Mineral Resources Limited

Review of Fauna Assessments within the

Mt Marion Lithium Project area

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Executive summary

Bamford Consulting Ecologists (BCE) was commissioned by Mineral Resources Ltd to conduct a review of fauna assessments within the Mt Marion Lithium Project area, in support of a mining proposal and Native Vegetation Clearing Permit amendment. The leases included within the project are M15/717, M15/1000, M15/999, L15/376, L15/353, L15/220, L15/360, L15/392 and the Hamptons Area 53. The review was primarily based on fauna assessments that have been conducted across the Mt Marion Lithium Project area since 2010.

BCE uses an impact assessment process with the following components:

- The identification of fauna values:
  - Assemblage characteristics: uniqueness, completeness and richness;
  - Species of conservation significance;
  - Recognition of vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
  - Patterns of biodiversity across the landscape;
  - Ecological processes upon which the fauna depend.
- The review of impacting processes such as:
  - Habitat loss leading to population decline;
  - Habitat loss leading to population fragmentation;
  - Degradation of habitat due to weed invasion leading to population decline;
  - Ongoing mortality from operations;
  - Species interactions including feral and overabundant native species;
  - Hydrological change;
  - Altered fire regimes; and
  - Disturbance (dust, light, noise).
- The recommendation of actions to mitigate impacts.

Based on a desktop assessment and the findings of the previous fauna assessments, 289 vertebrate fauna species have been identified as potentially occurring in the Mt Marion Lithium Project area, including: five frogs, 85 reptiles, 164 birds, 25 native and ten introduced mammals. Eighty-five species have been recorded from the project area, including one frog, 10 reptiles, 59 birds, nine native mammals and six introduced mammals. Conservation significant fauna species recorded from the project area included the Malleefowl (based on several old to very old mounds) and nine locally significant bird species.

Key fauna values are:

Fauna assemblage. Largely intact and rich (missing some medium-sized mammals in common with much of WA), and broadly typical of the Coolgardie Bioregion. Some south-western species occur at the eastern edge of their range (Blue-breasted Fairy-wren, Western Yellow Robin) and the assemblage also has elements from adjacent biogeographic zones.

Species of conservation significance. 20 significant species are considered likely to occur as either residents of the survey area, or at least as regular visitors. These are the Malleefowl (considered unlikely to currently nest in the study area, but likely to forage through the area); Peregrine Falcon (resident or regular visitor); Central Long-eared Bat (resident); Carpet Python (resident); 16 locally

significant declining woodland birds (nine species recorded and an additional seven species expected as residents or regular visitors) and the Kultarr (resident).

Vegetation and Substrate Associations (VSAs). The survey area supports intact native vegetation across a ridge of greenstone hills above a broad paleo-drainage system that flows to Lake Lefroy, south-east of the study area. Eight VSAs were identified within the area, including:

1) Mixed Eucalypt Woodland on Greenstone hills.
2) Dense Acacia shrubland in gullies and slopes of Greenstone hills.
3) Eucalypt Woodland over mixed shrubs on clay-loam flats.
4) Mixed Eucalypt woodland over *Melaleuca sheathiana* on gravelly rises.
5) Dense Mallee and Eucalypt woodland associated with minor drainage lines.
6) Dense Acacia and Allocasuarina shrubland on sandy clay flats.
7) Mixed Eucalyptus woodland over sclerophyll shrubland with *Diocirea acutifolia* (P3) on undulating hills.
8) *Casuarina pauper* shrubland with *Eucalyptus lesouefii* over mixed shrubland across greenstone hills.

Two of these VSAs, #5 and #8 are limited in their extent within the project area, heavily disturbed through previous mining activity and will be impacted by the proposed life of mine footprint; they are both expected to occur as a similar proportion of the landscape outside of the project area.

Notable features of these VSAs include:

- Areas of Eucalypt woodland, particularly Salmon Gum woodland, contain mature hollow-bearing trees that are likely to be utilised by range of fauna species including obligate hollow nesting species.
- Areas of dense understorey are likely to be preferentially utilised by a range of species, including several bird species that have declined across the south-west due to widespread land-clearing e.g. Blue-breasted Fairy-wren and Western Yellow Robin.

Patterns of biodiversity. Detailed patterns of biodiversity could not be examined, but it can be predicted that important features for biodiversity will be the structural complexity, presence of large, hollow-bearing trees and the presence of dense shrub lands.

Key ecological processes. Key ecological processes affecting the fauna assemblage in the project area are hydrology, feral species and interactions with native species.

Potential Impacts upon fauna include:

- Loss of restricted habitats/VSAs;
- Altered hydrology impacting downstream VSAs/habitats;
- Fragmentation of habitat; and
- Increased abundance of feral species.

An assessment of the project's fauna values was made against the Ten Clearing Principles, as part of the Natural Vegetation Clearing Permit (NVCP) application. This assessment highlighted one principle that the project may be at variance, i.e. it is growing in, or in association with, an environment associated with a watercourse or wetland.

Recommendations relate to impacts and include:

- Minimise disturbance footprint wherever possible;
- Stockpile and re-use large trees in rehabilitation where possible;
- Monitor and document roadkill of significant species;
- Minimise altering surface and sub-surface hydrology;
- Implement feral and over-abundant native species management;
- Practice standard minesite weed hygiene management
- Minimise loss of mature hollow-bearing Eucalypts; and
- Progressive rehabilitation of cleared areas as soon as practicable after construction or operations.

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1 Introduction

1.1 Introduction

Bamford Consulting Ecologists (BCE) was commissioned by Mineral Resources Limited (MRL) to conduct a review of fauna assessments conducted within the Mt Marion Project Area to support a mining proposal covering lease area that includes M15/717, M15/1000, M15/999, L15/376, L15/353, L15/220, L15/360, L15/392 and the Hamptons Area 53. The purpose of this review is to collate information about species and habitats recorded/expected within the area and to update information relating to species conservation status that may have changed since the initial assessment/s.

The earlier assessments provide information on the fauna values of the project areas (particularly for significant species), an overview of the ecological function of the sites (within both the local and regional context) and provide discussion on the interaction of the proposed developments on these fauna values and functions.

1.2 General Approach to Fauna Impact Assessment

The purpose of impact assessment is to provide government agencies with the information they need to decide upon the significance of impacts of a proposed development. BCE uses an impact assessment process with the following components:

- The identification of fauna values:
  - Assemblage characteristics: uniqueness, completeness and richness;
  - Species of conservation significance;
  - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
  - Patterns of biodiversity across the landscape;
  - Ecological processes upon which the fauna depend.
- The review of impacting processes such as:
  - Habitat loss leading to population decline;
  - Habitat loss leading to population fragmentation;
  - Degradation of habitat due to weed invasion leading to population decline;
  - Ongoing mortality from operations;
  - Species interactions including feral and overabundant native species;
  - Hydrological change;
  - Altered fire regimes; and
  - Disturbance (dust, light, noise).
- The recommendation of actions to mitigate impacts.

Descriptions and background information on these values and processes can be found in Appendix A to Appendix D. In particular, Appendix A explains and defines the fauna values, including the recognition of three classes of species of conservation significance (CS): those listed under legislation (CS1), those listed as priority by the Department of Biodiversity, Conservation and Attractions (CS2), and those that can be considered of local or other significance, but which have no formal listing (CS3). Appendix B describes threatening processes, while Appendix C outlines the legal definitions and

classes of conservation significance, and Appendix D presents the threatening processes recognised under legislation. Based on this impact assessment process, the objectives of investigations are to: identify fauna values; review impacting processes with respect to these values and the proposed development; and provide recommendations to mitigate these impacts.

1.3 Description of Survey Area

The Mount Marion Lithium Project is located approximately 35 km south of Kalgoorlie, in the Goldfields region of Western Australia (see Figure 1). The mining proposal covers a total area of 1890.89 ha, of which it is proposed to directly impact approximately 900 ha through clearing throughout the Life of Mine (LOM) (see Figure 2).

Figure 1. Regional location of the Mt Marion Project Area.

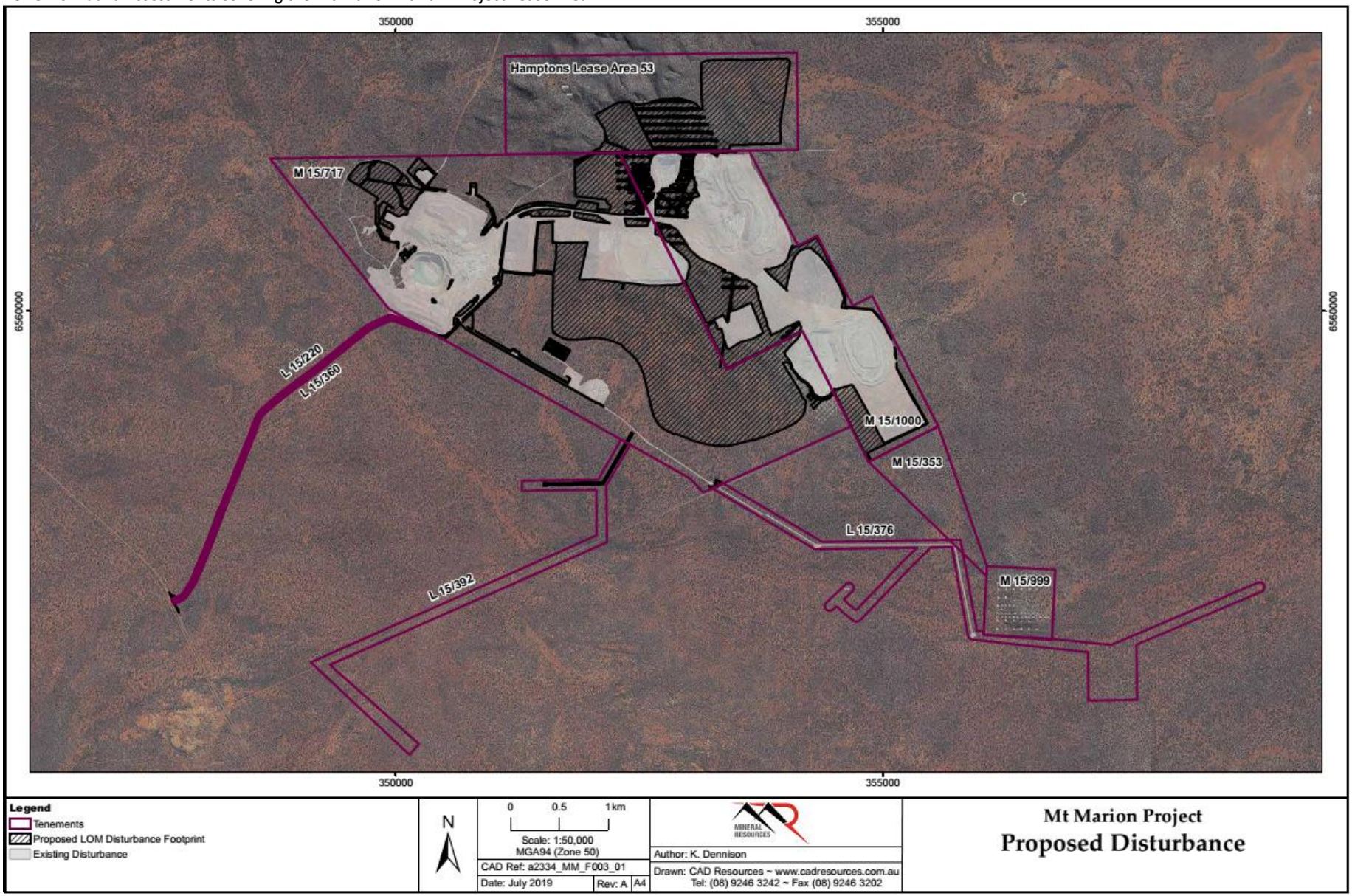


Figure 2. Mt Marion Lithium Project lease areas, with proposed LOM footprint shown.

2 Background

2.1 Project Description

The Mt Marion Lithium Project is a joint venture project owned by Mineral Resources Ltd., and Jiangxi Ganfeng Lithium Co. Ltd., and is operated by Process Mineral International Pty (a subsidiary of MRL) Ltd. The purpose of the project is to extract spodumene (a lithium bearing ore) for processing into a 6% spodumene concentrate, for use in various industries including the production of batteries. The project will include a borefield, pipelines, entrance road, mining and processing areas.

2.2 Regional Description

The Interim Biogeographic Regionalisation of Australia (IBRA) (EA, 2000) has identified 26 bioregions in Western Australia. Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell, 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA, 2004). The Mt Marion survey area lies within the Coolgardie Bioregion and the Eastern Goldfields Subregion (Coolgardie 3, IBRA, 2008). The Coolgardie Bioregion falls within the Bioregion Group 2 classification (EPA, 2004). Bioregions within Group 2 have "native vegetation that is largely contiguous but is used for commercial grazing."

Cowan (2001) describes the Eastern Goldfields subregion as:

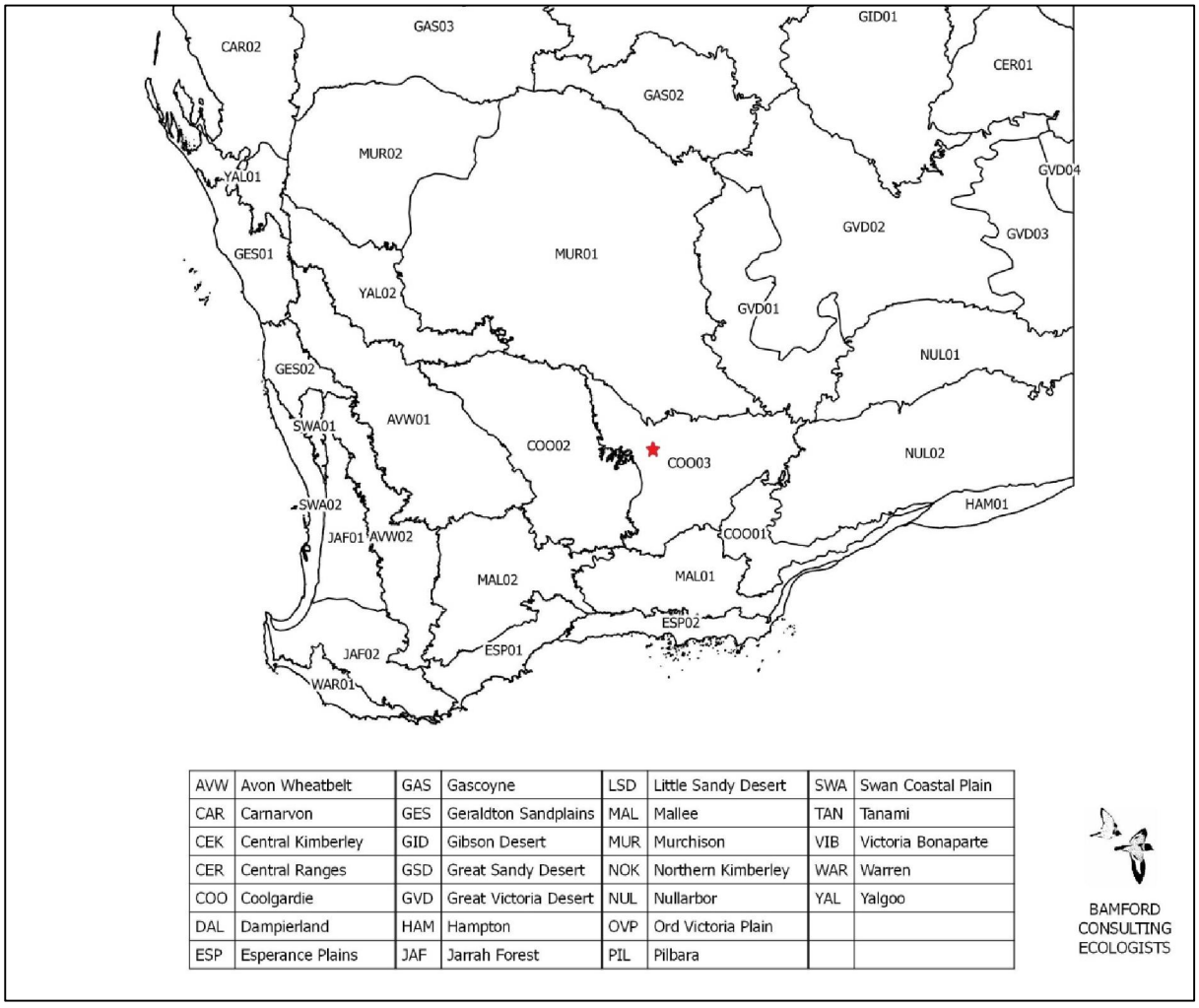
"*The vegetation is of Mallees, Acacia thickets and shrub heaths on sandplains. Diverse Eucalyptus woodlands occur around salt lakes, on ranges, and in valleys. Salt lakes support dwarf shrublands of samphire. The area is rich in endemic Acacias. The climate is Arid to Semi-arid with 200-300 mm of rainfall, sometimes in summer but usually in winter. The subregional area is 5,102,428ha*."

