



## **Tronox Mining Australia**

Atlas Campaspe Offset Area - Pest Fauna, Weeds and  
Malleefowl Mound Monitoring  
February 2020 Surveys

March 2020

# Abbreviations

Abbreviation	Full Title
BC Act	NSW <i>Biodiversity Conservation Act 2016</i>
BMP	Biodiversity Management Plan
Cristal	Cristal Mining Australia Ltd (now Tronox Mining Australia)
DPIE	NSW Department of Planning, Industry and Environment (Formerly Office of Environment and Heritage)
EIS	Environmental Impact Statement
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
GHD	GHD Pty Ltd
MOP	Mining Operations Plan
MLA	Mining Lease Area
Tronox	Tronox Mining Australia

# Executive summary

GHD were commissioned by Tronox Mining Australia (Tronox) to establish a Pest Fauna, Weeds and Malleefowl Mound Monitoring program at the Atlas-Campaspe Mine Site and Offset Area. The program will be completed quarterly, for five years beginning in October 2018. This report documents the fifth round of monitoring completed in February 2020

This report was prepared for Tronox Mining Australia by GHD to fulfil the requirements of the Pest Fauna, Weeds and Malleefowl Mound Monitoring program at the Atlas and Campaspe Offset and Mining Lease Area (MLA). This work was conducted using previously defined methodologies of the Atlas-Campaspe mineral sands project Biodiversity Management Plan (Resource Strategies 2018) to contribute to a site based monitoring programme for reserves and pest fauna species in south-western NSW.

This survey was completed in February 2020 following data collection in November 2019, August 2019, May 2019 and October 2018., and suggests that the numbers of pest fauna within the offset sites and the control sites within the uncleared pastoral areas are relatively similar, with overall numbers for all species and both uncleared pastoral areas and Offset areas being generally quite low. The low numbers of all pest and grazing fauna numbers are likely influenced by the very dry conditions across the area at present. The similarity in records across the uncleared pastoral areas and Offset areas is as expected as the offset and control areas have undergone the same or similar management practices prior to the establishment of the monitoring sites, with future management actions expected to drive improvements within the offset area having yet to be undertaken. The similarity in vegetation and its condition between offset and control sites at the time of site establishment will benefit the ongoing monitoring program, as any changes in condition observed at only the offset or control sites will be more easily attributed to the management actions being undertaken across the Atlas-Campaspe Offset Area, rather than other variables that cannot be controlled.

This monitoring aims to determine whether the implementation of conservation offset areas and the associated management actions by Tronox for its Atlas and Campaspe mines, result in benefits (and increases in abundance/diversity) to biodiversity, and key threatened species as a result of improved habitats and removal of threats. The surveys assess pest fauna, weed cover and Malleefowl mound activity, for continual comparison with future monitoring events as part of a long-term monitoring program, to assist Tronox to meet its planning approval requirements.

The February 2020 survey of pest fauna monitoring transects, weed sites and Malleefowl mounds has built upon the baseline data which will provide fundamental data to assist with the management and control of exotic pests, weeds and assessment of Malleefowl nesting with management areas.

It is critical that continued monitoring is completed in the future, to allow long term trends in condition within this area to be detected, and suitable management actions undertaken (e.g. increased goat capture due to increased abundance). To record true changes in pest fauna numbers, weed areas and Malleefowl mound activity and to accurately track changes and trends in numbers, monitoring and data analysis needs to be undertaken over a number of years. With four surveys completed to date, long term trends or changes in numbers of pest herbivores or predators are not obvious at this stage.

It is critical to implement the control of identified vertebrate pests and weeds before populations establish or increase within management areas to maintain and improve native plant and animal richness and diversity within management areas, reduce damage over time and reduce operational effort and costs (DPI 2018a,b).

Recommendations for the ongoing monitoring for the Atlas-Campaspe Offset area are:

1. Continue monitoring of pest fauna, weeds and Malleefowl mound activity as outlined in the Atlas-Campaspe BMP (Resource Strategies. 2018), as long-term data are required to determine changes and trends in these to inform management intervention and in the future to measure the effectiveness of management intervention.
2. Consider integration of automated camera traps to monitor active Malleefowl mounds, and at additional sites to target predators, which are much more likely to be detected using baited camera traps than vehicle based transects.

It is recommended that the following management actions are implemented within the offset area in 2020 to control pest fauna and improve vegetation and habitat condition:

- Implement an ongoing, targeted predator control program, to limit existing numbers of introduced predators such as Red Fox and Cats, particularly in the vicinity of Malleefowl mounds (and particularly with the increased observation of animal carcasses during this survey);
- Implement Feral Goat and Rabbit controls to reduce numbers and prevent incursion from surrounding areas;
- Implement adaptive Weed control methods as per the Atlas-Campaspe Biodiversity Management plan (BMP) (Resource Strategies 2018), including preventing the spread of weeds into and across management areas;
- Signage of the offset area at key entry points and on roads.

The recommended management actions of the Atlas-Campaspe BMP should be reviewed annually, with the results of the ongoing monitoring used to determine the effectiveness of the management actions that have been undertaken over time. The results of the ongoing monitoring may lead to recommendations for additional management actions to be undertaken within the offset area to aid the improvement of the offset and uncleared pastoral areas.

*This report is subject to, and must be read in conjunction with, the limitations set out in section 7 and the assumptions and qualifications contained throughout the Report.*

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# 1. Introduction

## 1.1 Background

GHD were commissioned by Tronox Mining Australia (Tronox) to establish a Pest Fauna, Weeds and Malleefowl Mound Monitoring program at the Atlas-Campaspe Mine Site and Offset Area. The program will be completed quarterly, for five years beginning in October 2018. This report documents the fifth round of surveys, completed in February 2020.

Tronox currently operates three mineral sands mines in the Murray Basin of southwest New South Wales, and have approval for the commencement of two new mines, Atlas and Campaspe, at Boree Plains Station approximately 80 km north of Balranald (Figure 1). The initial activities are associated with the development of the Atlas deposit footprint, supporting infrastructure at the Atlas-Campaspe Mine, gravel pits for haul road construction and construction of the Ivanhoe Rail Facility (Figure 1 and Figure 2).

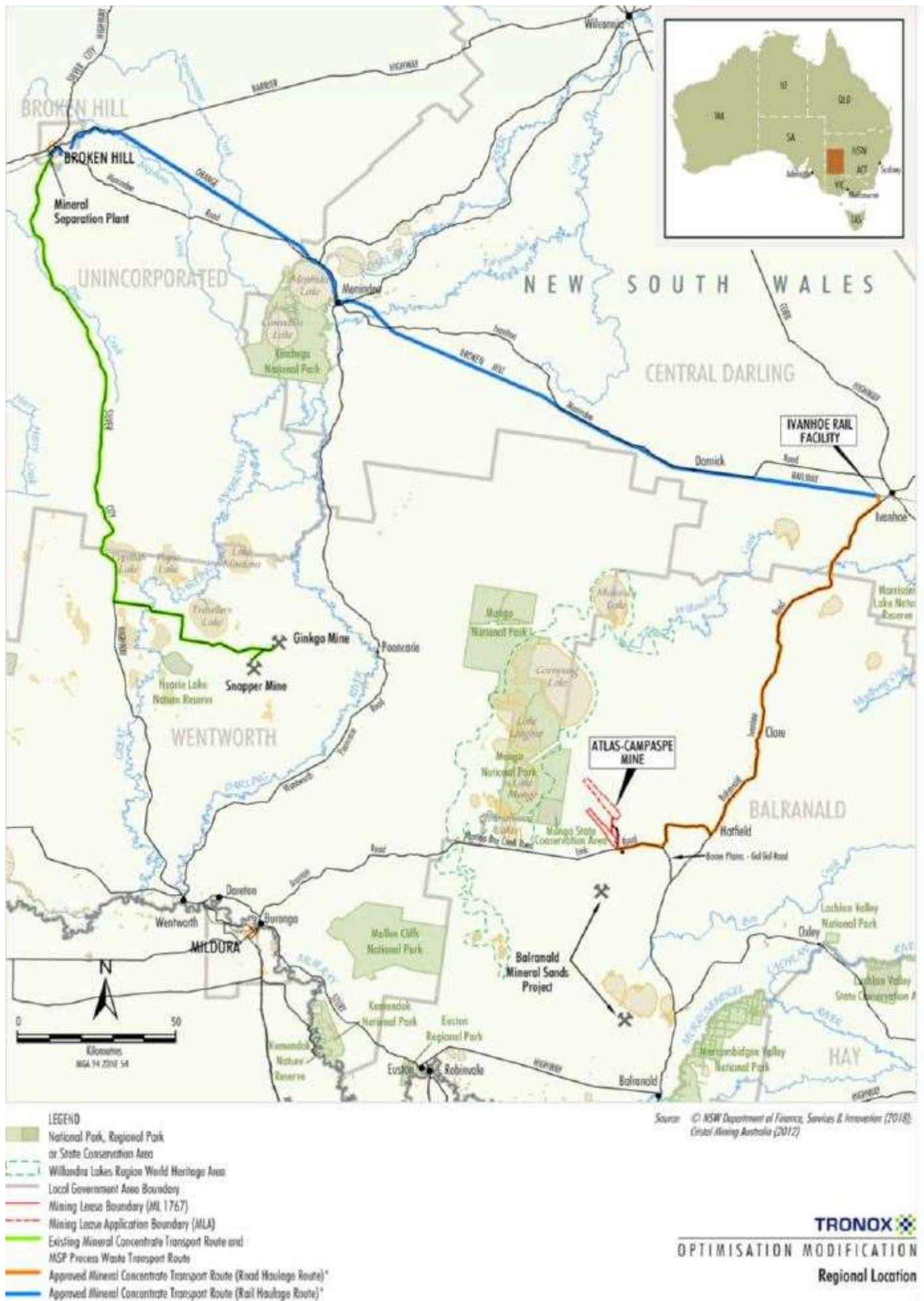
The Atlas Mineral Sands Mine (Atlas mine) has been approved subject to a number of conditions, including those listed in the Atlas-Campaspe Mineral Sands Mine Project Biodiversity Management Plan (BMP) (Resource Strategies, 2018). These include the establishment and quarterly completion of a monitoring program for pest fauna, comprising herbivores and predators. This work was conducted using previously defined methodologies of the Atlas-Campaspe BMP (Resource Strategies 2018) to contribute to a site based monitoring programme for reserves and pest fauna species in south-western NSW.

All wildlife surveys undertaken at the Atlas Mine were performed pursuant to GHD's New South Wales National Parks and Wildlife Act, 1974 Scientific Licence number SL 100146.

