Fauna Assessment for the Malleefowl (*Leipoa ocellata*)

Mulga Rock Uranium Project Area

October 2015

Authorship and Review

Name	Role	Version	Date
Colin Woolard	Author	Rev 0	30.05.2015
Jan Henry	Fauna Technical Advisor	Rev 1.0	29.05.2015
Gay Bradley	Reviewer	Rev 1.1	16.05.2015
Xavier Moreau	Project Manager –Reviewer	Rev 1.1	16.05.2015
Gerry Bradley	Reviewer – Protocol	Rev 1.2	16.05.2015
Xavier Moreau	Authorised for distribution	06.05.2015	
Gay Bradley	Update new Project mining parameters	Rev 2.0	27.10.2015

Notes and Acknowledgements

This Assessment Report has been prepared using information provided from a range of published sources, in some cases unpublished research results and material from documents submitted for EIA-assessed projects in the Great Victoria Desert in both Western Australia and South Australia. These are acknowledged in the text and referenced in Section 6.

Suggested Document Citation

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Cover photo: Source: Jessica Van der Waag

Table of Contents

List of Figures

List of Tables

List of Plates

Summary

The Mulga Rock Uranium Project (MRUP) is located on unallocated Crown Land approximately 240km north of the regional city of Kalgoorlie-Boulder. The Project area is located entirely within the Interim Biogeographic Regionalisation of Australia (IBRA) Great Victoria Desert (GVD1) Shield subregion (DotE 2015).

Under the IBRA characterisation, vegetation of the Shield subregion is described as Aeolian sandplains dominated by spinifex with mainly mallees over hummock grasslands (*Triodia basedowii*) (Mattiske 2015a). Scattered *Eucalyptus gongylocarpa* and *Callitris* occur on the deeper sand while patches of Mulga (*Acacia aneura* complex) woodlands occur on colluvial and residual soils (Barton and Cowan 2001).

The primary objective of this review was to collate all available data on the Malleefowl (*Leipoa ocellata*) in the immediate vicinity of the MRUP, assess its status and the impact of the proposal on this conservation significant species and identify any potentially suitable, untested habitat for the species in the Project area.

Exploration work commenced in the current MRUP area in 1978 and biophysical surveys were undertaken in the period 1984 to 1986 and more recently from 2008 to 2015. Targeted surveys for conservation significant taxa, including the Malleefowl, have been commissioned by Vimy Resources Limited, other mining companies and the Malleefowl Preservation Group (MPG) in the surrounding terrain resulting in the identification of approximately 87 inactive mounds of various ages in Mulga habitats external to the MRUP. Two active mounds and one bird sighting were recorded in the Pinjin area 65km west of the MRUP (Ninox 2009, URS 2010) in unburnt habitat.

All the mounds have been located on sandy loam substrates in extended Mulga woodlands over low shrubs or hummock grasslands (*Triodia* spp.). Gravels are commonly present.

Targeted surveys in the MRUP have included traverses along the extensive exploration gridline network, pedestrian traverses over extended Project areas by geologists and botanists during other baseline survey work, targeted surveys by fauna specialists using recognised monitoring techniques for Malleefowl, annual sand pad traverses along nominated sandy tracks, observations during two low-level helicopter surveys, monitoring of camera trap images gathered as part of the Sandhill Dunnart studies and searches of remnant Mulga patches external to the Development Area in conjunction with a review of the recent fire history.

This review found no evidence of Malleefowl or their past occupation within the MRUP proposed Development Area or immediate surrounds.

1. Introduction

1.1 Background

Vimy Resources Limited (Vimy), formerly known as Energy and Minerals Australia Limited, is proposing to develop the remote Mulga Rock Uranium Project (MRUP or the Project) which is located 240km ENE of Kalgoorlie in dune fields on the western flank of the Great Victoria Desert (GVD).

The Project is a "controlled action" for the purpose of the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the potential impact to threatened species such as the Malleefowl (*Leipoa ocellata*) is one of the controlling provisions. The Project will be assessed by the Western Australian Environmental Protection Authority (EPA) and, in accordance with a new bilateral agreement, by the Federal Minister for the Environment under the EPBC Act.

Several systematic surveys for Malleefowl have been undertaken within what is now the MRUP Development Envelope area and the immediately adjacent sand dune environment. These surveys identified limited suitable habitat, no bird sightings, nor any evidence of mounds.

1.2 Scope and Purpose of this Report

As part of the impact assessment process, Vimy has requested a review of Great Victoria Desert (GVD1 Shield) Malleefowl data, including a summary on the recorded distribution, ecology and threats, recent fire history, and findings from other surveys to assess the impact of the MRUP proposal on this conservation significant species and determine if suitable untested refuge habitats are present in the Project area and the likelihood of Malleefowl being present in the proposed Project Development Area.

1.3 Conservation Status

The Malleefowl is listed as Vulnerable under the Western Australian *Wildlife Conservation Act 1950* (WC Act), and the Federal *Environment Protection and Biodiversity Conservation Act* (EPBC Act) *1999* (Mutton 2014). The Malleefowl occurs in all mainland states except Queensland and is recognised as threatened wherever it occurs. The species is listed as Critically Endangered in the Northern Territory, Endangered in New South Wales and Victoria and Vulnerable in South Australia.

The Malleefowl is recognised as an important endangered species in need of national conservation efforts, and a National Malleefowl Recovery Plan (Benshemesh 2007) has been implemented.

1.4 Distribution

The Malleefowl had a pre-European distribution that extended across the southern half of Australia from the west coast of Western Australia to the Great Dividing Range in New South Wales but its geographic range has contracted in recent years (Benshemesh 2007), particularly in arid areas and where agricultural practices below the 26th latitude have resulted in significant habitat modification (Figure 1).

In Western Australia, Malleefowl currently have a patchy distribution and their census to 2005, shown in Figure 2 and Figure 3, suggests that their range has contracted and, in some areas outside the rangelands, are believed to be locally extinct. Current records suggest that Malleefowl are still widely distributed over the rangelands in low numbers where suitable habitat is preserved (Benshemesh 2007).

Benshemesh (2008) reports that Malleefowl have been reported less frequently in the uncleared rangelands. This review of surveys undertaken in the GVD1 and GVD2 regions in the period 2008-2015, associated with other resource developments, has identified a limited number of aged (typically >5 years) inactive mounds and only two mounds at Pinjin on the western boundary of GVD1, which have any signs of recent activity. The locations of database recorded sites are shown on Figure 3 and those from recent surveys on Figure 9.

110°0'0"E 120°0'0"E 130°0'0"E 140°0'0"E 150°0'0"E 160°0'0"E

10°0'0"S

20°0'0"S

30°0'0"S

40°0'0"S

Northern Territory

Western Australia

Queensland

South Australia

New South Wales

Victoria

Alice Springs

Carnarvon

Warburton

Perth

Albany

Broken Hill

Cobar

Dubbo

Sydney

Griffith

Adelaide

Horsham

Melbourne

Current Range (records from 1981 to 1998)

Historical Range (records from 1800 to 1981)

LEGEND

MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

0 500 1,000

1:15,000,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
CURRENT AND HISTORICAL RANGE OF MALLEEFOWL ACROSS AUSTRALIA (BENSHEMESH 2007)