The dominant land use in this subregion is grazing, with smaller areas of crown reserves, mining, freehold, and conservation. Only 4.35 % of the sub-region is vested within conservation reserves (Cowan, 2001). Cowan (2001) describes the Goldfields Woodlands as having an exceptionally high diversity of Eucalyptus species with as many as 170 species occurring in the bioregion.

The survey area lies within the Coolgardie Vegetation System. The region is characterised by woodlands of *Eucalyptus torquata*, *Eucalyptus lesouefii* and *Eucalyptus clelandii* with *Eremophila scoparia*, *Eremophila glabra* and *Eremophila oldfieldii* shrubs. All woodlands in the Coolgardie System have been logged in the past for mining timber and firewood so that stands seen today are secondary growth that has regenerated from seed and coppice (Beard 1972). Beard (1972) describes the vegetation of the region as including:

- Greenstone Ridges supporting a characteristic *Eucalyptus torquata – E. lesouefii* association. Both *E. torquata* and *E. lesouefii* are co-dominant, abundant and characteristic. Associated trees include *E. clelandii*, *E. campaspe*, *Casuarina pauper* and *Grevillea nematophylla*. There is an open shrub understorey, largely of *Eremophila* spp. ("Broombush"), *Dodenia lobulata*, *Senna cardiosperma* and *Acacia* species, interspersed with *Atriplex nummularia*. Two understorey types, "broombush" and "saltbush", occur on slopes, with broombush appearing on less alkaline soils;

- Eucalypt Woodlands of the lower slopes and flats consist typically of *Eucalyptus salmonophloia*, often with *E. salubris*, *E. torquata* and *E. longicornis*. *Melaleuca pauperiflora* (boree) occurs as a dominant understorey on heavy, periodically wet soils;
- Salt lakes and samphire flats. Distinct localised vegetation communities occur in saline or alkaline soils and fringed with open saltbush or bluebush, lightly wooded with *Casuarina pauper*, *Myoporum platycarpum* and some *Acacia* species; and
- Red sand dunes with scattered *Callitris columellaris*, *Pittosporum angustifolium*, *Acacia tetragonophylla*, *Eremophila miniata* and shrubs of *Grevillea sarissa* and *Acacia* species (Beard, 1972).



AVW	Avon Wheatbelt	GAS	Gascoyne	LSD	Little Sandy Desert	SWA	Swan Coastal Plain
CAR	Carnarvon	GES	Geraldton Sandplains	MAL	Mallee	TAN	Tanami
CEK	Central Kimberley	GID	Gibson Desert	MUR	Murchison	VIB	Victoria Bonaparte
CER	Central Ranges	GSD	Great Sandy Desert	NOK	Northern Kimberley	WAR	Warren
COO	Coolgardie	GVD	Great Victoria Desert	NUL	Nullarbor	YAL	Yalgoo
DAL	Dampierland	HAM	Hampton	OVP	Ord Victoria Plain		
ESP	Esperance Plains	JAF	Jarrah Forest	PIL	Pilbara		

Figure 3. Location of the study area within the Eastern Goldfields subregion of the Coolgardie Bioregion (within the IBRA system v7).

3 Methods

3.1 Overview

This review summarises the findings of the previous Level 1 and Level 2 fauna assessments conducted within the Mt Marion Project area. The methods used for these assessments were based upon the general approach to fauna investigations for impact assessment as outlined in Section 1.2 and with reference to Appendices 1 to 4. Thus, the impact assessment process involves the identification of fauna values, review of impacting processes and preparation of mitigation recommendations.

This approach to fauna impact assessment has been developed with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth biodiversity legislation (EPA2002; EPA 2004). The EPA proposes two levels of investigation that differ in the approach to field investigations, Level 1 being a review of data and a site reconnaissance to place data into the perspective of the site, and Level 2 being a literature review and intensive field investigations (e.g., trapping and other intensive sampling). The level of assessment recommended by the EPA is determined by the size and location of the proposed disturbance, the sensitivity of the surrounding environment in which the disturbance is planned, and the availability of pre-existing data.

The following approach and methods is divided into three groupings that relate to the stages and the objectives of impact assessment:

- Desktop assessment. The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the project area based on unpublished and published data using a precautionary approach;
- Field investigations. The purpose of the field investigations is to gather information on this assemblage: confirm the presence of as many species as possible (with an emphasis on species of conservation significance), place the list generated by the desktop review into the context of the environment of the project area, collect information on the distribution and abundance of this assemblage, and develop an understanding of the project area's ecological processes that maintain the fauna. Note that field investigations cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible in the EIA process. For example, in a study spanning over two decades, Bamford *et al.* (2010) has found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling; and
- Impact assessment. Determine how the fauna assemblage may be affected by the proposed development based on the interaction of the project with a suite of ecological and threatening processes.

3.2 Desktop Assessment

3.2.1 Sources of information

Information on the fauna assemblage of the survey area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), DBCA (formerly DPaW) NatureMap (incorporating the Western Australian Museum's FaunaBase and the DBCA Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA), the EPBC Protected Matters Search Tool and the BCE database (Table 1) Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler *et al.* (2009);
- Reptiles: Storr *et al.* (1983); Storr *et al.* (1990); Storr *et al.* (1999); Storr *et al.* (2002) and Wilson and Swan (2013);
- Birds: Blakers *et al.* (1984); Johnstone and Storr (1998, 2004) and Barrett *et al.* (2003); and
- Mammals: Menkhorst & Knight (2004); Churchill (2008); and Van Dyck and Strahan (2008).

Table 1. Sources of information used for the desktop assessment.

Source	Type of records	Year/Area searched
Atlas of Living Australia.	Records of biodiversity data from multiple sources across Australia.	Survey area centre point plus 20 km buffer. Searched 8/5/2019.
NatureMap (DBCA 2017).	Records in the WAM and DBCA databases. Includes historical data and records on Threatened and Priority species in WA.	Survey area centre point plus 20 km buffer. Searched 8/5/2019.
BirdLife Australia Atlas Database (Birdlife Australia 2017).	Records of bird observations in Australia, 1998-2017.	One-degree cell containing survey area Searched 8/5/2019.
EPBC Protected Matters (DEE 2017).	Records on matters of national environmental significance protected under the EPBC Act.	Survey area centre point plus 20 km buffer. Searched 8/5/2019.
Fauna Assessment of a proposed borefield pipeline corridor (Woolibar borefield Stage 2)	Level 1 Fauna Survey conducted by BCE in 2018.	Borefield area, Mt Marion Project Area 2018.
Fauna Assessment of a proposed borefield pipeline corridor (Woolibar borefield Stage 1)	Level 1 Fauna Survey conducted by BCE in 2017.	Borefield area, Mt Marion Project Area, 2017
Fauna Assessment of M15/717 lease area, part of the Mt Marion Lithium Project.	Level 1 Fauna Survey conducted by BCE in 2017.	M15/717 lease area, Mt Marion Project Area, 2017.
Fauna Assessment of the Mt Marion Study Area.	Level 2 Fauna Survey conducted by BCE in 2016.	Mt Marion Project Area, 2016.
Fauna Assessment of the Gunga West Project.	Level 1 Fauna Survey conducted by BCE in 2016.	Gunga West Project, 2016.
Fauna Assessment of the Cannon Project.	Level 1 Fauna Survey conducted by BCE in 2015.	Cannon Project, 2015.
Fauna Assessment of the Southern Gold Bulong Project.	Level 1 Survey conducted by BCE in 2012.	Bulong, 2012.
Fauna Assessment of the Mt Marion Mining Lease Area.	Level 1 Survey conducted by BCE in 2012.	Mount Marion, 2012.
Fauna Assessment of the South Kalgoorlie TSF.	Level 1 Survey conducted by BCE in 2012.	South Kalgoorlie, 2012.
Fauna Assessment of the South Kalgoorlie Pipeline.	Level 1 Survey conducted by BCE in 2012.	South Kalgoorlie, 2012.
Fauna Assessment of the Bardoc Mining Lease Area.	Level 1 Survey conducted by BCE in 2012.	Bardoc, 2012.

Source	Type of records	Year/Area searched
Fauna Assessment of the St Ives Mining Area.	Level 2 Survey conducted by BCE in 2010.	Lake Lefroy, 2010.
Fauna Assessment of the St Ives Pistol Club Mining Area.	Level 1 Fauna Survey conducted in 2015.	Kambalda, 2015.
Rapallo Level 1 Fauna Survey of Mount Marion	Level 1 Fauna Survey conducted by Rapallo in 2010	Mount Marion, 2010
Fauna Assessment of the Kangaroo Hills and Calooli Nature Reserves	Level 2 report by M. Bamford and S. Davies.	Kangaroo Hills and Calooli 1990

3.2.2 Previous fauna surveys

This review is based primarily on the findings from previous fauna assessments within the Mt Marion Lithium Project Area, but also draws on the findings from surveys outside the project area, but within the greater goldfields region. Four Level 1 and one Level 2 fauna assessments have been conducted in the area covering parts of the Mt Marion Lithium Project Area (Rapallo, 2010; BCE, 2012; 2016; Metcalf and Bamford 2017a; 2017b; 2018); see Table 2 for a list of lease areas and relevant fauna assessments. A preliminary Level 1 fauna assessment for the Mount Marion Lithium Project was conducted in March 2010 (Rapallo, 2010); BCE conducted a Level 1 fauna assessment for the expansion of the Mount Marion Ghost Crab Gold Mine in 2012, a Level 2 survey for the broader Mt Marion area in 2016, a Level 1 of the M15/717 lease area in 2017, a Level 1 assessment of a proposed borefield pipeline corridor (Woolibar borefield Stage 1) in 2017 and a Level 1 assessment of the Stage 2 borefield pipeline corridor in 2018.

Table 2. Fauna Assessments covering Mt Marion lease areas.

Lease Area	Relevant Fauna Assessment/s
M15/717	Bamford, 2012; Bamford, 2016b; Metcalf and Bamford, 2017a;
M15/1000	Rapallo, 2010; Bamford, 2016b;
M15/999	Bamford, 2016b;
L15/376	Metcalf and Bamford, 2017b
L15/353	Bamford, 2016b; Metcalf and Bamford, 2017b (lease area was updated from L15/321).
L15/220	Bamford, 2016b;
L15/360	Bamford, 2016b;
L15/392	Metcalf and Bamford, 2018;
Hamptons Area 53	Bamford, 2016a; 2016b

A number of fauna assessments, both Level 1 and Level 2 have also been conducted by BCE in the greater area, including near Coolgardie, Kambalda, Bulong and Kalgoorlie (see Table 1). The reports provide data on conservation significant species recorded in vegetation soil associations (VSAs) in some cases similar to those found across the Mt Marion Lithium Project area. VSAs observed at the survey area are presented in Section 4.1.

3.2.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM 2019) Checklist of the Fauna of Western Australia 2018. The authorities used for each vertebrate group were: amphibians (Doughty 2019), reptiles (Doughty 2019), birds (Johnstone and Darnell 2019) and mammals (Travouillon 2019). In some

cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g., the BirdLife Australia 2017 working list of names for Australian Birds). English names of species, where available, are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

3.2.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey area, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the site is of no importance.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:

- Resident: species with a population permanently present in the survey area;
- Regular migrant or visitor: species that occur within the survey area regularly in at least moderate numbers, such as part of annual cycle;
- Irregular Visitor: species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the survey area in at least moderate numbers and for some time;
- Vagrant: species that occur within the survey area unpredictably, in small numbers and/or for very brief periods. Therefore, the survey area is unlikely to be of importance for the species; and
- Locally extinct: species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the survey area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the site is not important in a conservation sense, and species which use the site in other ways but for which the site is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence the site will not support it, and even then, it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals.

3.3 Survey limitations

The EPA Guidance Statement 56 (EPA, 2004) outlines several limitations that may arise during surveying. These survey limitations are discussed in the context of the BCE fauna survey at the survey area in Table 3.

Table 3. Survey limitations as outlined by EPA (2004).

Limitation	Comment
Level of survey.	A review of Level 1 and Level 2 surveys undertaken throughout the project area. These surveys are adequate to identify VSAs and assess the likelihood of fauna species, including conservation significant species, utilising the project area.
Competency/experience of the consultant(s) carrying out the survey.	The authors have had extensive experience in conducting desktop reviews and field surveys.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	All fauna groups during trapping surveys and site visits, although birds were focussed on during site visits.
Proportion of fauna identified, recorded and/or collected.	All vertebrate fauna observed identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous reports on the fauna of the local area (BCE database); databases (BA, DBCA, EPBC); BCE (and other) surveys in nearby areas at Bardoc, St Ives, Mt Martin, Mt Marion, South Kalgoorlie, Cannon.
The proportion of the task achieved and further work which might be needed.	Survey completed.
Timing/weather/season/cycle.	N/A
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	N/A
Intensity. (In retrospect, was the intensity adequate?).	Survey intensity was adequate to determine the likelihood of conservation significant species utilising the lease area.
Completeness (e.g. was relevant area fully surveyed).	Complete.
Resources (e.g. degree of expertise available).	All species identified to taxon level.
Remoteness and/or access problems.	N/A
Availability of contextual (e.g. biogeographic) information on the region.	Extensive regional information was available and was consulted.

