021) prepared for the Project.

The proposed mitigation measures to be implemented to reduce potential impacts on fauna habitat removal are presented in Section 10. The need for buffer zones has been assessed and management of palustrine wetlands is discussed in Section 10.4.6.

[4] The non-remnant vegetation comprises Mature Regrowth / Disturbed Eucalypt Woodland (Habitat 2b), Mature Regrowth / Disturbed Brigalow +/- Eucalyptus spp. Woodland (Habitat 3b), Brigalow Regrowth (<2m tall) (Habitat 3c), Pastureland without Gilgai (Habitat 6a) and Pastureland with Gilgai (Habitat 6b) (Figure 12). These mapping units are further discussed in Section 7.2.

Table 17. Remnant vegetation clearance

Broad Vegetation Group	RE	Conservation status			Clearance within Project area (ha)	Total Remnant within the Northern Bowen Basin subregion and Isaac-Comet Downs subregion[1] (ha)
		VM Act	Biodiversity status	EPBC Act		
Brigalow Woodland	11.3.1	E	E	E	64.5	29,173.77
	11.4.9	E	E	E	23.1	23,397.40
	11.9.5	E	E	E	17.7	10,475.30
Poplar Box	11.3.2	OC	OC	E[2]	9.6	66,297.69
	11.5.3	LC	No Concern at Present	-	111.0	151,463.73
	11.9.2	LC	No Concern at Present	-	167.1	49,628.91
Natural Grasslands	11.4.4	LC	OC	E[3]	112.0	2,154.39
	11.9.3	LC	No Concern at Present	E[4]	165.8	9,179.15
Coolabah wetlands	11.3.3c	OC	OC	-	6.9	807.47
Eucalypt open woodlands	11.3.4	OC	OC	-	39.8	26,320.53
	11.4.8	E	E	-	2.4	22,659.91
				Total	**719.9**	**391,558.25**

1 Accad *et al.* (2019).
2 Approximately 9.6 ha of RE 11.3.2 in the Project area equates to the Poplar Box TEC.
3 Approximately 45.7 ha of RE 11.4.4 in the Project area equates to the Natural Grasslands TEC.
4 Approximately 35.2 ha of RE 11.9.3 in the Project area equates to the Natural Grasslands TEC.

Table 18. Habitat clearance

Habitat Type		Clearance within Project area (ha)
Habitat 1	Coolabah Wetlands	6.88
Habitat 2a	Eucalypt Woodland	327.13
Habitat 2b	Mature Regrowth / Disturbed Eucalypt Woodland	75.35
Habitat 3a	Brigalow +/- *Eucalyptus spp*. Woodland	107.46
Habitat 3b	Mature Regrowth / Disturbed Brigalow +/- Eucalyptus spp. Woodland	244.89
Habitat 3c	Brigalow Regrowth (<2m tall)	1,433.15
Habitat 4	Riparian Blue Gum Open forest	0
Habitat 5	Native Grassland	277.64
Habitat 6a	Pastureland without Gilgai	4,220.99
Habitat 6b	Pastureland with Gilgai	426.28
Habitat 7	Farm Dams	7.8
	Total	**7,127.9**

Species diversity was relatively low within highly disturbed habitats, such as the pasturelands, where historical clearing or grazing has occurred. As to be expected, species diversity was found to be higher in areas of remnant woodlands that contained complex understories and an abundance of microhabitat features or adjacent to water sources (e.g. farm dams).

7.2.1 Habitat Connectivity

Habitat connectivity for the Study Area is low with a highly fragmented landscape and disturbance present throughout from historical clearing of native vegetation and cattle grazing. Eucalypt Woodland (Habitat 2a) within the Study Area are comprised of scattered eucalypts with sparsely scatter shrubs and grasses throughout. Habitat 2b (Mature Regrowth/Disturbed Eucalypt Woodland) has been historically subjected to thinning, as such, the sub-canopy and groundcover are sparsely vegetated, and mature trees are retained which support habitat to generalist fauna species. Habitat Type 3a contains variable canopy cover (20-80%) and a sparsely vegetated ground layer. Habitat 3b (Mature Regrowth / Disturbed Brigalow +/- Eucalyptus spp. woodland) is comprised of a disturbed woodland landscape with regrowth Brigalow and occasional coolabah extant throughout. The sub-canopy and ground cover is sparse with grasses and shrubs scattered throughout the habitat area. The Study Area contains low Brigalow regrowth (Habitat Type 3c) in several patches throughout, however, connectivity of these patches to remnant vegetation is low as it is surrounded by cleared and grazed areas. Only small areas are extant connecting these patches to remnant vegetation. Habitat Type 4 contains moderate connectivity and consists of scattered mature blue gums and a dense canopy cover. Native Grassland (Habitat Type 5) and Pastureland with Gilgai (Habitat Type 6b) are present throughout the Study Area.

There are no well-defined fauna movement corridors being impacted by the Project that need to be retained, and the post-mine landforms would be rehabilitated in a manner that results in patches of woodland in pasture areas.

7.2.2 Animal Breeding Places

In accordance with the *Nature Conservation (Animals) Regulation 2020*, an Animal Breeding Place is defined as 'animal breeding place of an animal, means a bower, burrow, cave, hollow, nest or other

things that is commonly used by the animal to incubate or rear the animals offspring'. As such, animal breeding places may occur generally across the Study Area including the remnant vegetation shown on Figure 7.

The Project would disturb breeding locations and therefore Whitehaven WS will prepare a Species Management Program in accordance with the *Nature Conservation (Animals) Regulation 2020* for approval by the DES prior to undertaking any activities that would disturb animal breeding places.

Section 5.3 of this assessment describes the habitat features including breeding habitat for relevant threatened Fauna. Section 7.2 further describes impacts to habitat for fauna due to the Project. Sections 8.1 and 8.2 provides a summary of Impacts to MNES and MSES respectively.

7.3 Edge effects

Edge effects occur when previously intact remnant vegetation is partially cleared, exposing a new boundary of vegetation to disturbance. The impact of edge effects on flora and fauna can alter habitat composition and quality, resulting in a reduction of the effective area of habitat and an increase in competition for resources with aggressive pest or edge species. These impacts can extend well into a habitat area, resulting in the eventual displacement of more sensitive native flora and fauna.

As described above, the habitat in the Project area is highly fragmented due to historical clearing of native vegetation and cattle grazing. As such, edge effects are likely to have already manifested in remaining vegetated areas and the Project is unlikely to increase the potential of edge effects in these areas greatly.

7.4 Fauna mortality and injury

Construction and operational activities have the potential to lead to fauna injury or mortality. Vehicles and machinery can cause injury or mortality to fauna if individuals are struck. Measures to manage vehicle strike are described in Section 10.4.5.

Fauna that are unable to disperse away from areas under active clearing are also particularly susceptible to injury or mortality. Measures to manage vegetation clearance are described in Section 10.4.1. Pre-clearance surveys would be required to identify fauna utilising vegetation and microhabitat sites to better manage potential mortality and injury associated with construction activities.

Due to the highly fragmented local landscape, less agile fauna may not be able to relocate to similar habitats in adjacent areas. However, there are no populations of fauna that are likely to be restricted to the clearance areas and therefore it is unlikely that the Project would result in the local extinction of species surrounding the Project.

Other causes of injury or mortality include animals becoming trapped in excavations/ trenches. Measures to manage fauna in excavations/ trenches are described in Section 10.4.1.

Vehicle strike of animals along the infrastructure corridor is possible, however, it is not expected to be of a magnitude that would threaten the local persistence of any species, given there are no well-defined fauna movement corridors being impacted by the Project nor would the Project infrastructure corridor cross any waterways.

7.5 Hydrological changes

Changes to surface water quality and quantity can indirectly impact terrestrial ecosystems surrounding the Project.

7.5.1 Surface water quality

The Surface Water and Flooding Assessment (supported by site water balance modelling) by WRM (2021) concludes that:

- No uncontrolled spills of mine-affected water from mine-affected water dam overflows are predicted.
- Some overflow of sediment dams (designed in accordance with the *Best Practice Erosion and Sediment Control guideline* [Institute for Environmental Monitoring and Research, 2008]) would occur when rainfall exceeds the design standard, however the salinity of the sediment dam overflows would have a negligible impact on the quality of the Isaac River.
- There is a predicted negligible impact on the downstream water quality through controlled releases from the Project.

Based on the implementation of management strategies (e.g. erosion and sediment controls) and the implementation of the surface water monitoring program for the Project, impacts to downstream waters is considered negligible (WRM, 2021).

If no measurable impacts on surface water quality are likely to occur, no adverse impacts are likely to occur on surrounding habitats.

7.5.2 Surface water quantity

The Project would reduce the catchment area draining to receiving watercourses (i.e. Isaac River and Ripstone Creek) due to capture of runoff from disturbed catchment areas within the water management system. The maximum mine-affected catchment areas during the life of the Project were determined by WRM (2021) as follows:

- Less than 1.5% of the Isaac River catchment to the Isaac River/Ripstone Creek confluence.
- Less than 6% of the Ripstone Creek catchment.

Only a small proportion of the excised catchments are captured in-pit and mine-affected dam catchments, and the remainder drains offsite through the sediment water management system. The effective reduction in downstream flow during operations would therefore be closer to 0.4% and 1.3% in Isaac River and Ripstone Creek, respectively, and are insignificant.

Post-mining, the loss of catchment flows in the Isaac River and Ripstone Creek would be indiscernible, and as such the potential impact on water quantity in Isaac River and Ripstone Creek due to the final landform is considered negligible.

7.6 Groundwater dependent ecosystems

Changes to groundwater quality and quantity can have an indirect impact on ecosystems surrounding a development site and particularly ecosystems that are dependant or partially dependant on groundwater. The process of mining reduces water levels in the surrounding groundwater units. The extent of the zone affected is dependent on the properties of the aquifers/aquitards and is referred to as the zone of drawdown. Aquifer drawdown is greatest at the working coal-face, and generally, gradually decreases with distance from the mining operations (SLR Consulting, 2021).

7.6.1 Riparian Vegetation Along Isaac River and Cherwell Creek

As described in Section 4.8, the riparian vegetation associated with the Isaac River and Cherwell Creek (RE 11.3.25) has a moderate to high potential to meet the definition of a terrestrial GDE, and any dependency on groundwater is likely to be facultative, during dry times.

In regards to changes to groundwater quality and quantity, the Groundwater Assessment (SLR Consulting, 2021) concludes that there would be negligible drawdown in the Quaternary alluvium along the Isaac River and Cherwell Creek as a result of the Project and no adverse changes to groundwater quality. The Project would not directly intercept groundwater from the Quaternary alluvium (SLR Consulting, 2021). Interference of the alluvial groundwater would largely be due to increased leakage to the underlying Permian coal measures that would be depressurised as a result of the Project.

The numerical groundwater modelling predicted that the increase in seepage from the Quaternary alluvium to the underlying Permian coal measures would be negligible (SLR Consulting, 2021).

If no measurable impacts on groundwater quality and quantity are likely to occur from the Project, no adverse impacts are likely to occur on the riparian vegetation associated with the Isaac River and Cherwell Creek.