PROJECT NO.	CONTROL	REV.	FIGURE
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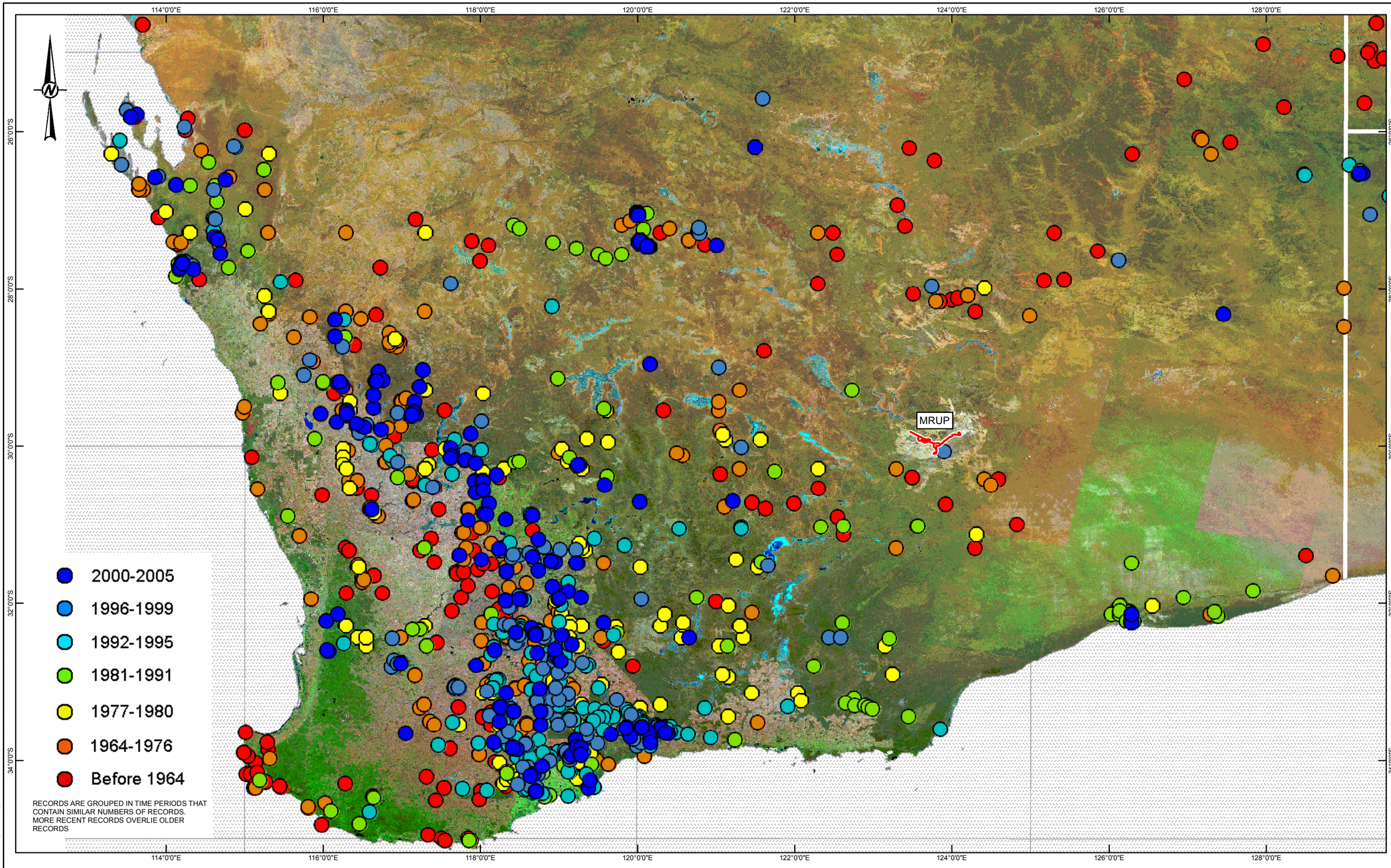

LEGEND

MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

0 100 200 300

1:5,000,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
RECORDS OF MALLEEFOWL PRESENCE IN WESTERN AUSTRALIA TO 2005 (BENSHEMESH 2007)

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B6	0	**2**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

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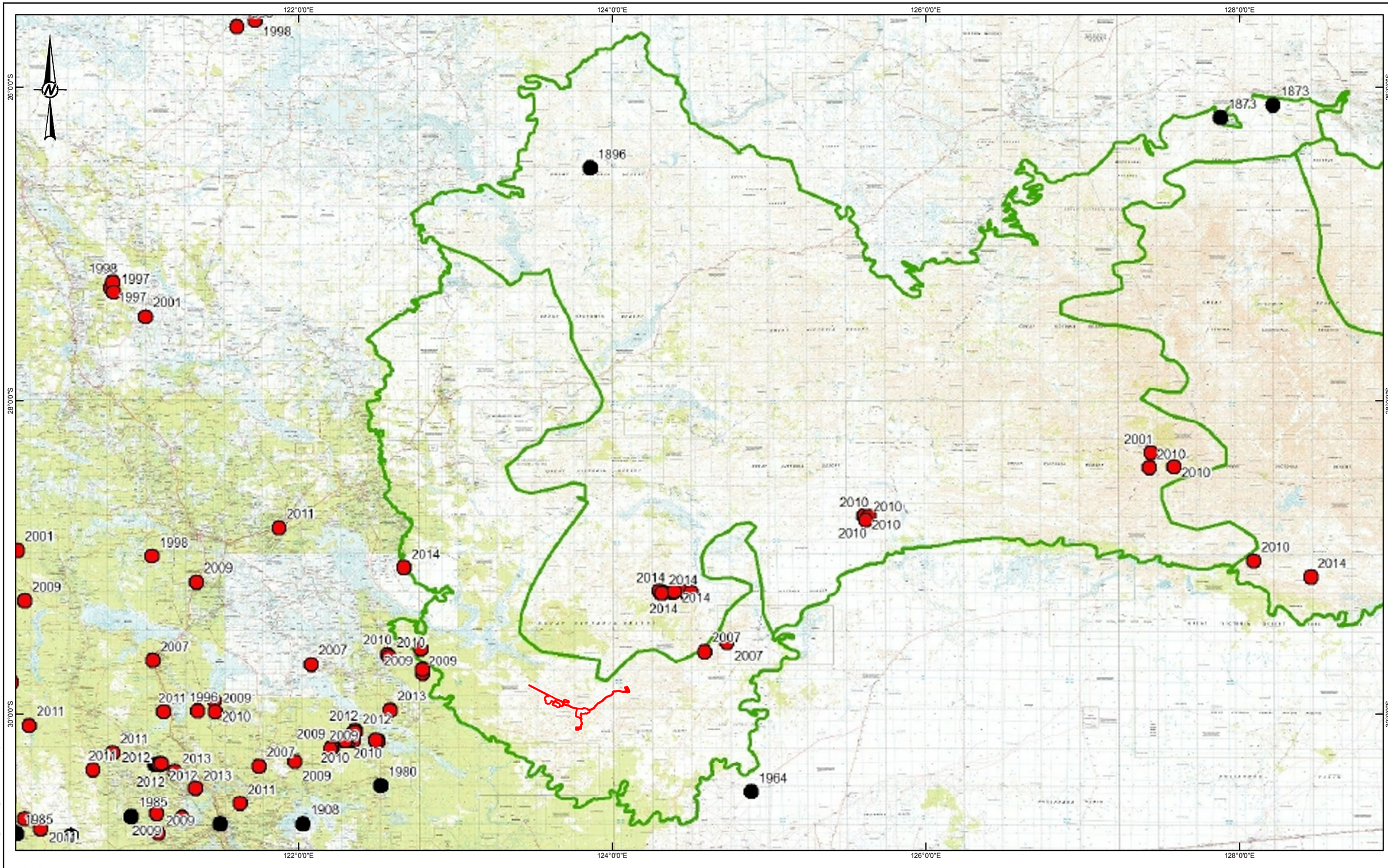

LEGEND

- MRUP DEVELOPMENT ENVELOPE
- IBRA Vegetation - GVD
- Malleefowl records post 1990
- Malleefowl records pre 1990

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

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1:2,500,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
LOCATION OF RECORDED MALLEEFOWL PRESENCE WITHIN GVD1 AND GVD2 BIOREGIONS (MUTTON 2014)

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B6	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

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1.5 Species Profile

Malleefowl belong to the family *Megapodiidae*, the megapodes or mound builders. Established pairs and adult individuals tend to be sedentary and remain in the same area throughout the year, although local shifts in home range over longer timeframes are recorded (DSEWPaC 2011). Young birds are recorded as dispersing over substantial distances (DotE 2015). The Malleefowl is the most southerly distributed of the three species of megapodes that occur in Australia and the only species in the genus *Leipoa* (Benshemesh 2007). It is restricted to the Australian mainland and inhabits semi-arid and arid regions. These dry regions are less conducive to the incubation methods employed by other Australian megapodes (Frith 1956) and the Malleefowl has developed the most sophisticated and elaborate technique of incubation involving the integration of solar and vegetative matter fermentation. First heat for incubation is derived from fermentation of leaf matter, but as the litter dries, the male increasingly relies on solar heat, exposing the nest chamber to the sun in the morning and filling in during the afternoon to maintain an egg temperature of about 34°C (Johnstone and Storr 1998).

Malleefowl have declined across their Australian range (Benshemesh 2007) and the loss of optimal habitat due to agricultural and pastoral impacts in Western Australia is reported as a major causative agent. Other factors such as predation by foxes (particularly of eggs and chicks), increased fire frequency in mallee habitats, habitat fragmentation – resulting in smaller isolated populations and reduced prospects for their long term conservation – and climate change (Malleefowl appear to avoid breeding in low rainfall years).