3.4 Presentation of results for Impact Assessment

While some impacts are unavoidable during a development, of concern are long-term, deleterious impacts upon biodiversity. This is reflected in documents such as the Significant Impact Guidelines provided by DSEWPaC (see Appendix D). Significant impacts may occur if:

- There is direct impact upon a VSA and the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.
- There is direct impact upon conservation significant fauna.
- Ecological processes are altered and this affects large numbers of species or large proportions of populations, including significant species.

The impact assessment process therefore involves reviewing the fauna values identified through the desktop assessment and field investigations with respect to the project and impacting processes. The severity of impacts on the fauna assemblage and conservation significant fauna can then be quantified based on predicted population change.

The presentation of this assessment follows the general approach to impact assessment as given in Section 1.2 but modified to suit the characteristics of the site. Key components to the general approach to impact assessment are addressed as follows:

Fauna values

This section presents the results of the review in terms of key fauna values (described in detail in Appendix A):

- Assemblage characteristics (uniqueness, completeness and richness) - based upon desktop assessment and information from the previous fauna assessments;
- Species of conservation significance – based upon desktop assessment and previous fauna assessments;
- Recognition of ecotypes or vegetation/substrate associations (VSAs) - based upon desktop assessment and previous fauna assessments;
- Patterns of biodiversity across the landscape - based upon desktop assessment and previous fauna assessments; and
- Ecological processes upon which the fauna depend - based upon desktop assessment and previous fauna assessments.

Impact assessment

This section reviews impacting processes (as described in detail in Appendix A) with respect to the proposed lithium mining project and examines the potential effect of these impacts upon biodiversity of the survey area. It thus expands upon Section 1.2 and discusses the contribution of the project to impacting processes, and the consequences of this with respect to biodiversity. A major component of impact assessment is consideration of threats to species of conservation significance as these are a major and sensitive element of biodiversity. Therefore, the impact assessment includes the following:

- Review of impacting processes; will the proposal result in:
  - Habitat loss leading to population decline, especially for significant species;
  - Habitat loss leading to population fragmentation, especially for significant species;
  - Weed invasion that leads to habitat degradation;
  - Ongoing mortality;
  - Species interactions that adversely affect native fauna, particularly significant species;
  - Hydrological change;
  - Altered fire regimes; and
  - Disturbance (dust, light, noise).
- Summary of impacts upon significant species, and other fauna values.

Impact assessment also reviews the project against the 10 clearing principles that govern the assessment of NVCPs. The impact assessment concludes with recommendations based upon predicted impacts and designed to mitigate these.

3.4.1 Criteria for impact assessment

Impact assessment criteria are based on the severity of impacts on the fauna assemblage and conservation significant fauna, and were quantified on the basis of predicted population change (Table

4). Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

The significance of population change is contextual. The EPA (2004) suggests that the availability of fauna habitats within a radius of 15km can be used as a basis to predict low, moderate or high impacts. In this case, a high impact is where the impacted environment and its component fauna is rare (<5% of the landscape within a 15km radius or within the Bioregion), whereas a low impact is where the environment is widespread (10% of the local landscape). Under the Ramsar Convention, a wetland that regularly supports 1% of a population of a waterbird species is considered to be significant. These provide some guidance for impact assessment criteria, but are really only appropriate when considering very large proposed developments. In the case of the current project area of 1699ha, of which it is proposed to clear ~900ha, a 15km radius is considered appropriate for context. In the following criteria (Table 4), the significance of impacts is based upon estimated percentage fauna population decline within the immediate area of the surroundings, and upon the effect of the decline upon the conservation status of a recognised taxon (recognisably discrete genetic population, sub-species or species). Note that percentage declines can usually only be estimated on the basis of distribution of a species derived from the extent of available habitat.

Note that for a few species, such as the black-cockatoos, there is guidance for the assessment of impact significance (DSEWPaC 2012a, 2012b, 2012c, 2012d) and this is referred to as necessary. The impact assessment concludes with recommendations based upon predicted impacts and designed to mitigate these.

Table 4. Assessment criteria of impacts upon fauna.

Impact Category	Observed Impact
Negligible	Effectively no population decline; at most few individuals impacted and any decline in population size within the normal range of annual variability.
Minor	Population decline temporary (recovery after project end, such as through rehabilitation) or permanent, but <1% within immediate area. No change in taxon viability or conservation status.
Moderate	Permanent population decline 1-10% within the immediate area. No change in viability or conservation status of taxon.
Major	Permanent population decline >10% within the immediate area. No change in viability or conservation status of taxon.
Critical	Taxon extinction within immediate area and/or change in taxon viability or conservation status.

4 Fauna Values

4.1 Vegetation and Substrate Associations (VSAs)

Eight VSAs were identified from the Mt Marion Project area by Bamford (2016b), based on the vegetation types recognised by NVS (2016; see Figure 4) and the substrate with which the vegetation is associated. These incorporate the habitats and VSAs described in the other fauna assessments (as summarised in Table 5Table 1). The representation of these VSAs within the tenement areas compared to the LOM disturbance footprint is detailed in Table 6. Both Table 5 and Table 6 also include another "VSA" category that encompasses previously disturbed and revegetated areas.

VSA #1 Mixed Eucalypt Woodland on Greenstone hills.
Mixed Eucalyptus woodland over sclerophyll shrubland on undulating hills (dominated by *Eucalyptus transcontinentalis, E. lesouefii, E. gracilis, E. ravida, Melaleuca sheathiana, Acacia erinacea* and *Trymalium myrtillus*); incorporating NVS (2016) vegetation types b, g, n, o, r, s and t.

VSA #2 Dense Acacia shrubland in gullies and slopes of Greenstone hills.
Acacia shrubland (dense areas in gullies of greenstone ridges dominated by *Acacia acuminata* and *Acacia quadrimarginea* with areas of *Allocasuarina* shrubland); incorporating NVS (2016) vegetation type j.

VSA #3 Eucalypt Woodland over mixed shrubs on clay-loam flats.
Transitional Eucalypt woodland over mixed shrubland (dominated by *Eucalyptus transcontinentalis, E. gracilis, E. salmonophloia, E. ravida, Senna artemisioides, Eremophila scoparia*); incorporating NVS (2016) vegetation types a, ab, ac, ad, c, d, e, f, i and z.

VSA #4 Mixed Eucalypt woodland over *Melaleuca sheathiana* on gravelly rises.
Wooded areas with *Eucalyptus transcontinentalis, E. lesouefii, E. oleosa subsp. oleosa, E. salmonophloia, E. gracilis, Melaleuca sheathiana, Senna artemisioides subsp. Artemisioides, Eremophila scoparia and Olearia muelleri.* In some areas, the Eucalypt canopy is sparse to absent and the vegetation is dominated by *Melaleuca sheathiana*; incorporating NVS (2016) vegetation types aa, g, l and p.

VSA #5 Dense Mallee and Eucalypt woodland associated with minor drainage lines.
Dense vegetation fringing minor drainage lines in small areas throughout the survey area; likely to be vegetation type r, as defined by NVS (2016).

VSA #6 Dense Acacia and Allocasurina shrubland on sandy clay flats.
A small area of dense shrubland occurs adjacent to the proposed access road; incorporating NVS (2016) vegetation types w and x.

VSA #7 Mixed Eucalyptus woodland over sclerophyll shrubland with *Diocirea acutifolia* (P3) on undulating hills.
Dominant species include *Eucalyptus transcontinentalis, E. gracilis, E. lesouefii, E. oleosa subsp. oleosa, E. salmonophloia, Eremophila decipiens subsp. decipiens, and Diocirea acutifolia;* incorporating NVS (2016) vegetation types k and u.

VSA #8 *Casuarina pauper* shrubland with *Eucalyptus lesouefii* over mixed shrubland across greenstone hills.
Minor VSA, restricted to some greenstone hills in the north; incorporating NVS (2016) vegetation type q.

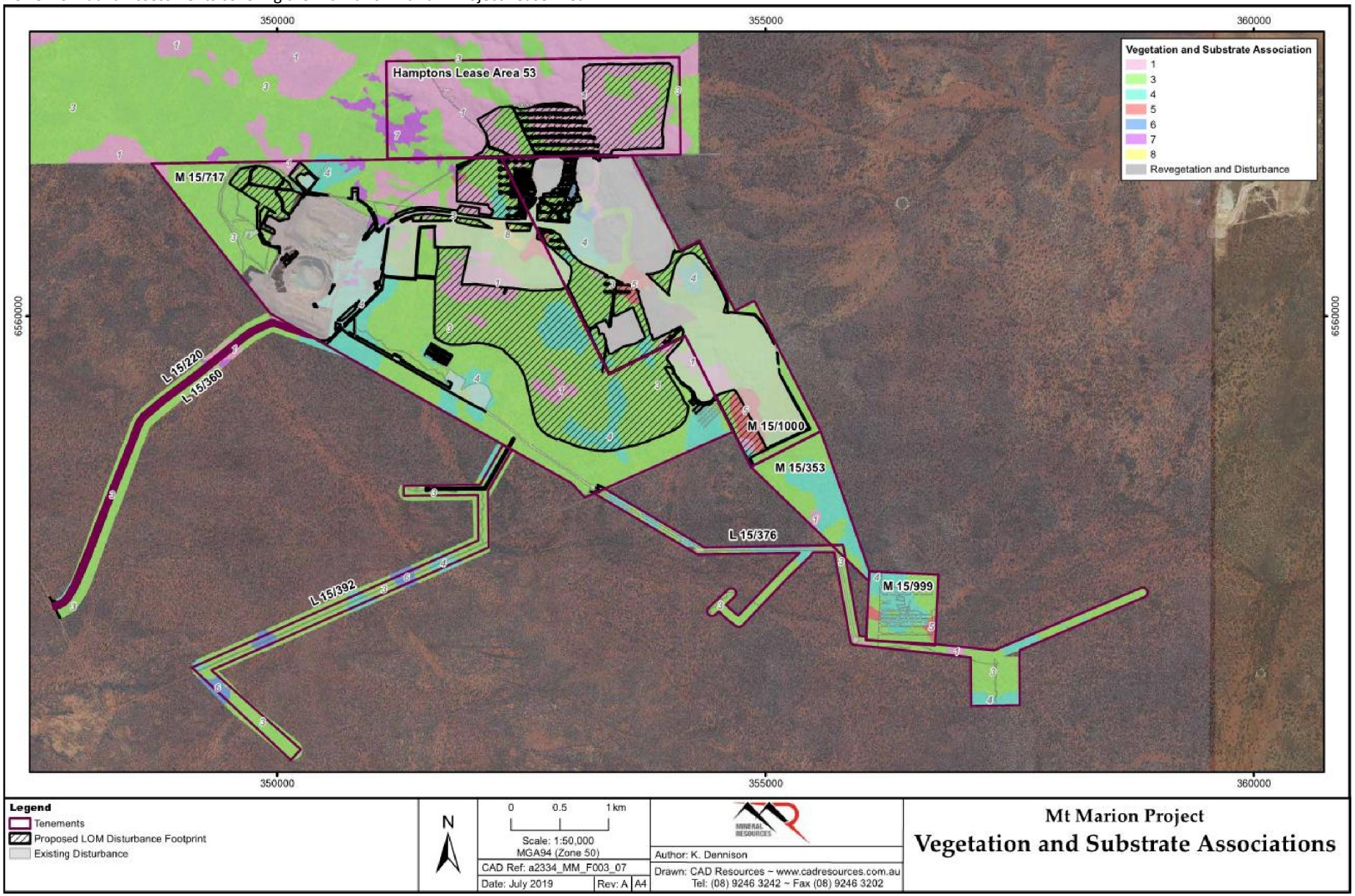


Figure 4. Vegetation/Substrate Associations of the Mt Marion Project Area

Table 5. Summary of VSAs and habitat recorded within different fauna/flora assessments.

Vegetation/ Substrate Associations (Bamford 2016b)	Vegetation types (based on NVS, 2019)	Vegetation/ Substrate Associations (Metcalf and Bamford 2017a)	Vegetation/ Substrate Associations (Metcalf and Bamford 2017b)	Vegetation/ Substrate Associations (Metcalf and Bamford 2018)
1	b, g, m, n, o, s, t	2 (part)		
2	j			
3	a, ab, ac, ad, c, d, e, f, i, z	1	1, 3	1
4	aa, h, l, p	2 (part)	2	2
5	r			
6	w, x	3		3
7	k, u			
8	q			
Revegetation and disturbance	v, y			

Table 6. Representation of Vegetation/Substrate Associations within the LOM disturbance footprint (based on analysis by CAD Resources)

VSA	Total Area Mapped (Ha)	Area within proposed NVCP boundary	Area already disturbed as per MRF final disturbance layer	Area proposed to be disturbed in additional LOM design (outside existing clearing)	Area to be un-disturbed within NVCP
	Ha	Ha (% of total)	Ha (% of total)	Ha (% of total)	Ha (% of total)
1	1675.852	312.68 (19%)	47.68 (3%)	129.25 (8%)	135.75 (8%)
2	29.539	0 (0%)	0 (0%)	0 (0%)	0 (0%)
3	4114.731	1052.44 (26%)	233.74 (6%)	329.14 (8%)	489.56 (12%)
4	290.340	216.65 (75%)	66.95 (23%)	59.35 (20%)	90.36 (31%)
5	37.293	33.59 (90%)	18.60 (50%)	14.34 (38%)	0.65 (2%)
6	15.342	10.73 (70%)	2.89 (19%)	0.01 (0%)	7.84 (51%)
7	34.693	23.63 (68%)	2.66 (8%)	1.03 (3%)	19.94 (57%)
8	5.375	5.38 (100%)	4.85 (90%)	0.52 (10%)	0 (0%)
Revegetation and Disturbance	116.096	114.66 (99%)	112.95 (97%)	0.58 (0%)	1.13 (1%)
Not Mapped		111.63 (-%)	97.17 (-%)	3.34 (-%)	11.12 (-%)
TOTAL	**6319.26**	**1881.38 (30%)**	**589.49 (9%)**	**537.55 (9%)**	**756.34 (12%)**

The analysis shown in

Table 6 suggests that two VSA's will be the most heavily impacted within the tenement areas:

- #5 - Dense Mallee and Eucalypt woodland associated with minor drainage lines; and
- #8 - *Casuarina pauper* shrubland with *Eucalyptus lesouefii* over mixed shrubland across greenstone hills.

It is expected that both VSAs will be represented, as a similar portion of the landscape, outside the project area.