7.6.2 Vegetation Associated with Wetlands on the Isaac River Floodplain and its Tributaries

As described in Section 4.8, the riparian vegetation surrounding these ephemeral wetlands has a moderate potential to meet the definition of a terrestrial GDE, and any dependency on groundwater is likely to be facultative, during dry times. The *Winchester South Project Aquatic Ecology and Stygofauna Assessment* (ESP, 2021) describes how these ephemeral wetlands are not likely to be aquatic GDEs as these wetlands do not receive groundwater discharge, rather, the clay-rich substrates of these wetlands are likely to hold surface water run-on for extended periods, thereby creating the temporary aquatic habitat.

The Groundwater Assessment (SLR Consulting, 2021) concludes that there would be negligible drawdown in the Quaternary alluvium beneath these wetlands as a result of the Project and no adverse changes to groundwater quality are predicted. If no measurable impacts groundwater quality and quantity are likely to occur from the Project, no adverse impacts are likely to occur on the riparian vegetation surrounding these ephemeral wetlands.

7.6.3 Vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands)

As described in Section 4.8, the woodland dominated by RE 11.3.2 on the floodplains on the Isaac River and Cherwell Creek has a moderate potential to meet the definition of a terrestrial GDE, and any dependency on groundwater is likely to be facultative, during dry times.

There would be no impacts to vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands) that may access water from the Quaternary alluvium, as there would be negligible drawdown to the Quaternary alluvium (SLR Consulting, 2021). Where the vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands) occurs outside of the mapped extent of the Quaternary alluvium, negligible drawdown to the underlying water table is predicted.

Further, there would be no impacts on the vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands), as the Project would not result in adverse changes to groundwater quality, including the Quaternary alluvium (SLR Consulting, 2021).

7.6.4 Vegetation in the Vicinity of the Project Mapped as having Low Potential for Groundwater Interaction

As described in Section 4.8, there are various patches of woodland to the north and east of Project that are mapped as having low potential for groundwater interaction due to sub-surface presence of groundwater (i.e. terrestrial GDEs) in the GDE Atlas (BOM, 2020).

The numerical groundwater modelling predicted areas of drawdown in the regolith, largely constrained to the Project area, only extending up to approximately 1.7 km to the north-west and 1.5 km to the south-east of the Project (Figure 22) (SLR Consulting, 2021). The Project would result in a predicted drawdown of up to 5 m below the woodland to the north of Project (Figure 22).

It is concluded that these woodland patches have a low potential to meet the definition of a terrestrial GDE, and any dependency on groundwater in the regolith is likely to be facultative, during dry times (if at all). It is unlikely that these REs would be dependent on the groundwater due to the poor quality (high salinity) of the groundwater source. Therefore, a predicted drawdown of up to 5 m below the woodland to the north of Project is unlikely to have any material impacts on this woodland.

Further, there would be no impacts on the vegetation in the vicinity of the Project mapped as having low potential for groundwater interaction, as the Project would not result in adverse changes to groundwater quality, including the regolith (SLR Consulting, 2021).

7.7 Invasive weeds

Introduced flora species disrupt ecosystems by outcompeting and replacing native species, resulting in altered ecosystem diversity and function. Five weed species listed as WoNS and / or restricted matters under the Biosecurity Act were recorded within the Study Area. These species include:

- *Cryptostegia grandiflora*
- *Harrisia martinii*
- *Opuntia stricta*
- *Opuntia tomentosa;* and
- *Parthenium hysterophorus*.

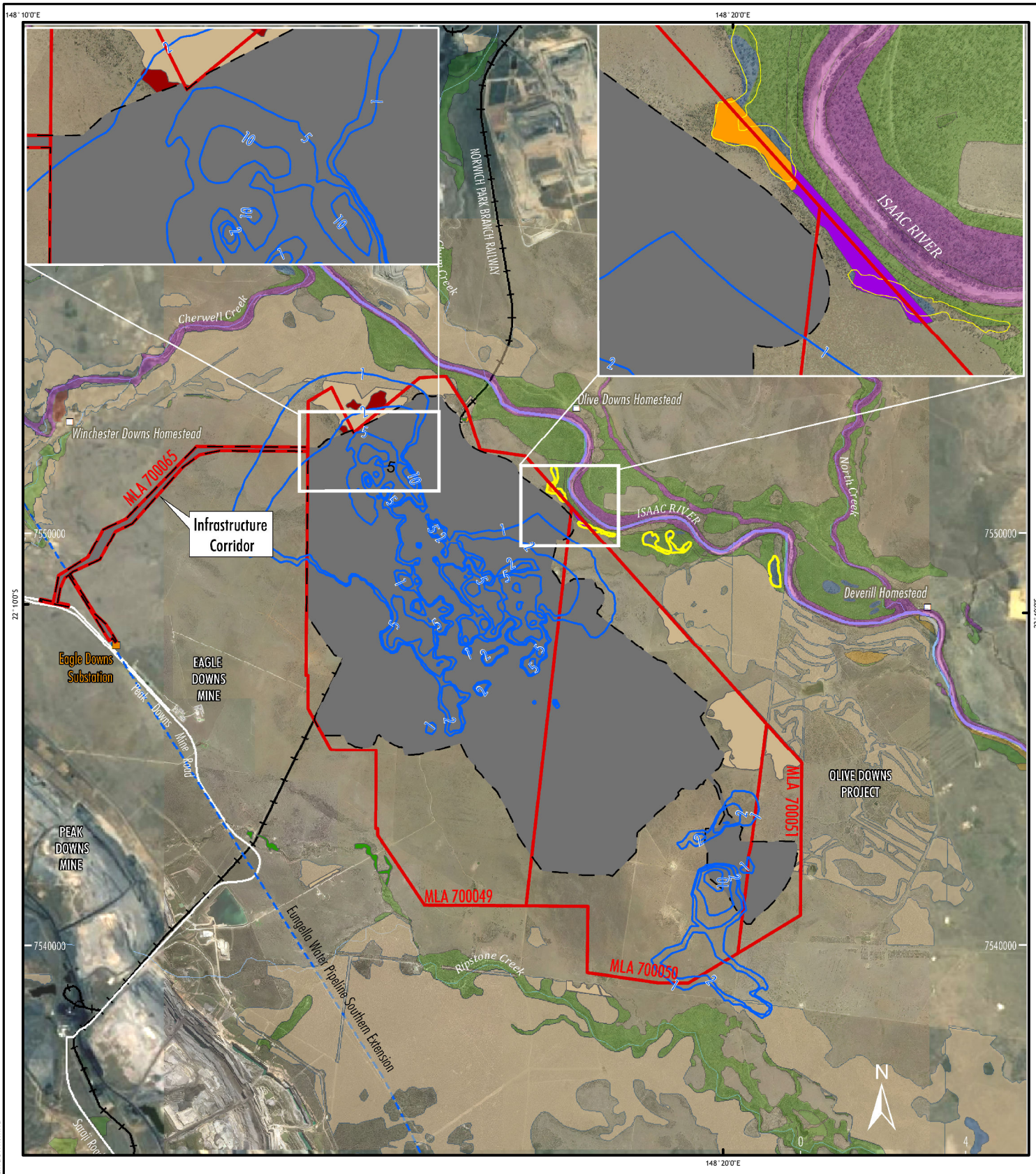
Weed seeds can be transported in contaminated fill, the mud on machinery or in the machinery itself. The spread of weed species is facilitated by disturbance. Construction activities have the potential for disturbing or introducing weeds, resulting in the establishment of weeds within and outside the Project area. It is unlikely that the Project would increase the weeds within the surrounding landscape, as mitigation and management measures would be implemented for the Project (Section 10.4.2).

7.8 Feral animals

Eight pest fauna species were observed during field assessments within the Study Area:

- cane toad (*Rhinella marina*)
- common myna (*Acridotheres tristis*)
- cat (*Felis catus*)
- European hare (*Lepus europaeus*)
- European rabbit (*Oryctolagus cuniculus*)
- house mouse (*Mus musculus*)
- pig (*Sus scrofa*); and
- wild dog (*Canis lupus*).

The presence and abundance of feral animals adversely impacts native fauna through increased competition of resources, predation and habitat degradation. It is unlikely that the Project would increase the pest fauna species within the surrounding landscape, as mitigation and management measures would be implemented for the Project (Section 10.4.3).



LEGEND

- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- Project Drawdown (Regolith)
- Substation

Vegetation Communities with Potential for Groundwater Dependence Ground-truthed (E2M, 2020)

- RE 11.3.2
- RE 11.3.25
- RE 11.3.3c
- RE 11.3.4
- RE 11.5.3

State Mapped (Dominant) (DNRME, 2020)

- RE 11.3.25
- RE 11.3.2
- RE 11.3.3
- RE 11.3.4
- RE 11.3.27b
- RE 11.5.3
- Palustrine Wetland (ESP, 2020)

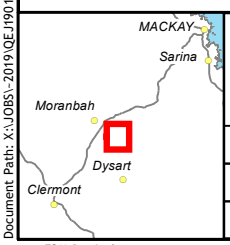
N

Scale 1:128,000 (A4)

0 1 2 3 4

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	RS	RS	27/11/2020
G	Issued for Review	RS	RS	02/11/2020

FIGURE 22: TERRESTRIAL VEGETATION AND PREDICTED DRAWDOWN IN REGOLITH

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

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7.9 Bushfire risk

Accidental ignitions in the Project area may be caused by machinery, an accident or collision, scheduled burns getting out of control, hot works, spontaneous combustion of coal or from the incorrect disposal of flammable items. These ignitions have the potential to cause uncontrollable fires that can have pronounced impacts on vegetation and habitat within and adjacent to the Project area. It is unlikely that the Project would increase the bushfire potential within the surrounding landscape, as mitigation and management measures would be implemented for the Project (Section 10.4.4).

7.10 Artificial lighting, noise and vibration

Construction and operational activities can disrupt local fauna roosting, breeding and foraging activities as a result of increased exposure to artificial lighting, noise and vibration. Due to the day and night operation of the mine, artificial lighting would be used. Artificial lighting poses risks to fauna, as increased light allows predators to locate prey more easily. Additionally, noise and vibration can also lead to increased predation of some species, as it makes it harder for prey to detect approaching predators.

Fauna that inhabit areas affected by construction and operational activities are predominantly common species that are more tolerant to some disturbance. Animals may exhibit initial fright behaviour and would either adapt to the disturbance levels or move away to similar habitats in the adjacent landscape.