Appearance

The adult Malleefowl has a greyish head and neck, with a short dark bill, brown irises, a narrow white stripe beneath each eye, chestnut colouring on the chin, a dark-brown to blackish medial stripe that extends from the forehead to the base of the head, and a broad black stripe that extends from the throat to the upper breast. The upper surfaces of the wings have a complex pattern of markings, consisting of mottled brown, white, grey and black. The upper surface of the tail is mostly greyish, with narrow brown-black barring and some small patches of white. The breast, belly and flanks are a creamy white colour, and the legs and feet range from pale grey to blackish-brown in colour, and have darker claws (Johnstone and Storr 1998). Adult males (65-67.5cm) are slightly larger than females (56.5-62.0cm) and are much heavier (1.7-2.1kg versus 1.5-1.6kg).

1.6 Habitat

The habitat requirements of the Malleefowl are still poorly understood, but there are clear requirements for sandy clay substrate, gravel and an abundance of leaf litter for the construction of the birds' nesting mounds (Frith 1959, 1962). Densities of the breeding birds are positively influenced by rainfall, soil fertility, shrub diversity and density of canopy cover (Benshemesh 2007). In Western Australia, Malleefowl are recorded in low open woodlands dominated by mallee over low shrubs and in the western and eastern section of the Great Victoria Desert in Mulga and shrub thickets. Within the Anangu-Pitjantjatjara/Yankunytjatjara Lands in the north-eastern Great Victoria Desert, Malleefowl are recorded as mounding in Mulga thickets and using adjacent sandplain areas for foraging where food was more common (Benshemesh 1997, 2007). Typically, these Mulga areas have an understorey of hard/lobed spinifex (*Triodia basedowii* or other *Triodia* species) and shrub thickets where seed-bearing shrubs are more common. Malleefowl favour old growth habitat that is long unburnt and a timeframe of 30 to 60+ years post fire has been suggested as necessary to maintain viable breeding populations (Benshemesh 1992).

1.7 Home Range

Malleefowl are generally monogamous and, once breeding begins, appear to pair for life. Various home range areas have been reported for breeding pairs who can move several kilometres between nesting seasons (Frith 1962, Booth 1987, National Malleefowl Recovery Team website). Booth (1987) reported that home ranges in a Murray mallee belt population were approximately 4km^2, although overlap between different mounds occurred. Non-breeding birds can travel significant distances if appropriate corridors are present (SPRAT 2015). Birds can fly to escape predators, but spend most of their time on the ground.

1.8 Food

The Malleefowl is an opportunistic, generalist forager that feeds mainly on seeds but will take flowers, fruits and foliage, invertebrates and tubers (SPRAT 2015). Access to food resources is an important factor for what are largely sedentary birds and the mounds so far recorded in the western GVD1 are located in areas where *Acacia* seed resources are available.

1.9 Threatening Processes

Many potential threats to Malleefowl have been identified although the importance of each of these threats may vary in different circumstances and in different localities (Benshemesh 2008). The major threats to Malleefowl identified in Western Australia include widespread clearing of vegetation that fragments habitat and disperses populations, increased wildfire frequency, predation by foxes and cats (DPaW 2012), climate change that results in habitat alteration and potential changes to breeding patterns. In respect to the GVD1, Barton and Cowan (2001) identified the primary threatening processes as wildfire and predation by cats and foxes.

Impact of Fire

Although no research information on the effect of fire on Malleefowl in desert environments was identified as part of this review, recent studies in the Western Australian wheatbelt (Parsons 2012) suggested that the vulnerability of Malleefowl differs depending on the type of habitat and the size of the remnant. Resources for Malleefowl appear to increase in mallee with time (60 years plus) but diminish in *Acacia* shrubland after about 25 years. The impact of wildfire on Malleefowl populations is severe across all communities, and breeding in extensively burnt areas is usually curtailed for at least thirty years (Benshemesh 2008). Mortality from wild fires is also likely to be high as Malleefowl tend to be poor flyers and do not disperse.

Predators

Predation by introduced cats and foxes is listed as a primary threat to Malleefowl in the GVD1 by Barton and Cowan (2001). There is also evidence that interactions occur between predators in arid areas, and that dingos may suppress fox and cat numbers. Preliminary evidence from the MRUP camera trapping programme and site evidence, suggests that the Mulga Rock area has a healthy and visible dingo population, a subdued cat population and no evidence of foxes.

2. Existing Environment

2.1 Study Area

The Mulga Rock Uranium Project (MRUP) is located on unallocated Crown Land approximately 770km east-northeast of Perth in Western Australia and 240km northeast of the regional city of Kalgoorlie-Boulder. The Project area is located between the Queen Victoria Springs and Plumridge Lake Nature Reserves (Figure 4). The proposed development consists of three subsurface uranium bearing carbonaceous deposits that formed in buried paleochannel environments in Pleistocene times and together they comprise the Mulga Rock Deposits.

The Project area is located in the south-western portion of the Great Victorian Desert 1 (GVD1) Shield subregion (Figure 3), as defined in the Interim Biogeographic Regionalisation of Australia (IBRA) Version 7.0 (DotE 2014) at an elevation of 305 - 400m (AHD). It is traversed by largely vegetated east-southeast trending, 8m to 12m high yellow, orange sand dunes and sand sheets over a red brown sandy substrate. Project tenure, proposed development envelopes and footprints are shown on Figure 5.

As a consequence of the climate and the geographical isolation of the region, pastoralism and agriculture are not considered viable within the sandplain terrains. Consequently, there has been little large-scale land clearance or grazing by domestic stock although feral camels are present. The region is considered relatively undisturbed, with some elements of the yellow sandplains exhibiting high ecological values (Barton and Cowan 2001).

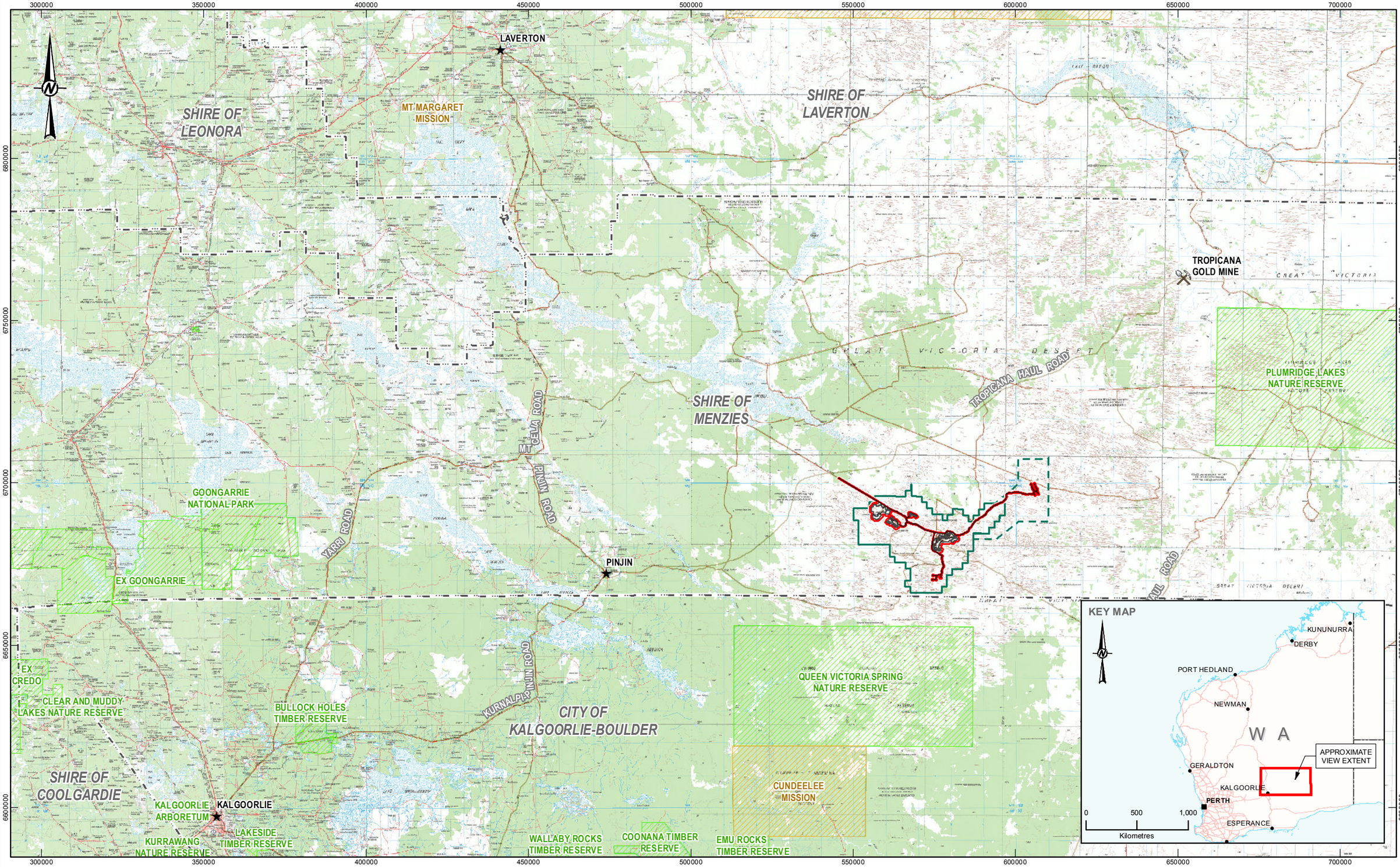
The hummock grasslands are prone to frequent, widespread and commonly hot wildfires, which have a devastating impact on the quality of potential Malleefowl habitat by reducing the structure and density of Mallee and Mulga habitat and shrub cover. Survival of Malleefowl populations after wildfires is not well documented (Parsons 2008), but information from other small mammal species suggests it can depend on aspects such as the availability and connectivity between the small unburnt vegetation patches that exist following fire in hummock grassland environments.