4.2 Vertebrate Fauna

4.2.1 Overview of fauna assemblage

The desktop study identified 289 vertebrate fauna species as potentially occurring in the Mount Marion Lithium Project area (see Appendix E, Table 12 to Table 15): five frogs, 85 reptiles, 164 birds, 25 native and ten introduced mammals. Of these, 84 species have been recorded during fauna assessments within the project area, including one frog, 10 reptiles, 58 bird species, nine native mammals and six introduced mammals.

The faunal assemblage expected is typical of the Coolgardie region. Most fauna species recorded or expected to occur in the survey area are widespread, but some species may have restricted or habitat limited distributions, and some fauna species expected have declined in the region. The composition of the vertebrate fauna expected to occur and recorded within the survey area is presented in Table 7a and 7b (see Also Appendix E). The conservation significant fauna species occurring or likely to occur in the survey area are discussed below and are detailed in Table 8 and Table 10.

Key features of the fauna assemblage expected in the survey area are:

- Uniqueness: The assemblage is typical of that found in Goldfields eucalypt woodlands. The site occurs near the edge of some fauna species' distribution e.g., Blue-breasted Fairy-wren and Western Yellow Robin;
- Completeness: The assemblage of species from the survey area is mostly complete, with a portion of the mammal fauna considered locally extinct; and
- Richness: The assemblage contains a high level of richness to be expected in relatively undisturbed intact woodland vegetation.

Table 7a. Composition of vertebrate fauna assemblage of the survey area, based on conservation significance and resident/migrant/visitor status (See Appendix A for definitions of Conservation Significance (CS) levels).

Taxon	Total species expected from the study area	Total species recorded	Significant Fauna expected			
			CS1	CS2	CS3	INT
Frogs	5	1	0	0	0	0
Reptiles	85	10	0	0	1	0
Birds	164	58	9	1	19	0
Native Mammals	25	9	1	1	1	0
Introduced Mammals	10	6	0	0	0	10
Total	**289**	**84**	**10**	**2**	**21**	**10**

Table 7b. Composition of vertebrate fauna assemblage of the survey area, based on resident/ migrant/visitor status

Taxon	Number of species	Number of species in each status category				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Frogs	5	5	-	-	-	-
Reptiles	85	85	-	-	-	-
Birds	164	86	35	7	36	-
Native Mammals	25	22	1	1	-	1
Introduced Mammals	10	5	2	3	-	-
Total	289	203	38	11	36	1

4.2.2 Species of conservation significance

Details on species of conservation significance recorded or expected to occur in the survey area (even as vagrants) are presented in Table 7 and 8, and Appendix E. The suite of significant species includes many that are expected to occur only as vagrants or irregular visitors (Table 8), and thus for which the site is of low importance, except where it may have value for connectivity. The project area is likely to be important for several significant species which are expected to occur there in resident populations or may utilise the project area during foraging or breeding. These species are discussed below.

As outlined in Appendix A, species classed as CS1 are those listed under legislation, while those classed as CS2 are listed as Priority by the Department of Biodiversity, Conservation and Attractions (DBCA, formerly DPaW). The CS3 class is more subjective, but includes species that have declined extensively across the Wheatbelt and Goldfields due to land clearing, and species that occur at the edge of their range in the region. This makes their presence in the survey area significant as populations on the edge of a species' range are often less abundant and more vulnerable to extinction than populations at the centre of the range (Curnutt *et al.* 1996). The CS3 class also includes potential short range endemic (SRE) invertebrates and the potential for these is discussed with other CS3 species below.

Ten conservation significant fauna species were recorded from the survey area, including:

- Malleefowl (considered Vulnerable; several old to very old mounds were recorded from throughout the study area);
- Rainbow Bee-eater (previously listed as a migratory species);
- Purple-crowned Lorikeet (declining woodland species);
- Rufous Tree-creeper (declining woodland species);
- Blue-breasted Fairy-wren (declining woodland species, edge of distribution);
- White-browed Babbler (declining woodland species);
- Copper-backed Quail-thrush (declining woodland species);
- Gilbert's Whistler (declining woodland species, edge of distribution);
- Southern Scrub Robin (declining woodland species, edge of distribution); and

- Western Yellow Robin (declining woodland species, range limit).

These species are discussed below (see also Table 10).

Table 8. Significant fauna species recorded or expected in the Mt Marion Lithium Project area.

Common Name	Latin Name	Conservation Status				Expected status in project area	Local records
BCA		EPBC	BCA	Priority	CS3		
Conservation Significance 1 (CS1)							
Malleefowl	*Leipoa ocellata*	Vul	Vul			Visitor	Mt Marion
Fork-tailed Swift	*Apus pacificus*	Mig	Mig			Irregular visitor	Woolgangie
Hooded Plover	*Thinornis rubricollis*	Mig	Mig			Vagrant	Bulong
Sharp-tailed Sandpiper	*Calidris acuminata*	Mig	Mig			Vagrant	Kambalda West
Curlew Sandpiper	*Calidris ferruginea*	Mig	Mig			Vagrant	Kambalda East
Red-necked Stint	*Calidris ruficollis*	Mig	Mig			Vagrant	Kambalda East
Common Greenshank	*Tringa nebularia*	Mig	Mig			Vagrant	Kambalda East
Wood Sandpiper	*Tringa glareola*	Mig	Mig			Vagrant	Kambalda East
Peregrine Falcon	*Falco peregrinus*		OS			Visitor	St Ives
Chuditch	*Dasyurus geoffroyii*	Vul	Vul			Vagrant/Locally Extinct	Kalgoorlie
Arid Bronze Azure	*Ogyris subterrestris petrina*	CE	CE			Unknown/Unlikely	Lake Douglas
Conservation Significance 2 (CS2)							
Western Rosella (Inland)	*Platycercus icterotis xanthogenys*			4		Irregular Visitor	Kalgoorlie
Central Long-eared Bat	*Nyctophilus major tor*			3		Resident	Coolgardie
Inland Hairstreak Butterfly	*Jalmenus aridus*			1		Unknown	Lake Douglas
Conservation Significance Level 3							
Carpet Python	*Morelia spilota imbricata*				X	Resident	Kalgoorlie
Australian Bustard	*Ardeotis australis*				X	Irregular Visitor	Coolgardie
Bush Stone-curlew	*Burhinus grallarius*				X	Visitor	Jilbadji
Square-tailed Kite	*Lophoictinia isura*				X	Visitor	St Ives
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*				X	Resident	Mt Marion
Regent Parrot	*Polytelis anthopeplus*				X	Visitor	St Ives
Scarlet-chested Parrot	*Neophema splendida*				X	Irregular Visitor	St Ives
Major Mitchell's Cockatoo	*Cacatua leadbeateri*				X	Visitor	Coolgardie
Rainbow Bee-eater	*Merops ornatus*				X	Regular migrant	Mt Marion
White-browed Treecreeper	*Climacteris affinis*				X	Resident	Cannon
Rufous Treecreeper	*Climacteris rufus*				X	Resident	Mt Marion
Blue-breasted Fairy-wren	*Malurus pulcherrimus*				X	Resident	Mt Marion
Purple-gaped Honeyeater	*Lichenostomus cratitius*				X	Resident	Kalgoorlie
Shy Heathwren	*Hylacola cauta whitlocki*				X	Irregular visitor	St Ives

Common Name	Latin Name	Conservation Status				Expected status in project area	Local records
BCA		EPBC	BCA	Priority	CS3		
White-browed Babbler	*Pomatostomus superciliosus*				X	Resident	Mt Marion
Copper-backed Quail-thrush	*Cinclosoma clarum*				X	Resident	Mt Marion
Gilbert's Whistler	*Pachycephala inornata*				X	Resident	Mt Marion
Crested Shrike-tit	*Falcunculus frontatus*				X	Resident	Kalgoorlie
Western Yellow-robin	*Eopsaltria griseogularis*				X	Resident	Mt Marion
Southern Scrub-robin	*Drymodes brunneopygia*				X	Irregular Visitor	Mt Marion
Kultarr	*Antechinomys laniger*				X	Resident	Kalgoorlie

See Appendix C for descriptions of conservation status codes. EPBC Act (EPBC) and Biodiversity Conservation Act (BCA): Vul: Vulnerable; End: Endangered; CE: Critically Endangered, Mig: Migratory, OS: Other Specially Protected Fauna; DBCA Priority: P1 – P4 = Priority 1 - 4. CS3: locally significant but not listed.

Malleefowl (*Leipoa ocellata*)

The Malleefowl is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) and *WA Biodiversity Conservation Act* (BC Act). In Western Australia, Malleefowl occur mainly in scrubs and thickets of Mallee (*Eucalyptus* spp.), Boree (*Melaleuca lanceolata*), Bowgada (*Acacia linophylla*), and other dense litter-forming shrublands including Mulga (*Acacia aneura*) shrub lands (Johnstone and Storr, 2004). The species' distribution was once larger and less fragmented, but the widespread clearing of suitable habitat, coupled with the degradation of habitat by fire and livestock, and fox predation, has reduced Malleefowl numbers considerably (Johnstone and Storr, 2004).

Eleven Malleefowl mounds were recorded from the Mt Marion area (see Table 9), all Moderately Old to Very Old and inactive, suggesting Malleefowl may no longer nest in the project area, though they may utilise the area for foraging. Malleefowl could forage anywhere through the extended project area, but mounds are most likely to be constructed in shrublands and thickets where dense vegetation provides leaf-litter for the mounds, and where the soil is free-draining at least to some extent; thus not clays or heavy loams. Such conditions can be found in VSA 1, VSA 2 and VSA 7; together these VSAs cover 336.31ha of the NVCP area (18% of the total NVCP area), of which 155.69ha are proposed to be undisturbed (see Table 6 for VSA disturbance data).

Malleefowl Mound Profile

The profile of a Malleefowl mound changes with breeding activity and age (erosion and vegetation growth). A number of profile stages are classified according to age (Benshemesh *et al.,* 2000):

- Profile 1: Typical crater with raised rims. This is the typical shape of an inactive nest. However, this is also the profile of a mound being worked early in the breeding season;
- Profile 2: Nest fully dugout. The characteristic of this profile is that the crater slopes down steeply and at the base the sides drop vertically to form a box- like structure with side usually 20 to 30 cm deep. Often, litter will have been raked into windrows, and may have started to enter the nest;
- Profile 3: Nest with litter. This is the next stage after profile 2. Litter will have been raked into the nest by Malleefowl, and thick layers of litter are evident on the surface. There may or may not be sand mixed with the litter at this stage;

Table 9. Malleefowl Mounds recorded during the fauna survey (UTM Zone 51). Note Width (W, metres), Height (H, centimetres), Depth (D, centimetres) and Profile (P) listed. Profile and Age categories are explained below.

	Easting	Northing	Habitat / Vegetation	W	H	D	Age	P	Reference
1	352822	6561252	*Eucalyptus spp.* And *Acacia acuminata* over *Melaleuca* and *Eremophila*.	3	50	-	Very Old	6	Rapallo (2010)
2	353078	6560931	*Allocasuarina* over *Melaleuca pauperiflora* shrubland	4	40	20	Very Old	6	Rapallo (2010)
3	352725	6561923	*Acacia quadrimarginea* over *Allocasuarina* on gravelly/rocky slight	NA	NA	NA	Very Old	NA	Bamford (2016a)
4	352953	6562206	*A. quadrimarginea* shrubland, *A. acuminata*, *E. oldfieldi*	7	50	40	Moderately old	1	Bamford (2016b)
5	351715	6562579	*A. quadrimarginea* shrubland, *A. acuminata*, *E. lesouefii*	6	30	30	Very Old	1	Bamford (2016b)
6	352240	6562367	*Acacia, Allocasuarina, Senna,* Mallee thicket	7	100	50	Old	1	Bamford (2016b)
7	351255	6562637	Mallee*, A. quadrimarginea, Dodonea sp, Scavola spinescens*	4	50	20	Old	1	Bamford (2016b)
8	351621	6561856	Mallee, Melaleuca thicket	5	10	10	Very Old	1	Bamford (2016b)
9	352017	6561688	Mallee, Melaleuca thicket	10	50	0	Very Old	6	Bamford (2016b)
10	352828	6562100	*A. quadrimarginea*, *A. acuminata*, *E. oldfieldi, E scoparia*	7	50	0	Very Old	6	Bamford (2016b)
11	354110	6559159	*Eucalypt* woodland over open mixed shrubland	4	20	0	Very Old	6	Metcalf and Bamford (2017a)

Malleefowl Mound Profile (cont.)

- Profile 4: Nest mounded up (no crater). This is the typical profile of an active but unopened Malleefowl nest. The active mound is closed and dome shaped;
- Profile 5: Nest a crater with peak in centre. This is a typical profile of an active nest which is in the process of being closed by Malleefowl; and
- Profile 6: Nest low and flat without peak or crater. This mound has not been used for some time and weathering and erosion have 'flattened" the original mound.