7.11 Dust

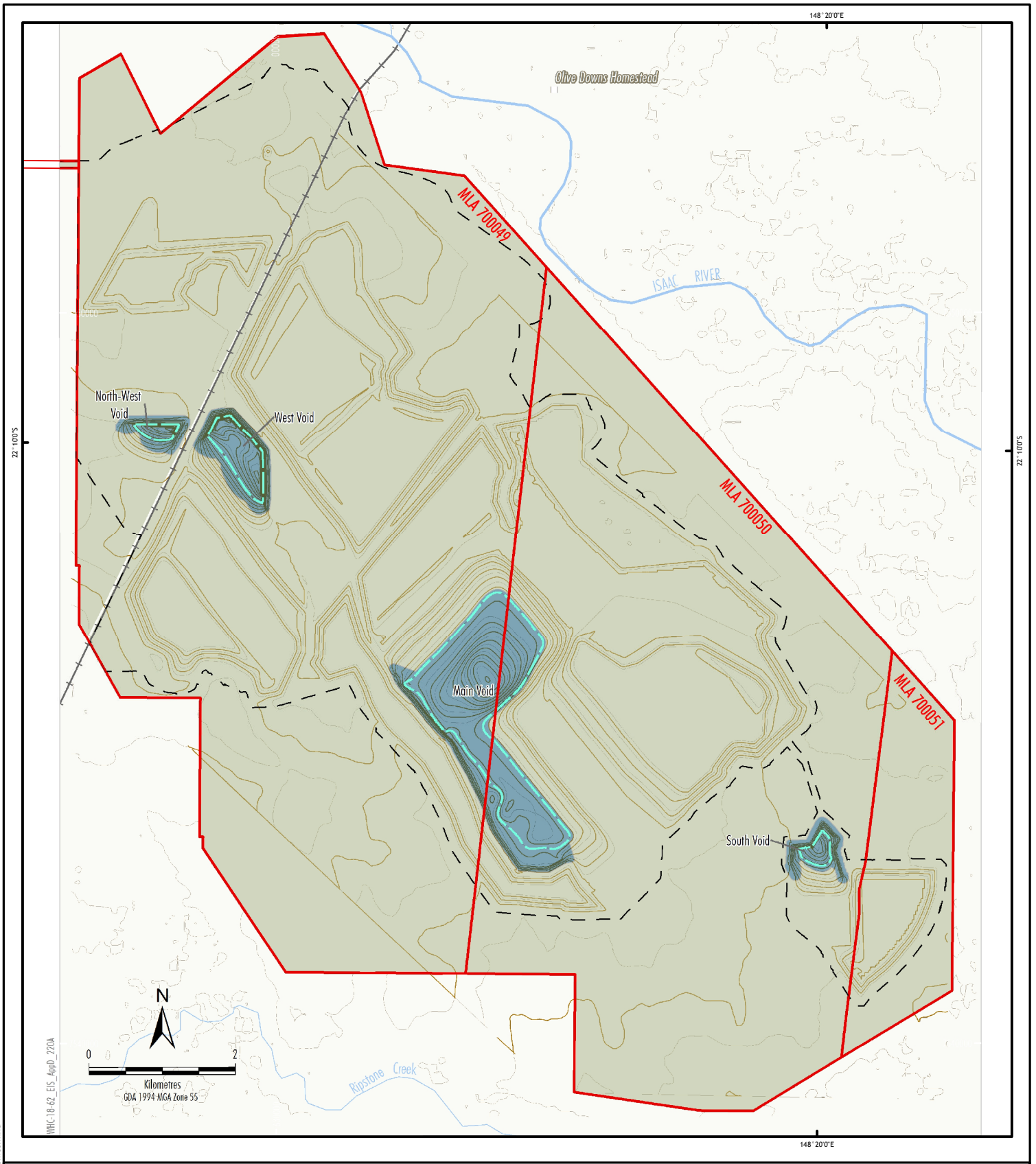
Excessive dust deposition on foliage can cause impacts to vegetation, including reducing photosynthetic processes, respiration, transpiration, health and growth rates. Potential dust impacts on vegetation are concentrated near dust sources such as haul roads and areas with active mine landforms as a result of construction and operation activities and vehicle ad machinery use.

The landscape surrounding the Project is heavily cleared. Due to this, it is unlikely that dust from the Project would cause significant degradation of surrounding native vegetation given vegetation in the locality is already subjected to dust from exposed soils which have not led to any observed impacts on vegetation. It is also likely that seasonal rainfall in the locality would help wash dust from the vegetation and/or encourage new growth.

7.12 Final landform

The post-mine landform would be progressively rehabilitated. The post-mine landforms would contain a mixture of woodland and pasture and would be rehabilitated in a manner that results in patches of woodland in pasture areas. The land use would be grazing (Figure 23).

Four residual voids are proposed within the Project area to remain in perpetuity (Figure 23). Water within the residual voids would evaporate from the residual void water body and draw in groundwater from the surrounding strata and rainfall runoff from the residual void catchment areas. As the residual voids would act as sinks, evaporation from the residual void water body would overtime concentrate salts in the residual void water body (SLR Consulting, 2021). However, the gradual increase in salinity of the residual void water body would not pose a risk to the surrounding groundwater regime as the residual voids would remain as groundwater sinks in perpetuity (SLR Consulting, 2021).



LEGEND

- Mining Lease Application Boundary
- Indicative Residual Void Pit Lake
- Indicative Surface Disturbance Extent
- Contours (10 m)
- Contours (5 m)

Conceptual Land Outcome

- Agriculture (LowIntensity Cattle Grazing)
- Non-Use Management Area

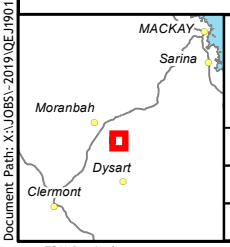
N

Scale 1:71,000 (A4)

0 1 2 3

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
Watercourse: Regulated vegetation - intersecting a watercourse © DNRME 2019
Road: © PSMA 2014
Cadastre: © DNRME 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	RS	RS	27/11/2020
G	Issued for Review	RS	RS	02/11/2020

FIGURE 23: CONCEPTUAL LAND OUTCOMES

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

Document Path: X:\JOBS\-2019\QEJ19011\GIS\QEJ19011_TEA_23_LandOutcomes.mxd

7.13 Cumulative impacts

Land use in the Isaac Region consists primarily of mining, cattle grazing and grain production. The Project area comprises of patches of remnant and regrowth vegetation and agricultural land, primarily utilised for cattle grazing.

The Project is located in a mining precinct comprising several existing and approved coal mining operations, including:

- Olive Downs Project (adjacent to the east and south east of the Project)
- Eagle Downs Project (adjacent to the west of the Project)
- Moorvale South Project (approximately 2 km north-east of the Project)
- Peak Downs (approximately 6 km west of the Project)
- Daunia (approximately 7.5 km north of the Project)
- Poitrel (approximately 8 km north of the Project)
- Millennium (approximately 10.5 km north-west of the Project)
- Isaac Plains (approximately 25 km north-west of the Project)
- Moorvale (approximately 19 km north of the Project)
- Saraji (approximately 19.5 km south of the Project)
- Lake Vermont (approximately 21 km south-east of the Project); and
- Goonyella Riverside and Broadmeadow Mines – coordinated project (approximately 50 km north-west of the Project).

The majority of these projects are required to provide offset areas for impacts associated with their mining operations in order to reduce the final impact on MNES and / or MSES (Department of Environment and Resource Management [DERM], 2010; DERM, 2011; Department of State Development, Manufacturing, Infrastructure and Planning [DSDMIP], 2019b; Department of Infrastructure and Planning [DIP], 2009; DIP, 2010; Environmental Protection Agency, 2005; Stanmore IP South, 2020).

The Project would result in the removal of 719.9 ha of remnant vegetation and 6,408.6 ha of non-remnant vegetation that provides habitat for flora and fauna to varying degrees. The native RE and fauna habitat types to be cleared during the life of the Project occur more widely in surrounding landscapes and subregions (Table 17).

The change in potential cumulative impacts on threatened species and communities arising from the Project is considered to be minimal because of the localised nature of the Project compared to the wider distribution of the species and associated habitats and communities in the surrounding landscapes and subregions.

The Project's impact on the environment is additive to that from past and present grazing, agriculture and mining activities within the Northern Bowen Basin and Isaac Comet subregions. Evaluating the Project's impact on the target MNES on an incremental scale inclusive of other local and regional disturbances is often more realistic than assessing the Project impacts in isolation.

The Project is likely to impact the following MNES: Poplar Box TEC, Natural Grasslands TEC, koala, greater glider, squatter pigeon and ornamental snake.

The cumulative impact on the MNES identified within the Project area was determined by comparing the Project's direct impact to the area of habitat present within the Northern Bowen Basin and Isaac Comet Subregions. The available habitat for each MNES was calculated across the Northern Bowen Basin and Isaac Comet subregions using similar habitat definitions applied on the Project area with the exception of field-based criteria (such as species diversity, ground cover, etc) (Table 19). Species profiles and listing advice were used to identify REs and Broad Vegetation Groups (BVGs) within both subregions that provide suitable habitat for each MNES. Where potential habitat occurred within mixed polygons, the relevant percentage from the *Regional Ecosystem Description Database* (Queensland Herbarium, 2019) was applied to estimate the area for each patch.

For both the Poplar box TEC and Natural grassland TEC, it was conservatively assumed that all remnant vegetation containing the relevant REs was of suitable quality and condition to meet the TEC criteria. For the threatened fauna species, it was conservatively assumed that all remnant vegetation contains the necessary microhabitat for each species. For ornamental snake and squatter pigeon, it was also conservatively assumed that mapped regrowth vegetation was also suitable as both of these species are tolerant of disturbed and regrowth vegetation.

Table 19. Target MNES habitat type

MNES	Qualifying RE/BVG*	Broad vegetation class
Poplar Box TEC	11.3.2, 11.3.17, 11.4.7 and 11.4.12	Remnant
Natural Grassland TEC	11.3.21, 11.4.4, 11.4.11, 11.8.11, 11.9.3, 11.9.12 and 11.11.17	Remnant
ornamental snake	11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.3.3 and 11.5.16	Remnant and regrowth
squatter pigeon	11.5.1, 11.5.10, 11.5.12, 11.5.16, 11.5.17, 11.5.2, 11.5.20, 11.5.2a, 11.5.3, 11.5.3b, 11.5.5c, 11.5.8c, 11.5.9, 11.5.9a, 11.5.9b, 11.5.9c, 11.7.1, 11.7.2, 11.7.3 and 11.7.4	Remnant and regrowth woodland
koala	8a, 9e, 10a, 11a, 12a, 13c, 13d, 16a, 16c, 17a, 17b, 18b, 19d and 34d	Remnant eucalypt dominated woodland
greater glider	8a, 9e, 10a, 11a, 12a, 13c, 13d, 16a, 16c, 17a, 17b, 18b, 19d and 34d	Remnant eucalypt dominated woodland

* BVGs used as surrogate habitat values, when applicable, for conciseness

Based on the analysis of Project related disturbance, approved disturbance from nearby major resource projects (Table 20) and the available habitat/area in the region, the Project is predicted to have negligible cumulative impacts on terrestrial Flora and Fauna (Appendix D). The below text provides a more detailed discussion of this analysis.

7.13.1 Threatened Ecological Communities

7.13.1.1 Poplar Box TEC

Project development would result in the removal of approximately 9.6 ha. The removal of 9.6 ha of Poplar Box TEC conservatively equates to the loss of ~0.0001% of the mapped Poplar Box TEC across the Northern Bowen Basin and Isaac Comet subregions (72,618 ha). Local mining projects (as based on publicly available information) equate to 117.9 ha of Poplar Box TEC (0.015%).