2.2 Biophysical Elements

Climate

Long term regional weather data is available from Bureau of Meteorology (BOM) stations at Laverton, 182km northwest of the Project area, Kalgoorlie 260km southwest and Balgair 204km to the southeast. In addition three automatic weather stations providing a range of climatic data were established on the MRUP site in 2009.

The climate is arid, with mean annual rainfall ranging from below 150mm to over 250mm. Rainfall is aseasonal, but shows great variability between years with above average rainfall experienced at site in 2011 (584mm) and below average (<220mm) in 2012 to 2014. Summers are very hot, with mean maxima during summer between 32°C and 35°C. Diurnal ranges are also large, and overnight temperature minima commonly fall below 0°C during winter.



LEGEND

- TROPICANA GOLD MINE
- TOWN
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- CONSERVATION RESERVE
- ABORIGINAL LAND TRUST ESTATE
- LOCAL GOVERNMENT AUTHORITY (LGA) BOUNDARY

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
BASE DATA © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2015)
IMAGE SOURCED FROM GEOSCIENCE AUSTRALIA 250K TOPO
INSET BASE DATA/ROADS SOURCED FROM STREET PRO DATA 2009

0 25 50
1:1,100,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-27
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
REGIONAL LOCATION

PROJECT NO.	CONTROL	REV.	FIGURE
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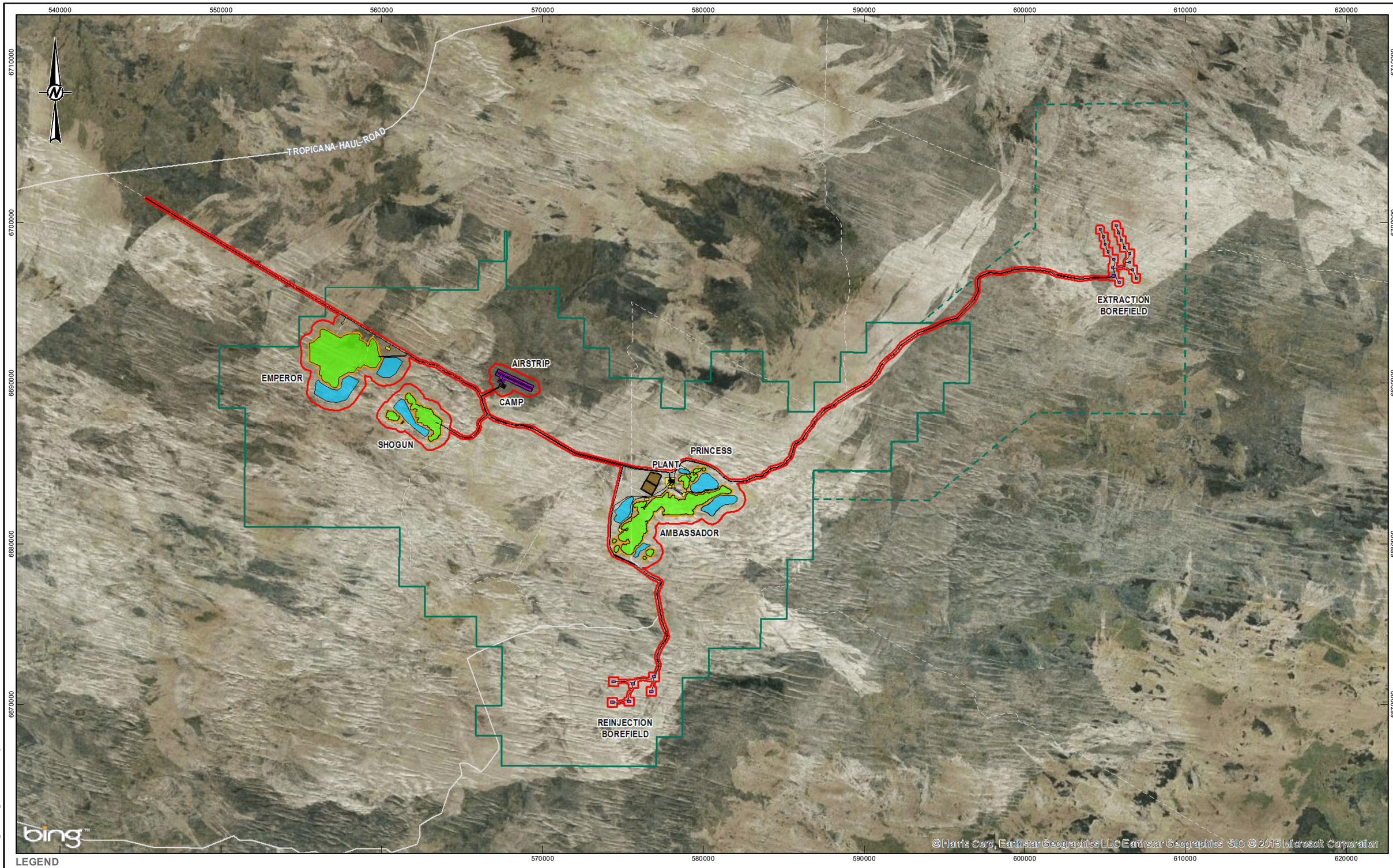

LEGEND

- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- PIT
- OVERBURDEN LANDFORM
- PROCESSING INFRASTRUCTURE
- ABOVE GROUND TSF
- SUPPORTING INFRASTRUCTURE
- PIT CLEARING (50 m BUFFER)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10
1:220,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-27
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
PROJECT TENURE, PROPOSED DEVELOPMENT ENVELOPE AND DISTURBANCE FOOTPRINT

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B6	0	**5**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

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Terrain

The Project area lies wholly within the Shield subregion of the GVD Interim Biogeographic Regionalisation of Australia (DotE website www.environment.gov.au).

The western part of GVD1 is underlain by the Yilgarn Craton and a higher proportion of sandplains are present in comparison to the rest of the bioregion. To the east is an arid active sand-ridge desert of deep Quaternary Aeolian sands overlying Permian and Mesozoic strata of the Officer Basin. Regional landforms consist of isolated salt lakes and major wide valley floors with lake derived (local) dunes and sandplains with patches of longitudinal dunes running approximately east west. The subregion contains the major Ponton Creek ephemeral channel.

The MRUP area consists essentially of vegetated yellow and orange sandplain landforms, with an average height of 10m and a length of 1.5km to 5km. Interdune areas range from 100m to 800m in width and contain yellow orange to red brown sandy loams of variable thickness. The northern, eastern and western perimeter of the MRUP area contains some local outcrop areas (such as Malcolm Soak) and sediment hosted areas that include lacustrine silts, weathered bedrock and ferruginous and siliceous duricrusts and gravels.

Two soil units, based on Northcote *et al.* (1968) occur in the MRUP area. The dominant soil unit is AB47, described as plains and dunes with longitudinal and ring dunes with interdune corridors and plains, and the occasional salt pan (comprises 95.7% of the MRUP Development Envelope). Soil unit My99 also occurs in the MRUP area (comprises 4.3% of the MRUP Development Envelope) and is described as plains with extensive gravel pavements and small tracts of longitudinal dunes (Northcote *et al.* 1968). Detailed soils investigation undertaken by Soilwater Consultants (SWC, 2015) has identified that the sand dunes represent <10% of both the Development Envelope and Disturbance Footprint, with the remaining flat (or plain) area consisting of a deep sandy duplex (60 – 75% of the area) and calcareous topographic lows (20 – 30%).

The major lithostratigraphic dune forming units for the GVD appear to have been stable for a long time (Sheard *et al.* 2006) and several researchers (Hesse *et al.* 2004) have suggested some dune ages greater than 125,000 years. Dating by optical luminescence dating on site has documented ages of 91-92ka at MRUP in swales (Morris *et al*. 2013). Swale areas between the dunes are characterised by shallow red, earthy soils and sand from the dunes.