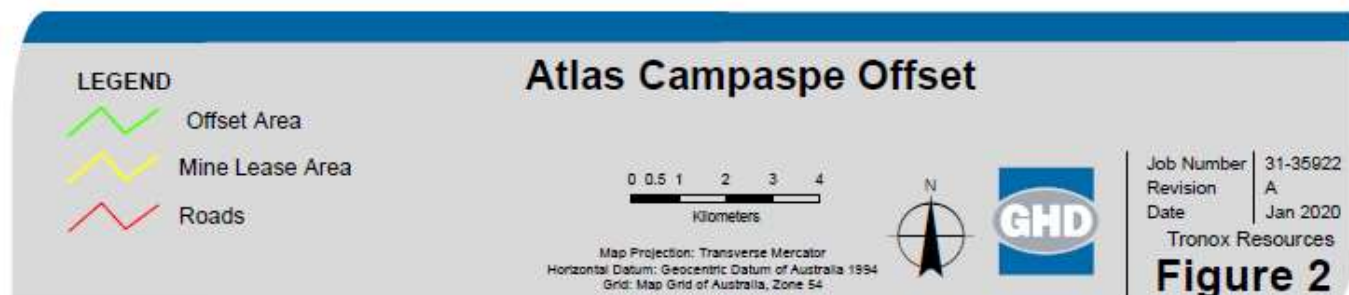
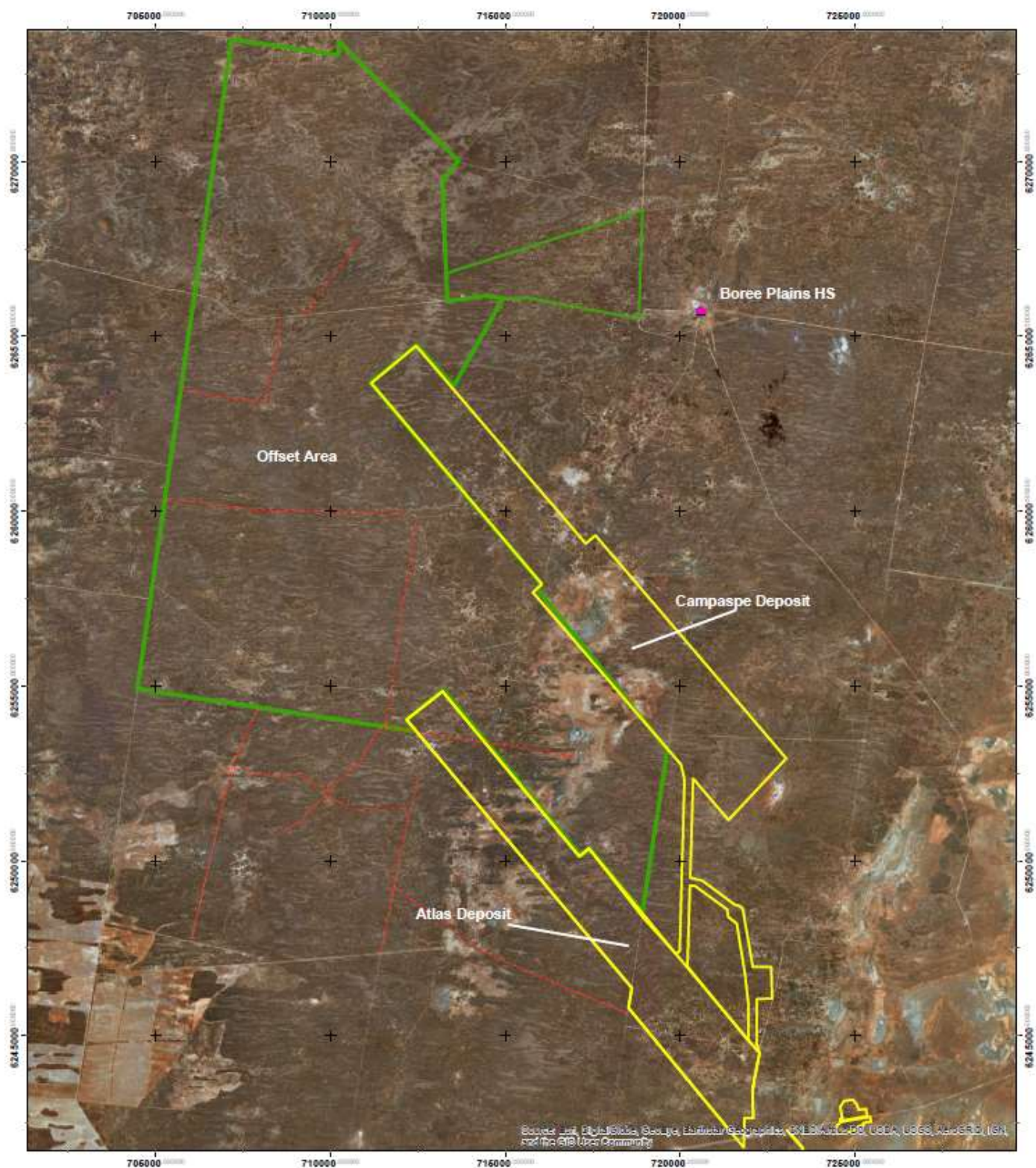
## 1.2 Objectives

The establishment and ecological monitoring of offset areas aims to maintain and improve the quality of native vegetation, biodiversity, and habitat for threatened species. The monitoring of these sites will build a dataset of ecological values, for comparison with past and future monitoring events as part of a long-term monitoring program of the offset area.

The monitoring of pest fauna in the offset area, and comparison of these with unreserved pastoral lease 'control' sites will allow Tronox to assess the effectiveness of its offset management program and where necessary change the way management is conducted to enhance biodiversity within the offset area. These results when input into an adaptive management process allow for a state of continuous improvement in the approach to reserve management over time. All offsets are gazetted on the property titles and are subject to exclusion of domestic livestock and control of wild goats, with watering points decommissioned and pest species of plant and animal controlled.



**Figure 1 Tronox Mining operations in the Murray Basin**



C:\Documents and Settings\dyley\Desktop\Projects\DenGIS\Templates 57 Orange Avenue Mildura VIC 3500 Australia T 61 3 5018 5200 F 61 3 5018 5201 E mdamail@ghd.com.au W www.ghd.com.au  
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**Figure 2 Atlas and Campaspe Mine locations and Offset area.**

## 2. Methods

### 2.1 Pest Fauna (Feral Goat, Red Fox, Feral Cat and European Rabbit) Monitoring

Monitoring of pest fauna was completed using previously defined vehicle-based methodologies of the NSW DPI Monitoring Techniques For Vertebrate Pests specific to Feral Cats (Mitchell & Balogh, 2007a), Foxes (Mitchell & Balogh, 2007b), European Rabbit (Mitchell & Balogh, 2007c) and Feral Goats (Mitchell & Balogh, 2007d) as specified in the Atlas-Campaspe mineral sands project BMP (Resource Strategies 2018). These monitoring techniques all use similar vehicle-based survey methods that allow all species to be systematically monitored using diurnal (daytime) transects for goats, and nocturnal (night) transects for foxes, cats and rabbits. Surveys also count native herbivores numbers (kangaroos) to help measure total grazing pressure across the study areas.

In consultation with Tronox, nine permanent 5 km long vehicle-based transects were established along existing management tracks, four within the broader property in uncleared pastoral areas, and five within the Offset area for use during each monitoring event (Figure 3, Table 1). Each transect monitoring event is assessed on three separate days (targeting goats) and three corresponding nights (targeting foxes, cats and rabbits). The three repeat surveys per monitoring event provide a more accurate estimate of animal numbers.

Each 5 km transect makes use of existing vehicle tracks and traverses different vegetation types. The beginning and end points of each transect were recorded using a GPS. Nocturnal monitoring starts approximately half an hour after sunset, diurnal monitoring was commenced at least four hours before sunset. During each transect:

3. The vehicle is driven at a constant slow speed (15-20 km/hr, the vehicle stopping as required to identify species and count the number of animals when encountered);
4. Two people carry out counts, with a spotlight each during nocturnal surveys, observing one side of the transect each;
5. An estimate made of the distance to each herd/individual, and a sighting compass-bearing made of the angle of observation from the vehicle, together with the location of the vehicle along the transect (kilometres from start). These data together will enable the determination of the distribution and abundance of animals.
6. The monitoring program is repeated on three consecutive days (goats) and nights (European Red Fox, Feral Cat and European Rabbit).

These survey methods allow relative densities of each of the target species to be calculated as a number of individuals per kilometre, giving an estimate of numbers across the Offset and uncleared pastoral lease that can be compared between survey periods, and over time, thereby tracking changes in these populations over time and informing management actions, such as targeted control of species when an increase in abundance is detected.

## 2.2 Weed Monitoring

Monitoring of the location, density and abundance of noxious and environmental weeds was completed through inspections of previous records documented in the EIS and previous surveys (Table 2). Widespread baseline weed monitoring is completed as part of the Offset vegetation monitoring surveys (GHD 2019). Targeted weed monitoring was completed at three previously determined sites shown in Figure 3. These sites target any areas with exotic plant cover, focussed on species of national and state significance.

Under the National Weeds Strategy, 32 introduced plants have been identified as Weeds of National Significance (WONS). These weeds are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts. A small number of WONS have potential to occur at the Atlas Campaspe site, including African boxthorn (*Lycium ferocissimum*).

The NSW Biodiversity Conservation Act 2016 also lists weed species of state significance, which include Onion weed (*Asphodelus fistulosus*), and Horehound (*Marrubium vulgare*).

## 2.3 Malleefowl Habitat Monitoring

Malleefowl habitat sites and all recently active known Malleefowl mounds within the offset area and within the uncleared pastoral areas (Table 3) are monitored in each quarterly survey. At each site the mound condition and activity is assessed using the 1 to 6 profile rating system (Plate 1) of the National manual for the Malleefowl monitoring system standards (National Malleefowl Recovery Team, 2016) to define mound size, use and age, and a site photo was taken.

Malleefowl habitat sites with no recent activity since baseline surveys (GHD 2018) that are inactive (dormant) or very long unused mound (profiles 1 or 6, Plate 1), were not surveyed in this survey.

- 1. Typical crater with raised rim.** This is the typical shape of an inactive (dormant) mound.
- 2. Mound fully dug out.** The crater slopes down steeply and at the base the sides drop vertically to form a box-like structure with sides usually 20-30cm deep. Often litter will have been raked into windrows, and may have started to enter the mound.
- 3. Mound with litter.** This is the next stage after Profile 2. Litter will have been raked into the mound by Malleefowl, and thick layers of litter are evident on the surface. There may or may not be some sand mixed with the litter at this stage.
- 4. Mound mounded up (no crater).** An active but unopened Malleefowl mound.
- 5. Mound that has a sandy crater with peak in centre.** An active mound which is in the process of being closed by Malleefowl.
- 6. Mound low and flat without peak or crater.** A very long unused mound, or a deliberately flattened mound late in a breeding season to capture heat from the sun.