Table 20. Cumulative direct impacts to relevant Matters of National Environmental Significance in the locality

Local development projects	Approximate relative location from Winchester South	Habitat clearance of protected matters					
		Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	Poplar Box Grassy Woodland on Alluvial Plains	*Denisonia maculata* ornamental snake	*Phascolarctos cinereus* koala	*Petauroides volans* greater glider	*Geophaps scripta scripta* squatter pigeon (southern subspecies)
Estimate of habitat available within the Northern Bowen Basin and Isaac Comet subregions	-	40,2689	72,618	111,103	1,052,403	1,052,403	431,721
Winchester South Project	-	80.9	9.6	1,834.2	314.5	167.1	261.2
Olive Downs Project[1]	Adjacent	-	-	7,797.5	5,865	5,699.5	5,445.5
Eagle Downs Project[2]	Adjacent	36	-	-	-	-	-
Moorvale[8]	22 km NE	-	-	-	-	-	-
Daunia[4]	7.5 km N	-	-	-	-	-	2.4
Poitrel[5]	8 km N	-	-	-	-	-	28.8
Millennium[6]	10.5 km NW	-	-	-	-	-	-
Isaac Plains[7]	25 km NW	-	-	2.4	207.8	207.8	180.7
Moranbah North[9]	50 km NW	343	-	2	74	-	483
Caval Ridge Mine[10]	25 km NW	124.6	108.3	22.9	601.9	280.10	317.3
Peak Downs[11]	6 km W						
Saraji[11]	20 km S						
Lake Vermont[11]	20 km S						
Goonyella Riverside and Broadmeadow Mines[11]	50 km NW						
South Walker Creek Mine[11]	50 km N						

Local development projects	Approximate relative location from Winchester South	Habitat clearance of protected matters					
		Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	Poplar Box Grassy Woodland on Alluvial Plains	*Denisonia maculata* ornamental snake	*Phascolarctos cinereus* koala	*Petauroides volans* greater glider	*Geophaps scripta scripta* squatter pigeon (southern subspecies)
Grosvenor Coal Mine[11]	40 km NW						

1 Olive Downs Project Mine Site and Access Road, near Moranbah, Queensland (EPBC 2017/7867) Approval (DAWE, 2020e), Olive Downs Project Water Pipeline, 40 km south-east of Moranbah, Queensland (EPBC 2017/7868) Approval (DAWE, 2020f), Olive Downs Project Electricity Transmission Line, 20 km south-east of Moranbah, Queensland (EPBC 2017/7869) Approval (DAWE, 2020g) and Olive Downs Project Rail Spur, 40 km south-east of Moranbah, Queensland (EPBC 2017/7870) Approval (DAWE, 2020h).

2 Eagle Downs Coal Mine Project – EPBC No 2008/3945 Approval (DSEWPaC, 2011d).

3 Commonwealth EPBC Act Referral (Olive Downs Coal Pty Ltd, 2005).

4 Poitrel Coal Mine Project (EPBC 2004/1770) Variation to Conditions Attached to Approval (DEE, 2019b).

5 Assessment Report under the Environmental Protection Act 1994 on the Environmental Impact Statement for the Poitrel Coal Mine Project proposed by BHP Mitsui Coal Pty Ltd (EPA, 2005).

6 Environmental Impact Statement (EIS) Assessment Report under the Environmental Protection Act 1994 – Millennium Expansion Project Proposed by Millennium Coal Pty Limited (DERM, 2011).

7 Isaac Plains East Extension, near Moranbah, Queensland (EPBC 2019/8548) Approval (DAWE, 2020i).

8 Environmental Impact Statement (EIS) Assessment Report – Moorvale Coal Project (EPA, 2002).

9 Moranbah South Coal Project, Queensland (EPBC 2012/6337) Approval (DotE, 2014f).

10 Terrestrial Ecology (Section 8), Caval Ridge Mine Project Environmental Impact Statement 2009, habitat based on offsetable RE.

11 No publicly available information regarding impacts to MNES.

7.13.1.2 Natural Grasslands TEC

Project development would result in the removal of approximately 80.9 ha. The removal of 80.9 ha of Grassland TEC conservatively equates to the loss of ~0.002% of the mapped Grassland TEC across the Northern Bowen Basin and Isaac Comet subregions (40,2689 ha). Local mining projects (as based on publicly available information) equate to 584.5 ha of Poplar Box TEC (0.002%).

7.13.2 Threatened species

7.13.2.1 Koala and greater glider

Suitable koala and greater glider habitat is largely confined to the remnant eucalypt woodland paralleling the Isaac River and it's larger tributaries. The location of previous and recent koala and greater glider records (Figure 14 and Figure 15, respectively) represent, to a degree, how the species are likely utilising the watercourses as movement corridors throughout the landscape. As the Project is not expected to directly impact the koala and greater glider habitat along the Isaac River and movement corridors will be retained, the cumulative impact is likely to be relatively low.

The Project development would result in the removal of approximately 315 ha of koala habitat categorised as remnant and regrowth eucalypt woodland with koala food trees (i.e. eucalyptus spp.) as well as approximately 167 ha of greater glider habitat defined as potential breeding and foraging remnant woodland with suitable hollow bearing trees.

In a regional context, habitat within the Project impact area equates to a very small proportion of koala and greater glider habitat (conservatively ~0.0003% and ~0.0002%, respectively) within the Northern Bowen Basin and Isaac Comet subregions (~1,052,403 ha). Based on species habitat available across the subregions, the proportions of habitat loss as a result of the Project development equates to relatively low cumulative impact. A conservative estimate of koala and greater glider habitat cumulatively impacted (i.e. cleared) by local mining projects (including Winchester South) is approximately 7,063 ha and 6,355 ha within the two subregions.

As the Project is not expected to directly impact the remnant eucalypt woodland fringing on the Isaac River thereby retaining koala and greater glider habitat and remant corridors throughout the local landscape, the Project's cumulative direct impact on the local koala and greater glider population is expected to be low.

Koala and greater glider habitat utilisation within regional Queensland is currently unknown and the minimum population size or quantity of habitat required to main population viability in the context of ongoing development is unclear. That said, from a local and regional context, the cumulative impact on koala and greater glider population from the Winchester South Project is realistically low due to the location of the Project footprint (i.e. not impeding the Isaac River habitat or movement corridor).

7.13.2.2 Ornamental snake

The Project development would result in the removal of approximately 1,834 ha of ornamental snake habitat located predominately within an unfragmented patch of regrowth brigalow (RE 11.4.8/11.4.9) situated in the southern half of the disturbance footprint. A number of ornamental snakes were recorded within the gilgai during the wet season and dry season surveys in addition to several previously recorded observations (ALA; Wildnet database). In the context of incremental habitat loss, the Project impact is conservatively ~0.09% of the ornamental snake habitat available in the Northern Bowen Basin and Isaac Comet subregions (111,103 ha). Including the Winchester South Project, local mining projects (as based on publicly available information) have directly cleared approximately of 9,659 ha (0.09%) of ornamental snake habitat.

7.13.2.3 Squatter pigeon

Project development would result in the removal of approximately 261.2 ha of suitable breeding/foraging and foraging habitat squatter pigeon (southern subspecies). The habitat areas to be disturbed by the Project (suitable areas of Landzone 5 and 7) are fragmented. Previous squatter pigeon observations (E2M field survey records) are associated with farm dams and cattle troughs situated near the eastern boundary of the Project. The removal of 261.2 ha of fragmented squatter pigeon habitat conservatively equates to the loss of ~0.0005% of the squatter pigeon habitat across the Northern Bowen Basin and Isaac Comet subregions (~431,721 ha). Including the Winchester South Project, local mining projects (as based on publicly available information) equate to approximately 6,720 ha (0.02%) of squatter pigeon habitat. Squatter pigeon habitat is fairly ubiquitous within the mining precinct. Squatter pigeon habitat utilisation, particularly foraging habitat, appears to be more influenced by the availability of permanent water sources than soil type and as such, is likely to be more abundant than land zone 5 and 7 resulting in a lower cumulative impact.

8 Impact Summary

8.1 MNES impact summary

In accordance with the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (DotE, 2013b), an assessment has been completed for each MNES known, or likely to, occur in the Project area. Results of these assessments identified that the Project is likely to result in significant residual impacts on six MNES. A summary of impacts on MNES and the results of the assessments for MNES known, likely to occur or identified within the ToR (DSDMIP, 2019a) are provided in Table 21. Appendix G provides a detailed assessment for MNES that are considered to be significantly impacted by the Project. Appendix G also provides detailed assessment for the white-throated needletail, Australian painted snipe and the Brigalow TEC.

All three actions referred under the EPBC Act (EPBC 2019/8460, 2019/8458 and 2019/8459) overlap and share common disturbance, to some extent. To avoid duplicating disturbance assessments where the individual actions overlap, the following approach has been taken for assessing impacts associated with the three actions referred under the EPBC Act. Figure 2 provides a graphical representation of the disturbance extents described above for each of the actions referred under the EPBC Act.

8.1.1 Mine Site and Access Road (EPBC 2019/8460)

All Project related impacts within MLAs 700049, 700050, and 700051 associated with “listed threatened species and communities” are assessed under the EPBC Mine Site and Access Road Action (EPBC 2019/8460). This is because the alignments of the EPBC ETL Action (EPBC 2019/8458) and the EPBC Water Pipeline Action (EPBC 2019/8459) are common with the access road and other infrastructure requirements of the EPBC Mine Site and Access Road Action (EPBC 2019/8460) within these MLAs.

8.1.2 Electricity Transmission Line (EPBC 2019/8458)

All Project related impacts associated with “listed threatened species and communities” within MLA 700065 are assessed under the EPBC ETL Action (EPBC 2019/8458). All three Actions that traverse MLA 700065 share a common disturbance corridor, including for construction (e.g. access tracks, laydown areas, construction disturbance, trenching, erosion control, water management) and operation. The EPBC ETL Action; however, extends the largest (i.e. to the Eagle Downs Substation) and also requires access from the Peak Downs Mine Access Road. It is therefore the most sensible Action in which to assess the common impacts.

8.1.3 Water Pipeline (EPBC 2019/8459)

No impacts are assessed under the EPBC Water Pipeline Action (EPBC 2019/8459) as its impacts are assessed in full by the other two EPBC Actions (i.e. EPBC 2019/8458 and EPBC 2019/8460).