Vegetation

The MRUP area is entirely located in the Helms Botanical District. Mattiske (2015) has completed detailed mapping of the MRUP and identified 26 vegetation communities consisting of 14 open mallee woodlands, one *Acacia* dominated woodland and 11 shrublands. A review of potential suitable Malleefowl habitats, based on the vegetation descriptions where mounds had been located in regional surveys (MPG 2009, Ninox 2009, URS 2010 and ecologia 2009a) identified one preferred Mulga woodland habitat (A1) and two potential shrubland communities (S1 and S3) that warranted targeted searches. These were:

A1: Low woodland to tall shrubland of *Acacia aneura* over *Aluta maisonneuvei* subsp. *auriculata*, *Eremophila latrobei*, *Phebalium canaliculatum*, *Prostanthera* spp. and mixed shrubs. This community occurs on orange sandy loams or clay loams with some laterite pebbles on flats.

S1: Shrubland of *Melaleuca hamata* with *Hakea francisiana* and mixed shrubs over *Triodia desertorum* with emergent *Eucalyptus* spp. This community occurs on yellow and orange sand on slopes and flats.

S3: Shrubland of *Allocasuarina spinosissima* and *Allocasuarina acutivalvis* subsp. *acutivalvis* with *Grevillea juncifolia* and *Hakea francisiana* over *Triodia desertorum* with emergent *Eucalyptus youngiana* and *Eucalyptus gongylocarpa.* This community occurs on yellow sand on slopes.

Field inspections confirmed that vegetation communities S1 and S3 were sub-optimal for Malleefowl and of very limited extent (amounting to less than 74ha out of a total of 27,221 mapped - less than 0.3%).

Fire

Wildfires are an annual summer event in the Shield areas of the GVD and present a significant threat to regional biodiversity as they commonly destroy habitat over very large areas, isolating vegetation remnants and often limiting connectivity and reoccupation as the vegetation recovers (Woinarski *et al.* 2014). The impact of wildfires on vegetation communities is dependent on several factors including fire intensity, areal extent, time of the year, fuel availability and the fire interval.

Studies on the fire prone and fire adapted landscapes of the GVD and their effects on biota are limited. Hayden *et al*. (2000) reported on fire studies carried out utilising Landsat satellite imagery on featureless vegetated sandplain 200km to the north of Mulga Rock covering the period 1972-1991. These studies suggested that between 2 to 5% of the west GVD landscape was burnt each year, the average fire size was approximately 28km^2 and the fire return interval was at least 20 years. Recent analysis of fire records for the broader Mulga Rock area, where fires were recorded in 1999, 2005, 2007 and 2014, suggest a shorter return timeframe at a local level, possibly in response to increased annual rainfall and fuel availability. These burn areas, with the exception of the November 2014 fire in the Project area, are shown in Figure 6.

Observations following the November 2014 fire at MRUP and surrounds (Figure 7) which burnt out approximately 79,203ha which included 74% of the MRUP Development Envelope and 78% of the Disturbance Footprint (MCPL 2015a), suggest that in cool fires isolated shrub thickets, gridline/road verge vegetation and, depending on wind direction, dunal vegetation can be preserved and form localised connecting corridors between vegetation patches of varying size and age. Despite this, the outcome of the “cool to medium” fire through the Project Development Envelope, and surrounds, in 2014 is that this area is likely to be unsuitable as optimal habitat for a range of fauna species for the next 10 to 15 years (Colin Woolard, pers. comm. 2015).

520000 540000 560000 580000 600000 620000 640000

6720000 6700000 6680000 6660000 6640000

Burnt Area - 2014
Burnt Area - 2013
Burnt Area - 2012
Burnt Area - 2011
Burnt Area - 2010
Burnt Area - 2009
Burnt Area - 2008
Burnt Area - 2007
Burnt Area - 2006
Burnt Area - 2005
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Burnt Area - 2003
Burnt Area - 2002
Burnt Area - 2001
Burnt Area - 2000
Burnt Area - 1999
Burnt Area - 1998
Burnt Area - 1997
Burnt Area - 1996
Burnt Area - 1995

LEGEND

- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- NOVEMBER 2014 FIRE SCAR

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
BASE DATA © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2015)

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1:400,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-27
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

TITLE
FIRE MAPPING SHOWING BURN HISTORY OF THE WESTERN SHIELD REGION OF THE GREAT VICTORIAN DESERT 1995-2014 (DATA FROM LANDGATE 2015)

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B6	0	**6**

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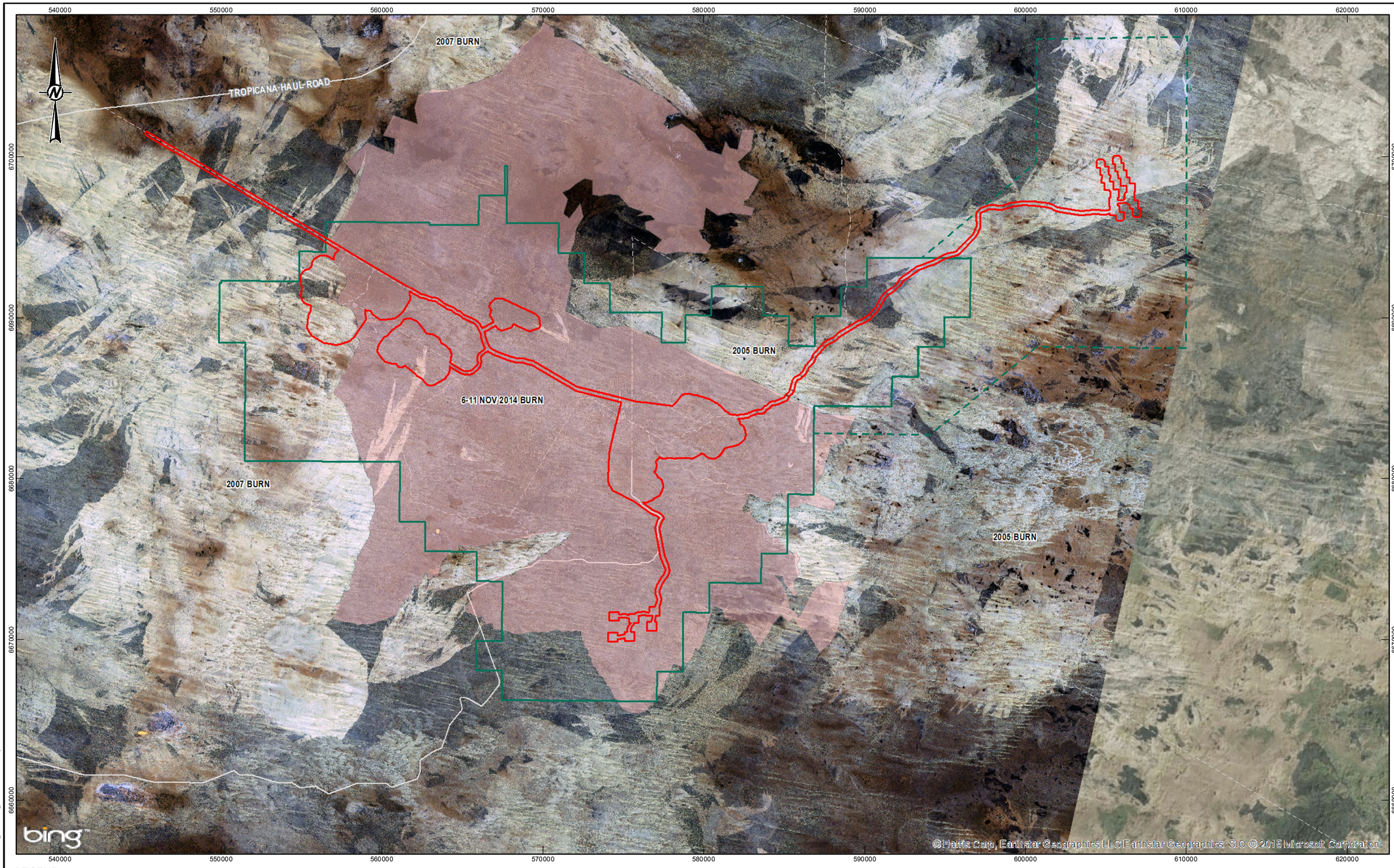

LEGEND

- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- NOVEMBER 2014 FIRE SCAR

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

2011 AERIAL IMAGERY AND INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10
1:220,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-27
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
FIRE MAPPING SHOWING NOVEMBER 2014 BURN OUTLINE AND PREVIOUS WILDFIRE BOUNDARIES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B6	0	7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

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3. Methodology

3.1 Overview

This review has used Malleefowl information from DPaW's *NatureMap,* the *EPBC Act 1999 Protected Matters database* utilising a point search centred on the Mulga Rock Camp (29.97046S and 123.78472E) with a 50km radius. In addition to the detailed fauna and flora surveys of the MRUP area undertaken in 1986 (Martinick 1986), 2008 to 2015 (Mattiske 2015), Ninox (2010) and the wider helicopter surveys (Murdock *et al*. 2010), opportunistic targeted surveys have been initiated by Vimy in the period 2008 to 2015 that have included gridline/sand pad monitoring and targeted searches (WCPL 2014) and camera trapping programmes (Vimy 2013-2015).