Malleefowl Mound Age

- Active: Fresh scratching, Malleefowl scats, loose soil, mound may be dug out in preparation for the breeding season or mounded for breeding;
- Recently used (1-5 years): Mound contains signs of recent activity (e.g., eggshell fragments) and mound may still contain large amounts of leaf litter if not excavated. Soil surface compacted, mound structure intact with well-defined central depression. No vegetation colonising mound.;
- Moderately old (5-20 years): No recent activity, mound compacted. Surface of mound showing some weathering and some minor plant colonisation possibly present. Mound profile raised; central depression defined;

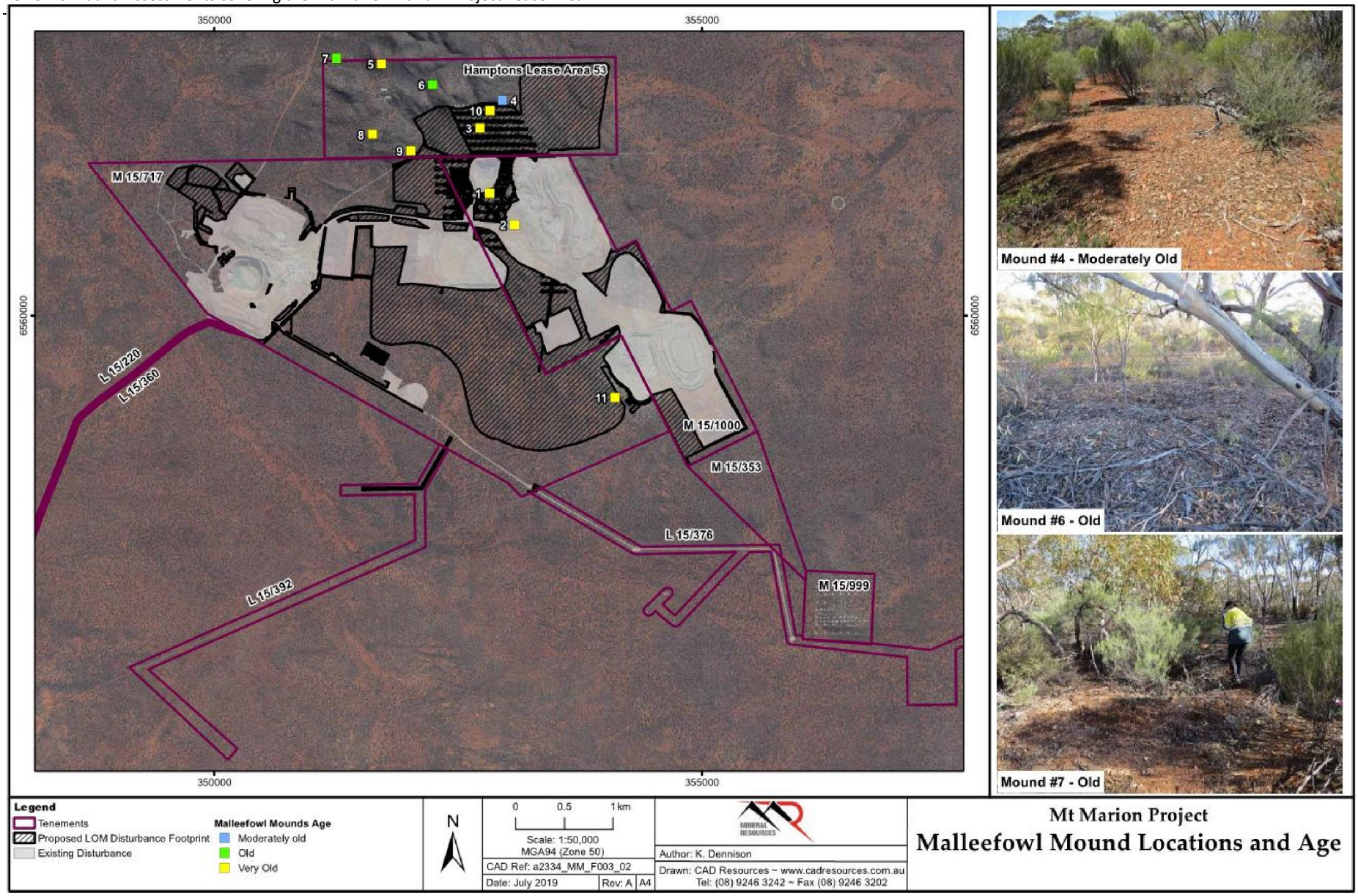


Figure 5. Location of Malleefowl Mounds within the Mt Marion project area.

Mallefowl Mound Age (cont.)

- Old (20-100 years): Mound moderately to very weathered, often with a veneer of gravel on the slopes because of removal of fine materials from the surface. Extensive plant colonisation. Mound profile raised; no or minimal central depression; and
- Very old (100+ years): Mound very weathered, with a low profile. Bushes and even small trees growing on mound. No central depression.

Locally Significant Birds recorded at Mount Marion

A number of south-west Australian woodland bird species are recognized as declining (Saunders and Ingram, 1995; Birds Australia, 2012) and are listed in this review under CS3 (see Table 8). These species have lost considerable areas of habitat throughout the Wheatbelt and adjacent Goldfields as a result of large-scale habitat clearance and the removal of mature Eucalypt trees. Species include Regent Parrot, Southern Scrub-robin, Purple-crowned Lorikeet, Gilbert's Whistler, Rufous Tree-creeper and Purple-gaped Honeyeater. These species generally remain widespread and, in some cases, common in the broader Great Western Woodlands. The retention of these species in their natural abundances is of particular conservation significance as these species are now increasingly absent or rare over much of the Wheatbelt (Duncan *et al.*, 2006; Watson *et al.*, 2008). Furthermore, some species recorded at Mount Marion are near the limit of their range and are also considered locally significant (and thus listed here as CS3). These include the Blue-breasted Fairy-wren and Western Yellow Robin.

Conservation Significant Fauna expected at Mount Marion

The project area is likely to be important for 20 significant species which are expected to occur there in resident populations or may utilise the project area during foraging or breeding. A further 15 conservation significant species may occur as irregular visitors or vagrants. Significant species for which the area may be important include:

- Malleefowl (CS1) – likely to be a regular visitor;
- Peregrine Falcon (CS1) – likely to be a regular visitor;
- Central Long-eared Bat (CS2) – potential for resident population;
- Carpet Python (CS3) – potential for resident population;
- Fifteen locally significant (CS3) birds (including Bush Stone-curlew, Scarlet-chested Parrot, Regent Parrot, Rainbow Bee-eater, Purple-gaped Honeyeater, Crested Shrike-tit and Southern Scrub-robin); and
- Kultarr (CS3) – potential for a resident population.

4.2.3 Significant Invertebrates

Three conservation significant invertebrate species have been recorded in the Coolgardie - Kalgoorlie area (DBCA, 2017), including the Arid Bronze Azure Butterfly (*Ogyris subterrestris petrina*), Inland Hairstreak (*Jalmenus aridus*) and the freshwater shrimp *Branchinella denticulate*; these species are discussed below. Rapallo (2010) collected a number of snail shells that were identified down to four different taxa, including *Sinumelon kalgum, Pupoides* sp*, Pupoides* sp. cf. *P. myoporinae* and *Bothriembryon* sp.. Full identification of all taxa to species was made difficult due to the snails all being deceased, but of those collected, *Bothriembryon* sp. was the only taxa considered to potentially be a short-range endemic (SRE). Due to the erratic nature of snail activity in arid areas, usually associated with rainfall events, no live specimens of any snails have been collected from the site.

The Arid Bronze Azure Butterfly is listed as Critically Endangered under the *Biodiversity Conservation Act* and EPBC Act. It is only known from Barbalin Nature Reserve (10km west of Mukinbudin, in the Wheatbelt), however was formerly known from the Lake Douglas area (12 km south-west of Kalgoorlie). At Lake Douglas, the Arid Bronze Azure was recorded from undulating stony rises supporting *Eucalyptus concinna*. While the species has not been recorded in the Lake Douglas area since 1993, it has the potential to persist in the wider area. The Arid Bronze Azure is dormant from June-August (Braby, 2004); where site visits/assessments were conducted during suitable periods, efforts were made to record the species, however based on available habitats and absence of the ant in whose nest the larvae occur, the species is considered unlikely to occur in the Mt Marion area.

The Inland Hairstreak is listed as Priority 1 by the DBCA. There is limited knowledge of its distribution and biology; it is only known from an area near Kalgoorlie, the larvae feed on leaves and flowers of *Senna nemophila* and *Acacia tetragonophylla*, and the caterpillars are attended to by the ant species *Froggattella kirbii.*

The freshwater shrimp *Branchinella denticulata* is listed as Priority 3 by the DBCA. There is limited information on the species range, population dynamics and threats, but it is considered vulnerable (Inland Water Crustacean Specialist Group, 1996). No suitable waterbodies have been identified within the project area during any of the assessments, therefore it is considered unlikely to occur within the project area.

No additional invertebrate species of listed conservation significance were recorded during the desktop assessment. Invertebrates in general are beyond the scope of assessment for environmental impact assessment because there are so many species and their taxonomy is so poorly understood, but it is possible to focus on a small range of taxa that are short-range endemics (SRE). Harvey (2002) notes that the majority of invertebrate species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Schizomida (schizomids; spider-like arachnids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). Harvey (2002) classes invertebrates as SRE species if they have a distribution of <10,000 km2 and notes that they are often associated with fragmented and/or relictual environments. No SRE taxa were recorded during the survey and in general the environment is not conducive to the evolution of such species, but this does not rule out the possibility of limited range species in the region.

4.3 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and is beyond the fauna assessments conducted across the Mt Marion Lithium Project area. However, the presence of a range of VSAs are factors in patterns of biodiversity. Within the survey area, the VSAs are considered to be mostly intact with some historical mining, timber harvesting and grazing disturbance. Fauna that occur in eucalypt woodlands throughout the region are likely to utilise the site for foraging, transit and/or nesting. Areas of dense thicket are important for species that prefer dense cover such as the Blue-breasted Fairy-wren and Western Yellow Robin. The presence of large Eucalypts (predominantly Salmon Gums) containing large hollows is likely to influence patterns of distribution of fauna that rely on such hollows for breeding, such as several parrot species and the Rufous Tree-creeper.

4.4 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix D for descriptions and other ecological processes). Key ecological processes affecting the fauna assemblage in the project area are habitat loss, hydrology, feral species and interactions with native species, habitat degradation due to clearing and loss of connectivity.

Local hydrology. The landscape of the survey area is influenced by the ridge of greenstone hills and the paleo-drainage system that is the focus of the borefield. This system drains into Lake Lefroy, south-east of the study area. The generally heavy soils in the area mean that surface and sub-surface water movement can be complex and can affect the distribution of plants.

Feral species and interactions with over-abundant native species. Feral species occur throughout Western Australia and it is expected that the fauna assemblage within the survey areas has been impacted by feral species (particularly foxes, feral cats and goats), which has resulted in the loss of some mammal and bird species. Rabbits and introduced rodents may cause further degradation to the native vegetation and, in combination with introduced predators (cats, dogs and foxes), reduce the capacity of the area to support native fauna diversity. Over-abundant native species such as the Galah may have suppressed the abundance of species such as Major Mitchell's Cockatoo.

Connectivity and landscape permeability. The survey area is part of a much greater area of native vegetation. The eucalypt woodlands in the survey area provide connectivity between the surrounding woodlands, with fauna, such as birds and mammals, likely to move across the landscape.

Fire. Fire may rarely be a feature of this landscape, with some of the vegetation too open to carry fire regularly, but thickets more likely to burn. The fauna is largely adapted to occasional fires but alterations to fire regimes have probably affected the abundant of some species, and thus fire is a factor to consider in understanding impacts.

4.5 Summary of fauna values

The desktop study identified 289 vertebrate fauna species as potentially occurring in the project area, (see Table 7 and Appendix E) five frogs, 85 reptiles, 164 birds, 25 native and ten introduced mammals. Eighty-four of these species have been recorded during the fauna assessments included within this review (See Table 7 and Appendix E). This total includes one frog, ten reptiles, 58 bird species, nine native mammals and six introduced mammals. Conservation significant fauna species recorded comprised nine locally significant bird species and several old to very old Malleefowl mounds.

Fauna values within the study area can be summarised as follows:

Fauna assemblage. Largely intact and rich, and broadly typical of the Coolgardie Bioregion. Some south-western species occur at the eastern edge of their range (Blue-breasted Fairy-wren, Western Yellow Robin) and the assemblage also has elements from adjacent biogeographic zones.

Species of conservation significance. 20 significant species likely to occur as residents of the survey area, or at least as regular visitors. The majority of these are locally significant and are not listed under legislation. Significant species are:

- Malleefowl (CS1) – regular visitor;

- Rainbow Bee-eater (CS3) – regular migrant;
- Peregrine Falcon (CS1) – resident or regular visitor;
- Central Long-eared Bat (CS2) – resident;
- Carpet Python (CS3) – resident;
- Locally significant (CS3) declining woodland birds; nine species recorded including Rainbow Bee-eater, Purple-crowned Lorikeet, Rufous Treecreeper, Blue-breasted Fairy-wren, White-browed Babbler, Copper-backed Quail-thrush, Gilbert's Whistler, Southern Scrub-Robin and Western Yellow Robin, and an additional seven species expected as residents or regular visitors including Bush Stone-curlew, Square-tailed Kite, Regent Parrot, Major Mitchell's Cockatoo, White-browed Treecreeper, Purple-gaped Honeyeater and Crested Shrike-tit; and
- Kultarr (CS3) – resident.

A further 15 conservation significant species are expected to occur as vagrants or irregular visitors (see Table 8). This includes two butterfly species (the CS1 Arid Bronze Azure and the CS2 Inland Hairstreak whose status in the area is uncertain.

Vegetation and Substrate Associations (VSAs). There are eight VSAs identified. Most of the survey area contains intact eucalypt woodland or Mallee over a range of understorey types (ranging from Melaleuca and Acacia thickets, Eremophila shrub lands or sparsely vegetated). There are areas of open Salmon Gum woodland containing mature, hollow-bearing trees and valleys and slopes of the Saddle Hills contain dense Acacia and Allocasuarina shrub lands. Small areas on the crests of hills contain Casuarina or Melaleuca thickets. All VSAs are considered important for fauna, with large Salmon Gums providing important nesting opportunities for fauna and dense vegetation providing cover and habitat for species such as the Golden Whistler, Western Yellow Robin and Malleefowl.

Two VSAs, #5 and #8, are not well represented within the project area and will be impacted by the proposed LOM footprint. It is expected they will be represented outside of the project area as a similar portion of the landscape.

Patterns of biodiversity. The fauna assessments do not provide adequate data to examine detailed patterns of biodiversity, but it can be predicted that important features for biodiversity will be the structural complexity of shrublands and the presence of large, hollow-bearing trees in woodlands.

Key ecological processes. Key ecological processes affecting the fauna assemblage in the project area are hydrology, feral species and possibly over-abundant native species.

5 Impact Assessment

5.1 Impacting Processes

Impacting processes must be considered in the context of fauna values, the landscape and the nature of the proposed action; these impacting processes are examined below. Predicted impacts need to be considered in the light of recommendations made in Section 0.

Habitat loss leading to population decline. For the Coolgardie Bioregion (a Group 2 Bioregion), the EPA (2004) considers a proposal impacting >50ha as having a high impact. The Mt Marion Lithium Project is proposed to impact 900ha within a lease area of 1699ha. Population decline is inevitable with some habitat loss, but significance depends on proportion of VSA and of populations impacted. Most of the project area contains VSAs that are well represented in the region. Of the area mapped for vegetation types by NVS (2019) (totalling 6319.26ha), VSAs 1, 3 and 4 together cover 96%. The same VSAs represent 84% of the proposed NVCP footprint area (totalling 1581.77ha). Two VSAs, #5 and #8, are limited in extent within the project area and will be impacted by the proposed LOM footprint;

- 90% (33.59ha) of the area mapped as VSA 5 is within the NVCP area, of which 18.6ha has previously been disturbed and a further 14.34ha is proposed to be disturbed in the LOM footprint; and
- 100% (5.38ha) of the area mapped as VSA 8 is within the NVCP area, of which 4.85ha has previously been disturbed and a further 0.52ha is proposed to be disturbed in the LOM footprint.

Both VSA 5 and 8 are expected to occur as a similar proportion of the landscape outside of the project area.

Large, hollow-bearing Eucalypt trees occur within the survey area, support conservation significant fauna and contain breeding or roosting sites (tree hollows) for a range of fauna. Impact Minor to Moderate.

Habitat loss leading to population fragmentation. Linear landscape features that might be disrupted include drainage lines and to some extent hills, although these are broadly undulating rather than confined. Roads may limit movement of small, terrestrial fauna species. Such effects are localised in the development area. Impact Negligible to Minor.

Local hydrology. The landscape of the survey area is influenced by the ridge of greenstone hills and the paleo-drainage system that is the focus of the borefield. This system drains into Lake Lefroy, south-east of the study area. Surface and sub-surface drainage patterns are likely to be complex due to heavy soils. Alteration of drainage pattern can significantly impact downstream environments, therefore maintaining local hydrology is considered to be of high importance. Impact Minor (with management).