Table 21. MNES Assessment Summary

MNES	Conservation status		Assessment summary
	EPBC Act	NC Act	
Brigalow TEC	Endangered	N/A	Confirmed present: The Project would not significantly impact Brigalow TEC as the occurrence in the MLAs would be avoided (Figure 20) and potential indirect impacts would be managed (e.g. weeds). An impact assessment for this species is provided in Appendix G.
Natural Grasslands TEC	Endangered	N/A	Confirmed present: The Project would significantly impact 80.9 ha of 'good quality' Natural Grasslands TEC (Figure 20), comprising 74.4 ha in the mine site (EPBC 2019/8460) and 6.5 ha along the infrastructure corridor (EPBC 2019/8458) (Table 20). An impact assessment for this species is provided in Appendix G.
Poplar Box TEC	Endangered	N/A	Confirmed present: The Project would result in a significant impact on Poplar Box TEC through the removal of approximately 9.6 ha of "Good Quality" Poplar Box TEC (Figure 20) in the mine site (EPBC 2019/8460) (Table 20). No Poplar Box TEC is present in the infrastructure corridor (EPBC 2019/8458). An impact assessment for this species is provided in Appendix G.
Semi-evergreen Vine Thicket TEC	Endangered	N/A	Not present.
Cycas ophiolitica marlborough blue	Endangered	Endangered	Not recorded. The species has not been previously recorded in the desktop search extent and potential habitat for the species is not present within the Study Area (Appendix D).
Dichanthium queenslandicum king blue-grass	Endangered	Vulnerable	Not recorded. The species has been previously recorded within the desktop search extent. Despite extensive surveys by E2M in optimal conditions (wet season surveys), the species was not detected, reducing its likelihood of occurring.
Dichanthium setosum bluegrass	Vulnerable	N/A	Not recorded. The species has been previously recorded within the desktop search extent. Despite extensive surveys by E2M in optimal conditions (wet season surveys), the species was not detected, reducing its likelihood of occurring.
Samadera bidwillii quassia	Vulnerable	Vulnerable	Not recorded. The species has not been previously recorded in the desktop search extent and potential habitat for the species was limited within the Study Area (Appendix D).
Eucalyptus raveretiana black iron box	Vulnerable	N/A	Not recorded. The species has not previously been recorded within the desktop search extent and the Study Area is outside of the current known distribution for the species.
yakka skink (*Egernia rugosa*)	Vulnerable	Vulnerable	Not recorded. Potential habitat for the species occurs within the Study Area, however, the species has not previously been recorded within the desktop search extent.

MNES	Conservation status		Assessment summary
	EPBC Act	NC Act	
Allan's lerista/retro slider (*Lerista allanae*)	Endangered	Endangered	Not recorded. The species has not previously been recorded within the desktop search extent and the Study Area is outside of the current known distribution for the species (Appendix D).
Dunmall's snake (*Furina dunmalli*)	Vulnerable	Vulnerable	Not recorded. Potential habitat for the species occurs within the Study Area, however, the species has not previously been recorded within the desktop search extent.
ornamental snake (*Denisonia maculata*)	Vulnerable	Vulnerable	Known to occur: The Project would result in a significant impact on the ornamental snake through the removal of approximately 1,834.2 ha of potential habitat, comprising 1,821.9 ha in the mine site (EPBC 2019/8460) and 12.3 ha along the infrastructure corridor (EPBC 2019/8458) (Table 20). An impact assessment for this species is provided in Appendix G.
koala (*Phascolarctos cinereus*)	Vulnerable	Vulnerable	Known to occur: The Project would result in a significant impact on the koala through the removal of approximately 314.5 ha of known habitat, comprising 278.6 ha in the mine site (EPBC 2019/8460) and 35.9 ha along the infrastructure corridor (EPBC 2019/8458) (Table 20). An impact assessment for this species is provided in Appendix G.
greater glider (*Petauroides volans volans*)	Vulnerable	Vulnerable	Known to occur: The Project would result in a significant impact on the greater glider through the removal of approximately 167.1 ha of known habitat, located entirely within the mine site (EPBC 2019/8460). An impact assessment for this species is provided in Appendix G.
white-throated needle-tail (*Hirundapus caudacutus*)	Vulnerable	Least Concern	Likely to occur: In Australia, the species is almost exclusively aerial. Therefore, the Project is considered unlikely to have any adverse or significant impacts on the species.
red goshawk (*Erythrotriorchis radiatus*)	Vulnerable	Endangered	Not recorded. The species has not been previously recorded within the desktop search extent. In addition, remnant woodland within the Study Area has undergone historical disturbance of from clearing reduces the habitat value for the species.
Australian painted snipe (*Rostratula australis*)	Endangered	Endangered	Likely to occur: The Project is unlikely to result in a significant impact on the Australian painted snipe as no potential breeding habitat would be removed. An impact assessment for this species is provided in Appendix G.
curlew sandpiper (*Calidris ferruginea*)	Critically Endangered	Critically Endangered	Not recorded. The species has not been previously recorded within the desktop search extent. Potential habitat for the species within the Study Area (farm dams) was considered marginal.
squatter pigeon (southern subspecies) (*Geophaps scripta scripta*)	Vulnerable	Vulnerable	Known to occur. The Project would result in a significant impact on the squatter pigeon (southern subspecies) through the removal of approximately 261.2 ha of suitable breeding/foraging and foraging habitat, comprising 140.5 ha of breeding/foraging habitat and 120.7 ha of foraging habitat within the mine site (EPBC 2019/8460) (Table 20). An impact assessment for this species is provided in Appendix G.

MNES	Conservation status		Assessment summary
	EPBC Act	NC Act	
painted honeyeater (*Grantiella picta*)	Vulnerable	Vulnerable	Not recorded. Potential habitat for the species occurs within the Study Area, however, the species has not previously been recorded within the desktop search extent.
star finch (eastern subspecies) (*Neochmia ruficauda ruficauda*)	Endangered	Endangered	Not recorded. The species has not previously been recorded within the desktop search extent and the Study Area is outside of the current known distribution for the species.
Black-throated finch	Endangered	Endangered	Not recorded. The species has not previously been recorded within the desktop search extent and the Study Area is outside of the current known distribution for the species.
northern quoll (*Dasyurus hallucatus*)	Endangered	N/A	Not recorded. Suitable habitat for the species was not recorded within the Study Area.
ghost bat (*Macroderma gigas*)	Vulnerable	Endangered	Not recorded. Suitable habitat for the species was not recorded within the Study Area.
Corben's long-eared bat (*Nyctophilus corbeni*)	Vulnerable	Vulnerable	Not recorded. Suitable habitat for the species was not recorded within the Study Area.
northern hairy-nosed wombat (Lasiorhinus krefftii)	Critically Endangered	Endangered	Not recorded. The species has not previously been recorded within the desktop search extent and the Study Area is outside of the current known distribution for the species.

Table 22. MNES clearing impacts

MNES		Infrastructure Corridor (EPBC 2019/8458)	Mine Site and Access Road (EPBC 2019/8460)[1]		
		Stage 1	Stage 1	Stage 2	Stage 3
Brigalow TEC		0	0	0	0
Poplar Box TEC		0	9.6	0	0
Natural Grasslands TEC		6.5	59.8	14.6	0
ornamental snake (*Denisonia maculata*)		12.3	790.5	770.4	261
squatter pigeon (southern subspecies) (*Geophaps scripta scripta*)	Breeding / Foraging Habitat	0	111.8	0	28.7
	Foraging Habitat	0	37.9	0	82.8
koala (*Phascolarctos cinereus*)		35.9	167.1	0	111.5
greater glider (*Petauroides volans*)		0	132.8	0	34.3

[1] Disturbance associated with the Electricity Transmission Line EPBC (2019/8458), Water Pipeline EPBC (2019/8459) and Mine Site and Access Road EPBC (2019/8460) within MLA 700049, MLA 700050 and MLA 700051 is assessed under the Mine Site and Access Road EPBC (2019/8460).

8.2 MSES impact summary

In accordance with the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (DEHP, 2014), a significant residual impact assessment has been completed for each MSES known or likely to be located in the Project area (Appendix H). Results of these assessments identified that the Project is likely to result in significant residual impacts on MSES values. A summary of impacts on MSES and the results of the assessments are provided in Table 23.

Table 23. MSES impact summary

MSES	Area (ha)	Assessment Summary
Regulated Vegetation		
Endangered RE		
11.3.1	64.5	The Project would have a significant residual impact on this mid-dense RE, exceeding the threshold of 0.5 ha.
11.4.8	2.4	The Project would have a significant residual impact on this sparse RE, exceeding the threshold of 2 ha.
11.4.9	23.1	The Project would have a significant residual impact on this sparse RE, exceeding the threshold of 2 ha.
11.9.5	17.7	The Project would have a significant residual impact on this mid-dense RE, exceeding the threshold of 0.5 ha.
Of Concern RE		
11.3.2 [A]	9.6	The Project would have a significant residual impact on this sparse RE, exceeding the threshold of 2 ha.
11.3.3c	6.9	The Project would have a significant residual impact on this sparse RE, exceeding the threshold of 2 ha.
11.3.4	39.8	The Project would have a significant residual impact on this sparse RE, exceeding the threshold of 2 ha.
Regional Ecosystems within the Defined Distance of a Vegetation Management Watercourse		
11.3.1	1.3	The Project would have a significant residual impact on this mid-dense RE located within a mapped vegetation management watercourse, exceeding the threshold of 0.5 ha, as well as clearing within 5 m of the defining bank. [#]
11.4.4 [B]	0.1	The Project would not have a significant residual impact on this grassland RE located within a mapped vegetation management watercourse. Although the clearing is within 5 m of the defining bank, it would not exceed the 5 ha threshold. [#]
11.9.3 [C]	3.1	The Project would not have a significant residual impact on this grassland RE located within a mapped vegetation management watercourse. Although the clearing is within within 5 m of the defining bank, it would not exceed the 5 ha threshold. [#]

MSES	Area (ha)	Assessment Summary
Essential habitat		
Essential habitat mapping for the ornamental snake, as defined under the VM Act is shown on Figure 13. Essential habitat is defined under the VM Act as a category A, B or C area that has at least three essential habitat factors (a component of the wildlife's habitat that is necessary or desirable for the wildlife at any stage of its lifecycle), that are stated as mandatory for the protected wildlife in the essential habitat database, or in which the wildlife, at any stage of its lifecycle is located. Ornamental snake habitat in the Study Area is mapped as known important habitat because the species was recorded in these areas and they contain suitable microhabitat features of which the species relies on (Section 5.3.1). Assessment of whether impacts on essential habitat for the species are significant has been considered in the assessment of impacts on protected wildlife habitat for the ornamental snake, in accordance with the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (DEHP, 2014). Refer to Protected Wildlife Habitat below.		
Protected Wildlife Habitat		
Solanum adenophorum	0.2 (individuals and supporting habitat)	The Project would result in the removal of approximately 0.2 ha of known habitat (three individuals) and an additional 1,487.2 ha of potential habitat. This is considered to potentially lead to a long-term decrease in the size of a local population and would result in the Project likely having a significant residual impact on the species.
squatter pigeon (southern subspecies)	140.5 (breeding / foraging) 120.7 (foraging) 612.8 (dispersal)	Refer to Table 21.
Australian painted snipe	1,859.3 (intermittent foraging)	Refer to Table 21.
greater glider	167.1	Refer to Table 21.
ornamental snake	1,834.2	Refer to Table 21.
koala	314.5	Refer to Table 21.
common death adder	230.3	Likely to occur: The Project is unlikely to result in a significant residual impact on the common death adder as a result of removal of approximately 230.3 ha of suitable breeding habitat.
short-beaked echidna	2,471	Likely to occur: Given the species is widespread and abundant within the broader region, the Project's removal approximately 2,471 ha of potential habitat is unlikely to result in a significant residual impact for the species.
Connectivity		
Remnant REs	719.1	The Landscape Fragmentation and Connectivity Tool determined that the Project would result in a significant residual impact on Connectivity.