**Plate 1 Malleefowl mound profiles**

**Table 1 Permanent Transects (GDA94 Zone 54H ±5m)**

Transect Name	Area	Start – Easting, Northing	End – Easting, Northing
OS 1	Offset	713335, 6266021	708154, 6265497
OS 2	Offset	706204, 6266489	706938, 6271552
OS 3	Offset	705412, 6261300	704674, 6256141
OS 4	Offset	711576, 6254864	706906, 6256458
OS 5	Offset	716839, 6256079	715871, 6251649
MLA 1	Uncleared Pastoral Lease	704520, 6254888	708180, 6251188
MLA 2	Uncleared Pastoral Lease	708865, 6250491	712538, 6246783
MLA 3	Uncleared Pastoral Lease	714528, 6247332	718507, 6246483
MLA 4	Uncleared Pastoral Lease	717322, 6261131	720455, 6264964

**Table 2 Weed Monitoring Sites (GDA94 Zone 54H ±5m)**

Weed Site	Easting, Northing	Baseline Weed Species
Weed Site 1	716757, 6256521	Match-head Plant ( <i>Psilocalon tenue</i> ), Onion weed* ( <i>Asphodelus fistulosus</i> ), Burr Medic ( <i>Medicago</i> sp.), Mustard ( <i>Sisymbrium officinale</i> ).
Weed Site 2	713346, 6266023	Horehound* ( <i>Marrubium vulgare</i> ), Burr Medic ( <i>Medicago</i> sp.), Wild Sage ( <i>Salvia verbanaca</i> ), Camel Melon ( <i>Citrullus lanatus</i> ).
Weed Site 3	719653, 6241731	Onion weed* ( <i>Asphodelus fistulosus</i> ), Horehound* ( <i>Marrubium vulgare</i> ), Burr Medic ( <i>Medicago</i> sp.), Wild Sage ( <i>Salvia verbanaca</i> ).

\*species listed under the NSW Biosecurity Act 2015.

**Table 3 Malleefowl Monitoring Sites (GDA94 Zone 54H ±5m)**

Mound Number	Easting, Northing
Mound 1	714308, 6269820
Mound 2	713172, 6269094
Mound 3	713193, 6268754
Mound 4	710120, 6266754
Mound 5	712998, 6262600
Mound 6	707162, 6261320
Mound 7	711726, 6257045
New Mound 1	713376, 6270014
New Mound 2	713094, 6267936

## **2.4 Incidental records**

Any noteworthy species observed during surveys were recorded as incidental records. These records were included as “opportunistic on-site” or “opportunistic off-site” observations and added to the general list of species observed during the survey. These records are not intended to be included in any formal analysis of data, but are complimentary information to the project. Incidental records of threatened species are documented for the purpose of building on Tronox’s knowledge base of the survey areas.

## **2.5 Nomenclature**

Common and scientific names for terrestrial vertebrate fauna (mammals, birds, reptiles, amphibians) generally follow the NSW BioNet Atlas database<sup>1</sup>, although in some instances, recent reclassification of reptile species derived from Wilson and Swan 2017 have been used, as these were the most up-to-date and accurate available information at the time of the surveys.

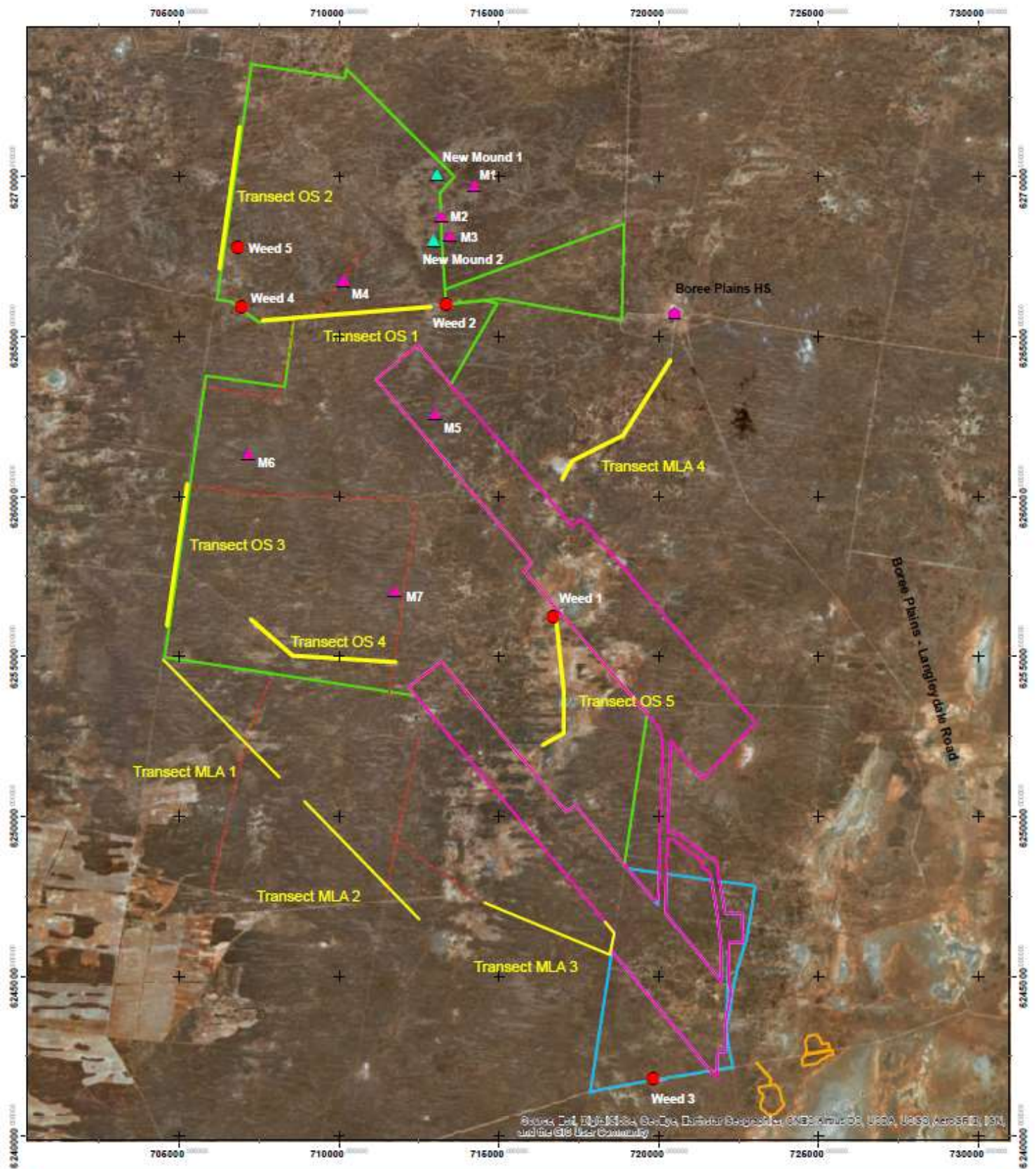
## **2.6 Permits and data submission requirements**

These surveys were completed under GHDs Scientific License number SL100146, under section 132c of the NSW NPW Act 1974. GHD has in place its own animal ethics committee, which gives approval to implement the methods stated.

It is a requirement under this permit that all fauna data will be submitted to the NSW OEH in the required format for inclusion in the Atlas of NSW Wildlife database.

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<sup>1</sup> <http://www.bionet.nsw.gov.au/>



## Cristal Atlas Mine Feral animal surveys 2018



Job Number 31-35922  
Revision A  
Date May 2019

Cristal Resources  
**Figure 3**

### LEGEND



Offset Area



Roads

Malleefowl Mound (7)

New Malleefowl Mound (2)

Weed Survey Site (5)

Driving Transect (5km, 20 mins)

Gravel Pit boundaries

Vegetation Management Area



Map Projection: Transverse Mercator  
Horizontal Datum: Geocentric Datum of Australia 1994  
Grid: Map Grid of Australia, Zone 54

### 3. February 2020- Results

Surveys have been completed over the three days and nights, most recently on 3<sup>rd</sup>-5<sup>th</sup> February 2020. Previous survey rounds were conducted from November 12<sup>th</sup>-14<sup>th</sup> 2019, August 6<sup>th</sup>-8<sup>th</sup> 2019, May 15<sup>th</sup>-17<sup>th</sup> 2019 and October 9<sup>th</sup>-11<sup>th</sup> 2018.

#### 3.1 Pest Fauna – driving transect results

Detailed results of all transects are provided in Appendix A, and summarised below in Table 4, Table 5 and Table 6. Surveys in February 2020 recorded 18 individuals of four species during diurnal surveys and 21 individuals of five species during nocturnal surveys.

These results provide data for comparison with future survey results.

Values are colour coded green where the abundance of the species recorded since the previous survey have increased in number by 20% or more, and red where the abundance of the species decreased in value by 20% or more.

**Table 4 Summary of October 2018, May 2019, August 2019, November 2019 and February 2020 diurnal driving transect survey results**

**Offset Transects (5 x 5km transects)**

Survey	Oct 2018		May 2019		Aug 2019		Nov 2019		Feb 2020	
Species	No. recorded	No. per km	No. recorded	No. per km	No. recorded	No. per km	No. recorded	No. per km	No. recorded	No. per km
European Rabbit	0	0	0	0	0	0	0	0	0	0
Emu	0	0	12	0.48	6	0.24	4	0.16	1	0.04
Feral Goat	17	0.68	0	0	28	1.12	8	0.32	0	0
Red Fox	0	0	0	0	0	0	0	0	0	0
Red Kangaroo	44	1.76	41	1.64	9	0.36	12	0.48	11	0.44
Sheep	0	0	10	0.4	0	0	0	0	0	0
Western Grey Kangaroo	78	3.12	6	0.24	7	0.28	10	0.40	1	0.04

**Mine Lease Transects (4 x 5km transects)**

Survey	Oct 2018		May 2019		Aug 2019		Nov 2019		Feb 2020	
Species	No. recorded	No. per km	No. recorded	No. per km	No. recorded	Species	No. recorded	No. per km	No. recorded	No. per km
European Rabbit	0	0	0	0	0	0	1	0.05	0	0
Emu	0	0	12	0.6	7	0.35	16	0.8	0	0
Feral Goat	6	0.3	4	0.2	0	0	15	0.75	6	0.3
Red Fox	0	0	0	0	0	0	0	0	0	0
Red Kangaroo	21	1.05	2	0.1	12	0.6	9	0.45	7	0.35
Western Grey Kangaroo	21	1.05	5	0.25	23	1.15	16	0.8	5	0.25

**Key:** - green - abundance of species since previous survey increased by 20% or more.  
- red - abundance of species decreased by 20% or more.