Degradation of habitat due to weed invasion. This impact should be Negligible assuming standard hygiene procedures are followed (see recommendations).

Ongoing mortality from operations. The viability of species that occur at low population densities in areas adjacent to the project area may be compromised by ongoing mortality, such as through roadkill.

The Malleefowl is of particular concern as it may occur in low densities in areas adjacent to the proposed project and is highly susceptible to roadkill. The status of the Chuditch in the area is uncertain, but it may be present in low numbers and thus the occasional road death would be a significant impact on this population. Impact Minor with management.

Species interactions. Feral fauna can increase in abundance around human disturbance which may exacerbate localised impacts on other native fauna. Tracks through otherwise intact native vegetation can facilitate access by feral predators. Increases in the abundance of predatory and/or scavenging bird species can adversely impact smaller bird, including some of those listed as CS3. These effects could result in Minor impacts but can be minimised (see recommendations).

Altered fire regimes. Impacts from fire arising from the project are anticipated to be Negligible providing management measures are in place.

Disturbance (dust, noise, light). The level of dust, noise and light from the proposed action is uncertain but impacts would be localised. Minor impact with some management possible.

5.2 Summary of impacts

Impacts upon significant fauna species and key fauna values are summarised in Table 10 and Table 11 and are mostly considered to be Negligible to Minor; this is largely because the impact area is small relative to the broad and largely intact landscape. Impact upon some of the less widespread VSAs may be Minor to Moderate because they are limited in extent within the project area and their status in the broader region is uncertain (though they are expected to be represented at a similar portion of the landscape outside the project area). Some management measures to mitigate are included in Table 10 and

Table 11, and are expanded in Section 6.

Table 10. Impact assessment of the significant fauna species expected to occur in the survey area.

Common Name	Status	Habitat	Occurrence	Management	Residual Impact
Malleefowl	Vul	Dense shrublands	Potential visitor	Habitat preservation, roadkill management, monitor local population. Avoid increasing abundance of feral species.	Negligible
Carpet Python	CS3	Woodland tree hollows	Potential Resident	Conserve mature trees. Relocation if encountered during clearing	Negligible
Peregrine Falcon	OS (Sect 18 of WA BCA)	Woodland tree hollows	Potential Resident	Maintain breeding sites if found (if possible); avoid direct impact on active nests	Negligible
Major Mitchell's Cockatoo	CS3	Woodland tree hollows	Irregular visitor	Conserve mature trees, maintain breeding sites if found (if possible); avoid direct impact on active nests. Avoid over-abundant native species.	Negligible
Central Long-eared Bat	P4	Woodland tree hollows	Potential Resident	Conserve mature trees, maintain breeding sites if found	Negligible

Common Name	Status	Habitat	Occurrence	Management	Residual Impact
Rainbow Bee-eater	CS3	Woodland	Regular Migrant	None	Negligible
CS3 Birds	CS3	Woodland	Resident	Habitat preservation / conserve mature trees where possible. Avoid over-abundant native species.	Negligible

Table 11. Summary of potential impacts upon key fauna values.

Fauna Value	Nature and Significance of Impact		Recommended Actions
	Potential Impacts	Significance	
Fauna assemblage	Increased mortality; Loss of habitat; species interactions.	Minor as impacts very localised in a regional context	• Minimise impact footprint; • Conserve large, mature, hollow-bearing trees where possible; • Ensure landscape permeability is maintained by creating cross-over/underpass points along transport corridors/pipelines. • Manage feral and over-abundant species
VSAs	Loss of habitat; Habitat degradation.	Minor to Moderate – most of the area contains widespread VSAs; some VSAs are restricted within and outside the project area.	• Minimise footprint; • Minimise disturbance to mature Eucalypt trees and areas of dense understorey;
Significant fauna	Ongoing mortality; Loss of habitat; Species interactions.	Minor as impacts localised but consideration may be needed for Malleefowl if present in adjacent areas.	• Minimise footprint; • Habitat preservation – retain / manage important areas; • Monitor local Malleefowl population if present; and • Retain mature, hollow-bearing trees where possible.
Patterns of biodiversity	Loss of habitat	Minor as impacts very localized.	• Minimise footprint; and • Minimise disturbance to mature Eucalypt trees and dense Acacia shrubland areas.
Ecological processes	Increased mortality; habitat degradation	Minor	• Minimise disturbance footprint. • Manage hydrology. • Feral species management

5.3 Assessment of the project's fauna values against the Ten Clearing Principles

Under the WA Environmental Protection Act (1986), any clearing must be conducted under a Native Vegetation Clearing Permit (NVCP), unless the project is exempted. As part of the application for a NVCP, the project should be assessed against the Ten Clearing Principles, as outlined under Schedule 5 of the EP Act. For the purposes of this review, the project's fauna values were assessed against the Ten Clearing Principles. For each of the Clearing Principles (listed as titles for Sections 5.3.1 to 5.3.10) a general statement is made on how the fauna values of the Mt Marion Lithium Project area relates to that Clearing Principle, with further discussion providing the basis for this general statement.

5.3.1 It comprises a high level of biological diversity

The project is not considered to be at variance to this Principle.

The study area lies near the western boundary of the Eastern Goldfields subregion (COO3), adjacent to the Southern Cross subregion (C002), both of which are in the Coolgardie Biogeographical Region; as recognised through IBRA v7 (DoEE, 2017b). Cowan (2001) recognises a range of special values within the Eastern Goldfields subregion including several wetland systems, plant assemblages associated with isolated landscape features (i.e. ridgelines and ranges), threatened flora, arid zone Eucalypt communities and conservation significant fauna. Of the values listed, the following are considered relevant to the fauna assemblages recorded/expected within the Mt Marion Project Area:

- Malleefowl (*Leipoa ocellata*);
- Carpet Python *(Morelia spilota imbricata*);
- Peregrine Falcon (Falco peregrinus); and
- Chuditch (*Dasyurus geoffroii*).

It should be noted that the project area is not noted for a high biodiversity relative to the surrounding region, therefore the project is not considered to be at variance to this principle.

5.3.2 It comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia

The project is considered not to be at variance to this Principle.

Several significant fauna species have been recorded from the project area or are expected to occur nearby, including Malleefowl, Central Long-eared Bat, Purple-crowned Lorikeet, Rainbow Bee-eater and Blue-breasted Fairy-wren, with the potential for 27 significant species to occur in the Mt Marion Project Area or nearby. None of these species are considered to be heavily reliant on habitats/VSAs within the project area. Although some VSAs within the project are restricted, and may have limited occurrence within the region, they are not considered to be particularly significant for fauna within the project area. Therefore, the project is not considered to be at variance to this principle.

5.3.3 It includes, or is necessary for the continued existence of, rare flora

Not assessed.

5.3.4 It comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community

Not assessed.

5.3.5 It is significant as a remnant of native vegetation in an area that has been extensively cleared

The project is considered not to be at variance to this principle.

The Coolgardie Bioregion is listed Group 2 Bioregions which includes "bioregions of the Eremaean Botanical Province, native vegetation is largely contiguous but used for commercial grazing" (EPA, 2106). The Mt Marion Project area is within an area that has been impacted by grazing and historical mining/forestry activity, but much of the vegetation is considered to still be intact. Therefore, the project is considered not to be at variance to this principle.

5.3.6 It is growing in, or in association with, an environment associated with a watercourse or wetland

The project may be at variance to this Principle.

The project area includes part of a paleo-drainage system that flows to the south into Lake Lefroy. This system is expected to drain episodically and efforts have been made by MRL to ensure local surface hydrology is minimally altered. The VSAs associated with that system are generally widespread and expected to be well represented outside of the Mt Marion Lithium Project Area. VSA #5, which consists of small areas of dense vegetation fringing minor watercourses is considered restricted; its occurrence outside of the impact area is currently unknown but is considered likely to occur as a similar proportion of the VSAs within the landscape.

5.3.7 The clearing of the vegetation is likely to cause appreciable land degradation

Not assessed.

5.3.8 The clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area

The project is considered not to be at variance to this Principle.

Numerous conservation areas, including Timber Reserves, were identified within the region; of which the five in closest proximity are listed in the table below.

Adjacent or nearby conservation areas	Distance and direction from Mt Marion (km)	Gazetted reserve area
Yallari Timber Reserve	10.6 km west	6,075 ha
Kambalda Nature Reserve	14.6 km south-east	3,683 ha
Scahill Timber Reserve	22.3 km west	6,916 ha
Kurrawang Nature Reserve	29.5 km north-west	636 ha
Kambalda Timber Reserve	30.4 km south-east	2391 ha

As the nearest conservation area is approximately 10.6km away, it is considered unlikely that the project will impact on the environmental values of any of these sites, therefore it is considered that the project will not be at variance to this principle.

5.3.9 The clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water

Not assessed.

5.3.10 The clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding

The project is considered not to be at variance to this Principle.

A Bureau of Meteorology station near to the project area (Kalgoorlie-Boulder Airport), recorded an average annual rainfall of 283.3ml (st. dev. ± 94.2) between 1989- 2019 (BoM, 2019). There is potential for flooding following major/sustained rainfall events, however this is considered unlikely to be caused or exacerbated by clearing associated with this project, therefore the project is considered not to be at variance to this principle.

6 Recommendations

Section 5 (Impact Assessment) identified several potential adverse impacts that may occur from the disturbance to the survey area. Impacts to significant species are expected to be Negligible, however some fauna values have the potential to be impacted due to the size of the area proposed for clearing and the limited extent of some VSAs. Any reduction in impacts is desirable. Management strategies recommended to reduce the potential impacts of this development are listed in Table 10 and Table 11 and are summarised below.

Increased Mortality - Roadkill

- Manage access road traffic to minimise the potential for roadkill (particularly Malleefowl). Roadkill of any significant species (particularly Malleefowl, Chuditch and Carpet Python) should be documented and if areas of activity of Malleefowl are documented, monitoring may be required to identify birds a risk.

Loss of habitat

- Minimise clearing as much as possible, particularly in areas of limited VSAs;
- Avoid disturbance to large mature Eucalypt trees where possible;
- Stockpile and re-use old trees in rehabilitation; and
- Rehabilitate any cleared areas not needed after construction.

Habitat fragmentation

- Avoid altering drainage patterns including dynamics of groundwater.

Local hydrology

- Create cross-over/underpass points along the length of the borefields pipeline, allowing for fauna to easily cross the pipeline corridor. Underpass points should also be available where roads cross drainage lines.[1]

Weeds

- Standard minesite weed hygiene practices should be implemented to prevent introduction and/or spread of weeds.

Species interactions

- Manage waste to ensure that feral and over-abundant native fauna species do not become a problem; and
- Minimise the creation of new tracks through native vegetation, thereby minimising access for feral predators e.g. cats and foxes, that regularly use tracks to increase their home range.
- Minimise access to freshwater by fauna.

Disturbance

- Minimise dust and noise as much as possible. Lighting should be directed away from areas of native vegetation to reduce attraction and mortality of invertebrates.

Fire

- Minimise fire risk to native vegetation; probably through standard minesite procedure such as hot work regulation.

[1] MRL have indicated that pipelines will be buried when they pass through drainage lines. Jump overs will be in pace at intervals along the pipeline to not only secure it in place but also provide access over the line. The gauge of the line will only be small do as not to impede the majority of animals from crossing the line.

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8 Appendices

Appendix A. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation/substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the Western Australian Wildlife Conservation Act 1950 (Wildlife Conservation Act). In addition, the Western Australian Department of Environment and Conservation (DEC) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix C.

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The *Wildlife Conservation Act* uses a series of Schedules to classify status, but also recognizes the IUCN categories and ranks species within the Schedules using the categories of Mace and Stuart (1994).

Conservation Significance (CS) 2: Species listed as Priority by the DBCA but not listed under State or Commonwealth Acts.

In Western Australia, the DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the *Wildlife Conservation Act* but for which the DBCA feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as

habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DBCA, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (Department of Environmental Protection 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix B. Explanation of threatening processes.

Potential impacts of proposed developments upon fauna values can be related to threatening processes. This is recognised in the literature (e.g. Gleeson and Gleeson 2012) and under the EPBC Act, in which threatening processes are listed. Processes that may impact fauna values are discussed below. Rather than being independent of one another, processes are complex and often interrelated. They are the mechanisms by which fauna can be affected by development. Impacts may be significant if large numbers of species or large proportions of populations are affected.

Loss of habitat affecting population survival

Clearing for a development can lead to habitat loss for a species with a consequent decline in population size. This may be significant if the smaller population has reduced viability. Conservation significant species or species that already occur at low densities may be particularly sensitive to habitat loss affecting population survival.

Loss of habitat leading to population fragmentation

Loss of habitat can affect population movements by limiting movement of individuals throughout the landscape as a result of fragmentation (Gleeson and Gleeson 2012, Soule *et al.* 2004). Obstructions associated with the development, such as roads, pipes and drainage channels, may also affect movement of small, terrestrial species. Fragmented populations may not be sustainable and may be sensitive to effects such as reduced gene flow.

Degradation of habitat due to weed invasion leading to population decline

Weed invasion can occur as a result of development and if this alters habitat quality, can lead to effects similar to habitat loss.

Increased mortality

Increased mortality can occur during project operations; for example from roadkill, animals striking infrastructure and entrapment in trenches. Roadkill as a cause of population decline has been documented for several medium-sized mammals in eastern Australia (Dufty 1989; Jones 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented (Scheick and Jones 1999; Clevenger and Waltho 2000; Jackson and Griffin 2000).

Increased mortality of common species during development is unavoidable and may not be significant for a population. However, the cumulative impacts of increased mortality of conservation significant species or species that already occur at low densities may have a significant impact on the population.

Species interactions, including predation and competition

Changes in species interactions often occur with development. Introduced species, including the feral Cat, Red Fox and Rabbit may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are very sensitive to introduced predators and the decline of many mammals in Australia has been linked to predation by the Red Fox, and to a lesser extent the feral Cat (Burbidge and McKenzie 1989). Introduced grazing species, such as the Rabbit, Goat, Camel and domestic livestock, can also degrade habitats and deplete vegetation that may be a food source for other species.

Changes in the abundance of some native species at the expense of others, due to the provision of fresh watering points, can also be a concern. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species. Common, water-dependent birds were found to out-compete some less common, water-independent species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species through competition and displacement. Read *et al.* (2015) found that large, aggressive and often predatory birds increased in abundance close to mine sites at the expense of some other bird species.

Hydroecology

Interruptions of hydroecological processes can have major effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Fauna may be impacted by potential changes to groundwater level and chemistry and altered flow regime. These changes may alter vegetation across large areas and may lead to habitat degradation or loss. Impacts upon fauna can be widespread and major.