[A] The area associated with this MSES equates to the Poplar Box TEC.

[B] The area associated with this MSES equates to the Natural Grasslands TEC.

[C] The area associated with this MSES equates to the Natural Grasslands TEC.

[#] In accordance with the *Queensland Environmental Offset Policy Significant Residual Impact Guideline* (DEHP, 2014), both criteria 1 and 3 must be exceeded for a prescribed activity to have a significant impact on a RE that is within the defined distance of watercourses. Criteria 1 being clearing within 5 m of the defining bank and criteria 3 being a specified area of clearance dependent on the clearing activity (linear infrastructure or other) and the structural category of the RE.

9 Habitat Quality Assessment Results

The habitat quality scores for each MNES and MSES value which is considered likely to have a significant residual impact is detailed in Table 24. Detailed habitat quality survey data is also provided within Appendix I.

Table 24. Habitat Quality Assessment Summary

Matter	AU	RE	Clearance Area (ha)	Weighted BioCondition Score	BioCondition Score	Fauna Species Habitat Score
Matters of National Environmental Significance						
Natural Grasslands TEC	8	11.4.4 Remnant	45.7	2.93	5.60	N/A
	17	11.9.3 Remnant	35.2	2.67		
Poplar Box TEC	3	11.3.2 Remnant	9.6	6.94	6.94	N/A
ornamental snake	1	11.3.1 Remnant	64.5	0.2	3.85	6.77
	2	11.3.1 Regrowth	115.2	0.02		
	5	11.3.3c Remnant	6.9	0.03		
	9	11.4.8 Remnant	2.4	0.01		
	10b	11.4.8 Regrowth	1,341.3	3.58		
	11	11.4.9 Remnant	3.7	0.01		
koala	3	11.3.2 Remnant	9.6	0.2	5.77	7.00
	5	11.3.3c Remnant	6.9	0.14		
	6	11.3.4 Remnant	39.8	0.69		
	12	11.5.3 Remnant	110.9	1.99		
	13	11.9.2 Remnant	147.4	2.72		
greater glider	3	11.3.2 Remnant	9.6	0.4	6.07	8.75
	5	11.3.3c Remnant	6.9	0.27		
	6	11.3.4 Remnant	39.8	1.4		
	12	11.5.3 Remnant	110.9	4		
squatter pigeon (southern subspecies)	12	11.5.3 Remnant	76.7	2.58	5.70	7.63
	13	11.5.3 Regrowth	38.7	0.76		
	15	11.9.2 Remnant	111.6	2.37		
Matters of State Environmental Significance						
Endangered RE (BVG 25a)	1	11.3.1 Remnant	64.5	2.19	5.46	N/A
	9	11.4.8 Remnant	2.4	0.08		
	11	11.4.9 Remnant	23.1	1.74		
	18	11.9.5 Remnant	17.7	1.45		
	5	11.3.3c Remnant	6.9	0.93	5.68	N/A

Matter	AU	RE	Clearance Area (ha)	Weighted BioCondition Score	BioCondition Score	Fauna Species Habitat Score
Of Concern RE (BVG 16c)	6	11.3.4 Remnant	39.8	4.74		
Of Concern RE (BVG 17a)	3	11.3.2 Remnant	9.6	6.94	9.94	N/A
Regulated Vegetation - Watercourse (BVG 25a)	1	11.3.1 Remnant	1.3	5.10	5.82	N/A
Regulated Vegetation - Watercourse (BVG 30b)	8	11.4.4 Remnant	0.1	0.18	6.02	N/A
	17	11.9.3 Remnant	3.1	5.84		
Solanum adenophorum	10b	11.4.8/ 11.4.9 Regrowth	0.2	3.75	3.75	N/A

10 Impact avoidance and mitigation measures

This section describes the measures proposed to avoid and mitigate impacts on terrestrial ecology. Where significant residual impacts remain following implementation of the avoidance and mitigation measures, these impacts would be offset (Section 11).

10.1 Impact avoidance measures

The following refinements to the mine design have resulted in avoiding impacts on terrestrial ecology:

- minimising the overall mine footprint by optimising the backfilling of the open cut
- avoiding clearance of Brigalow TEC (Figures 8A, 8C, 8D and 8E)
- avoiding clearance of riparian vegetation associated with the Isaac River (Figure 7A-E)
- avoiding creek crossings for the infrastructure corridor (Figure 7A-E)
- avoiding palustrine wetlands on the boundary of MLA 700049/700050 and establishing a 50 m buffer on two of the wetlands (Section 10.4.6); and
- Consolidation and co-location of the Project ETL, Water Pipeline and Mine Site Access Road into a single corridor within MLA 700065.

10.2 Summary of impact avoidance and mitigation measures for MNES

Impact avoidance and mitigation measures proposed to be implemented for MNES are detailed in Table 25.

10.3 Summary of impact avoidance and mitigation measures for MSES

Impact avoidance and mitigation measures proposed to be implemented for MSES are detailed in Table 26.

Table 25. MNES impact avoidance and mitigation measures

MNES	Avoidance/Mitigation Measure	Predicted Effectiveness	Statutory or Policy basis
Brigalow TEC	Refinements to the Project area have avoided the clearing of Brigalow TEC (Section 10.1)	Highly effective – avoidance of impact.	(DotE, 2013a); (DES, 2019b); (DES, 2020a); (TSSC, 2001a).
Poplar Box TEC	Boundaries of areas to be cleared, and those not to be cleared, would be defined during construction and operation (Section 10.4.1)	Highly effective – avoidance of impact.	(DEE, 2019a); (DES, 2019b).
Natural Grasslands TEC	Boundaries of areas to be cleared, and those not to be cleared, would be defined during construction and operation (Section 10.4.1)	Highly effective – avoidance of impact.	(DES, 2019b); (TSSC, 2009).
ornamental snake (*Denisonia maculata*)	• Fauna spotter / catchers to be on site during clearing in ornamental snake habitat (Section 10.4.1)	Potentially effective. Ornamental snake may be difficult to capture during clearing.	(DotE, 2014a).
	• Feral animal management (Section 10.4.3)	Highly effective – standard management technique widely used	(DSEWPaC, 2011a); (Ponce *et al.*, 2016).
koala (*Phascolarctos cinereus*)	• Avoid clearing riparian vegetation associated with the Isaac River (Section 10.4.1)	Highly effective – avoidance of impact	(DSEWPaC, 2012c); (DotE, 2014c); (TSSC, 2012).
	• Experienced koala spotters to be on site when clearing in koala habitat (Section 10.4.1)	Highly effective – standard management technique widely used	Standard measure.
	• Minimise/target artificial directional lighting (Section 10.4.8)	Highly effective – standard management technique widely used	(DES, 2019d).
	• Manage vehicle strike on roads (e.g. speed limit, signage, education) (Section 10.4.5)	Highly effective – standard management technique widely used	(DSEWPaC, 2012c); (DotE, 2014c); (DES, 2019d).
	• Feral animal management (Section 10.4.3)	Highly effective – standard management technique widely used	(DSEWPaC, 2012c); (DotE, 2014c).
greater glider (*Petauroides volans*)	• Avoid clearing riparian vegetation associated with the Isaac River (Section 10.4.1)	Highly effective – avoidance of impact.	(TSSC, 2016a).
	• Fauna spotter/catchers to be on site when clearing in greater glider habitat (Section 10.4.1)	Potentially effective if hollow-bearing trees and limbs are carefully salvaged.	Standard measure.

MNES	Avoidance/Mitigation Measure	Predicted Effectiveness	Statutory or Policy basis
squatter pigeon (southern subspecies) (*Geophaps scripta scripta*)	• Fauna spotter/catchers to be on site during vegetation/habitat clearing (Section 10.4.1)	Highly effective – standard management technique widely used	(TSSC, 2015a).
	• Feral animal management (Section 10.4.3)	Highly effective – standard management technique widely used	(DotE, 2015a-c); (DEE, 2016); (DEE, 2017); (DEWHA, 2008c).
Australian painted snipe (*Rostratula australis*)	• Remove cattle and avoid clearing two palustrine wetlands to the north of the Project (Section 10.4.6)	Effective when applied.	(TSSC, 2013b).
	• Establish 50m buffers on two of the wetlands (Section 10.4.6)	Effective when applied and buffer areas are clearly delineated.	(DSEWPaC, 2013a); (TSSC, 2013b).

Table 26. MSES impact avoidance and mitigation measures

MSES	Avoidance/Mitigation Measure
Endangered and Of Concern REs Regulated Vegetation within the Defined Distance of a Vegetation Management Watercourse	• Boundaries of areas to be cleared, and those not to be cleared would be defined during construction and operation (Section 10.4.1) • Clearing of native vegetation would be undertaken progressively (Section 10.4.1)
Essential Habitat (DNRME mapped)	N/A
Solanum adenophorum habitat	N/A
ornamental snake habitat (*Denisonia maculata*)	• Refer to Table 23
koala habitat (*Phascolarctos cinereus*)	• Refer to Table 23
greater glider habitat (*Petauroides volans*)	• Refer to Table 23
squatter pigeon (southern subspecies) habitat (*Geophaps scripta scripta*)	• Refer to Table 23
Australian painted snipe habitat (*Rostratula australis*)	• Refer to Table 23
Connectivity Areas	• Impact avoidance measures are described in Section 10.1

10.4 Environmental management plans

The development and implementation of the following environmental management plans are recommended for the Project:

- Environmental Management Plan – including vegetation clearing measures, management of palustrine wetlands, vehicle strike management, artificial lighting management, weed management and animal pest management and bushfire risk management
- Water Management Plan, including erosion and sediment control
- Species Management Program addressing the requirements under the NC Act; and
- MNES Management Plan, including measures specific to management of MNES (Section 8).

A Progressive Rehabilitation and Closure Plan would be implemented and would outline suitable rehabilitation schedules, methods and monitoring requirements for the Project. Rehabilitation objectives would be monitored and audited, and corrective actions managed, through the Progressive Rehabilitation and Closure Plan (Section 10.6).

Each of the above mentioned plans would contain mechanisms for ongoing and regular review to assess the effectiveness of the Plans and their management methods.

10.4.1 Vegetation clearing measures

While the Project would result in unavoidable impacts on potentially occurring terrestrial ecology, a range of vegetation clearing measures would need to be implemented over both the construction and operational phases of the Project. These include the following:

- Pre-clearance fauna surveys would be undertaken by suitably experienced and qualified persons to identify individual fauna at direct risk from clearing activities.
- A suitably experienced and qualified fauna spotter/catcher would be present during the clearing of MSES and MNES habitat areas.
- Management of fauna identified during clearing would include relocating individuals to adjacent habitat or treating injuries.
- If a koala is found, it would be left to move away from the clearance area on its own accord.
- Boundaries of areas to be cleared, and those not to be cleared would be defined during clearing activities.
- Select habitat features (e.g. hollow-bearing trees, woody debris, logs and rocks) would be salvaged for re-use in rehabilitation of the Project.
- Land clearing would be carried out progressively over the life of the Project to allow mobile fauna species the opportunity to disperse away from clearing areas.
- Directional clearing towards retained vegetation would be undertaken where practical to enable the movement of fauna into retained vegetation.
- During construction works, work areas and excavations (trenches) would be checked for fauna that may have become trapped.
- If trenches remain open after daily site works have been completed, fauna ramps would be put in place.