Included in this review are the results from eleven regional surveys undertaken on lands surrounding the MRUP area as part of the PER Assessment (EPA Assessment 1745 - 2009) for the Tropicana Gold Project and the infrastructure surveys for the period 2007 to 2010. This data is summarised in Table 1.

Table 1 Summary of previous fauna surveys in the immediate region to MRUP which reported on Malleefowl searches

Year	Survey	Proximity to MRUP	Observations			Reference
			Malleefowl	Mounds	Habitat	
Malleefowl Surveys external to the Mulga Rock Uranium Project area						
1975	Queen Victoria Spring Nature Reserve, Yeo Lake	210km N	None recorded	1 inactive	Mulga Woodland (Yeo Lake Area)	Burbridge, McKenzie, Chapman and Lambert (1976)
2006 - 2008	Tropicana Gold Project (TGP) – Operations Area Fauna Assessment	110km NE	None recorded	6 inactive	Sandplain communities, hummock grass, low tree steppe, Mulga/Acacia	*ecologia* Environmental (2009a)
2008	TGP – Malleefowl Mulgara Study Operations Area	100km N	None recorded	13 inactive	Mulga over *Triodia*, red sandy loam, gravel	URS (2008b)
2009	TGP – Level 1 Survey Pinjin Corridor	64km SW	Sighted	1 active 1 inactive Tracks	Open Mulga woodland shrub layer, red loam, gravel	Ninox (2009)
2009	TGP – Minigwal Trough Water Area Level 1	140km	None recorded	1 inactive	Dense Mulga woodland	*ecologia* Environmental (2009b)
2009	TGP – Transline Infrastructure Corridor Level 1	35km SE to 83km NE	None recorded	8 inactive	Open Mulga woodland ± shrub layer, red sandy loam	*ecologia* Environmental (2009c)
2009	TGP – Pinjin Infrastructure Corridor	64km SW	None recorded	1 inactive	Open Mulga shrub layer, red sandy loam, gravel	URS (2009)

Year	Survey	Proximity to MRUP	Observations			Reference
			Malleefowl	Mounds	Habitat	
2009	TGP – Plumridge Lake, East of Queen Victoria Spring Nature Reserve, Malcolm Soak Area	35km SE-NE	None recorded	32 inactive 5 sites	Open Mulga shrub layer, red sandy loam	Malleefowl Preservation Group (2009)
2010 Pinjin	TGP – Group II/III Tenure Malleefowl Habitat Assessment	35km E to 64km SW	None recorded	4 inactive 1 active 1 inactive Tracks	Open Mulga woodland ± shrub, red sandy loam and gravel, pale loam	URS (2010b)
2014	TGP – Gas Pipeline to Sunrise Dam Corridor Fauna Assessment	120km N-NW	None recorded	19 inactive	Mulga over shrub layer, red sandy loam with gravel	Turpin J (2014)
Malleefowl Surveys in the Mulga Rock Project area						
1985	MRUP Area	30km radius of MRUP Camp	None recorded	None recorded	Sandplain communities, hummock grasslands and low tree steppe (Mulga)	Martinick (1986)
2007-2015	MRUP Area	35km radius of MRUP Camp	None Recorded	None recorded	Sandplain/dunal communities, hummock grasslands and low tree steppe (Mulga)	Mattiske (2015a, b)
2009	MRUP Area - Level 2	25km radius of MRUP Camp	None recorded	None recorded	Sandplain and sheet communities, tree and shrub steppe, scattered Mulga remnants	Ninox (2010)
2009-2010	MRUP and Regional Areas Helicopter Surveys	100km radius of MRUP Camp	None recorded	None recorded	Sandplain and dunal communities, tree and shrub steppe,	Mattiske (2010), Murdoch *et. al* (2010)
2009-2014	MRUP Gridline and Sand Pad Track Surveys	Exploration Gridlines, Ambassador, Shogun, and Emperor sites	None Recorded	None recorded	Sandplain communities, hummock grasslands and low tree steppe (Mulga)	Vimy Staff and Woolard (2014) Records on Vimy database

3.2 Survey Area

The survey area for this review covers approximately 27,000ha and coincides with the area floristically mapped and reported by Mattiske (2015a). The Project Development Envelope covers an area of approximately 9,998ha (Figure 8) which includes the Disturbance Footprint of 3,787ha. Both are entirely enclosed within the floristic survey area.

3.3 Guidance Documentation

The database review, data collection and survey methodology were consistent with the relevant requirements for environmental surveying and reporting in the following guidance documents:

- Environmental Protection Authority (EPA) Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002);
- EPA Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004);
- EPA and Department of Environment and Conservation *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010);
- Department of Environment and Conservation: Standard Operating Procedure – *Remote Operation of Cameras SOP No. 5.2* (DEC 2011);
- Department of Sustainability, Environment, Water, Population and Communities – *Survey Guidelines for Australia's Threatened Birds (2011)*;
- National Heritage Trust (2007), *National Manual for the Malleefowl Monitoring System Standards, Protocols and Monitoring Procedures*. Ed. L. Hopkins.

3.4 Previous Regional Surveys

Fauna survey information for the MRUP area and for other mining developments in the immediate vicinity are summarised in Table 1. Many of these surveys included targeted searches for Malleefowl and, where information is available, details on the presence of Malleefowl, secondary information on mounds, their status, tracks and habitat.

3.4.1 Project Area Surveys

Detailed fauna and flora surveys of the MRUP area were first undertaken in 1986 and the results reported in Martinick (1986).

Vegetation mapping of the Project area by Mattiske Consulting commenced in 2007 and habitat assessment and foot searches for Malleefowl by Mattiske ecologists and Vimy geologists and consultants have continued to the present day.

Two regional helicopter surveys to test the predictive model for the then Declared Rare Flora *Conospermum toddii* in the yellow sandplain community were undertaken in 2009 and 2010 (Mattiske 2009, 2010 and Murdock *et al*. 2010). Visual searches at low altitude were undertaken as part of this programme for Malleefowl mounds in burnt and unburnt dune environments. Search time exceeded 35 hours.

Ninox Consulting undertook pedestrian searches of potential Malleefowl habitat (based on Mattiske's 2009 vegetation mapping) and sand pad road traverses in 2009.

Following development of the area's fire history in 2009, Vimy have undertaken targeted searches of remnant Mulga/*Acacia*/Mallee thickets in burnt and unburnt areas outside of the Project area and continued sand pad monitoring on prepared roads, east and west of the MRUP base camp. The locations of these surveys are shown on Figure 8.

Vimy commenced trialling remote camera trapping in a range of Project habitats for the Sandhill Dunnart (*Sminthopsis psammophila*) in 2013. Although designed primarily to test specific Sandhill Dunnart habitats, the cameras are spread across the Project area and have recorded a range of local fauna and have provided an indication of predator numbers.

A summary of the regional and site surveys, and the Malleefowl observations during these survey is provided in Table 1.

3.5 Survey Methods

3.5.1 Flora Surveys

Mattiske Consulting have undertaken a number of floristic mapping surveys at MRUP since 2007 and survey ecologists have monitored for the presence of Malleefowl mounds in all vegetation communities surveyed (Mattiske 2015a).

Site mapping has identified 14 Eucalyptus Woodland communities (E1 - E14), 10 Mixed Shrubland communities (S1 - S10), one Chenopod Shrublands (C1) and one *Acacia* Woodland community (A1) within a total mapped area of 27,221ha.

The *Acacia* (A1) community which has similar characteristics to those recorded as hosting inactive Malleefowl mounds to the east of the Project area (MPG 2009, ecologia 2009a and URS 2009), occupies 114ha within the Project area mapped. This community is described as:

> *Low Woodland to Tall Shrubland of Acacia aneura over Aluta maisonneuvei subsp. auriculata, Eremophila latrobei, Phebalium canaliculatum, Prostanthera spp. and mixed shrubs.*

This community does not occur in the Development Envelope or Development Footprint (Mattiske 2015a).