Changes to flow regime across the landscape may alter vegetation and lead to habitat degradation or loss, affecting fauna. For example, Mulga has a shallow root system and relies on surface sheet flow during flood events. If surface sheet flow is impeded, Mulga can die (Kofoed 1998), which may impact on a range of fauna associated with this vegetation type.

Fire

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (Gill *et al.* 1981; Fox 1982; Bamford and Roberts 2003). It is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge and McKenzie 1989). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Changes in fire regime, whether to more frequent or less frequent fires, may be significant to some fauna. Impacts of severe fire may be devastating to species already occurring at low densities or to species requiring long unburnt habitats to survive. In terms of conservation management, it is not fire *per se* but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity. Fire management may be considered the responsibility of managers of large tracts of land.

Dust, light, noise and vibration

Impacts of dust, light, noise and vibration upon fauna are difficult to predict. Some studies have demonstrated the impact of artificial night lighting on fauna, with lighting affecting fauna behaviour more than noise (Rich and Longcore 2006). Effects can include impacts on predator-prey interactions, changes to mating and nesting behaviour, and increased competition and predation within and between invertebrates, frogs, birds and mammals.

The death of very large numbers of insects has been observed around some remote mine sites and attracts other fauna, notably native and introduced predators (M. Bamford pers. obs). The abundance of some insects can decline due to mortality around lights, although this has previously

been recorded in fragmented landscapes where populations are already under stress (Rich and Longcore 2006). Artificial night lighting may also lead to disorientation of migratory birds. Aquatic habitats and open habitats such as grasslands and dunes may be vulnerable to light spill.

Appendix C. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the Environment Protection and Biodiversity Conservation Act 1999 and the Western Australian Wildlife Conservation Act 1950.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (Ex)	Taxa known to survive only in captivity.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the WA Wildlife Conservation Act 1950

Schedule 1 (S1)	Critically Endangered fauna.
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties.
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependant fauna
Schedule 7 (S7)	Other specially protected fauna

WA Department of Environment and Conservation Priority species (species not listed under the Wildlife Conservation Act 1950, but for which there is some concern).

Priority 1. (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2. (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3. (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4. (P4)	Taxa in need of monitoring. a) Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change; b) Species that are considered to have been adequately surveyed and are close to qualifying for Vulnerable, but are not listed as Conservation Dependent; and c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix D. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule *et al.* 2004):

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 21 key threatening processes listed by the federal Department of the Environment and Energy (DEE 2017):

- Aggressive exclusion of birds from potential woodland and forest habitats by over-abundant Noisy Miners (*Manorina melanocephala*).
- Competition and land degradation by rabbits.
- Competition and land degradation by unmanaged goats.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South.
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations.
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.
- Invasion of northern Australia by Gamba Grass and other introduced grasses.
- Land clearance.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity.
- Predation by European red fox.
- Predation by exotic rats on Australian offshore islands of less than 1000 km2 (100,000 ha).

- Predation by feral cats.
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs.
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (Bufo marinus).
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, Solenopsis invicta (fire ant).

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, Dept of Energy and the Environment (DEE, formerly DSEWPaC) has produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action interfere with the recovery of the species?

Appendix E Fauna expected to occur in the survey area (Table 12 to Table 15).

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the Kalgoorlie region. These are:

- Species listed under fauna databases – NatureMap (DBCA, 2017), Birdata (BirdLife Australia, 2017), Atlas of Living Australia (ALA, 2017) or EPBC Protected Matters Search (DEE, 2017), or from the literature;
- Local records (BCE database) and fauna recorded during previous BCE fauna assessments in the local area:
- Species previously recorded at Mt Marion by BCE (2012) or Rapallo (2010);
- Alacer Gold Level 1 Fauna surveys (conducted by BCE during 2012 at the South Kalgoorlie operations) listed under "A" (see BCE, 2012a, b, c, d).
- Level 1 Fauna survey of Excelsior Gold's Bardoc Project (listed under "B", BCE, 2012e).
- Level 1 Fauna survey of the Metals X Cannon Project (listed under "C", see BCE 2015);
- Level 1 Fauna survey of the Metals X Gunge West Project (listed under "G", BCE 20126);
- Level 1 Fauna survey at Red Hill, Kambalda (listed under "K", BCE 2015);
- Level 2 Fauna survey conducted by BCE at St Ives, Lake Lefroy (Si);
- Fauna recorded during a previous Mount Marion BCE survey (listed under "BCE", 2016)
- Fauna recorded during a BCE survey of M15/717, within the Mt Marion area (listed under "BCE", 2017a);
- Fauna recorded during the BCE survey of the Stage 1 borefields pipeline corridor listed under "BCE", 2017b);
- Fauna recorded during the BCE survey of the Woolibar Stage 2, borefields pipeline corridor (listed under "BCE", 2018);
- Note conservation significant fauna are listed under CS;
- Species recorded opportunistically outside the survey, but within the region, are listed under "R";
- Species recorded indirectly by prints, nests, bones etc and listed under "S";
- Species recorded breeding within the area are listed under "X^{B}";
- Species recorded or expected from the region, but not the specific study area are listed as "-"; and
- Species recorded using motion-sensitive cameras are listed as "C".

Table 12. Frogs recorded or expected to occur in the Mt Marion area.

FROGS	CS	Outside Areas	Mt Marion surveys					
			Rapallo 2010	BCE				
				2012	2016	2017a	2017b	2018
Limnodynastidae (burrowing frogs)								
Kunapalari Frog *Neobatrachus kunapalari*		**SI, B**			**X**			
Humming Frog *Neobatrachus pelobatoides*								
Shoemaker Frog *Neobatrachus sutor*								
Goldfields Bull Frog *Neobatrachus wilsmorei*								
Myobatrachidae (ground-frogs)								
Western Toadlet *Pseudophryne occidentalis*		**SI, B**						
Total Number of Species Expected: 5 Total Number of Species Recorded from the Mt Marion Lithium Project Area: 1		**2**	**0**	**0**	**1**	**0**	**0**	**0**

Table 13. Reptiles recorded or expected to occur in the Mt Marion area.

REPTILES		CS	Outside Areas	Mt Marion surveys					
				Rapallo	BCE				
				2010	2012	2016	2017a	2017b	2018
CARPHODACTYLIDAE									
Pale Knob-tailed Gecko	*Nephrurus laevissimus*		SI						
Midline Knob-tail	*Nephrurus vertebralis*								
Barking Gecko	*Underwoodisaurus milii*		SI, B, A, K			X			
DIPLODACTYLIDAE									
Clawless Gecko	*Crenadactylus ocellatus*		SI						
Western Stone Gecko	*Diplodactylus granariensis*		SI, K			X			
Beautiful Gecko	*Diplodactylus pulcher*		SI, K						
Reticulated Velvet Gecko	*Hesperoedura reticulata*		SI			X			
Beaded Gecko	*Lucasium damaeum*								
Main's Ground Gecko	*Lucasium maini*		SI, K						
Beaked Gecko	*Rhynchoedura ornata*					X			
Thorn -tailed Gecko	*Strophurus assimilis*		SI						
Jewelled Gecko	*Strophurus elderi*		SI						
Ring-tailed Gecko	*Strophurus strophurus*								
GEKKONIDAE									
Marbled Gecko	*Christinus marmoratus*		SI						
Purplish Dtella	*Gehyra purpurascens*		SI						
Tree Dtella	*Gehyra variegata*		SI, A, K, G	X		X			
Bynoe's Gecko	*Heteronotia binoei*		SI, B, A, K	X		X			
PYGOPODIDAE									
Marble-faced Delma	*Delma australis*		SI						
Unbanded Dema	*Delma butleri*		SI						
Fraser's Delma	*Delma fraseri*		SI						
Burton's Legless-Lizard	*Lialis burtonis*		SI						
Common Scaly-foot	*Pygopus lepidopodus*		SI						
Western Scaly-foot	*Pygopus nigriceps*								
AGAMIDAE									
Crested Dragon	*Ctenophorus cristatus*		SI, A, K	X	X	X			
Mallee Dragon	*Ctenophorus fordi*		SI						
Western Netted Dragon	*Ctenophorus reticulatus*		SI, A						
Claypan Dragon	*Ctenophorus salinarum*		SI, K						
Lozenge-marked Dragon	*Ctenophorus scutulatus*		SI, B						
Mulga Dragon	*Diporiphora amphiboluroides*								
Thorny Devil	*Moloch horridus*		SI, K						
Bearded Dragon	*Pogona minor*		SI						
Pebble Dragon	*Tympanocryptis pseudopsephos*		SI, C						
SCINCIDAE									
A skink	*Cryptoblepharus australis*								
A skink	*Cryptoblepharus buchananii*		SI	X					
Southern Mallee Skink	*Ctenotus atlas*		SI						
Leonhardi's Ctenotus	*Ctenotus leonhardii*		SI						
Barred Wedge-snouted Ctenotus	*Ctenotus schomburgkii*		SI						
Rock Ctenotus	*Ctenotus severus*								
Spotted Ctenotus	*Ctenotus uber*		SI, A						
Spinifex Slender Blue-tongue	*Cyclodomorphus melanops*		SI						
Pygmy Spiny-tailed Skink	*Egernia depressa*		B, A						
Goldfields Crevice Skink	*Egernia formosa*		SI, B, A		X	X			
Woodland Crevice Skink	*Egernia richardi*								
Broad-banded Sandswimmer	*Eremiascincus richardsonii*		SI						
Southern Five-toed Mulch Skink	*Hemiergis initialis*		SI						
Four-toed Mulch Skink	*Hemiergis peronii*								
South-west Four-toed Lerista	*Lerista distinguenda*		SI						
King's Lerista	*Lerista kingi*								
Robust Lerista	*Lerista macropisthopus*								
Goldfields Robust Lerista	*Lerista picturata*		SI						

REPTILES		CS	Outside Areas	Mt Marion surveys					
				Rapallo	BCE				
				2010	2012	2016	2017a	2017b	2018
Common Mulch Lerista	*Lerista timda*								
Desert Skink	*Liopholis inornata*		SI						
Bull-headed Skink	*Liopholis multiscutata*		SI						
Night Skink	*Liopholis striata*								
Common Dwarf Skink	*Menetia greyii*		SI						
Saltbush Flecked Skink	*Morethia adelaidensis*		SI						
Woodland Dark Fleck Skink	*Morethia butleri*		SI						
Woodland Flecked Skink	*Morethia obscura*		SI						
Western Blue-tongue	*Tiliqua occipitalis*		SI						
Bobtail	*Tiliqua rugosa*		SI, A, C, K, G						
VARANIDAE									
Pygmy Mulga Monitor	*Varanus caudolineatus*								
Bungarra or Sand Monitor	*Varanus gouldii*		SI, B, A, C, K		X	X			
Racehorse Monitor	*Varanus tristis tristis*		A						
TYPHLOPIDAE									
Southern Blind Snake	*Anilios australis*		SI						
Dark-spined Blind Snake	*Anilios bicolor*		SI						
Prong-snouted Blind Snake	*Anilios bituberculatus*		SI						
Hook-Snouted Blind Snake	*Anilios hamatus*								
Common Beaked Blind Snake	*Anilios waitii*								
BOIDAE									
Stimson's Python	*Antaresia stimsoni*								
Carpet Python	*Morelia spilota imbricata*	3	SI						
ELAPIDAE									
Desert Death Adder	*Acanthophis pyrrhus*								
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolata*		SI						
Southern Shovel-nosed Snake	*Brachyurophis semifasciata*		SI						
Yellow-faced Whipsnake	*Demansia psammophis*		SI						
Bardick	*Echiopsis curta*								
Moon Snake	*Furina ornata*								
Black-naped Snake	*Neelaps bimaculatus*								
Gould's Snake	*Parasuta gouldii*		SI						
Monk Snake	*Parasuta monachus*		SI						
Black-backed Hooded Snake	*Parasuta nigriceps*								
Mulga Snake	*Pseudechis australis*		SI						
Ringed Brown Snake	*Pseudonaja modesta*		SI						
Western Brown Snake	*Pseudonaja mengdeni*		SI, K						
Jan's Banded Snake	*Simoselaps bertholdi*		SI						
Rosen's Snake	*Suta fasciata*								
Total Number of Species Expected: 85 **Total Recorded from the Mt Marion Lithium Project Area: 10**			**59**	**4**	**3**	**9**	**0**	**0**	**0**

Table 14. Birds recorded or expected to occur in the Mt Marion area.

Birds		CS	Outside Areas	Mt Marion surveys					
				Rapallo	BCE				
				2010	2012	2016	2017a	2017b	2018
CASUARIIDAE									
Emu	*Dromaius novaehollandiae*		SI,B,A,G,C		X	X	S	X[B]	X
ANATIDAE									
Pink-eared Duck	*Malacorhynchus membranaceus*		A				-	-	-
Black Swan	*Cygnus atratus*		A				-	-	-
Australian Shelduck	*Tadorna tadornoides*		A				-	-	-
Hardhead	*Aythya australis*						-	-	-
Australasian Shoveler	*Spatula rhynchotis*						-	-	-
Australian Wood Duck	*Chenonetta jubata*		A				-	-	-
Pacific Black Duck	*Anas superciliosa*		A				-	-	-
Grey Teal	*Anas gracilis*						-	-	-
Chestnut Teal	*Anas castanea*						-	-	-
Freckled Duck	*Stictonetta naevosa*						-	-	-
Musk Duck	*Biziura lobata*						-	-	-
MEGAPODIIDAE									
Malleefowl	*Leipoa ocellata*	1	SI,A,K,G,C	X		X	S		S
PHASIANIDAE									
Stubble Quail	*Coturnix pectoralis*								-
PODICIPEDIDAE									
Australasian Grebe	*Tachybaptus novaehollandiae*		B,A				-	-	-
Hoary-headed Grebe	*Poliocephalus poliocephalus*						-	-	-
COLUMBIDAE									
Common Bronzewing	*Phaps chalcoptera*		SI,B,K,G,C	X		X		X	X
Crested Pigeon	*Ocyphaps lophotes*		SI,B,A,K,C						
Diamond Dove	*Geopelia cuneata*		A						
CUCULIDAE									
Horsfield's Bronze-Cuckoo	*Chalcites basalis*		SI,A,K,C						
Black-eared Cuckoo	*Chalcites osculans*		K,C			X			
Fan-tailed Cuckoo	*Cacomantis flabelliformis*								
Pallid Cuckoo	*Heteroscenes pallidus*			X					
OTIDIDAE									
Australian Bustard	*Ardeotis australis*	3							
PODARGIDAE									
Tawny Frogmouth	*Podargus strigoides*		B,A,G,C		X	X			
EUROSTOPODIDAE									
Spotted Nightjar	*Eurostopodus argus*					X			
AEGOTHELIDAE									
Australian Owlet-nightjar	*Aegotheles cristatus*		SI,K		X				
APODIDAE									
Fork-tailed Swift	*Apus pacificus*	1							
RALLIDAE									
Buff-banded Rail	*Hypotaenidia philippensis*						-	-	-
Australian Spotted Crake	*Porzana fluminea*		A				-	-	-
Baillon's Crake	*Zapornia pusilla*						-	-	-
Spotless Crake	*Zapornia tabuensis*						-	-	-
Black-tailed Native-hen	*Tribonyx ventralis*						-		
Eurasian Coot	*Fulica atra*						-	-	-
BURHINIDAE									
Bush Stone-curlew	*Burhinus grallarius*	3							
RECURVIROSTRIDAE									
Red-necked Avocet	*Recurvirostra novaehollandiae*						-	-	-
Pied (Black-winged) Stilt	*Himantopus leucocephalus*		A				-	-	-
Banded Stilt	*Cladorhynchus leucocephalus*		A				-	-	-
CHARADRIIDAE									
Red-capped Plover	*Charadrius ruficapillus*						-	-	-
Hooded Plover	*Thinornis rubricollis*	2					-	-	-
Black-fronted Dotterel	*Elseyornis melanops*		A				-	-	-
Banded Lapwing	*Vanellus tricolor*								
Red-kneed Dotterel	*Erythrogonys cinctus*						-	-	-
Inland Dotterel	*Charadrius australis*								
SCOLOPACIDAE									
Sharp-tailed Sandpiper	*Calidris acuminata*	1					-	-	-