10.4.2 Weed management

During the life of the Project, weed management (prevention, monitoring and control) would be undertaken to mitigate the abundance and species of weeds in the MLAs and minimise the potential for weeds to spread into adjacent habitat areas.

As described in Section 4.7, exotic flora species occur extensively across the Study Area, likely due to the high level of past clearance and the current land use (e.g. grazing). Weeds that are present on-site would be identified by regularly surveying (of tracks, revegetation [rehabilitation] areas and topsoil stockpiles, etc.) on a bi-annual basis or more frequently as required.

Restricted matters that are listed under the Biosecurity Act would be specifically targeted for control (refer to Table 11).

Weed prevention techniques would be implemented in the MLAs and include washdown of machinery when moving from weed infested areas. Weed control techniques would be implemented in the MLAs as required. Physical removal and chemical application are the main weed control methods available. Specific weed control methods would be in accordance with those specified by the Queensland Department of Agriculture and Fisheries and the *Isaac Regional Biosecurity Plan 2020-2023* (IRC, 2020). The control techniques used would be documented and areas subject to weed control would be mapped for follow-up inspection and management.

10.4.3 Feral animal management

During the life of the Project, feral animals would be deterred from the Project area by maintaining a clean, rubbish-free environment. Appropriately qualified persons would be engaged to undertake bi-annual pest animal monitoring in the MLAs, which may include coordination with adjoining mining operations/adjacent landowners. Feral animal control strategies and measures (e.g. baiting, trapping) would be implemented in the MLAs in accordance with relevant standards and the *Isaac Regional Biosecurity Plan 2020-2023* (IRC, 2020) to maintain low abundance of feral animals. The control strategies and measures would be directed towards the following feral animals observed during field assessments within the Study Area:

- cat (*Felis catus*)
- European hare (*Lepus europaeus*)
- European rabbit (*Oryctolagus cuniculus*)
- pig (*Sus scrofa*); and
- wild dog (*Canis lupus*).

The following threat abatement plans would be relevant:

- *Threat Abatement Plan for Predation by Feral Cats* (DotE, 2015a)
- *Threat Abatement Plan for Competition and Land Degradation by Rabbits* (DEE, 2016); and
- *Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs* (DEE, 2017).

The *Threat Abatement Plan for Predation by the European Red Fox* (DEWHA, 2008d) is not relevant to the Project as red fox were not recorded in the locality.

10.4.4 Bushfire risk management

Potential impacts of the Project on bushfire risk would be mitigated through the following:

- managing vegetation within the MLAs to maintain safe fuel loads
- any chemicals used in the Project area would be handled and disposed of in accordance with the relevant Safety Data Sheet
- implementing access tracks, to be used by Queensland Fire and Rescue Service for emergency purposes; and
- implementing an Emergency Response Procedure prepared in consultation with emergency services.

10.4.5 Vehicle strike management

The following measures would be undertaken to manage the risk of vehicle strike on fauna:

- designating site speed limits (i.e. maximum speed of 60 km on all internal access roads)
- developing a process for the removal of roadkill to minimise the risk of attracting fauna to the roadway; and
- developing a process for the management of fauna injured by vehicle strike.

10.4.6 Management of palustrine wetlands

During the life of the Project, cattle would be excluded from two palustrine wetlands (i.e. within the 50 m buffer inside the MLAs) (Figure 24). These two palustrine wetlands are located on privately-owned land (PW2) and land owned by Whitehaven WS (PW3), noting that both are proposed to be disturbed by a railway for the adjacent approved Olive Downs Project (EPBC 2017/7870).

Excluding cattle from these wetlands is considered likely to have a positive influence on the condition and ecological value of these wetlands (noting that the aquatic ecological values of these wetlands are limited to times of inundation e.g. during floods, and the wetlands have terrestrial ecological value at other times).

10.4.7 Erosion and sediment control

An Erosion and Sediment Control Plan would be developed and implemented as part of the Project Water Management Plan throughout the construction and operation phases of the Project in order to reduce the amount of sediment laden run-off entering downstream waterways. A 'best practice' approach towards erosion and sediment control would be adopted. The following general principles would apply to the Erosion and Sediment Control Plan:

- minimise the surface disturbance areas, which has been incorporated into the design of the Project
- where possible, apply local temporary erosion control measures
- intercept run-off from undisturbed areas and divert around surface disturbance areas, through the use of up-catchment diversions; and
- where temporary measures are likely to be ineffective, direct surface water run-off from surface disturbance areas to sediment dams prior to release from the Project area.

Active haul roads would be regularly watered (or applied with dust suppressants) to minimise dust generation potential.

10.4.8 Artificial lighting management

Where artificial lighting is required, directional lighting should be implemented in a way to:

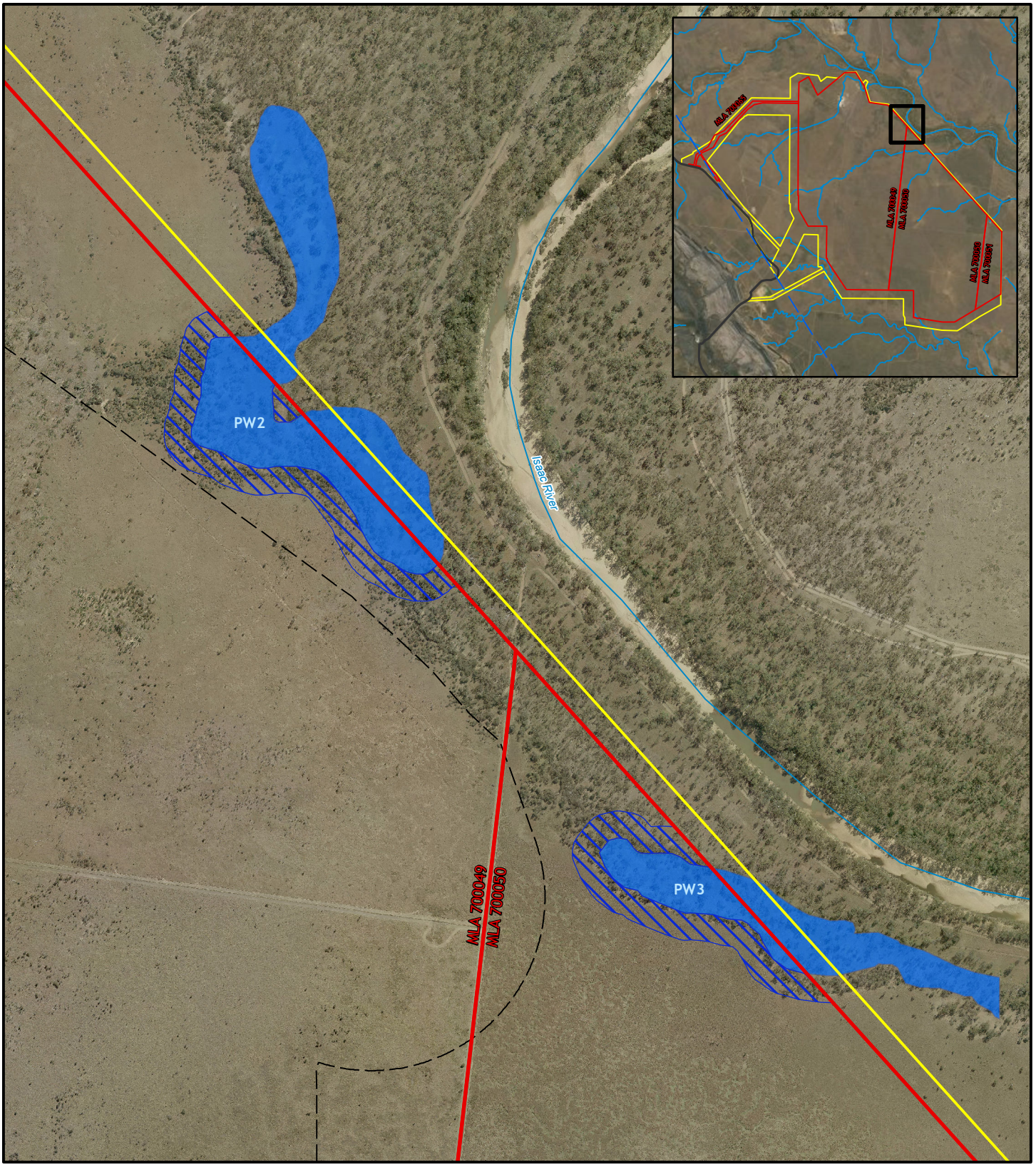
- focus on disturbance/work areas
- minimise/avoid lighting of remnant vegetation; and
- implemented in accordance with Australian Standards.

10.5 Monitoring programmes

As described in the Terms of Reference, the objective, with regards to flora and, is that biodiversity (terrestrial flora and fauna) would be identified and appropriately safeguarded. This objective would be achieved through the implementation of a monitoring programme.

The development and implementation of the following monitoring programmes are recommended for the Project:

- threatened flora and fauna species
- weed monitoring
- animal pest monitoring; and
- groundwater monitoring.



Legend

- Watercourse and Drainage Feature
- Road
- Primary Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- Ground-truthed Wetland (ESP, 2019)
- Wetland Management Area

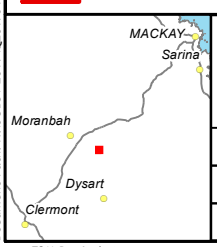
N

Scale 1:10,000 (A4)

0 0.5

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © DNRME 2018, Whitehaven 2019
MDL: © DNRME 2018
Watercourse: © Geoscience Australia 2018
Road: © PSMA 2014
Cadastre: © DNRME 2019
Wetland: © ESP 2019

Rev	Description	Drawn	Approved	Date
0	Issued for Use	DL	BD	27/11/2020
G	Issued for Review	DL	BD	02/11/2020

FIGURE 24: WETLAND MANAGEMENT AREAS

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	0

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10.6 Mine rehabilitation

Rehabilitation activities would be conducted as soon as possible for inactive and complete areas. The post-mine landforms would be for an agricultural land use and contain a mixture of woodland and pasture (Figure 23). Woodland plant species used for rehabilitation would be specific to the original ecosystem and local provenance. The pasture species would be either native and/or improved pasture species already present in the area, or other appropriate species suited to the Project final landforms.

Framework species from RE 11.5.3 and from REs occurring in analogous landforms in the region would be used for the establishment of woodland patches on waste rock emplacements, where appropriate, and along drainage paths in the final landform.

Where appropriate, woodland patches would provide habitat such as nest hollows, watering points and ground litter for native fauna. Select habitat features (e.g. hollow-bearing trees, woody debris, logs and rocks) would be salvaged and re-used in the mine rehabilitation.

A Progressive Rehabilitation and Closure Plan would be implemented which outlines suitable rehabilitation schedules, methods and monitoring requirements for areas that can be rehabilitated over the life of the Project.