3.6 Track and Sand Pad Surveys

Gridline tracks in the MRUP area total approximately 1,200km in length (the majority of which were cleared by a previous tenement holder) and have been utilised over the past seven years by geological personnel, environmental teams and fauna specialists to opportunistically check for mounds in a wide variety of verge vegetation communities. These tracks extend beyond the proposed MRUP Development Envelope.

Sand Padding

Selected road alignments totalling 25km have been used for annual sand pad monitoring using a tyre dragged behind a vehicle to “clean” the sand of tracks prior to inspection in early morning light conditions (see Plate 1 and Plate 2). The two sand pad traverse locations are shown on Figure 8. This methodology is used to assess the presence/absence of the target species and is also useful for recording the movements of other fauna including introduced predators. The road transects were sited to cover a range of habitats including those where Malleefowl had been recorded elsewhere in the region.

3.7 Pedestrian Transects

Remnant Mulga and Mallee “thickets” occur outside the Development Envelope within the MRUP tenure boundary. These thickets typically cover areas less than 5ha but can be connected via narrow vegetation corridors to other remnant unburnt patches. Selected sites that appear to exhibit appropriate Malleefowl habitat requirements were tested by grid traversing and searching for signs of tracks, mounds and other evidence using methodology consistent with that developed by the Natural Heritage Trust (2007).

3.8 Targeted Fauna Surveys

Ninox (2010) conducted targeted gridline searching for tracks covering 92km as part of their Level 2 survey in 2009. Further searches were undertaken as part of daily systematic bird observations. No evidence of Malleefowl was detected during the Ninox Level 2 Survey in 2009.

Plate 1: Levelling soft road sand for sand pad monitoring transects

Plate 2 MRUP track levelled to monitor fauna tracks including those of the Malleefowl

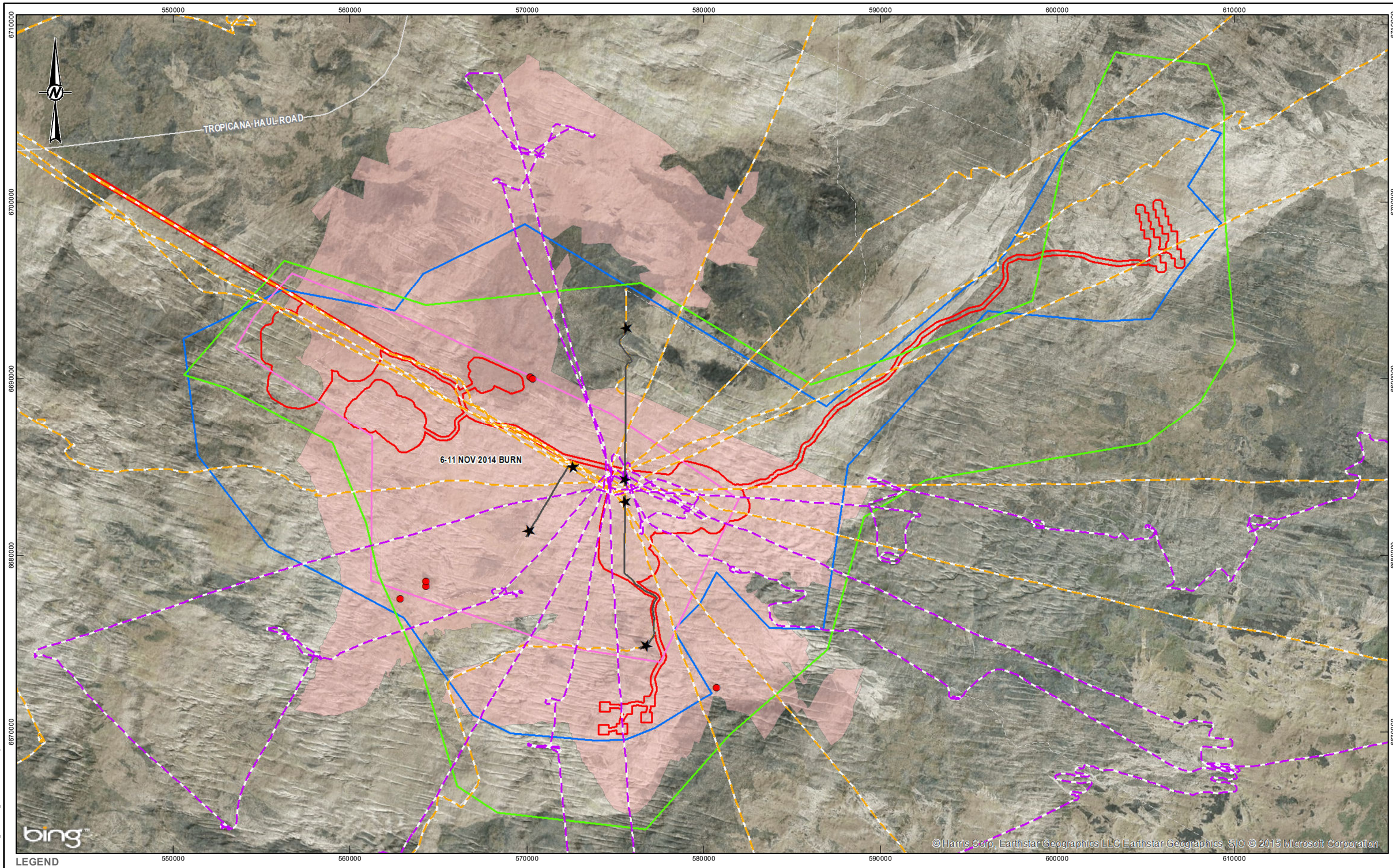
3.9 Helicopter Surveys

Helicopter surveys to test the predictive model for *Conospermum toddii* in yellow and red sandplain communities were undertaken in 2009 and 2010 (Mattiske 2010 and Murdock *et al.* 2010). Searches were made at low altitude within a 150km radius of the Project area by observers seated on either side of the helicopter. Search tracks are shown on Figure 8. Flyovers were conducted over several Mulga remnants within burnt areas, however thicket density often made it difficult to see the ground. In most sand dune and sand sheet quadrants, ground visibility was good to excellent due to wildfires over the past ten years.

Database searches and literature reviews were undertaken on material that was available in NatureMap, EPBC Protected Matter database and in the public domain. Significant data on presence/absence was obtained from baseline consulting reports lodged with EPA as part of the approval for the Tropicana Gold Project. Limitations of the assessment are outlined in Table 2, where indicated, consistent with EPA Guidance Statement 56 (EPA (2004)).

Table 2 Limitations of the Malleefowl *Leipoa ocellata* review

Aspect	Constraint Yes / No	Impact on Survey Outcomes
Competency and experience of personnel	No	All personnel involved in the Mulga Rock Malleefowl project have experience with surveys of this type
Scope	No	This review found that field surveys have been undertaken over an extended time frame 2009-2015 using a variety of recognised survey techniques.
Proportion of fauna identified, recorded	No	Not relevant
Sources of information	No	The review sought information from State and Federal fauna databases, recent baseline reports for the MRUP and adjacent areas and the National Recovery Plan for the Malleefowl.
Proportion of task achieved	No	The review was able to complete all the tasks scoped.
Timing, weather, season	No	The review found that site surveys and monitoring activities were undertaken in different months over a period of several years under a range of weather conditions.
Disturbances	No	The review found no evidence of disturbance that potentially impacted the survey outcomes. Significant wildfires occurred during the survey period, but this is a natural variable in the GVD.
Completeness	No	The review found that the several stages of the Malleefowl assessment project for the MRUP area from opportunistic searches, targeted surveys by external consultants, sand pad monitoring, grid line searches – pre and post fire remnant surveys adequately searched the target area.
Resources	No	The review did not identify any resources constraints.
Remoteness and access	No	The review found that the PNC gridline system provided adequate access and coverage of the Project area.