Birds		CS	Outside Areas	Mt Marion surveys					
				Rapallo	BCE				
				2010	2012	2016	2017a	2017b	2018
Curlew Sandpiper	*Calidris ferruginea*	1					-	-	-
Red-necked Stint	*Calidris ruficollis*	1					-	-	-
Common Greenshank	*Tringa nebularia*	1					-	-	-
Wood Sandpiper	*Tringa glareola*	1					-	-	-
TURNICIDAE									
Little Button-quail	*Turnix velox*		A			R			
ARDEIDAE									
White-necked Heron	*Ardea pacifica*						-	-	-
Eastern Great Egret	*Ardea alba*						-	-	-
White-faced Heron	*Egretta novaehollandiae*		B,A				-	-	-
PLATALEIDAE									
Straw-necked Ibis	*Threskiornis spinicollis*						-	-	-
Yellow-billed Spoonbill	*Platalea flavipes*						-	-	-
ANHINGIDAE									
Little Pied Cormorant	*Microcarbo melanoleucos*						-	-	-
Little Black Cormorant	*Phalacrocorax sulcirostris*						-	-	-
ACCIPITRIDAE									
Black-shouldered Kite	*Elanus axillaris*								
Black-breasted Buzzard	*Hamirostra melanosternon*								
Square-tailed Kite	*Lophoictinia isura*	3							
Wedge-tailed Eagle	*Aquila audax*		SI,B,A,G,C						
Little Eagle	*Hieraaetus morphnoides*		K						
Spotted Harrier	*Circus assimilis*								
Brown Goshawk	*Accipiter fasciatus*		SI,B,C						
Collared Sparrowhawk	*Accipiter cirrocephalus*								
Whistling Kite	*Haliastur sphenurus*								
Black Kite	*Milvus migrans*								
TYTONIDAE									
Eastern Barn Owl	*Tyto alba delicatula*								
STRIGIDAE									
Southern Boobook	*Ninox boobook*								
MEROPIDAE									
Rainbow Bee-eater	*Merops ornatus*	3	SI,A,K		X	X			
HALCYONIDAE									
Sacred Kingfisher	*Todiramphus sanctus*		A						
Red-backed Kingfisher	*Todiramphus pyrrhopygius*				X				
FALCONIDAE									
Nankeen Kestrel	*Falco cenchroides*		B,K						
Australian Hobby	*Falco longipennis*								
Brown Falcon	*Falco berigora*		SI,B,A,K,C	X		X		X	
Peregrine Falcon	*Falco peregrinus*	1							
CACATUIDAE									
Cockatiel	*Nymphicus hollandicus*								
Galah	*Eolophus roseicapillus*		K						
Major Mitchell's Cockatoo	*Lophochroa leadbeateri*	3							
Little Corella	*Cacatua sanguinea*								
PSITTACIDAE									
Regent Parrot	*Polytelis anthopeplus*	3	SI						
Mulga Parrot	*Psephotus varius*		SI,B,G,C			X	X	X	
Western Rosella (inland)	*Platycercus icterotis xanthogenys*	2							
Australian Ringneck	*Barnardius zonarius*		SI,B,A,K,G,C	X	X	X	X		X
Scarlet-chested Parrot	*Neophema splendida*	3	SI						
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	3	SI, B, K, G, C	X	X	X	X	X	X
Budgerigar	*Melopsittacus undulatus*		SI,K						
CLIMACTERIDAE									
White-browed Treecreeper	*Climacteris affinis*	3	C						
Rufous Treecreeper	*Climacteris rufa*	3	SI,C		X	X	X		X
MALURIDAE									
Blue-breasted Fairy-wren	*Malurus pulcherrimus*	3	A,K,G		X	X	X	X	X
Variegated Fairy-wren	*Malurus lamberti*								
Splendid Fairy-wren	*Malurus splendens*		B,A,C						
White-winged Fairy-wren	*Malurus leucopterus*		SI,B,A,K						
MELIPHAGIDAE									
Black Honeyeater	*Sugomel niger*								

Birds		CS	Outside Areas	Mt Marion surveys					
				Rapallo	BCE				
				2010	2012	2016	2017a	2017b	2018
Brown Honeyeater	*Lichmera indistincta*		SI,B,A,K,G,C	X	X	X			
White-cheeked Honeyeater	*Phylidonyris niger*								
White-eared Honeyeater	*Nesoptilotus leucotis*		B,A,K,G,C	X	X	X	X	X	
Brown-headed Honeyeater	*Melithreptus brevirostris*		SI,B,A,K,G,C	X	X	X	X	X	
Pied Honeyeater	*Certhionyx variegatus*								
Crimson Chat	*Epthianura tricolor*								
Orange Chat	*Epthianura aurifrons*								
White-fronted Cat	*Epthianura albifrons*		A						
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		SI,B,A,K,C		X	X	X	X	X
Red Wattlebird	*Anthochaera carunculata*		SI,B,A,K,G,C	X	X	X	X	X	X
Singing Honeyeater	*Gavicalis virescens*		SI,B,A,K,G,C		X				
Yellow-plumed Honeyeater	*Ptilotula ornatus*		SI,B,A,K,G,C	X	X	X	X	X	X
Grey-fronted Honeyeater	*Ptilotula plumula*		B						
White-fronted Honeyeater	*Purnella albifrons*		SI,B,A,K,C	X	X	X	X	X	
Purple-gaped Honeyeater	*Lichenostomus cratitius*	3							
Yellow-throated Miner	*Manorina flavigula*		SI,B,A,K,C	X	X	X	X	X	X
PARDALOTIDAE									
Spotted Pardalote	*Pardalotus punctatus*				X				
Striated Pardalote	*Pardalotus striatus*		SI,B,A,K,G,C		X	X	X	X	
ACANTHIZIDAE									
Western Gerygone	*Gerygone fusca*							X	
Weebill	*Smicrornis brevirostris*		SI,B,A,K,G,C	X	X	X	X	X	X
Redthroat	*Pyrrholaemus brunneus*		SI,B,A,K,G,C	X	X	X			
Shy Heathwren	*Calamanthus cauta whitlocki*	3	SI						
Rufous Fieldwren	*Calamanthus campestris*								
White-browed Scrubwren	*Sericornis frontalis*								
Southern Whiteface	*Aphelocephala leucopsis*		C						
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		B,A,K,C	X		X			
Inland Thornbill	*Acanthiza apicalis*		SI,B,A,K,G,C	X	X	X	X		X
Slaty-backed Thornbill	*Acanthiza robustirostris*		K						
Slender billed Thornbill	*Acanthiza iredalei*								
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		SI,B,A,K,G,C	X	X	X	X		
POMATOSTOMIDAE									
White-browed Babbler	*Pomatostomus superciliosus*	3	B,A,K,G,C	X	X	X	X	X	
NEOSITTIDAE									
Varied Sittella	*Daphoenositta chrysoptera*		SI,B,A,K,G,C		X	X			
CAMPEPHAGIDAE									
Ground Cuckoo-shrike	*Coracina maxima*								
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		SI,B,A,K,C	X	X	X	X	X	
White-winged Triller	*Lalage tricolor*								
PSOPHODIDAE									
Copper-backed Quail-thrush	*Cinclosoma clarum*	3	A,K,G,C	X	X	X	X	X[B]	
PACHYCEPHALIDAE									
Gilbert's Whistler	*Pachycephala inornata*	3	B,A,K,C		X	X			
Rufous Whistler	*Pachycephala rufiventris*		B,A,K,G,C			X			
Golden Whistler	*Pachycephala pectoralis*			X		X			
Grey Shrike-thrush	*Colluricincla harmonica*		SI,B,A,K,G,C	X	X	X		X	X
FALCUNCULIDAE									
Crested Shrike-tit	*Falcunculus frontatus*	3							
OREOICIDAE									
Crested Bellbird	*Oreoica gutturalis*		SI,B,A,K,G,C		X	X	X	X	X
ARTAMIDAE									
Grey Currawong	*Strepera versicolor*		SI,B,A,K,G,C		X	X	X	X	
Australian Magpie	*Gymnorhina tibicen*		SI,B,A,K,C						
Pied Butcherbird	*Cracticus nigrogularis*		A,G,C		X				X
Grey Butcherbird	*Cracticus torquatus*		SI,B,A,K,G,C		X	X	X		
Masked Woodswallow	*Artamus personatus*		SI,A,K						
Dusky Woodswallow	*Artamus cyanopterus*		SI,G,C		X	X	X	X	X
Black-faced Woodswallow	*Artamus cinereus*		B,K		X				
Little Woodswallow	*Artamus minor*								
RHIPIDURIDAE									
Willie Wagtail	*Rhipidura leucophrys*		SI,B,A,K,G,C	X	X	X		X	X
Grey Fantail	*Rhipidura fuliginosa*						X		
CORVIDAE									

Birds		CS	Outside Areas	Mt Marion surveys					
				Rapallo	BCE				
				2010	2012	2016	2017a	2017b	2018
Torresian Crow	*Corvus orru*			X					
Australian Raven	*Corvus coronoides*		SI,B,A,K,G,C		X	X	X		
MONARCHIDAE									
Magpie-lark	*Grallina cyanoleuca*		A						
PETROICIDAE									
Red-capped Robin	*Petroica goodenovii*		SI,B,A,K,C		X				
Jacky Winter	*Microeca fascinans*		B,A,G,C	X	X	X	X	X	
Southern Scrub-robin	*Drymodes brunneopygia*	3				R			
Western Yellow Robin	*Eopsaltria griseogularis*	3	A,K,G,C	X		X	X	X	
Hooded Robin	*Melanodryas cucullata*								
NECTARINIIDAE									
Mistletoebird	*Dicaeum hirundinaceum*		SI,B,A,K,C	X		X			
ESTRILDIDAE									
Zebra Finch	*Taeniopygia guttata*								
MOTACILLIDAE									
Australasian Pipit	*Anthus novaeseelandiae*		SI,A,K						
HIRUNDINIDAE									
White-backed Swallow	*Cheramoeca leucosterna*		SI,A,K,G						
Fairy Martin	*Petrochelidon ariel*		A						
Tree Martin	*Petrochelidon nigricans*		SI,A,K,G,C		X	X		X	
Welcome Swallow	*Hirundo neoxena*		A,K,G		X	X		X	
ZOSTEROPIDAE									
Silvereye	*Zosterops lateralis*		SI,A						
MEGALURIDAE									
Rufous Songlark	*Cincloramphus mathewsi*								
Brown Songlark	*Cincloramphus cruralis*								
Total Number of Species Expected for Region: 164 **Total number of species recorded from the Mt Marion Lithium Project Area: 59**			**50**	**32**	**43**	**48**	**30**	**29**	**20**

Table 15. Mammals recorded or expected to occur in the Mt Marion area.

MAMMALS		CS	Outside Areas	Mt Marion Surveys					
				Rapallo 2010	BCE				
					2012	2016	2017a	2017b	2018
Tachyglossidae									
Echidna	*Tachyglossus aculeatus*		SI,A,B,C,K,G		X	X		X	X
Dasyuridae									
Chuditch	*Dasyurus geoffroii*								
Ride's Ningaui	*Ningaui ridei*		SI						
Mallee Ningaui	*Ningaui yvonneae*		SI						
Kultarr	*Antechinomys laniger*	CS3							
Fat-tailed Dunnart	*Sminthopsis crassicaudata*		SI						
Little Long-tailed Dunnart	*Sminthopsis dolichura*		SI,G						
Gilbert's Dunnart	*Sminthopsis gilberti*								
Burramyidae									
Western Pygmy-possum	*Cercartetus concinnus*		SI						
Macropodidae									
Western Grey Kangaroo	*Macropus fuliginosus*		SI,A,B,C,K,G		X	X	X	X	C
Euro	*Macropus robustus*		SI,K,G	X		X			
Red Kangaroo	*Macropus rufus*		SI						
Molossidae									
Inland Freetail Bat	*Mormopterus petersi*		SI,A						
Southern Freetail Bat	*Mormopterus kitcheneri*				X				
White-striped Freetail Bat	*Austronomus australis*		SI,A		X				
Vespertilionidae									
Gould's Wattled Bat	*Chalinolobus gouldii*		SI,A		X				
Chocolate Wattled Bat	*Chalinolobus morio*		A		X				
Lesser Long-eared Bat	*Nyctophilus geoffroyi*								
Greater Long-eared Bat	*Nyctophilus major tor*	CS2							
Inland Broad-nosed Bat	*Scotorepens balstoni*		A						
Southern Forest Bat	*Vespadelus regulus*		A		X				
Inland Forest Bat	*Vespadelus baverstocki*		A		X				
Muridae									
Mitchell's Hopping Mouse	*Notomys mitchelli*		SI,K						
Bolam's Mouse	*Pseudomys bolami*		SI						
Sandy Inland Mouse	*Pseudomys hermannsburgensis*		SI						
INTRODUCED MAMMALS									
Dingo	*Canis lupus*		SI,A	X					
European Red Fox	*Vulpes vulpes*		A,B,G	X					
Feral Cat	*Felis catus*		SI,B,K,G			X			C
Rabbit	*Oryctolagus cuniculus*		SI,A,B,C,K,G		X	X	X	X	X
House Mouse	*Mus musculus*		SI,A						
Goat	*Capra hircus*		A,B,C,K,G		X	X			
Horse	*Equus caballus*		K						
Dromedary Camel	*Camelus dromedarius*								
Cattle	*Bos taurus*		A		X				
Sheep	*Ovis aries*								
Total Number of Native Species Expected (Recorded) from the Mt Marion Project Area: 25 (9)			**19**	**1**	**8**	**3**	**1**	**2**	**2**
Total Number of Introduced Species Expected (Recorded) from the Mt Marion Project Area: 10 (6)			**8**	**2**	**3**	**3**	**1**	**1**	**2**