11 Biodiversity offsets

An environmental offset is required to address the residual significant impacts on MNES and MSES that are likely as a result of the Project. This section describes the biodiversity offset requirements for the Project.

Offsets would be established for the Project in stages, in accordance with the *Queensland Environmental Offsets Policy*, accounting for the progressive disturbance of the Project. Attachment 6 of the EIS provides the Offset Management Strategy for the Project and presents the disturbance associated with each of the proposed offset stages and a breakdown of all potential MNES and MSES.

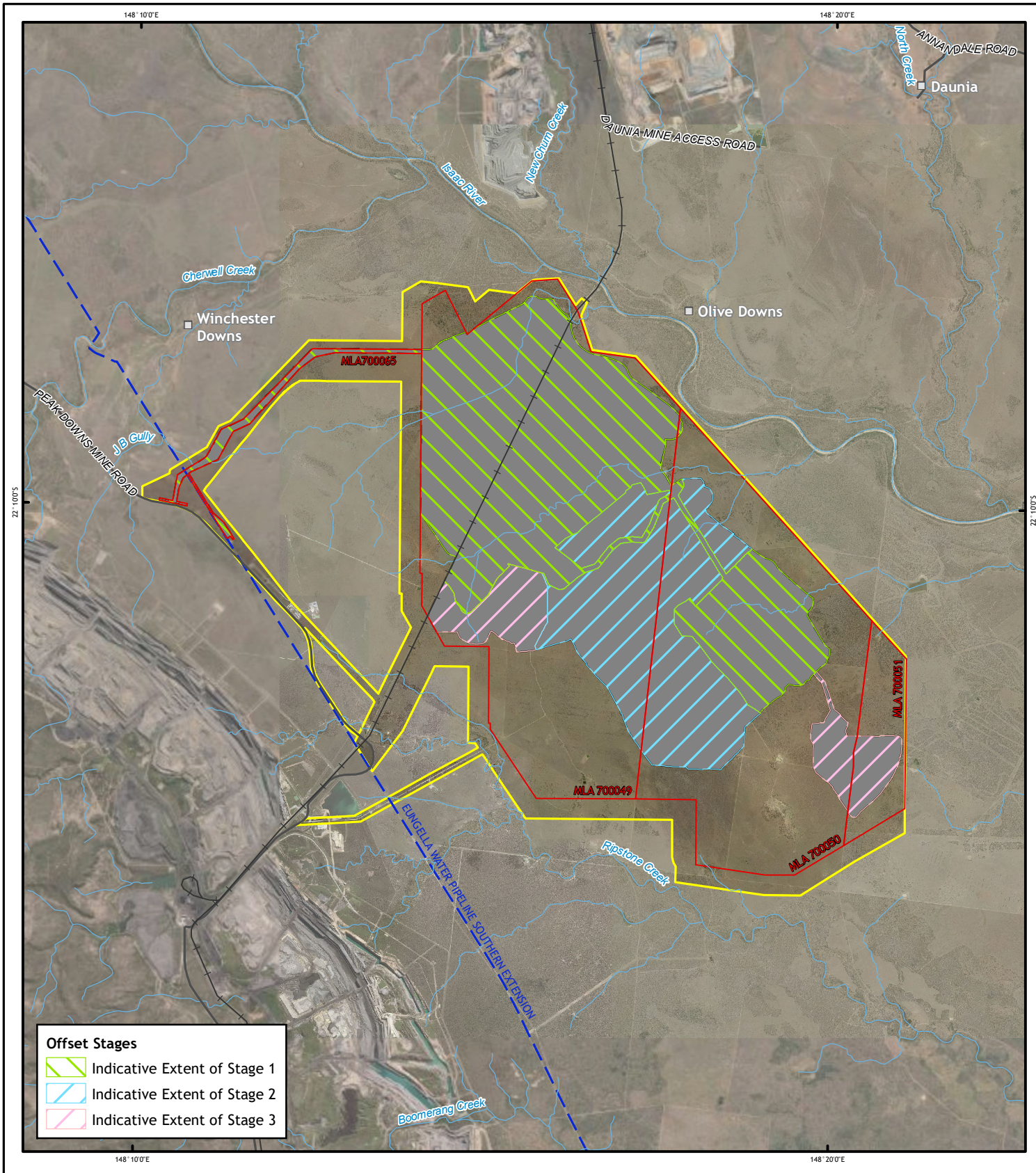
The extent of disturbance associated with each of the offset stages is shown on Figure 25.

In accordance with the *Queensland Environmental Offsets Policy*, a detailed assessment of the impact of each stage of the Project and the offset requirement for each stage would be conducted prior to providing the notice of election to DES for that stage. The offset would be provided before the commencement of each stage. As described in the *Queensland Environmental Offsets Policy*, offset staging will provide Winchester WS with flexibility to adapt the offset provisions to operational changes that may occur over time.

The *EPBC Act Environmental Offsets Policy* (DSEWPaC, 2012a) describes that a State offset will count toward an offset under the EPBC Act to the extent that it compensates for the residual impact to the protected matter identified under the EPBC Act.

11.1 MNES offset requirements

Based on the significant impact assessments detailed in Appendix G, the Project requires offsets for the MNES in Table 25.



Legend

- Homesteads
- Railways
- Road
- Watercourse
- Water Pipeline
- Study Area
- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent

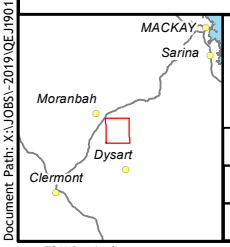
N

Scale 1:130,000 (A4)

0 2 4 6

Kilometres

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator



Notes:
Aerial Imagery: © ESRI 2019, Whitehaven 2019
Cadastre: © DNRME 2018
Watercourse: © Geoscience Australia 2018
Homesteads: © DNRME 2018
Mining Lease: © DNRME 2019

Rev	Description	Drawn	Approved	Date
1	Issued for Use	DL	BD	27/05/2021
0	Issued for Use	DL	BD	27/11/2020

FIGURE 25: PROPOSED OFFSET STAGING

Winchester South Terrestrial Ecology Assessment - WHITEHAVEN COAL

Map Number	Job Number	Rev
1 of 1	QEJ19011	1

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Table 27. MNES Clearance within Each Project Stage

MNES	Infrastructure Corridor (EPBC 2019/8458	Mine Site and Access Road (EPBC 2019/8460)[1]				Total (Infrastructure Corridor + Mine Site and Access Road)			Overall Total (ha)
	Stage 1 (ha)	Stage 1 (ha)	Stage 2 (ha)	Stage 3 (ha)	Total (ha)	Stage 1 (ha)	Stage 2 (ha)	Stage 3 (ha)	
Brigalow TEC	0	0	0	0	0	0	0	0	0
Poplar Box TEC	0	9.6	0	0	9.6	9.6	0	0	9.6
Natural Grasslands TEC	6.5	59.8	14.6	0	80.9	66.3	14.6	0	80.9
ornamental snake (*Denisonia maculata*)	12.3	790.5	770.4	261	1,834.2	802.8	770.4	261	1,834.2
squatter pigeon (southern subspecies) (*Geophaps scripta scripta*)[#]	0	149.7	0	111.5	261.2	149.7	0	111.5	261.2
koala (*Phascolarctos cinereus*)	35.9	167.1	0	111.5	314.5	203	0	111.5	314.5
greater glider (*Petauroides volans*)	0	132.8	0	34.3	167.1	132.8	0	34.3	167.1

[1] Disturbance associated with the Electricity Transmission Line EPBC (2019/8458), Water Pipeline EPBC (2019/8459) and Mine Site and Access Road EPBC (2019/8460) within MLA 700049, MLA 700050 and MLA 700051 is assessed under the Mine Site and Access Road EPBC (2019/8460).

[#] Note there would be no residual impact on dispersal habitat for the squatter pigeon (southern subspecies) and therefore an offset would not be required.

11.2 MSES offset requirements

Based on the significant impact assessments detailed in Appendix H, the Project requires offsets for the MSES in Table 26.

Table 28. MSES Impacts within Each Project Stage

MSES	BVG	Stage 1	Stage 2	Stage 3	Total
Regulated Vegetation Endangered RE					
11.3.1	25a	64.5	-	-	64.5
11.4.8		2.4	-	-	2.4
11.4.9		3.7	-	19.4	23.1
11.9.5		17.7	-	-	17.7
Of Concern RE					
11.3.2[A]	17a	9.6	-	-	9.6
11.3.3c	16c	6.9	-	-	6.9
11.3.4		39.8	-	-	39.8
Regional Ecosystems within the Defined Distance of a Vegetation Management Watercourse					
11.3.1	25a	1.3	-	-	1.3
11.4.4[B]	30b	0.1	-	-	0.1
11.9.3[C]		3.10	-	-	3.10
Essential habitat					
Refer to ornamental snake below.					
Protected Wildlife Habitat					
Solanum adenophorum[1]	N/A	0.2	0	0	0.2
ornamental snake	N/A	802.8	770.4	261	1,834.2
koala	N/A	203	0	111.5	314.5
greater glider	N/A	132.8	0	34.3	167.1
squatter pigeon (southern subspecies)	N/A	149.7	0	111.5	261.2
Connectivity					
Remnant REs	N/A	555	33	130.9	719.9

[1] Impact area only includes known habitat for the species.

[A] The area associated with this MSES equates to the Poplar Box TEC.

[B] The area associated with this MSES equates to the Natural Grasslands TEC.

[C] The area associated with this MSES equates to the Natural Grasslands TEC.

12 Conclusion

The development footprint for the Project covers a total of approximately 7,130 ha in area. Most of the Project area (6,408.6 ha) has been cleared in the past and is non-remnant. The Project would require the progressive removal of a total of 719.9 ha of the remnant vegetation over 30 years.

Where possible, the Project would avoid, mitigate and manage environmental impacts associated with the construction and operation, with findings of the field survey incorporated in the Project design. Mitigation measures to be implemented to minimise unavoidable impacts would include but not be limited to:

- vegetation clearing measures, including pre-clearance surveys
- rehabilitation of post-mine landforms; and
- weed/animal pest monitoring and management.

The Project has been designed to avoid or minimise impacts to terrestrial environmental values, however, some residual impacts are likely to occur.

Brigalow TEC identified would be avoided by the Project, however the Project would impact two TECs listed under the EPBC Act (Natural Grasslands TEC [80.9 ha] and Poplar Box TEC [9.6 ha]) and species habitat for four threatened fauna species listed under the EPBC Act, namely, the ornamental snake, koala, greater glider and squatter pigeon (southern sub-species).

MSES (some of which are also MNES) impacted by the Project would comprise:

- Regulated Vegetation including:
  - 'Endangered' and 'Of Concern' REs
  - Essential habitat (for the ornamental snake); and
  - within the defined distance of a vegetation management watercourse.
- Protected Wildlife Habitat for five species (*Solanum adenophorum*, ornamental snake, koala, greater glider and squatter pigeon [southern sub-species]); and
- Connectivity areas.

Residual impacts on MNES and MSES would be offset in accordance the *EPBC Act Environmental Offsets Policy* and *Queensland Environmental Offsets Policy*.

13 References

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