LEGEND

- TARGETED SURVEY 2014
- WCPL SANDPAD 2008-2014
- HELI SURVEY 2009
- HELI SURVEY 2010
- MINOR ROAD/TRACK
- ROAD
- VIMY SURVEY 2008-2014
- NINOX 2009
- MCPL 2008-2014
- MRUP DEVELOPMENT ENVELOPE
- NOVEMBER 2014 FIRE SCAR

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
OUTLINE OF PROJECT DEVELOPMENT ENVELOPE AND AREAS SURVEYED FOR MALLEEFOWL: 2008-2014

YYYY-MM-DD	2015-10-27
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B6	0	**8**

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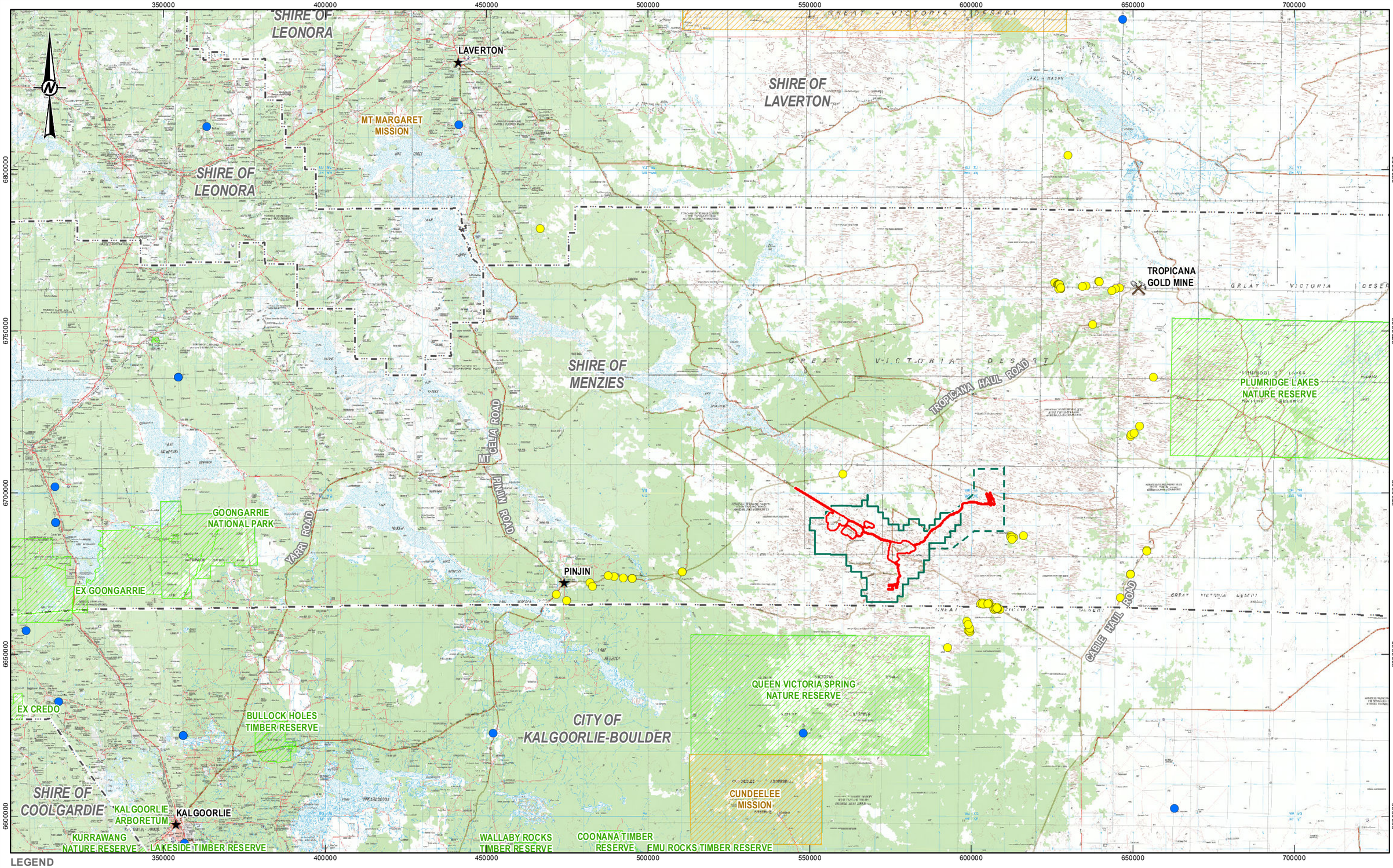
4. Results and Discussion

Compilation of records for this Malleefowl assessment was derived from NatureMap records and reported presence/absence details in surveys undertaken as part of the Tropicana Gold Project (TGP) and MRUP baseline studies and information from the GVD Biodiversity Trust Malleefowl workshop in November 2014. These data are referenced in Figure 3, Figure 8, Figure 9 and Table 1. Only two records of inactive (aged) mounds were recorded in the NatureMap dataset for the GVD1 Shield subregion in which the MRUP is located, with both located near the south-western corner of the Plumridge Lakes Nature Reserve (Figure 3).



LEGEND

- MOUND SURVEY RECORD
- ATLAS OF LIVING AUSTRALIA RECORD
- TROPICANA GOLD MINE
- TOWN
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- LOCAL GOVERNMENT AUTHORITY (LGA) BOUNDARY
- CONSERVATION RESERVE
- ABORIGINAL LAND TRUST ESTATE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
BASE DATA © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2015)
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CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
PROJECT DEVELOPMENT ENVELOPE AND REGIONAL RECORDS OF MALLEEFOWL PRESENCE

YYYY-MM-DD	2015-10-27
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
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5. Conclusion

Given the extensive search effort using a variety of different methods over several years for evidence of Malleefowl within the MRUP Development Envelope and wider Project area, and the lack of any evidence of occupation by Malleefowl, the proposed MRUP is unlikely to directly impact on any Malleefowl population. The recording of a bird sighting near Pinjin, 100km to the west, and the identification of 86 inactive mounds during regional surveys (a large proportion of which were 'aged' and eroded) associated with Mulga woodlands outside of the Project area, but within the region, suggest the species is still present within the broader landscape, although in very low densities. Detailed vegetation mapping has not identified the preferred Mulga woodland habitat within the Development Envelope.

Surveys undertaken in the Tropicana Gold Project operations area and infrastructure corridors (some elements of which fall within GVD2), identified 87 inactive mounds of varying ages in seven 'localities' and one active mound and a bird sighting near Pinjin, approximately 100km west of MRUP. All presence records were identified in Mulga woodland over a spinifex or shrub layer as the primary habitat. Preferred substrates are recorded as clayey sand or (lateritic) gravel. This habitat, typically identified as a Mulga Woodland Community, is present as remnant patches in the MRUP dunefield but is not recorded within the MRUP Development Envelope (Mattiske 2015a).

Vegetation mapping has been undertaken by Mattiske Consulting over an area covering approximately 29,962ha which includes the 9,998ha Development Envelope (Mattiske 2015). The *Acacia* (A1) community which is recorded as hosting mounds elsewhere in the region, occupies 114ha within the Project area (Mattiske 2015 - Table 5). This community is described as:

Low Woodland to Tall Shrubland of Acacia aneura over Aluta maisonneuvei subsp. auriculata, Eremophila latrobei, Phebalium canaliculatum, Prostanthera spp. and mixed shrubs.

This community does not occur in the Development Envelope or Development Footprint (Mattiske 2015a) and potential Malleefowl habitat is therefore not at risk.

The record shows that a substantial effort has been expended searching for Malleefowl presence in the MRUP and immediate surrounds; first in 1985 (Martinick 1986) and in the period 2007 to 2015 using a range of survey techniques including targeted searches, gridline searches and wide ranging pedestrian and remnant vegetation monitoring surveys. Targeted searches of suitably sized, remnant Mulga thicket habitat within Vimy's tenure, but outside the Development Envelope, have also not reported the presence of Malleefowl.

Therefore, based on assessment of recent survey data, and the absence of any signs of Malleefowl, it is considered unlikely that a Malleefowl population is present in the Project area.

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7. Abbreviations

Abbreviation	Description
BOM	Bureau of Meteorology
DE	Development Envelope – the buffer surrounding the proposed MRUP development footprint
DF	Development Footprint – the disturbance area for the MRUP
DotE or DOE	Commonwealth of Australia Department of the Environment (formerly Department of Sustainability, Environment, Water, Population and Communities – DSEWPaC)
DPaW	Department of Parks and Wildlife (formerly Department of Environment and Conservation – DEC, formerly Department of Conservation and Land Management – CALM)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EAMA or EMA	Energy and Minerals Australia Limited
Ecologia	Ecologia Environmental Pty Ltd
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986* (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
GVD	Great Victoria Desert
IBRA	Interim Biogeographic Regionalisation of Australia
Mattiske or MCPL	Mattiske Consulting Pty Ltd
MPG	Malleefowl Preservation Group
MRUP	Mulga Rock Uranium Project
Ninox	Ninox Wildlife Consulting
PEC	Priority Ecological Community
SPRAT	Species Profile and Threats Database
TEC	Threatened Ecological Community
TGP	Tropicana Gold Project
TJV	Tropicana Joint Venture
TSSC	Threatened Species Scientific Community
URS	URS Australia Pty Ltd
Vimy	Vimy Resources Limited
WC Act	The *Wildlife Conservation Act 1950* (WA) (WC Act)
WCPL	Woolard Consulting Pty Ltd