**Table 5 Summary of October 2018, May 2019, August 2019 and November 2019 nocturnal driving transect survey results.**

**Offset Transects (5 x 5km transects)**

Survey	Oct 2018		May 2019		Aug 2019		Nov 2019		Feb 2020	
Species	No. recorded	No. per km	No. recorded	No. per km	No. recorded	Species	No. recorded	No. per km	No. recorded	No. per km
Emu	0	0	1	0.04	0	0	0	0	0	0
European Rabbit	2	0.08	2	0.08	0	0	4	0.16	1	0.04
Feral Cat	0	0	0	0	0	0	1	0.04	0	0
Feral Goat	0	0	0	0	0	0	7	0.28	0	0
Red Fox	1	0.04	0	0	2	0.08	0	0	1	0.04
Red Kangaroo	12	0.48	16	0.64	9	0.36	2	0.8	2	0.08
Western Grey Kangaroo	29	1.16	4	0.16	2	0.08	13	0.52	5	0.2

**Mine Lease Transects (4 x 5km transects)**

Survey	Oct 2018		May 2019		Aug 2019		Nov 2019		Feb 2020	
Species	No. recorded	No. per km	No. recorded	No. per km	No. recorded	Species	No. recorded	No. per km	No. recorded	No. per km
Emu	0	0	0	0	0	0	1	0.05	0	0
European Rabbit	1	0.05	1	0.05	0	0	5	0.25	1	0.5
Feral Goat	0	0	0	0	0	0	0	0	0	0
Red Fox	1	0.05	1	0.05	2	0.1	1	0.05	1	0.5
Red Kangaroo	13	0.65	1	0.05	8	0.4	4	0.2	10	0.5
Western Grey Kangaroo	25	1.25	3	0.15	17	0.85	22	1.1	5	0.25

**Key:** - green - abundance of species since previous survey increased by 20% or more.

- red - abundance of species decreased by 20% or more.

**Table 6 Summary of COMBINED driving transect survey results.**

**Diurnal Transects (9 x 5km transects)**

Survey	Oct 2018		May 2019		Aug 2019		Nov 2019		Feb 2020	
Species	No. recorded	No. per km	No. recorded	No. per km	No. recorded	Species	No. recorded	No. per km	No. recorded	No. per km
European Rabbit	0	0	0	0	0	0	1	0.02	0	0
Emu	0	0	24	0.53	13	0.29	20	0.44	1	0.2
Feral Goat	23	0.51	4	0.09	28	0.62	23	0.51	6	0.13
Sheep	0	0	10	0.22	0	0	0	0	0	0
Red Fox	0	0	0	0	0	0	0	0	0	0
Red Kangaroo	65	1.44	43	0.96	21	0.84	21	0.47	0	0
Western Grey Kangaroo	99	2.2	11	0.24	30	0.67	26	1.58	6	0.13

**Nocturnal Transects (9 x 5km transects)**

Survey	Oct 2018		May 2019		Aug 2019		Nov 2019		Feb 2020	
Species	No. recorded	No. per km	No. recorded	No. per km	No. recorded	Species	No. recorded	No. per km	No. recorded	No. per km
European Rabbit	3	0.07	3	0.07	0	0	9	0.20	2	0.04
Emu	0	0	1	0.02	0	0	1	0.02	0	0
Feral Cat	0	0	0	0	0	0	1	0.02	0	0
Feral Goat	0	0	0	0	0	0	7	0.16	0	0
Red Fox	2	0.04	1	0	4	0.09	1	0.02	2	0.04
Red Kangaroo	25	0.56	17	0.38	17	0.38	6	0.13	12	0.27
Western Grey Kangaroo	54	1.2	7	0.16	19	0.42	35	0.78	10	0.22

**Key:** - green - abundance of species since previous survey increased by 20% or more.  
- red - abundance of species decreased by 20% or more.

### 3.2 Weed monitoring results
















Results of the weed monitoring are summarised below in Table 7 and site photos shown in Table 8. These results provide data for comparison with ongoing survey results.

**Table 7 Summary of February 2020 Weed monitoring results**

Weed Site	Easting Northing	Weed species	Comments
1	716757 6256521	Match-head Plant ( <i>Psilocaulon tenue</i> )	Limited cover (less than 5%)
2	713346 6266023	Match-head Plant ( <i>Psilocaulon tenue</i> )	Moderate cover
3	719653 6241731	Onion weed* ( <i>Asphodelus fistulosus</i> ), Wild Sage ( <i>Salvia verbanaca</i> )	95 % of the weed species were dead, with limited cover of Wild Sage (~5%)

\*species listed under the NSW Biosecurity Act 2015.

**Table 8    Atlas Campaspe Weed Site monitoring Photos over five survey periods**

Date	Weed Site 1	Weed Site 2	Weed Site 3
February 2020			
November 2019			
August 2019			
May 2019			
October 2018			

### 3.3 Malleefowl mound monitoring results

Results of the Malleefowl Mound monitoring are summarised below in Table 9 and site photos for recently active mounds (New Mounds 1 and 2) for each survey are shown in Table 10. These results will provide baseline data for comparison with future survey results.

New Mounds 1 and 2 were surveyed, with no new evidence of activity at each mound. The condition of New Mounds 1 and 2 did not change from the previously reported stage 1 (GHD 2019c).

During the surveys, Mounds 1 and 5 were located and assessed, with no change to the condition of each surveyed mound from previous surveys (GHD 2018, GHD 2019a, GHD 2019b, GHD 2019c). Mounds 2, 3, 4 and 6 were not assessed during this survey, as they have not shown any evidence of activity or change over time since surveys in 2018, and remain long un-used (GHD 2018, GHD 2019a, GHD 2019b, GHD 2019c)









**Table 9 Summary of February 2020 Malleefowl mound survey results**

Mound Number	Easting, Northing	1-6 rating	Comments
Mound 1	714308, 6269820	1	Not currently active, inactive for at least 3 years
Mound 2	713172, 6269094	NA	Mound could not be found. Likely long unused.
Mound 3	713193, 6268754	NA	Mound could not be found. Likely long unused.
Mound 4	710120, 6266754	NA	Not Surveyed
Mound 5	712998, 6262600	6	Likely long inactive, probably 4++ years.
Mound 6	707162, 6261320	NA	
Mound 7	711726, 6257045	6	Likely long inactive, probably 4++ years since used.
New Mound 1	713376, 6270014	1	Not recently active – little evidence of Malleefowl activity (digging, prints, litter accumulation), although still in use.
New Mound 2	713094, 6267936	1	Not recently active — no recent evidence of Malleefowl activity (digging, prints, litter accumulation).

### 3.4 Incidental Records

During February 2020 surveys, no species of note were observed.

Table 10 New Malleefowl Mound monitoring photos

Date	New Malleefowl Mound 1	New Malleefowl Mound 2
February 2020	 A photograph of a malleefowl mound in a dry, open landscape with sparse vegetation and scattered dead branches on the reddish-brown soil.	 A photograph of a malleefowl mound, showing a more defined shape with some low-lying shrubs nearby.
November 2019	 A photograph of a malleefowl mound, appearing slightly more vegetated than in February 2020, with more green shrubs visible.	 A photograph of a malleefowl mound, showing a similar shape to the one in February 2020, with some low-lying shrubs.
August 2019	 A photograph of a malleefowl mound, showing a more pronounced shape with some low-lying shrubs and dead branches.	 A photograph of a malleefowl mound, showing a more defined shape with some low-lying shrubs.
May 2019	 A photograph of a malleefowl mound, showing a more pronounced shape with some low-lying shrubs and dead branches.	 A photograph of a malleefowl mound, showing a more defined shape with some low-lying shrubs.

October  
2018



## 4. Discussion

The fifth round of the Atlas Campaspe Pest Fauna, Weeds and Malleefowl Mound monitoring was completed in February, following data collection in November 2019, August 2019, May 2019 and October 2018. These data collected from the Atlas Campaspe February survey indicates that there has been a general decline of 20% (or more) of the abundance of species detected across both management areas from the previous survey (November 2019).

Across both management areas (Offset and Mine Lease Areas), decline was observed in a total of five of the seven species during diurnal transects, and five of the seven species during diurnal transects. Only one native herbivore species (Red Kangaroo) showed an increased in abundance since the previous survey, whilst other native herbivores (Emu and Western Grey Kangaroo) declined 20% or more. Only one exotic species, Red Fox, had an observed increase in abundance of 20% (or more) from the previous survey, during nocturnal surveys.

Based on the general observations of the surveyors, overall densities of native and exotic herbivores remain relatively low across the study area. The perception of low numbers of all pest and grazing vertebrate numbers is likely influenced by the continued dry conditions across the broader area.

The similarity in exotic and native vertebrate fauna records across the uncleared pastoral areas and Offset areas is as expected, as the offset and control areas have generally undergone the same or similar management practices prior to the establishment of the monitoring sites, with future management actions expected to drive improvements within the offset area.

Weed cover continues to be low across the Atlas-Campaspe site. One weed species present is however listed under the NSW Biosecurity Act 2015; Onion weed\* (*Asphodelus fistulosus*). Ongoing monitoring will detect any increases in cover or additional weed species as they are established.

Of the nine known Malleefowl mound sites across the Atlas-Campaspe offset area, two were previously actively maintained since monitoring commenced in late 2018 to November 2019, and were likely to have been actively used for nesting. Of significance, both active mounds were previously recorded to have Red Fox activity during this active monitoring period, detected by camera traps (GHD 2018, GHD 2019b). The remainder of the nine known Malleefowl mounds remain inactive.

It is critical that ongoing monitoring is completed in the future, to allow the detection of long-term trends in condition within management areas. To capture true changes in pest fauna numbers, weed areas and Malleefowl mound activity and to accurately track changes and trends in numbers, monitoring and data analysis needs to be undertaken over a number of years. Ongoing monitoring will assist in assessment for suitable management plans and to monitor the effectiveness of ongoing management and control of pest weeds and animals.

### 4.1 Threats from exotic herbivores

Two exotic herbivore species; Feral Goats (*Capra hircus*) and European Rabbit (*Oryctolagus cuniculus*) have been detected within the survey areas since baseline surveys began in 2018 (GHD 2018). Competition and habitat degradation by Feral Goats has been identified as a key threatening process in NSW under the BC Act. Feral Goats are extremely versatile generalist herbivores that will browse shrubs and trees, graze forbs and grass, and eat fallen fruit capsules, bark and other dead plant material. Feral Goats appear to have a high taste threshold for compounds in many trees and shrubs normally unpalatable to other herbivores (Henzell 1993) and can survive on fibrous herbage with low levels of nutrients (Doyle et al. 1984).

Feral Goats present a potential threat to plant communities given the large number of plant species that are palatable to them and their ability to browse and graze in inaccessible areas such as in trees or in dense thickets (Henzell 1993; Parkes et al. 1996). Landsberg and Stol (1996) found that Feral Goats contribute substantially to total grazing pressure in the woody rangelands of NSW, and that they probably have the greatest potential for causing grazing impacts in the region. Feral Goats can cause significant habitat degradation. Removal or destruction of vegetation together with trampling by ungulate herbivores decreases soil stability and contributes to erosion.

Feral Goats trample spinifex clumps while grazing seed heads (Maher et al. 1995) and this degrades the habitat of spinifex-dependent lizard species e.g. the endangered Mallee Slender Blue-Tongue Lizard, (*Cyclodomorphus melanops elongata*), and the endangered Marble-faced Delma, (*Delma australis*).

The European Rabbit is distributed across much of NSW, and is a declared noxious animal in the state. Through foraging, aggressive competitive behaviour and erosion, European Rabbits are reported to impact 304 native plants and fauna, and five threatened ecological communities through (DPI 2018a). European Rabbits can significantly decrease plant abundances and diversity, as well as ground litter cover and cryptogam cover (Eldridge and Myers 2001). Whilst numbers within Offset (0.04 per km) and MLA areas (0.5 per km) are low, it is critical to the control and management of the European Rabbit that numbers are kept low if detected, with ongoing management and monitoring (DPI 2018a).

Management of the offset area will be undertaken to control livestock (e.g. sheep, farmed goats) whilst also limiting Feral Goats and European Rabbit so that natural regeneration of native vegetation in accordance with destocking can be facilitated.

## **4.2 Threats from exotic predators**

Baseline surveys using 5 km spotlighting transects and two fauna-camera traps at Malleefowl Mounds has so far recorded two species of exotic predator within the Atlas-Campaspe offset area and uncleared pastoral areas. During the recent surveys, two Red Fox's were detected within the Offset and the Mine Lease Areas. Additional camera traps may be used in the future in efforts to detect these typically elusive species, particularly for Feral Cats (*Felis catus*) which are not readily detected, possibly due to low densities of this secretive exotic predator.

The predation of native wildlife by the Red Fox, Feral Cat and Feral Pigs are all listed as Key threatening processes under Schedule 3 of the BC Act, and Feral Cats and Pigs as a key threatening process under the EPBC Act.

The European Red Fox is an adaptable and elusive predator common in rural and urban areas throughout southern Australia. It does not favour any particular habitat and the main determinants of its population size and distribution appear to be food supply, disturbance of natural habitats and refuge availability. Predation by the fox is a major threat to the survival of native Australian fauna, with non-flying mammals weighing between 35g and 5500g and ground-nesting birds at greatest risk. The high occurrence of severe declines and extinctions within this 'Critical Weight Range' for non-volant mammals is now recognised Australia-wide. Reptiles, amphibians and invertebrates are also preyed upon by the fox. The European Red Fox is currently threatening numerous Endangered and Vulnerable species in New South Wales (OEH).

Predation of native fauna by Feral Cats occurs in virtually all terrestrial habitats in Australia, and the main determinants of local population size appear to be the availability of food and shelters. Several Endangered and Vulnerable species in New South Wales are currently threatened from feral cats, including the Sandy Inland Mouse (*Pseudomys hermannsburgensis*), Bolam's Mouse (*Pseudomys bolami*), and Striated Grasswren (*Amytornis striatus*). Many other native species

are potentially at risk of becoming threatened as a result of feral cat predation. Small mammals such as rodents, dasyurids and ground-nesting birds are at particular risk.

Predation, habitat degradation, competition and disease transmission by Feral Pigs all present a significant threat to native species and ecological communities as a result of their behaviour and feeding habits. No feral pigs have been recorded within the study area.

## 5. Summary and conclusions

The February 2020 survey of pest fauna monitoring transects, weed sites and Malleefowl mounds has built upon the baseline data which will provide fundamental data to assist with the management and control of exotic pests, weeds and assessment of Malleefowl nesting with management areas. Data from these surveys is critical to identify priority areas, evaluate and review of the efficacy of management and control, and to assist in the general knowledge and understanding through changes in the abundance and distributions of pest fauna species, weed cover and Malleefowl mound activity over time as a result of changed management of the offset, MLA and uncleared pastoral areas.

It is critical to implement the control of identified vertebrate pests and weeds before populations establish or increase within management areas to maintain and improve native plant and animal richness and diversity within management areas, reduce damage over time and reduce operational effort and costs (DPI 2018a,b).

The impact of grazing on conservation land management on flora and fauna is likely to vary due to a range of factors within the landscape including the management of herbivores including domestic stock, feral goats, rabbits and kangaroos, predators including foxes and feral cats and the history of land use (i.e. clearing, fire, historic stocking rates) in the surrounding area. Even in conservation reserves, if species such as feral goats are not controlled, the effect of domestic stock removal may be muted or non-existent (Read and Cunningham 2010).

This fourth survey in February 2020, following surveys in November 2019, August 2019, May 2019 and baseline data collection in October 2018 suggests that the numbers of pest fauna within the offset sites and the control sites within the uncleared pastoral areas relatively similar, with overall numbers for all species and both uncleared pastoral areas and Offset areas being generally quite low. The low numbers of all pest and grazing fauna numbers are likely influenced by the ongoing very dry conditions across the area. The similarity in records across the uncleared pastoral areas and Offset areas is as expected as the offset and control areas have undergone the same or similar management practices prior to the establishment of the monitoring sites, with future management actions expected to drive improvements within the offset area having yet to be undertaken. The similarity in vegetation and its condition between offset and control sites at the time of site establishment will benefit the ongoing monitoring program, as any changes in condition observed at only the offset or control sites will be more easily attributed to the management actions being undertaken across the Atlas-Campaspe Offset Area, rather than other variables that cannot be controlled.

With five surveys completed to date, long term trends or changes in numbers of pest herbivores or predators are not obvious at this stage, and all are regarded as low in number, likely influenced by recent very dry climate. These data will however provide a fundamental baseline for the control and management of exotic plants and vertebrates across the Atlas Campaspe Offset areas. It is critical that continued monitoring is completed in the future, to allow long term trends in condition within this area to be detected, and suitable management actions taken. To capture true changes in pest fauna numbers, weed areas and Malleefowl mound activity and to accurately track changes and trends in numbers, monitoring and data analysis needs to be undertaken over a number of years.

## **5.1 Recommendations**

### **5.1.1 Monitoring Recommendations**

Recommendations for the ongoing monitoring for the Atlas-Campaspe Offset area are:

1. Continue monitoring of pest fauna, weeds and Malleefowl mound activity as outlined in the Atlas-Campaspe BMP (Resource Strategies. 2018), as long-term data are required to determine changes and trends in these to inform management intervention and in the future to measure the effectiveness of management intervention.
2. Consider integration of automated camera traps to monitor active Malleefowl mounds, and at additional sites to target predators, which are much more likely to be detected using baited camera traps than vehicle based transects.

### **5.1.2 Management Recommendations**

It is recommended that the following management actions are implemented within the offset area to control pest fauna and improve vegetation and habitat condition:

1. Implement an ongoing, targeted predator control program, to limit existing numbers of introduced predators such as Red Fox and Cats, particularly in the vicinity of Malleefowl mounds (and particularly with the increased observation of animal carcasses during this survey);
2. Implement Feral Goat and Rabbit controls to reduce numbers and prevent incursion from surrounding areas;
3. Implement adaptive Weed control methods as per the Atlas-Campaspe Biodiversity Management plan (BMP) (Resource Strategies 2018), including preventing the spread of weeds into and across management areas;
4. Signage of the offset area at key entry points and on roads.

The recommended management actions of the Atlas-Campaspe BMP should be reviewed annually, with the results of the ongoing monitoring used to determine the effectiveness of the management actions that have been undertaken over time. The results of the ongoing monitoring may lead to recommendations for additional management actions to be undertaken within the offset area to aid the improvement of the offset and uncleared pastoral areas.

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## 7. Limitations

*This Atlas Campaspe Mine Offset Areas - Pest Fauna Monitoring ("Report"):*

- 1. has been prepared by GHD Pty Ltd ("GHD") for Tronox Mining Australia Ltd;*
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## **Appendices**

## **Appendix A** - –Pest Fauna Monitoring – Diurnal and Spotlight Results.

### **Key**

3.37pm	Start time 3.37pm.
rk	Red Kangaroo
wgk	Western Grey Kangaroo
green	Start Transect
red	End Transect
bb	Black Box
br	Belah Rosewood
cm	Chenopod Mallee
dist	Disturbed Area
ldm	Linear Dune Mallee
sm	Spinifex Mallee
ysl	Yarran Shrubland

Time	Species	Number	Range (m)	Bearing	Habitat	km
<b>Survey Round 1</b>						
<b>DAY 1. 9/10/2018</b>						
3.37pm W	<b>OS 1</b>					
	wgk	1	35	345	SPM	2.4
	wgk	2	30	345	SPM	2.7
	wgk	2	60	345	SPM	3
	rk	1	70	345	SPM	3.5
	wgk	1	20	74	SPM	3.5
	wgk	1	30	345	SPM	3.6
	rk	1	45	345	SPM	4
3.56pm						
4.01pm N	<b>OS 2</b>					
4.05	wgk	1	35	330	SPM	1.1
4.06	wgk	1	15	350	spm	1.2
4.07	wgk	2	30	350	br	1.2
4.08	wkg	2	30	270	br	1.3
4.09	wkg	1	25	25	br	1.4
4.09	wkg	2	40	350	br	1.5
4.11	wgk	1	40	350	br	1.6
4.17	wgk	1	10	350	spm	3.6
4.18	rk	1	90	50	br	4
4.2	wgk	1	50	0	spm	4.7
4.21	Goat	3	120	75	br	4.7
4.22pm						
4.43pm S	<b>OS 3</b>					
4.47	rk	3	20	95	Dist	0.9
4.5	wgk	6	20	100	spm	2.3
4.52	rk	1	30	110	spm	2.9
4.56pm						
5.15pm SE	<b>MLA 1</b>					
5.17	wkg	1	10	45	ldm	0.3
5.21	wgk	1	70	190	br	2.2
5.23	rk	2	40	50	spm	2.7
5.26	rk	1	50	210	spm	3.8
5.29pm						
5.40 pm W	<b>OS 4</b>					
5.49	wgk	1	15	40	dist	4
5.51	wgk	1	20	280	dist	4.2
5.52	rk	3	25	310	dist	4.3
5.53	wgk	2	20	270	ldm	4.6
5.54pm						
6.12pm S	<b>OS 5</b>					
6.15	wgk	2	80	210	ysl	0.9

Time	Species	Number	Range (m)	Bearing	Habitat	km
6.15	rk	1	120	150	ysl	0.9
6.16	rk	3	250	240	ysl	0.9
6.17	wgk	1	35	110	ysl	1
6.18	wgk	1	110	80	ysl	1
6.2	wgk	1	120	210	ysl	1.5
6.2	wgk	3	230	190	ysl	1.5
6.22	wgk	3	160	100	ysl	1.9
6.22	rk	8	160	100	ysl	1.9
6.24	wgk	2	40	280	bb	2.5
6.24	wgk	2	90	170	bb	2.5
6.26	wgk	1	320	80	dist	2.9
6.26	rk	2	320	80	dist	2.9
6.27	rk	5	140	210	dist	3
6.27	wgk	3	140	210	dist	3
6.29	wgk	3	90	280	dist	3.6
6.29	rk	4	90	280	dist	3.6
6.31	Goat	2	70	260	dist	4.6
6.31	rk	2	50	190	dist	4.6
6.32	rk	1	40	220	dist	4.7
6.33 pm						
6.44pm NE	<b>MLA 4</b>					
6.46	wgk	1	20	350	br	0.6
6.5	Goat	3	40	130	br	2.6
6.5	wgk	1	50	40	dist	2.6
6.51	rk	2	30	100	br	2.7
6.52	wgk	2	60	30	br	3.4
6.53	rk	3	30	120	br	3.7
6.56 pm						
<b>Night 1. 9/10/2018</b>						
8.29 pm W	<b>OS 1</b>					
8.38	wgk	2	20	260	spm	3.8
8.44pm						
8.49pm N	<b>OS 2</b>					
8.59	wgk	1	10	40	br	4.3
9.01pm						
9.14pm S	<b>OS 3</b>					
9.24pm						
9.27pm NW	<b>MLA 1</b>					
9.37	wgk	1	5	90	spm	3.9
9.38	wgk	1	0	0	spm	4.5
9.40pm						
9.54pm	<b>OS 4</b>					
10.06pm						

Time	Species	Number	Range (m)	Bearing	Habitat	km
10.30pm SE	<b>MLA 2</b>					
10.31	wgk	1	10	90	ldm	0.1
10.36	rd	1	10	30	spm	1.8
10.39	wgk	1	25	90	spm	2.1
10.4	wgk	1	15	90	spm	2.6
10.43	wgk	1	15	90	ldm	3.7
10.53pm						
11.00pm E	<b>MLA 3</b>					
11.13pm						
11.26pm N	<b>OS 5</b>					
11.26	wgk	1	20	90	spm	0.1
11.31	wgk	1	30	80	dist	1.3
11.35	wgk	1	25	100	bb	2.7
11.40pm						
11.46pm NE	<b>MLA 4</b>					
11.56pm						
<b>DAY 2. 10/10/2018</b>						
10.22 am	<b>MLA4</b>	south				
10.31	goat	3	80	90	belah rosewood	2.6
10:39						
10:59	<b>OS5</b>	south				
11.04	rk	2	130	80	dist	2
11.05	rk	2	30	35	dist	2.1
11.07	wgk	1	5	70	black box	2.4
11.11	goat	4	15	80	dist	3.8
11:14						
11:26	<b>MLA3</b>	west				
11.27	rk	1	40	80	sm	0.1
11.35	wgk	1	30	110	belah rosewood	2.9
11.36	wgk	2	25	110	belah rosewood	3.1
11:41						
11:51	<b>MLA2</b>	west	spots of rain			
11.51	wgk	1	0	0	sm	0.4
11.55	wgk	1	5	0	sm	1.1
11.59	rk	1	5	5	sm	2.7
12.03	rk	1	15	90	sm	4.4
12:05						
12:09	<b>MLA1</b>	west	spots of rain			
12.15	rk	1	5	0	sm	1.7
12.18	rk	3	0	0	sm	2.5

Time	Species	Number	Range (m)	Bearing	Habitat	km
12:25						
12:37	<b>OS4</b>	west	light rain			
12:48	rk	1	35	90	sm	3.6
12:53						
13:21	<b>OS3</b>					
13:35	rk	1	30	70	sm	3.6
13:36	rk	1	35	90	sm	3.7
13:39	wgk	2	45	90	sm	5
13:41						
13:49	<b>OS2</b>					
13:54	goat	6	35	50	belah rosewood	1.6
14:02	wgk	1	30	60	sm	4.5
14:04						
14:27	<b>OS1</b>					
14:39						
<b>NIGHT 2. 10/10/2018</b>						
8.01 pm	<b>MLA 4</b>	south				
8.02	wgk	2	0	0	sm	0.3
8.04	wgk	1	20	80	belah rosewood	1
8.07	wgk	1	40	60	belah rosewood	2.2
8:12						
8:20	<b>OS 5</b>	south				
8.24	wgk	1	30	90	dist	2.1
8.24	wgk	2	70	60	dist	2.1
8.27	wgk	1	15	80	black box	2.7
8.29	wgk	2	0	0	black box	2.9
8.32	wgk	3	10	90	black box	4.2
8:34						
8:47	<b>MLA 3</b>	west				
8.49	red roo	1	20	70	sm	0.4
8:57						
9:04	<b>MLA 2</b>	west				
9.06	wgk	1	5	70	sm	0.7
9.1	rk	3	5	0	sm	1.9
9.14	rk	3	15	90	dist	3.8
9.16	wgk	3	0	0	sm	4.9
9:18						
9:31	<b>OS 4</b>	west				
9:47	nill					
10:05	<b>MLA 1</b>	west				
10.06	wgk	1	0	0	sm	0.1

Time	Species	Number	Range (m)	Bearing	Habitat	km
10.09	wgk	1	0	0	sm	1
10.16	wgk	1	10	70	sm	4.7
10:18						
10:21	<b>OS 3</b>	north				
10:30						
10:40	<b>OS 2</b>	north				
10.44	rabbit	1	15	90	belah rosewood	1.7
10:52						
11:05	<b>OS 1</b>	east				
11.07	wgk	1	5	90	sm	0.9
11.07	wgk	1	10	0	sm	1
11:15						
<b>DAY 3. 11/10/2018</b>						
10:33	<b>MLA 3</b>					
10:40	wgk	2	65	45	br	2.8
10:46						
10:53	<b>MLA 2</b>					
10:56	wgk	1	15	90	ldm	1.3
11:09						
13:53	<b>OS 2</b>					
14:00	wgk	2	100	50	br	4.2
14:03						
14:14	<b>OS 1</b>					
14:15	wgk	15	85	90	spm	0.8
14:20	Goat	2	50	35	spm	2.4
14:27						
14:39	<b>OS 3</b>					
14:48	nil					
14:50	<b>MLA 3</b>					
15:01	nil					
15:03	<b>MLA 2</b>					
15:16	wgk	2	10	90	spm	5
15:19						
15:21	<b>MLA 3</b>					
15:32	nil					
15:32	<b>OS 5</b>					
15:36	rk	1	0	0	bb	2.2
15:48	wgk	2	90	90	bb	2.7
15:48	wgk	1	10	90	bb	2.7
15:54						
16:01	<b>OS 4</b>					
16:01	wgk	2	15	60	spm	0.1
16:12	wgk	1	15	90	spm	4.7

Time	Species	Number	Range (m)	Bearing	Habitat	km
16:13						
16:28	<b>MLA 4</b>					
16:33	rk	6	80	120	dist	2.7
16:36	wgk	3	70	80	dist	4
16:36	wgk	2	40	90	dist	4
16:41						
<b>NIGHT 3. 11/10/2018</b>						
8:01 PM	<b>OS 1</b>					
8.13	rk	3	0	0	spm	4
8.14	wgk	2	5	10	spm	4.2
8:17						
8:19	<b>OS 2</b>					
8.23	wgk	1	0	0	br	1.5
8.23	rabbit	1	25	90	br	1.7
8.29	wgk	2	10	100	dist	2.9
8.33	rk	1	40	90	spm	4.1
8.33	wgk	4	0	0	br	4.1
8:37						
8:50	<b>OS 3</b>					
8.54	rk	2	40	100	spm	1.4
8.56	rk	1	5	30	dist	2.6
9:05						
9:15	<b>OS 4</b>					
9:27						
9:46	<b>MLA 1</b>					
9:50	rk	3	50	90	dist	1.5
10:01						
10:07	<b>MLA 2</b>					
10.07	wgk	1	0	0	spm	0.2
10.08	wgk	1	20	90	spm	0.2
10:14	wgk	1	10	90	spm	2.5
10.16	rabbit	1	15	90	br	3.2
10.17	rk	1	5	30	br	3.5
10.22	wgk	1	5	0	spm	3.9
10:24						
10:29	<b>MLA 3</b>					
13:39						
10:50	<b>OS 5</b>					
10.51	rk	2	15	60	dist	0.2
10.52	wgk	1	30	30	spm	0.7
10.58	fox	1	35	90	bb	2.3
10.59	rk	1	0	0	dist	2.9
10.59	wgk	2	10	30	dist	3

Time	Species	Number	Range (m)	Bearing	Habitat	km
11.03	rk	2	90	90	dist	3.7
11:07						
11:15	<b>MLA 4</b>	11.14 – Fox spotted	Close to start of	transect		
11.17	rk	1	7	0	br	1
11.22	wgk	4	25	70	br	3.9
11.26	fox	1	20	90	spm	4.7
11.29pm						
<b>Survey Round 2</b>						
<b>DAY 1. 15/5/2019</b>						
14:59	<b>OS5</b>					
	rk	2	60	0	hopbush	1.1
	sheep	10	60	45	bb	2
	rk	2	60	325	cm	2.1
	rk	12	150	80	bb	2.7
	rk	4	250	300	bb	3.1
15:13						
15:16	<b>MLA4</b>					
	rk	2	80	0	br	3.5
	wgk	1	20	270	sm	4.7
15:28						
15:37	<b>OS1</b>					
15:47						
15:51	<b>OS2</b>					
	rk	2	40	350	cm	0.5
	wgk	1	40	0	br	4
16:00						
16:13	<b>OS3</b>					
16:23						
16:24	<b>MLA1</b>					
	emu	4	150	0	cm	4.7
16:34						
16:50	<b>OS4</b>					
16:59						
17:13	<b>MLA2</b>					
17:22						
17:31	<b>MLA3</b>					
17:39						
<b>Night 1. 15/5/2019</b>						
19:07	<b>OS5</b>					
	rk	1	40	0	osl	2.9

Time	Species	Number	Range (m)	Bearing	Habitat	km
19:23						
19:30	<b>MLA4</b>					
19:40	wgk	1	70	0	br	2.7
19:48	<b>OS1</b>					
19:58						
20:02	<b>OS2</b>					
	rk	2	90	0	cm	3.1
20:16	wgk	1	10	0	br	4.3
20:28	<b>OS3</b>					
20:38						
20:45	<b>OS4</b>					
20:57						
21:08	<b>MLA1</b>					
21:18						
21:26	<b>MLA2</b>					
21:37						
21:47	<b>MLA3</b>					
	fox	1	90	0	br	2.3
	rab	1	20	60	br	3
22:00						
<b>DAY 2. 16/5/2019</b>						
9:57	<b>MLA3</b>					
	wgk	2	30	0	cm	3.4
	wgk	1	80	10	os	4.6
10:10						
10:18	<b>MLA2</b>					
	emu	6	200	0	cm	2.1
10:30						
10:31	<b>MLA1</b>					
10:42						
11:04	<b>OS4</b>					
11:16						
11:26	<b>OS3</b>					
11:37						
11:53	<b>OS2</b>					
12:02						
12:12	<b>OS1</b>					
12:23	rk	3	30	70	cm	1.5
12:35	<b>MLA4</b>					
12:46	goat	4	60	30	br	2.1
12:53	<b>OS5</b>					
	wgk	1	20	0	ys	0.5
	emu	12	200	0	ys	0.6

Time	Species	Number	Range (m)	Bearing	Habitat	km
13:06	rk	1	130	320	ys	1
<b>Night 2. 16/5/2019</b>						
18:11	<b>OS5</b>					
	wgk	1	40	70	bb	1
	wgk	2	60	60	bb	2.4
18:30	rk	3	40	50	cs	2.9
18:37	<b>MLA4</b>					
18:48						
18:57	<b>OS1</b>					
	rk	1	25	80	cm	4.1
19:09	emu	1	10	280	cm	4.5
19:17	<b>OS2</b>					
19:27						
19:40	<b>OS3</b>					
19:50						
20:01	<b>MLA1</b>					
20:11						
20:22	<b>OS4</b>					
20:33						
20:48	<b>MLA2</b>					
20:57						
21:01	<b>MLA3</b>					
	rk	1	20	270	cs	0.3
21:13						
<b>DAY 3. 17/5/2019</b>						
8:47	<b>OS5</b>					
	rk	4	200	80	cs	2.7
	rk	9	250	290	bb	3
8:59	rk	2	300	300	cs	3.4
9:04	<b>MLA4</b>					
9:13						
9:20	<b>OS1</b>					
9:28	wgk	1	40	340	sm	0
9:31	<b>OS2</b>					
	wgk	2	20	270	cm	0.3
9:40	wgk	1	30	40	br	4.3
9:51	<b>OS3</b>					
10:02						
10:12	<b>OS4</b>					
10:20						
10:29	<b>MLA1</b>					
10:38	wgk	1	30	270	sm	4.9

Time	Species	Number	Range (m)	Bearing	Habitat	km
10:45	<b>MLA2</b>					
10:57	emu	2	250	0	br	0.7
11:01	<b>MLA3</b>					
11:09						
<b>DAY 3. 17/5/2019</b>						
18:06	<b>OS5</b>					
	rk	2	80	10	cs	2.5
	rab	1	15	260	bb	2.8
	rk	2	60	0	cs	3
	rk	4	60	80	cs	3
	rk	1	70	0	cs	4.2
18:18						
18:24	<b>MLA4</b>					
18:31						
18:38	<b>OS1</b>					
18:46						
18:52	<b>OS2</b>					
	rab	1	20	90	cs	1.6
19:00						
19:11	<b>OS3</b>					
19:19						
19:25	<b>OS4</b>					
19:32						
19:40	<b>MLA1</b>					
19:49	wgk	1	20	0	cm	2.3
19:55	<b>MLA2</b>					
20:03						
20:07	<b>MLA3</b>					
20:15	wgk	1	25	250	cm	1.9
<b>Survey Round 3</b>						
<b>DAY 1. 6/8/2019</b>						
14.01	<b>OS5</b>					
14.05	emu	3	20	270	sm	0.9
14.05	rk	2	70	30	bb	0.9
2.08	rk	1	150	250	ds	2
14.1	emu	2	20	290	bb	2.7
14.19	rk	3	250	70	ds	3.7
14.16						
14.27	<b>MLA4</b>					
14.34	nil					
15.18	<b>OS1</b>					
15.27	nil					

Time	Species	Number	Range (m)	Bearing	Habitat	km
15.3	<b>OS2</b>					
15.32	wgk	3	20	250	cm	1.1
15.36	wgk	2	80	0	cm	2.3
15.41						
15.51	<b>OS3</b>					
15.57	rk	1	15	275	ds	3.5
16						
16.05	<b>OS4</b>					
16.15	nil					
16.25	<b>MLA1</b>					
16.26	wgk	1	40	0	sm	0.6
16.3	rk	3	40	20	br	2.4
16.31	wgk	2	70	0	cm	2.9
16.33	wgk	1	40	0	cm	3.3
16.36	wgk	2	80	0	cm	4.8
16.37						
16.39	<b>MLA2</b>					
16.39	wgk	1	5	350	sm	0
16.42	wgk	1	40	0	sm	0.8
16.45	wgk	2	50	0	cm	2.1
16.47	wgk	1	10	0	cm	2.7
16.48	rk	3	200	0	br	3
16.52	wgk	1	20	0	cm	4.7
16.53						
16.58	<b>MLA3</b>					
16.69	rk	2	40	270	cm	0.3
17.06						
<b>Night 1. 6/8/2019</b>						
18.46	<b>OS5</b>					
18.48	fox	1	30	280	ds	0.6
18.57	rk	1	50	270	ds	3.8
18.59	rk	1	20	45	bb	4.9
19						
19.06	<b>MLA4</b>					
19.11	rk	2	70	250	ds	2.9
19.15						
19.22	<b>OS1</b>					
19.3	nil					
19.33	<b>OS2</b>					
19.4	nil					
19.5	<b>OS3</b>					
19.55	rk	1	100	0	sm	2.5
20						
20.07	<b>OS4</b>					

Time	Species	Number	Range (m)	Bearing	Habitat	km
20.18	nil					
20.27	<b>MLA1</b>					
20.28	wgk	1	10	0	sm	0.2
20.31	wgk	1	30	0	cm	1.2
20.34	wgk	2	70	0	br	1.4
20.41	wgk	2	20	275	cm	4.9
20.42						
20.43	<b>MLA2</b>					
20.44	wgk	1	80	0	sm	0
20.45	rk	2	50	0	cm	0.2
20.47	wgk	2	80	0	cm	0.8
20.5	wgk	1	30	0	sm	2.7
20.48						
21	<b>MLA3</b>					
21.01	rk	1	80	0	ds	0.3
21.09						
<b>DAY 2. 7/8/2019</b>						
13:48	<b>OS5</b>					
13:51	Emu	1	120	0	DS	0.2
13:53	wgk	2	80	330	SM	0.8
13:56	goat	12	60	270	SM	1.6
14:02						
14:08	<b>MLA4</b>					
14:17						
14:27	<b>OS1</b>					
14:38						
14:41	<b>OS2</b>					
14:50						
15:00	<b>OS3</b>					
15:13						
15:18	<b>OS4</b>					
15:20	rk	2	40	0	SM	2
15:30						
15:43	<b>MLA1</b>					
15:51	rk	2	200	0	CM	4.8
15:52						
15:58	<b>MLA2</b>					
16:03	wgk	1	30	50	CM	2
16:05	wgk	1	200	0	CM	2.2
16:11	wgk	1	20	0	CM	4.5
16:12						
16:18	<b>MLA3</b>					
16:22	wgk	1	50	0	CM	1.7
16:31						

Time	Species	Number	Range (m)	Bearing	Habitat	km
<b>Night 2. 7/8/2019</b>						
18:45	<b>OS5</b>					
18:51	rk	2	70	0	YS	3.2
18:53	rk	1	100	280	YS	3.3
18:57						
19:03	<b>MLA4</b>					
19:04	rk	1	50	90	BR	0
19:13						
19:20	<b>OS1</b>					
19:29						
19:33	<b>OS2</b>					
19:35	rk	1	7	100	CM	0.3
19:44						
19:55	<b>OS3</b>					
19:59	wgk	2	30	0	DS	1.7
20:04	rk	1	200	0	DS	3.4
20:08						
20:13	<b>Os4</b>					
20:20	fox	1	20	40	BR	2.4
20:25						
20:35	<b>MLA1</b>					
20:35	wgk	1	200	0	SM	0
20:35	rk	1	200	0	SM	0
20:42	rk	1	30	90	CM	2.8
20:46						
20:48	<b>MLA2</b>					
20:50	wgk	1	140	0	SM	0.6
20:52	wgk	2	50	0	BR	1.3
20:57	wgl	1	7	90	CM	4.2
20:58						
21:04	<b>MLA3</b>					
21:07	Fox	1	80	280	DS	0.3
21:16						
<b>DAY 3. 8/8/2019</b>						
14:22	<b>OS5</b>					
14:40						
14:48	<b>MLA4</b>					
14:56						
15:05	<b>OS1</b>					
15:13						
15:18	<b>OS2</b>					
15:19	goat	16	30	90	CM	0.1
15:28						
15:41	<b>OS3</b>					

Time	Species	Number	Range (m)	Bearing	Habitat	km
15:49						
15:56	<b>OS4</b>					
16:04						
16:14	<b>MLA1</b>					
16:17	RK	2	80	0	SM	1.9
16:22						
16:24	<b>MLA2</b>					
16:27	WGK	2	250	0	SM	1.7
16:31	WGK	2	150	0	CM	4.4
	EMU	7	200	0	CM	4.6
16:40	<b>MLA3</b>					
16:44	WGK	2	30	340	BR	2.3
16:47	WGK	1	20	340	SM	3.7
16:50						
<b>Night 3. 8/8/2019</b>						
18:42	<b>OS5</b>					
18:52						
19:00	<b>MLA4</b>					
19:02	fox	1	150	340	BR	0.8
19:10						
19:20	<b>OS1</b>					
19:29						
19:35	<b>OS2</b>					
19:44						
19:58	<b>OS3</b>					
19:59	RK	1	80	20	CM	0.5
20:07						
20:13	<b>OS4</b>					
20:23						
20:35	<b>MLA1</b>					
20:38	WGK	2	60	0	CM	0.9
20:45						
20:47	<b>MLA2</b>					
20:54						
21:02	<b>MLA3</b>					
21:10						
<b>Survey Round 4</b>						
<b>DAY 1. 12/11/2019</b>						
15:41						
15:50	<b>MLA4</b>					
16:03	Nil					
16:34	<b>OS1</b>					

Time	Species	Number	Range (m)	Bearing	Habitat	km
16:36	WGK	1	30	0	LDM	0.5
16:48						
16:53	OS2					
17:07	Nil					
17:18	OS3					
17:19	WGK	2	100	0	SPM	4.1
17:34						
17:40	OS4					
17:40	Emu	4	200	0	DS	0.8
17:50	RK	1	30	270	SPM	2.7
17:56						
18:06	MLA1					
18:09	Emu	5	300	0	SPM	0.9
18:15	RK	1	350	0	SPM	3.4
18:19						
18:21	MLA2					
18:21	Emu	2	100	0	LDM	0
18:26	WGK	2	400	0	SPM	1.5
18:31	RK	1	40	0	SPM	2.9
18:32	RK	3	25	270	SPM	3.3
18:35	Goat	12	120	0	SPM	4.3
18:37						
18:43	MLA3					
18:43	Goat	3	100	220	BB	0
18:43	Emu	2	100	250	BB	0
18:43	RK	2	50	270	BB	0
18:46	WGK	3	20	90	DS	0.4
18:52	Emu	1	30	0	BR	2.4
19:00						
<b>Night 1. 12/11/2019</b>						
20:49	OS5					
20:52	WGK	1	70	270	DS	0.2
21:05	Cat	1	130	280	DS	3.6
21:08	WGK	3	100	270	DS	4
21:11	0					
21:21	MLA4					
21:33	Nil					
22:08	OS1					
22:19	Nil					
22:24	OS2					
22:34	Nil					
22:48	OS3					
22:50	WGK	1	20	0	LDM	0.5

Time	Species	Number	Range (m)	Bearing	Habitat	km
22:59	0					
23:07	<b>OS4</b>					
23:13	Goat	7	10	270	SPM	2.2
23:22	0					
23:38	<b>MLA1</b>					
23:47	RK	1	50	0	SPM	4.6
23:40	0					
23:51	<b>MLA2</b>					
23:23	WGK	1	20	0	SPM	0.2
23:55	WGK	1	100	0	DS	1.3
00:03	0					
0:10	<b>MLA 3</b>					
0:12	RK	2	40	300	DS	0.4
0:13	WGK	2	30	250	LDM	0.8
0:24	0					
<b>Day 2. 13/11/2019</b>						
10:48	<b>OS1</b>					
11:01	Nil					
11:05	<b>OS2</b>					
11:08	WGK	1	30	90	BR	0.9
11:21	0					
11:31	<b>OS3</b>					
11:43	Nil					
11:50	<b>OS4</b>					
11:52	RK	1	15	90	DS	0.7
11:58	Goat	8	50	340	BR	3.2
12:03	0					
12:14	<b>MLA1</b>					
12:16	WGK	2	60	350	LDM	0.9
12:22	RK	2	70	150	SPM	3.3
12:25	0					
12:32	<b>MLA2</b>					
12:36	WGK	2	30	270	SPM	1.8
12:39	Emu	1	800	0	BR	2.7
12:44	0					
12:49	<b>MLA3</b>					
12:51	WGK	4	30	330	SPM	0.5
12:56	WGK	2	20	270	BR	2.2
13:03	0					
13:20	<b>OS5</b>					
13:21	WGK	2	60	90	DS	0.5
13:23	RK	1	50	0	DS	1.2
13:31	0					

Time	Species	Number	Range (m)	Bearing	Habitat	km
13:55	<b>MLA4</b>					
14:06	Nil					
<b>Night 2. 13/11/2019</b>						
20:42	<b>OS1</b>					
20:55	Nil					
20:59	<b>OS2</b>					
21:12	Nil					
21:24	<b>OS3</b>					
21:26	RK	1	100	0	SPM	0.5
21:35	WGK	2	120	0	DS	3.4
21:39	0					
21:46	<b>OS4</b>					
21:49	Rabbit	1	100	0	DS	0.6
22:01	0					
22:13	<b>MLA1</b>					
22:15	WGK	2	50	0	LDM	0.5
22:17	WGK	2	60	270	SPM	1.2
22:20	WGK	2	60	0	LDM	1.8
22:24	WGK	1	40	0	DS	3.2
22:28	WGK	2	80	0	SPM	4.4
22:31	0					
22:32	<b>MLA2</b>					
22:34	WGK	1	100	0	LDM	0.5
22:36	WGK	2	80	0	LDM	0.8
22:44	Emu	1	20	90	SPM	4.3
22:44	Fox	1	20	90	SPM	4.3
22:47	0					
22:53	<b>MLA3</b>					
23:00	Rabbit	3	20	90	BR	3
23:06	0					
23:22	<b>OS5</b>					
23:31	WGK	2	140	0	YS	4
23:34	0					
23:40	<b>MLA4</b>					
23:47	Rabbit	2	20	90	BR	2.6
23:53	0					
<b>Day 3. 14/11/2019</b>						
11:08	<b>OS1</b>					
11:21	Nil					
11:27	<b>OS2</b>					
11:38	Nil					
11:51	<b>OS3</b>					

Time	Species	Number	Range (m)	Bearing	Habitat	km
12:01	Nil					
12:08	<b>OS4</b>					
12:20	Nil					
12:36	<b>MLA1</b>					
12:41	Emu	1	300	0	BR	2.1
12:47	0					
12:49	<b>MLA2</b>					
12:52	Emu	3	1000	0	BR	0.7
12:57	Emu	1	400	0	BR	3.1
13:02	0					
13:11	<b>MLA3</b>					
13:23	Nil					
13:38	<b>OS5</b>					
13:38	Nil					
14:24	<b>MLA4</b>					
14:31	Rabbit	1	7	270	BR	2.9
14:36	WGK	1	30	70	LDM	4.2
14:38	0					
<b>Night 3. 14/11/2019</b>						
20:48	<b>OS1</b>					
21:02	Nil					
21:05	<b>OS2</b>					
21:08	Rabbit	1	100	0	SPM	0.9
21:19	0					
21:31	<b>OS3</b>					
21:40	WGK	1	40	20	SPM	3.7
21:46	0					
21:51	<b>OS4</b>					
21:54	Rabbit	2	40	270	DS	0.8
22:04	0					
22:16	<b>MLA1</b>					
22:17	WGK	1	20	270	LDM	0
22:26	WGK	1	15	270	SPM	3.4
22:26	WGK	1	40	0	SPM	3.8
22:29	0					
22:31	<b>MLA2</b>					
22:42	Nil					
10:48	<b>MLA3</b>					
22:49	RK	1	10	270	DS	0
22:51	WGK	3	30	270	DS	0.4
23:05	0					
11:21	<b>OS5</b>					
23:23	RK	1	60	30	DS	0.4

Time	Species	Number	Range (m)	Bearing	Habitat	km
23:31	WGK	1	50	340	DS	4.4
23:33	WGK	2	40	270	SPM	4.9
23:40	<b>MLA4</b>					
23:51	Nil					
<b>Survey Round 5</b>						
<b>DAY 1. 03/02/2020</b>						
4.51	<b>OS1</b>					
5.00	Nil					
5.04	<b>OS2</b>					
5.10	Nil					
5.21	<b>OS3</b>					
5.30						
5.36	<b>OS4</b>					
5.45						
5.52	<b>MLA1</b>					
6.00	RK	2	100	80	LDM	5
6.09	<b>MLA 2</b>					
6.15						
6.20	<b>MLA3</b>					
6.27	NIL					
6.50	<b>OS5</b>					
6.53	RK	1	10	270	DS	1.7
6.54	RK	2	70	20	DS	1.9
7.00						
7.08	<b>MLA4</b>					
7.10	RK	2	70	270	BR	1
7.15						
<b>Night 1. 03/02/2020</b>						
8.57 pm	<b>OS1</b>					
9.06pm	Nil					
9.09pm	<b>OS2</b>					
9.12pm	Fox	1	0	0	BR	1.1
9.17pm						
9.29pm	<b>OS3</b>					
9.37pm	Nil					
9.44pm	<b>OS4</b>					
9.53pm	Nil					
10.02pm	<b>MLA1</b>					
10.09pm	WKG	1	0	0	SPM	4.1
10.17pm						
10.19pm	<b>MLA2</b>					

Time	Species	Number	Range (m)	Bearing	Habitat	km
10.21pm	WKG	1	90	0	SPM	0.8
10.28pm	RK	2	70	40	SPM	5
10.51pm	MLA3					
10.43pm	Fox	1	40	30	LDM	3.7
10.47pm						
11.09pm	OS5					
11.10pm	WGK	1	100	275	DS	4
11.12pm						
11.18pm	MLA4					
11..27pm	NIL					
<b>Day 2. 04/02/2020</b>						
8.43am	OS1					
8.50am	nil					
8.53am	OS2					
9.00am	nil					
9.11am	OS3					
9.12am	RK	1	40	80	SPM	0.8
9.19am						
9.25am	OS4					
9.34am	nil					
9.44am	MLA1					
9.52am	WGK	1	70	320	LDM	4.9
9.53am						
10.06am	MLA2					
10.07am	WGK	1	50	0	SPM	0.7
10.15am						
10.18zm	MLA3					
10.18am	RK	2	40	270	DA	0
10.27am						
10.37am	OS5					
10.45am	nil					
10.50am	MLA4					
10.56am	nil					
<b>Night 2. 04/02/2020</b>						
9:13	Os1					
9:23	NIL					
9:26	OS2					
9:33	Rabbit	1	70	270	SPM	1.7
9:42						
9:53	OS3					
9:57	WGK	2	30	0	DS	1
10:06						

Time	Species	Number	Range (m)	Bearing	Habitat	km
10:11	OS4					
10:18	WGK	2	120	0	BR	3.1
10:23						
10:33	MLA1					
10:42	WGK	1	80	0	SPM	3.9
10:44	RK	1	40	90	CM	4.5
10:45						
10:52	MLA2					
10:54	WGK	1	60	0	LDM	0.5
10:56	RK	1	140	0	BR	1
11:02	RK	1	50	0	SPM	3.4
11:02	Rabbit	1	50	0	SPM	3.4
11:05						
11:11	MLA3					
11:13	RK	3	120	0	DS	0.3
11:25						
11:36	OS5					
11:44	RK	1	40	0	YS	4
11:46						
11:53	MLA4					
11:56	RK	1	40	0	BR	1.1
12:04						
<b>Day 3. 05/02/2020</b>						
8:55	OS1					
8:56	WGK	1	30	90	LDM	0.6
9:00	Emu	1	50	0	SPM	3.1
9:04						
9:07	OS2					
9:16	Nil					
9:26	OS3					
9:36	Nil					
9:45	OS4					
9:55	Nil					
10:04	MLA1					
10:11	RK	1	30	270	BR	3.8
10:14						
10:21	MLA2					
10:22	WGK	1	20	270	LDM	0.6
10:29	WGK	1	20	350	SPM	4.4
10:31						
10:36	MLA3					
10:38	WGK	1	60	300	LDM	0.7
10:43	Goats	6	200	0	BR	2.7

Time	Species	Number	Range (m)	Bearing	Habitat	km
10:49						
11:00	OS5					
11:04	RK	2	25	270	SPM	2
11:09	RK	3	30	75	YS	4.4
11:11	RK	2	30	75	SPM	5
11:12						
11:17	MLA4					
11:27	Nil					
<b>Night 3. 05/02/2020</b>						
8:53PM	OS1					
9:04pm	nil					
9:08pm	OS2					
9:10pm	RK	1	40	270	SPM	1.1
9:20pm						
9:32pm	OS3					
9:44pm	Nil					
9:49	OS4					
10:00pm	Nil					
10:11pm	MLA1					
10:13pm	WGK	1	30	290	SPM	1.2
10:23pm						
10:29pm	MLA2					
10:31pm	RK	1	40	290	LDM	0.5
10:40pm						
10:46pm	MLA3					
10:59pm	Nil					
11:10pm						
11:16	OS5	1	40	70	BB	2.7
11:21pm						
11:27pm	MLA4					
11:38pm	Nil					



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Revision	Author	Reviewer		Approved for Issue		
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